EXPLORING CONSUMER ATTITUDE AND ITS INFLUENCE ON THE INTENTION TO PURCHASE GENETICALLY MODIFIED (GM) FOOD PRODUCTS: TOWARDS AN INTEGRATED RESEARCH FRAMEWORK TO ADVANCE FOOD SECURITY

by

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DEDICATION

I dedicate this thesis to my Heavenly Father for carrying me and giving me strength every day and to my parents, who have stood by me, who are my biggest supporters, and without whom this thesis would not have been possible.

DECLARATION

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I declare that the above thesis is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the thesis to originality-checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

February 2024

SIGNATURE DATE

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ABSTRACTS

Research in South Africa (SA) has not yet explored consumers' attitudes toward genetically modified food products (GMFPs) and attitude's influence on their purchase intention (PI) by combining the Expectancy Value (EV) Model of Attitudes and the Theory of Planned Behaviour (TPB) framework. It remains unknown what drives consumer attitudes toward these food products and its influence on PI. This study developed an integrated attitudinal framework to advance food security that highlighted the key aspects contributing to attitude development towards GMFPs. A qualitative methodology was used, together with a constructivist paradigm and phenomenological, descriptive and exploratory research design. Purposive, convenience and snowball sampling were used to recruit 32 participants residing in the Midlands in KwaZulu-Natal through a Facebook post. Data analysis revealed that the participants believed GMFPs have an altered state of existence, beneficial traits, with related risks and concerns. These food products were also valued for what consumers gain from them, but made ethical connotations to them. Consumer-related benefits were further expected of GMFPs, suggesting a dual attitude toward GMFPs. The findings suggest that the beliefs component of the EV Model of Attitudes plays the most prominent role in attitude formation in the GMFP context, followed by the values component, with the expectations component being the least influential. The participants lacked GMFP knowledge and did not consult GM-related information sources, leaving consumers' beliefs about GMFPs factually unfounded, with knowledge influencing the beliefs of GMFPs. It was demonstrated that attitudes and subjective norms do not influence the PI of GMFPs, while perceived behavioural control (PBC) does. This study contributes to the GMFP industry by showing what drives consumers' attitudes toward GMFPs, its influence on PI, and which components of the EV Model of Attitudes are the most influential in driving attitudes toward GMFPs, thereby highlighting key aspects that can be used to create consumer acceptance towards GMFPs to advance their food security status.

KEY TERMS:

Attitude; Expectancy value model of attitudes; Food security; Genetically modified crops; Genetically modified food products; Knowledge; Purchase intention; Sources of information; South Africa; Theory of planned behaviour

ISISHWANKATHELO

Uphando eMzantsi Afrika okwangoku alukayiphicothi indlela abaziva ngayo abathengi malunga neemveliso zokutya eziguqulwe ngokwemveliso yazo (ii*GMFP*) kunye nendlela abaziva ngayo echaphazela ngayo injongo yabo yokuthenga (*PI*) ngokusebenzisa indibanisela yesikhokelo se-*Expectancy Value (EV) Model of Attitude* kunye ne*Theory of Planned Behavior* (*TPB*). Akwaziwa ukuba yintoni eqhuba indlela abaziva ngayo abathengi malunga nezi mveliso zokutya kunye nempembelelo yayo kwinjongo yabo yokuthenga (*PI)*. Olu phando luqulunqe isikhokelo esihlanganisiweyo sendlela abaziva ngayo abathengi ukuqhubela phambili ukhuseleko lokutya, ukugqamisa iinkalo eziphambili ezinegalelo kuphuhliso lwendlela abaziva ngayo malunga nee*GMFP*. Kusetyenziswe indlela yophandontyilazwi, isikhokelo sengcingane yokudalwa kolwazi nokuqonda ngokwamava okuphila/ezentlalo kunye noyilo lophando lokuqonda iingcamango ngesiganeko esithile, oluchazayo noluphicothayo. Kusetyenziswe iindlela zovandlakanyo ezifana nokukhetha igcuntswana ledatha ngenjongo *(purposive sampling*), ukukhetha igcuntswana ledatha ngokufanelekileyo nalula (*convenience sampling*) kunye nokukhetha igcuntswana ledatha ngokufumaneka nzima (*snowball sampling*) ukukhangela iqela labathathinxaxheba abangama32 abahlala eMidlands KwaZulu-Natal ngokuxhoma ikhwelo kuFacebook. Uhlalutyo lwedatha lubonise ukuba abathathinxaxheba bakholelwa ukuba ii*GMPP* zikwimeko eguqulweyo, kukho imingcipheko neenkxalabo ezinxulumene nazo, kwaye ezi mveliso zineempawu eziluncedo. Ezi mveliso zokutya nazo zixatyiselwe oko abathengi abanokukufumana kuzo, kodwa abathengi bangqamanisa iingcamango ezithile zokuziphatha kuzo. Iinzuzo ezinxulumene nabathengi bezilindeleke ngakumbi kwii*GMFP*, nto leyo ebonisa indlela entlantlumbini abaziva ngayo malunga nee*GMFP*. Iziphumo zibonisa ukuba icandelo leenkolelo ze-*EV Model of Attitudes* lidlala indima ebonakalayo ekubunjweni kwendlela yokucinga okanye abaziva ngayo abathengi ngokubhekiselele kwi*GMFP*, lilandelwe licandelo lexabiso, lize lona icandelo lokulindela isiphumo esithile libenempembelelo encinci. Abathathinxaxheba bebengenalo ulwazi lwe*GMFP* kwaye abakhange bayijonge imithombo yolwazi enxulumene ne*GM*, nto leyo eshiya iinkolelo zabathengi malunga nee*GMFP* zibeyinyaniso engenasihlahla, ezinolwazi oluphembelela iinkolelo zee*GMFP*. Kubonakaliswe ukuba iindlela zokucinga okanye abaziva ngayo kunye neenkolelo zabathengi aziyiphembeleli i*PI* yee*GMFP*, ngelixa ulawulo lwendlela yokuziphatha olubonwayo (*perceived behavioural control* (*PBC*)) luyiphembelela. Olu phando lunegalelo kushishino lwe*GMFP* ngokubonisa ukuba yintoni eqhubela phambili iindlela zokucinga okanye abaziva ngazo abathengi malunga nee*GMFP* kunye nempembelelo yazo kwi*P*I, lukwabonisa amacandelo e-*EV Model of Attitudes* anempembelelo ngakumbi ukuqhubela phambili iindlela abaziva ngazo abathengi

malunga ne*GMFP*, ngaloo ndlela lugqamisa iinkalo eziphambili ezinokusetyenziswa ukudala ukwamkelwa kwee*GMFP* ngabathengi ukuqhubela phambili isimo sabo sokhuseleko lokutya.

**The student and supervisor are unable to confirm the correctness of the translated abstract.*

OKUCASHUNIWE

Ucwaningo eNingizimu Afrika (SA) alusivezi kahle isimo sokuthi bacabangani abathengi mayelana nemikhiqizo yokudla eyakhiwe ngemifuziselo *(GMFPs)* kanye nokuthi ukucabanga kwabo kunamuphi umthelela ekuthengweni kwempahla *(PI)* ngokusebenzisa inhlanganisela ye-*Expectancy Value (EV) Model of Attitudes* kanye nohlaka lwe-*Theory of Planned Behaviour (TPB).* Namanje akwaziwa ukuthi yini elawula ukucabanga kwabathengi mayelana nale mikhiqizo ngokunjalo nomthelela wayo ku-*PI*. Lolu cwaningo luqhamuke nohlaka oludidiyelwe mayelana nokucabanga kwabathengi ukuze kuphuculwe indlela yokuvikeleka kokudla okugqamisa iminxa ethile emqoka enomthelela endleleni yokucabanga ngokwe-*GMFP*. Lapha kuye kwasetshenziswa indlela yokuhlola isimo, uhlelo lokuhlola ukucabanga komuntu ngayedwa nalokho okumangazayo, uhlelo lokuchaza nokuhlola isehlo. Kuye kwasetshenziswa ingosi ka-*Facebook* kwaqhanyukwa nohlelo lokunxenxa abantu ukuba nabo banxenxe abanye kwase kutholakala ababambiqhaza abangama-32 abahlala Maphakathi neKwaZulu-Natali. Imininingwane yocwaningo iveza ukuthi ababambiqhaza bakholelwa ekutheni ama-*GMFP* awukushintsha kwesimo sokuphila, anobungozi futhi kunezikhalo ngawo, ngokunjalo nokuthi lolu hlobo lwemikhiqizo lunokhondolo oluthile. Le mikhiqizo yokudla iphinde yakalwa nangokuthi abathengi bangazuzani kuyo, kodwa kunezinto abathengi abaziphawulayo ngendlela abacabanga ngayo ngale mikhiqizo. Bekulindeleke ukuba kuvele ukuthi yini ezohlonyulwa abathengi mayelana ne-*GMFP*, ngokubheka ukucabanga ngezindlela ezimbili mayelana ne-*GMFP*. Imiphumela iveza ukuthi ingxenye yezinkolelo ze-*EV Model of Attitudes* idlala indima enkulu kakhulu endleleni yokucabanga ngokuphathelene ne-*GMFP*, kulandelwa ingxenye yezinga lomkhiqizo, neveza ukuthi kuncane kakhulu okuphawulekayo nokungumthelela ngalokhu. Ababambiqhaza bebengenalo ulwazi lwe-*GMFP* futhi abalwenzanga uphenyo ngokubheka imithombo enolwazi oluhlobene ne-*GM*, lokhu-ke kudale ukuthi kungatholakali kahle ukuthi abathengi bakholelwa kukuphi mayelana nama-*GMFP,* ngenxa yemininingwane engaqondakali ngokokucabanga nge-*GMFP.* Kuye kwavela ukuthi indlela yokucabanga nezinkambiso ezizimele akunamthelela ku-*PI* yama-*GMFP*, ekubeni kuyaye kube nomthelela othile ngokulawulwa kokuziphatha *(PBC).* Lolu cwaningo lunomthelela emkhakheni ye-*GMFP* ngokuthi lubonisa ukuthi yini elawula indlela yokucabanga kwabathengi mayelana nama-*GMFP* nomthelela ku-PI, luphinde futhi lubonise izingxenye ze-*EV Model of Attitudes* ezinomthelela omkhulu ekulawuleni ukucabanga nge-*GMFP,* ngokuthi kugqanyiswe iminxa emqoka engasetshenziswa ukuze abathengi bamukele imikhiqizo ye-*GMFP* ekuphuculeni isimo sokuvikeleka kokudla.

**The student and supervisor are unable to confirm the correctness of the translated abstract.*

SUMMARY

The threat of food insecurity is becoming a global problem; however, solace has been found in the development and use of genetically modified (GM) crops and subsequently genetically modified food products (GMFPs) to aid in the achievement of Sustainable Development Goal (SDG) 2 and alleviate food insecurity due to their modified traits, such as being weather, pest and disease resistant, ability to produce higher yields and develop a nutritionally enhanced food product sold at a lower cost (Chagwena et al. 2019; Aziz et al. 2022; Zhaleh et al. 2023). Even though the consumer plays an important role in the success of GM crops' and GMFPs' use to promote food security (Owusu-Gyan et al. 2023), it remains unknown what drives the SA consumers' attitude towards these food products. It further remains unknown which components of the Expectancy Value (EV) Model of Attitudes, namely beliefs, values and expectations, are the most influential in attitude formation in the GMFP context. It is also unclear whether knowledge plays a role in consumers' beliefs. South African consumers purchase intention (PI) toward GMFPs are also unknown. This needs to be established to promote consumers' food security status through their use of GMFPs and acceptance of GM food aid products.

A qualitative study, within a constructivist paradigm, using a phenomenological, descriptive and exploratory research design, was designed to recruit 32 participants from the Midlands in KwaZulu-Natal, SA, who met the inclusion criteria. Participants were recruited through non-probability sampling methods, namely purposive, convenience and snowball sampling to participate in online individual interviews. Before data collection commenced on Microsoft Teams, ethical clearance was received. Data gathering commenced after each participant signed the informed consent form and a demographic questionnaire was completed on Google Docs. Data saturation dictated the number of individual interviews to be held. Once saturation was achieved, the data were transcribed verbatim, and descriptive statistics were used to analyse the demographic questionnaires, while thematic analysis was used to analyse the data from the individual interviews to develop codes and categories. Themes were ultimately developed to present the data in the form of figures and tables.

The majority of participants who took part in this study were female, between the ages of 25 to 40 years, earned R20 000 or more per month, matriculated and had further educational qualifications, were married or living with a partner, and had permanent full-time employment. The participants did not farm with GM crops, nor did they have family or friends who farmed with GM crops. However, they did know someone who farmed with such crops, but were split

equally in terms of being aware of GM crop farming in the area where they resided. The findings suggest that the participants associated GMFPs with having an altered state of existence in terms of the biological change that has occurred within their DNA and genetics, thereby believing these food products are unnatural. However, it was believed that such biological changes can contribute to developing food products with improved and beneficial traits. The participants linked GMFPs to beneficial traits from which consumers could gain a direct benefit, such as having a lower price and improved aesthetic properties in terms of improved appearance and food processing properties like a longer shelf life. The findings suggested that in terms of GM crop production, the participants believed GM crops are weather resistant against droughts and floods, that they have resistant traits in terms of pest and disease resistance, that they lead to increased productivity and higher crop yields, and that they have the ability to advance food security. However, the participants also linked risks and concerns to producing GM crops and to the consumers themselves. They specifically mentioned environmental risks, the impact of using GM seeds, the threat of GM seed companies – particularly greed for profits – and long-term health risks.

The findings suggested that, although the cost task value category was not useful within the values component in exploring the value assigned to GMFPs, it emerged that the participants perceived an effort to attain GMFPs due to inadequate GMFP labelling. By combining the attainment, intrinsic and utility task categories of values – which proved useful – the participants valued GM crop production for their enhanced productivity and increased yields. GMFPs were also valued for their consumer-related benefits, such as their affordability and longer shelf life, but GMFPs would be used the same way as non-GMFPs. Ethical issues were, however, linked to the genetic modification of food products in terms of religion. Genetic modification was linked to playing with God's creation, which further showed that ethics should be considered within the attainment task category value when exploring the value of GMFPs. Regarding the participants' expectations, they expected GM crops to have enhanced productivity and be of benefit to them (as consumers) in terms of having improved aesthetic properties. Long-term health consequences were also expected from the consumption of GMFPs. The suggested favourable and unfavourable influence that these aspects have on attitude suggests a dual attitude toward GMFPs among the participants. Furthermore, by considering the depth of data based on the volume of salient and sub-salient aspects that emerged, it suggests that the beliefs component of the EV Model of Attitudes played the most prominent role in consumer attitudes toward GMFPs, followed by the values component, with expectations being the least influential in attitude formation.

The findings suggested that the participants lacked GMFP knowledge and were ignorant of such food products since they did not conduct enough research on these food products themselves; thus, they did not have the ability to identify food products that contain GM ingredients. The lack of GMFP knowledge was also attributed to the lack of information being shared about these food products. Therefore, platforms from which to share GM-related information were recommended, specifically television and social media. Although the participants did not visit any sources for information about GMFPs, they would consult the internet and use word-of-mouth as GM-related information sources should the need arise.

Even though the participants could not identify food products containing GM ingredients they purchased frequently, they knew that maize and soya are GM crops cultivated in SA. Other food products, such as maize or corn-containing food products, grain-based food products and vegetables and fruits, such as tomatoes, were identified as GMFPs by the participants. The findings suggested that the participants thought the majority of food products sold in SA supermarkets were GM, and they were consequently purchasing and consuming GMFPs frequently; it was perceived to be difficult for them not to purchase these food products. However, the participants were not concerned about the fact that they were purchasing GMFPs. Not specifically looking to purchase or not to purchase GMFP also pointed to their lack of GMFP knowledge, and alternative food products to GMFPs were thus preferred, such as GMO-free food products. Regardless of the few benefits of GMFPs, such as their lower price and longer shelf life, as well as a few risks with these food products were identified, the lack of elaboration indicated a lack of GMFP knowledge among the participants. It is therefore suggested that the participants' beliefs about GMFPs were factually unfounded as they stemmed from an unsolid knowledge foundation.

Despite the lower price of GMFPs and their longer shelf life in terms of improved food processing properties were identified as influential in the participants' PI of GMFPs, the absence of certain aspects and lack of depth of data on other aspects that emerged compared to the beliefs, values and expectations components – which form attitudes – suggest that attitudes did not influence the participants' PI of GMFP. It was, however, shown that the experience with GMFPs was the same as other food products. In terms of subjective norms, the participants mentioned that there was no influence or pressure from their referent people to purchase or not purchase GMFPs due to their referent people's ignorance of these food products and not conversing about such food products with their referent people. Thus, there was no judgement from the participants' referent people to purchase or not purchase GMFPs. Although the participants would listen to the opinions of their referent people, their opinions would not influence the participants' intent to purchase or not purchase these food products.

Regarding perceived behavioural control (PBC), the findings suggested that the perceived prevalence of GMFPs on the market – which led to participants believing that GMFPs were purchased and consumed frequently due to the difficulty of avoiding purchasing such food products (which they were not concerned about) – as well as not specifically looking to purchase or not to purchase GMFPs compromised the participants' PBC over purchasing these food products. Although GM food product alternatives were preferred, such as GMO-free food products, the belief that almost all food products on the market are GM contributed to their lack of control in terms of purchasing GMFPs. The findings thus suggested that the participants had a lack of control over purchasing GMFPs, further attributed to the increased availability of GMFPs, their affordability, limited research on GMFPs, and specifically the lack of and unclear GMFP labelling, with labelling being of an inappropriate size and location. Therefore, it was suggested that GM labels should be placed on the front of food products. Not actively reading food labels further contributed to the lack of PBC over purchasing GMFPs linked to labelling.

Based on the depth of data, PBC was the most prominent element in the Theory of Planned Behaviour (TPB) in terms of the intent to purchase and behaviour toward GMFPs, with the attitude element being the least prominent. Therefore, PBC influenced PI, while the attitude and subjective norms elements of the TPB did not. The findings also suggested that behavioural beliefs influenced attitudes favourably and unfavourably, but that the influence was not prominent, and control beliefs influenced PBC in an unfavourable way, while normative beliefs influenced subjective norms.

The newly proposed conceptual framework suggests that participants' disinterest in consulting GM-related information sources led to a lack of GMFP knowledge, thereby contributing to the development of factually unfounded beliefs. The framework suggests that the beliefs component of the EV Model of Attitudes is primarily driven by the beneficial attributes of GMFPs and crops, followed by their altered state of existence, with the risks and concerns of GMFPs and crops being the least influential. In terms of the values component, it is proposed within the framework that the cost, attainment, intrinsic and utility task value categories need to be considered; however, the cost task value category requires further investigation. Nevertheless, the values component was driven by the consumer-related value of GMFPs as well as the ethical aspects of GMFPs within the attainment task value category. The expectations component was driven by the consumer-related benefits of GMFPs. The framework further proposes a link between beliefs and values, but the association is not prominent, while beliefs and values do not lead to a prominent expectation. Therefore, the proposed framework suggests that the beliefs component is the most influential in attitude

formation, followed by the values component, with the expectations component not being influential in terms of GMFPs. It is also suggested that the attributes linked to GMFPs lead to a dual attitude toward GMFPs. In terms of the TPB framework, the new framework of the study suggests that the components of the EV Model of Attitudes (beliefs, values and expectations) – and thus attitudes – do not influence PI and that the influence of behavioural beliefs on attitudes is not prominent. The framework also suggests that, although normative beliefs influence subjective norms, subjective norms do not influence PI. However, control beliefs influence PBC, and PBC influences PI and thus behaviour toward GMFPs. The study's new framework thus reflects the aspects that emerged from the study, which need to be reinforced among consumers to create acceptance and hinder hesitancy toward these food products, thereby propelling consumers toward GMFPs, promoting their food security status, and contributing to the attainment of SDG 2: Zero Hunger.

In addition to the contribution of the new proposed conceptual framework, the study has contributed to methodology by showing that conducting a qualitative study with the use of a constructivist paradigm and phenomenological, descriptive and exploratory research design as well as purposive, convenience and snowball sampling is useful and leads to the acquisition of ample data in the GMFP context. The study contributed to theory by showing the role that each component of the EV Model of Attitudes plays in attitude formation toward GMFPs and that it is important to consider knowledge and the sources of information from which knowledge stems within the beliefs component of the EV Model of Attitudes. The study has also demonstrated the usefulness of merging the EV Model of Attitudes with the TPB framework to explore attitudes and the influence on PI toward GMFPs.

To the body of knowledge, the study has contributed by showing which salient beliefs, values and expectations are influential in attitude formation toward GMFPs and that rural consumers do not have experience with or sound knowledge of GMFPs, which could be attributed to their lack of seeking information about these food products, which contributes to their beliefs being factually unfounded. The study has further contributed to the body of knowledge by showing how attitudes can influence the achievement of food security. It is recommended that the consumer-related benefits of GMFPs, such as lower price and shelf life, can be used to propel consumers towards GMFPs, and GMFP labelling requires specific attention in terms of PBC. To promote food security through the use of GMFPs, it is also recommended that consumers' knowledge of GMFPs needs to be addressed, and information about GMFPs needs to be communicated to consumers to remedy any concerns and promote an optimistic and confident attitude, specifically through the television and social media. To theory, it is recommended that ethics should be considered within the attainment task value category and that the attainment,

intrinsic and utility task value categories need to be considered together within the value component of the EV Model of Attitudes. It is also suggested that future research explores the values and expectations component further; why there is no need to seek GM-related information among rural SA consumers; which sources of information SA consumers visit for GM-related information; and consumers from an urban area as well as the food-insecure consumers should be explored in terms of which aspects influence their attitudes and PI toward GMFPs in order to achieve food security for all South Africans.

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LIST OF ACRONYMS

AAM	Anchoring-and-Adjustment Model
AATF	African Agricultural Technology Foundation
ACB	African Centre for Biodiversity
ABC MODEL	Tri-Component Attitude Model
ADHD	Attention Deficit Hyperactivity Disorder
BE	Bioengineered
Bt	*Bacillus thuringiensis*
CAES	College of Agriculture and Environmental Sciences
CBAN	Canadian Biotechnology Action Network
CBD	Convention on Biodiversity
CBSD	Cassava Brown Streak Disease
COVID-19	Coronavirus Disease of 2019
CO_2	Carbon Dioxide
CPB	Cartagena Protocol on Biosafety
CRISPR-Cas9	Clustered Regularly Interspaced Short Palindromic Repeats
DMA	Dual Model of Attitudes
DNA	Deoxyribonucleic Acid
EAEA	Egyptian Atomic Energy Authority
ELM	Elaboration Likelihood Model
EU	European Union
EV MODEL OF ATTITUDES	Expectancy Value Model of Attitudes
EWG	Environmental Working Group
FAO	Food and Agriculture Organisation
FDA	Food and Drug Administration
GABA	Gamma-Aminobutyric Acid
GE	Genetic Engineering
GM	Genetically Modified
GMFP	Genetically Modified Food Product
GMFPS	Genetically Modified Food Products
GMO	Genetically Modified Organism
HREC	Health Research Ethics Committee
HSM	Heuristic-Systematic Model
HT	Herbicide-Tolerant

IPB	Institute of Plant Biochemistry
IPC	Integrated Food Security Phase Classification
IR	Insect-Resistant
ISAAA	International Service for the Acquisition of Agri-Biotech Applications
MCM	Meta-Cognitive Model
MODE	Motivation and Opportunity as Determinants
OECD	Organization for Economic Cooperation and Development
PBC	Perceived Behavioural Control
PI	Purchase Intention
RNA	Ribonucleic Acid
RNAi	Ribonucleic Acid Interference
SA	South Africa
SABC	South African Broadcasting Corporation
SADC	Southern African Development Community
SAGENE	South African Committee on Genetic Experimentation
SANBI	South African National Biodiversity Institute
SDG 2	Sustainable Development Goal 2
SSA	Sub-Saharan African
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UK	United Kingdom
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Program
UNISA	University of South Africa
USA	United States of America
VIGS	Virus-Induced Gene Silencing
WFP	World Food Programme
WHO	World Health Organisation

TERMINOLOGY LIST

The terminology list provides a list of definitions of the terms used in this thesis.

African Centre for Biodiversity (ABC)

Monitors the environmental and safety risks of GMOs in South Africa (African Centre for Biodiversity 2020).

Agricultural Biotechnology

Using technology to manipulate the material of plant crops to achieve specific traits (Ruiz et al. 2018).

Allergic Reaction

A pathological immune reaction in response to an antigen (Delaney et al. 2018).

AquAdvantage Salmon©

A genetically modified Atlantic salmon (Weir & Sproul 2019).

Arctic Apple

A non-bruising, non-browning GM variety of apple (Maxmen 2017).

Attainment Task Category Value

Refers to the relevance of something in relation to an individual's' personal values (Dietrich et al. 2019).

Attitudes

A positive or negative inclination or feeling toward something (Bakanauskas et al. 2020).

Attribute

A distinguishable trait of a product (Ajzen 2008).

Behavioural Beliefs

Refers to the belief that a behaviour will result in either a positive or negative outcome (Bakti et al. 2020).

Beliefs

Refer to the evaluation of product attributes (Osterlie et al. 2018).

Bio fortification

Increasing the existing nutritional value of food products through natural processes (Dizon et al. 2016).

Biosafety Act and Regulations

Regulates the activities of GMOs (Akinbo et al. 2021).

Bacillus thuringiensis (Bt)

A naturally occurring bacterium (Kotey et al. 2016). It also refers to crops with insecticidal traits (Ala-Kokko et al. 2021).

Cartagena Protocol on Biosafety (CPB)

An international agreement to manage and control activities associated with GMOs, to control the movement of GMOs between countries and to ensure that biodiversity remains protected (Karalis et al. 2020; Muzhinji & Ntuli 2021).

Categories of Task Values

Includes the cost, attainment, intrinsic and utility value which are used to explore values (Meyer et al. 2019).

Climate Change

A change in weather patterns, contributing to extreme weather conditions such as increased temperatures, droughts (Abbas et al. 2022).

CONICET Potato

A non-browning gene-edited potato (ISAAA Inc. 2023).

Control Beliefs

Refers to the perceived presence or absence of opportunities or resources needed to perform a behaviour (Farah 2017).

Cost Task Value Category

The willingness to give up something to obtain a product (Tang et al. 2022).

Cross Breeding

A natural process in which the existing traits are improved through the hybridisation of the traits of two species (Anand et al. 2022).

DNA

Genetic material that is found in all living things (Puhan 2018).

Dual Attitude

Having more than one attitude at the same time (Zhang et al. 2022).

Ethics

Refers to what a person feels is right or wrong based on their own values and morals (Mokgoantle 2021).

Expectancy Value Model of Attitudes

An attitude model suggesting that attitudes comprise of a beliefs, values and expectations component (Sheth & Tuncalp 1974; Psynso 2018a; Ahn et al. 2019).

Expectations

Refers to attributes a product is expected to offer and the consequence of an attribute (Panchal et al. 2012; Olsson et al. 2022).

Evaluation

An assessment of a product (Ledgerwood et al. 2018).

Flavr Savr™ Tomato

The first genetically modified crop approved for commercialisation and human consumption (Aziz et al. 2022).

Food Aid

The process of donating food to people in need (Dekkinga et al. 2022).

Food Insecurity

Food insecurity refers to the absence of physical, social and economic access to an adequate amount of safe and nutritious food in order to lead a healthy lifestyle (Muzhinji & Ntuli 2021).

Food Security

Access to sufficient nutritious food on a daily basis in order to maintain and lead normal and healthy lifestyles (Bozsik et al. 2022).

Fusarium

A type of fungus that infect plants, leading to vascular wilts (Dadgarnejad et al. 2017).

Genetically Modified Crop

Plants derived from genetically modified organisms (GMOs) whose genetic material has been changed in an unnatural manner (Sendhil et al. 2022). In the context of this study, a GM crop refers to the crop or plant being grown in a land which is then used to produce a GM food product.

Genetically Modified Food Product

Food derived from organisms whose DNA has been changed in such a way that does not occur in a natural manner (Kubisz et al. 2021). In the context of this study, a GM food product is a processed product which is produced from a GM crop and is available to consumers for purchase and consumption purposes.

Genetic Modification/Genetic Engineering/Transgenic

The process of manipulating the genetic material of an organism through the insertion of foreign material to produce a specific characteristic, through the use of technology (Ruiz et al. 2018; Bearth et al. 2022).

Genetically Modified Organism (GMOs)

Organisms whose genes have been altered in an unnatural manner (Sendhil et al. 2022).

Genetically Modified Organisms (GMO) Act No 3

Ensures that GMOs are developed, produced and used appropriately (Department of Agriculture South Africa 2004).

Genetically Modified Purple Tomato

A genetically modified tomato with increased antioxidant levels (John Innes Centre 2022).

Gene or Genome Editing

The process of changing the DNA of organisms, without introducing any foreign material (Muzhinji & Ntuli 2021).

Gene Revolution

Refers to an agricultural revolution in which biotechnology was used (Mmbando 2023).

Glyphosate

A type of herbicide used on GM crops for weed management (Novotny 2022).

Golden Rice©

A variety of genetically modified rice containing increased levels of vitamin A (Muzhinji & Ntuli 2021).

Green Revolution

Refers to the significant increase in crop production (Blakeney 2009).

Herbicide Tolerant (HT)

Refers to crops with herbicide-tolerant traits (Ala-Kokko et al. 2021).

Intrinsic Task Value Category

Refers to the reward or enjoyment experienced after purchasing a product (Loh 2019).

Knowledge

What a person thinks they know about something and represents a person's awareness or understanding of something (Edet & Ekeh 2022; Siddiqui et al. 2022).

Labelling

Words, phrases, brand names or symbols used on the packaging of food (Jiang & Zhang 2021).

Macronutrients

Components of food including carbohydrates, proteins, fibre and lipids (Dizon et al. 2016).

"Madai" Red Sea Bream

A gene-edited variety of fish (The Fish Site 2021).

Malnutrition

A condition caused by an inadequate intake of nutritious foods (WHO 2022).

Micronutrients

Refer to vitamins and minerals (Smyth 2020).

Monoculture

Refers to growing the same type of crop on a seasonal basis (Van Acker et al. 2017).

Normative Beliefs

Refers to the belief that referent people expect a certain behaviour (Phillips 2008b; Abdoul et al. 2023).

Perceived Behavioural Control

Refers to the degree of control over a behaviour (Ajzen 1985).

Personal Values

Refers to what is important to an individual (Gamage et al. 2021).

PinkGlow™ Pineapple

A gene-edited variety of pineapple that has a pink flesh (CropLife International 2021).

Purchase Intention

Refers to the extent of desire to purchase a product (Arifani & Haryanto 2018).

Referent People

People whose opinion an individual feel is important to them such as friends, family and spouses (Abdoul et al. 2023).

Roundup Ready Crops

Crops that have been genetically modified to have resistance against the herbicide known as glyphosate (Novotny 2022).

Selective Breeding

Using specific traits in parent crops to produce plant crops with desirable traits (Caradus 2023).

"Sicilian Rouge High Gaba" Tomato

A gene-edited variety of tomato (Nagamine & Ezura 2022).

South African Committee on Genetic Experimentation (SAGENE)

Aids the government, industry and public regarding the safety of GMOs (Okeno et al. 2013).

Staple Food

Food consumed frequently that is an important part of a diet (Shew et al. 2021).

Subjective Norms

Refers to the perception that referent people expect a certain behaviour towards something (Abdoul et al. 2023).

Sustainable Development Goal (SDG) 2: Zero Hunger

Goals aiming to address hunger through attaining food security through which adequate quantities of nutritional food are available to vulnerable groups of people; whilst promoting agriculture in a sustainable way (Gil et al. 2019).

The Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR-Cas9)

A gene-editing technology used to manipulate the DNA of organisms (Kalds et al. 2019).

Theory of Planned Behaviour

A framework used to study consumers' intent to purchase a product, through attitude, subjective norms and perceived behavioural control (Farah 2017; Akbari et al. 2019).

Tiger Puffer Fish

A gene-edited variety of fish (Loew 2022).

Utility Task Value Category

Refers to the usefulness and functionality of a product (Biedenbach & Jacobsson 2016; Bostrom & Palm 2020).

Values

The worth that a product holds (Goedegebure et al. 2022).

White Russet Potato

A non-bruising, non-browning GM variety of potato (Kubisz et al. 2021).

CHAPTER 1
INTRODUCTION

To present the purpose of the study and discuss how the researcher intends to meet the study's aims and objectives, this chapter introduces and describes the study's background, problem statement, justification for the study and the research aim and objectives. It also gives a concise description of the research design and methodology, the ethical clearance obtained for the study, and an outline of the thesis. Academic-related information is also presented.

1.1 INTRODUCTION AND BACKGROUND

The worldwide debate around genetically modified (GM) crops and food products remains controversial in developed and developing countries (Emede & Fasina 2020; Rathod & Hedaoo 2022), fuelled by the benefits and risks of such crops and food products. However, the lurking food insecurity crisis that many countries fear has resulted in GM crops and food products gaining additional attention in terms of their usefulness in alleviating food insecurity (Chagwena et al. 2019). The role that GM technology, crops and subsequent food products play in addressing food insecurity has thus sparked the interest and curiosity of various stakeholders, particularly farmers, agricultural experts, and consumers (Chagwena et al. 2019; Dovey & Ntuli 2020; Zhaleh et al. 2023).

Food insecurity refers to the absence of physical, social and economic access to an adequate amount of safe and nutritious food to lead a healthy lifestyle (Muzhinji & Ntuli 2021). Food is a basic human need and vital to sustain life to grow and develop adequately, but without access to sufficient quantities of food, starvation transpires (Olabinjo et al. 2020). Subsequently, a lack of food leads to the onset of food insecurity, which is becoming a threat in the 21st century as more than 800 million individuals worldwide do not have an adequate intake of food (Chagwena et al. 2019). The need for food is also increasing as the global population continues to grow and is predicted to reach approximately nine billion by 2050 (Owusu-Gyan et al. 2023; The Club of Rome 2023). This phenomenon requires food production to increase by 50% (Ehirim et al. 2020). However, the rise in global population has placed a significant strain on agricultural practices, contributing to insufficient food supplies, especially in the developing world (Emede & Fasina 2020). The production of GM crops and food products has thus become a focal point in the GM food industry in terms of producing sufficient amounts of food for the worldwide population (Muzhinji & Ntuli 2021). The intention

is to attain a food-secure status, which refers to individuals' access to sufficient nutritious food on a daily basis in order to maintain and lead normal and healthy lifestyles (Bozsik et al. 2022).

1.1.1 Global Status of Food Insecurity

Food insecurity is becoming more apparent across the globe (Muzhinji & Ntuli 2021). In 2017, an estimated 821 million people were chronically undernourished, and in 2021, 45 million children under the age of five were wasting, meaning these individuals suffered from malnutrition due to hunger and did not have access to sufficient amounts of nutritious foods (UNDP 2021; WHO 2022). This has placed further strain on their food security status (Van Acker et al. 2017). From 2019 to 2022, an additional 150 million people were undernourished worldwide (Action Against Hunger USA 2023). Regrettably, malnutrition has led to the prevalence of nutritional deficiencies, such as Vitamin A deficiency, which is considered the leading cause of blindness in children, may result in an impaired immune system, and have a negative effect on brain development (Chen et al. 2018; Martini et al. 2018). Anaemia, which is caused by iron deficiency, is another concern for adults, but is particularly harmful among children (Ehouman et al. 2022). Zinc deficiency is an additional looming problem among adults and children, from which many children succumb (Lu et al. 2023). Nutritional deficiencies are ultimately increasing the prevalence of diseases, largely due to individuals not consuming a healthy diet (Chen et al. 2022). The authors add that the challenge is attributed to individuals' financial inability to purchase foods high in micronutrients, such as protein-derived food products, aggravating hunger.

In 2019, 144 million children worldwide were stunted, and this number increased to 149 million in 2021 due to an insufficient intake of food (FAO 2020; WHO 2022). The United Nations Development Programme (UNDP) (2021) reported that an estimated 690 million people are hungry, which amounts to 8.9% of the global population. These statistics were predicted to increase by 130 million by the end of 2020 due to the Coronavirus Disease of 2019 (COVID-19) pandemic (WHO 2020). The UNDP (2021) also reported the devastating fact that the number of hungry people increased globally by 60 million over five years, and by 10 million in just one year. The UNDP's projection was accurate as it has been estimated that the number of hungry people in the world escalated to 783 million in 2022, illustrating that food security is absent among a large percentage of the global population, resulting in many people suffering from hunger (Chagwena et al. 2019; Action Against Hunger USA 2023).

The Food and Agriculture Organisation (FAO) (2020) adds that in 2019, approximately 750 million people globally – one in ten people – were food insecure. In 2021, an estimated 2.3

billion (29.3% of the worldwide population) people suffered from moderate to severe food insecurity, while 924 million (11.7% of the worldwide population) people were subjected to severe food insecurity, amounting to an increase of more than 200 million people in two years (WHO 2022). According to the Global Report on Food Crises, 193 million people were subjected to acute food insecurity in 53 countries in 2021, which increased to 258 million people in 58 countries in 2022 (FAO 2023). These devastating statistics subsequently indicate that food insecurity among the population is escalating and requires drastic measures to combat this phenomenon.

Food insecurity is also becoming rampant in Africa, specifically affecting countries such as Burundi, Central African Republic, Democratic Republic of the Congo, Guinea-Bissau, Liberia, Mali, Guinea, Kenya, Malawi, Mozambique, Somalia, South Sudan, and Sudan (Szenkovics et al. 2020; Wudil et al. 2022). The World Food Programme (WFP) of the United Nations (UN) has voiced its concern about the food security status in Africa by reporting that approximately 20% of the African population is subjected to undernourishment, which is believed to be the highest on the globe (Gbashi et al. 2021). According to these authors, these statistics are driven by the fact that a large proportion of Africa's population (30%) does not have access to a sufficient amount of food on a daily basis. Subsequently, one in five people were subjected to hunger in 2020, and according to the UN, 46 million people are going hungry in Africa (World Vision 2022; BritishRedCross 2023).

Based on the 2022 Global Report on Food Crises, the number of food-insecure people in Africa increased from 41 million to 43 million in 2021, and 140 million people in Africa are subjected to acute food insecurity, meaning they do not consume adequate quantities of food on a daily basis, thereby threatening their livelihood (Mohamed et al. 2021; Seyuba & Garcia 2022; The World Bank 2022). The World Economic Forum (2022) also reported the number of people in Africa suffering from chronic hunger increased to 278 million in 2021. The FAO further estimates that approximately 670 million individuals in Africa will be exposed to food insecurity in the future, which is of particular concern to the food industry (Patrick et al. 2021).

The countries that form part of the Southern African Development Community (SADC) – "a regional trade grouping comprising 16 Southern African countries: Angola, Botswana, Comoros, Democratic Republic of the Congo, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, SA, Tanzania, Zambia and Zimbabwe" – are particularly vulnerable to food insecurity (Muzhinji & Ntuli 2021; Seyuba & Garcia 2022). The results of the SADC's vulnerability assessment and analysis report show that an estimated 41 million individuals experience food insecurity, and nine million are in desperate need of food

supplies (Muzhinji & Ntuli 2021). Such statistics are particularly alarming as more than 70% of the sub-Saharan African (SSA) population farm as an occupation and are still unable to provide and assess adequate food supplies for their households (Emede & Fasina 2020). In 2017, it was estimated that 230 million out of the 1 billion population in SSA were undernourished, which escalated to 264.2 million in 2020 (Gbashi et al. 2021; Owolade et al. 2022). The Southern Africa Food Security Outlook Update of March 2020 to September 2020 also reached an alarming consensus that the number of families who do not have access to sufficient supplies of food in southern Africa is nearing a record (FEWS NET 2020). These statistics call for urgent attention to find a solution to provide adequate and nutritional food, particularly to African countries.

1.1.2 Status of Food Insecurity in South Africa

In South Africa (SA), a lack of food led to 3.5 million individuals being undernourished in 2017, and in 2018, 10% of households were suffering from hunger (Ala-Kokko et al. 2021). Between September 2020 and December 2020, approximately 9.34 million people (16% of the SA population) suffered from a high level of acute food insecurity, meaning that these individuals did not consume enough food, placing their lives and well-being at risk (Das et al. 2020; IPC 2021). These statistics were projected to increase to approximately 11.8 million people (20% of the SA population) by March 2021 (IPC 2021). According to Mukwevho (2022), statistics showed that, in 2020, 23.6% of the SA population was affected by moderate to severe food insecurity, whereas in 2022, more than 30 million people encountered food insecurity every month in SA (Smail 2023). In 2020, an estimated 1.7 million households in SA faced different levels of food insecurity, an estimated 16.2 million people were subjected to extreme poverty, an estimated 4.75 million households were below the poverty line, and an estimated 11 million people were earning a monthly income of approximately R800.00 ($41.96) (Galal 2021; Patrick et al. 2021). In 2019, statistics further showed that one in every five SA households was food insecure, and approximately 10 million South Africans could not afford to purchase food (Dlamini 2023). These statistics indicate that, although SA is currently food secure, food insecurity is becoming a concern as many individuals in the country are impoverished and may not earn enough money to sustain a food-secure status. As a result, many SA households have a compromised food security status (Mukwevho 2022).

Thus, food insecurity is becoming an imminent problem worldwide, in Africa and SA. This phenomenon has left the agricultural and food industries desperate to find a solution to alleviate food insecurity and enhance the population's food security status (Abdoul et al. 2023).

1.1.3 Aspects Compromising Food Security

Individuals' food security status could be compromised by various aspects such as climate change, population growth and poverty (Carzoli et al. 2018; Galal 2021). Additional aspects placing further strain on individuals' food security include food wastage and losses, job losses, unemployment, the COVID-19 pandemic – which specifically led to job losses and unemployment – and the ongoing Ukraine war, which led to increased food prices and limited availability of certain food items (Van Acker et al. 2017; van Wyk & Dlamini 2018; UNEP 2020; van Meijl et al. 2020; Rabbi et al. 2021; Bozsik et al. 2022; Harvey 2022; Hassen & Bilali 2022). Ukraine is a global producer of cereals, oilseeds and fertilisers (WHO 2022). Consequently, the war has disrupted the global trade of food supplies by contributing to the soaring prices of grains, energy, fertilisers and petroleum products, which, in turn, escalated food prices; this phenomenon is detrimental to maintaining food security (Seyuba & Garcia 2022; WHO 2022). To illustrate COVID-19's impact in SA, between March 2020 and July 2020, an estimated two million people were retrenched and access to food was compromised, thereby threatening their food security status (Feed the Nation Foundation 2023). In Africa, the pandemic exacerbated the already bleak picture of food insecurity (Patrick et al. 2021; Feed the Nation Foundation 2023). A global depiction of COVID-19's impact on food prices and people's ability to afford food reflects that 3.1 billion people could not afford healthy food products in 2020, an increase of 112 million people from 2019 (WHO 2022). In the SA context, the cost of an average food basket consisting of 28 items escalated by 9.4% from February 2020 to February 2021 (Feed the Nation Foundation 2023). The pandemic thus placed further financial constraints on consumers' budgets and encouraged the purchasing of food products of a lower standard, thereby further compromising individuals' food security (van Wyk & Dlamini 2018). Such factors are thus aggravating food insecurity and leaving individuals' food security status vulnerable (Bozsik et al. 2022).

Specifically in the SA context, many households are single-person households, meaning significant strain is placed on one individual – in many cases women – to provide for their families, exacerbating their food security (Mukwevho 2022). The author adds that the unrest experienced particularly in KwaZulu-Natal in July 2021, as well as the floods in the province in April 2022, placed additional strain on the country's unemployment rate and food prices, all of which exerted further pressure on communities' food security.

Additional aspects in SA, such as crime and domestic violence, could also contribute to a compromised food security status (Feed the Nation Foundation 2023). In Africa, poverty is another challenge that could drive the population to food insecurity (Gbashi et al. 2021). A

decline in poverty has been seen in Africa as statistics show that in 1990, the poverty rate was 54%, which declined to 41% in 2015; however, from 1990 to 2015, the number of poor people in Africa increased from 278 million to 413 million, respectively (Mohamed et al. 2021). In 2021, it was estimated that 490 million people in Africa lived below the poverty line, while a projected 428.62 million people were subjected to extreme poverty in Africa in 2022 (UNCTAD 2021; Saleh 2022). Regrettably, pandemics such as Ebola have threatened Africa's food security status, which was further exasperated when the COVID-19 pandemic hit the continent (Gbashi et al. 2021). The rate at which the population is growing in Africa could also threaten food security as the population has increased 5.7 times between 1950 and 2020, which translates to a six-fold increase in population growth (Kavhiza et al. 2022).

An estimated 10% of food production globally has been lost specifically to harsh weather conditions, diseases and pests, thereby contributing to the issue of promoting food security (Muzhinji & Ntuli 2021). Developing countries are also struggling to keep up with the rapidly increasing demand for food supplies that far outweighs their agricultural production (Olabinjo et al. 2020). Such struggles are largely fuelled by small-scale farmers not being able to irrigate their crops and not having the financial capacity to purchase herbicides and pesticides, leaving their crops vulnerable to pests and diseases, resulting in a reduction in crop yield and food availability (Matlakala et al. 2021; Mathinya et al. 2022). Biosafety measures and regulatory systems are also making it difficult for developing countries to implement biotechnology in their agricultural practices to assist them in food production (Gbashi et al. 2021). Developing countries are still trying to become self-sufficient in terms of the food they produce, making it even more challenging to meet the supply and demand gap (Muzhinji & Ntuli 2021). This shows that, from an agricultural point of view, the production of food is threatened, which could directly impact the availability of food to the population and their ability to attain a food-secure status. There are, evidently, numerous aspects contributing to the difficulty of securing food for the global population.

1.1.4 The Biotechnology Revolution

Due to an increased compromised food security status, countries are questioning and re-examining their agricultural systems (Muzhinji & Ntuli 2021). Many aim to ensure that they can uphold an adequate supply of food, be self-sufficient, and ensure that their dependence on food aid or imports for food relief is limited as it threatens local food production (Szenkovics et al. 2020). Szenkovics et al. (2020) add that food aid or imports can also decrease the price of locally produced food, thereby placing financial strain on small-scale farmers and their livelihoods. To keep up with the demand for food, the 'Green Revolution' was born during the

1960s and 1970s, referring to a substantial increase in crop production (Christou & Twyman 2004; Blakeney 2009; Pingali 2022). However, in the 1980s, it soon became evident that farmers could no longer only rely on the Green Revolution to meet the demand for food (Blakeney 2009). Other methods were needed to enhance agricultural production on the available cropland to address looming food shortages (Blakeney 2009; Pingali 2022). Biotechnology was considered as a method that could address such concerns; thus, the use of biotechnology in agriculture was known to be the largest agricultural revolution following the 'Green Revolution', which is referred to as the 'Gene Revolution' (Ghanian et al. 2016; Mmbando 2023).

Biotechnology has led to the development of new planting methods, which have revolutionised the way in which crops are produced, thereby creating an opportunity to address pertinent global issues such as malnutrition, hunger, and food insecurity (Ghanian et al. 2016; Olabinjo et al. 2020). Due to improved genetic technologies, breeders and farmers now enjoy the use of biotechnology to produce crops with a high-yielding ability, thereby assisting in food security (Abdoul et al. 2023). This agricultural revolution shows how genetic technologies have advanced and evolved, leading to improved crops, illustrating their ability to assist in evading food insecurity (Muzhinji & Ntuli 2021). However, it has been suggested that care should be exercised to ensure that biotechnology does not replace traditional, conventional, older farming methods (Abdoul et al. 2023). Instead, the authors add that biotechnology should be used to complement already-existing farming practices since conventional breeding also focuses on improving crop and food product traits. Therefore, according to Abdoul et al. (2023), biotechnology and conventional breeding methods can be used collaboratively in farming practices.

Nonetheless, biotechnology has taken the front seat to revolutionise agricultural production, and many countries have thus embraced this modern technology in their agricultural systems and have produced, and continue to produce, GM crops to feed the growing population (Olabinjo et al. 2020; Muzhinji & Ntuli 2021; Ghimire et al. 2023). This strategy demonstrates that solace can be found in the application of biotechnology where food insecurity is concerned.

1.1.5 Achieving Food Security and Sustainable Development Goal 2 through GM Food Products (GMFPs)

To aid in attaining food security, Sustainable Development Goal (SDG) 2, which aims to achieve zero hunger, was developed to address aspects such as poverty and hunger (Gil et

al. 2019; Akora & Mishra 2022). SDG 2 aims to “end hunger, achieve food security and improved nutrition, and promote sustainable agriculture”, where the population, particularly vulnerable groups of individuals, have access to an adequate amount of nutritious food (Gil et al. 2019). SDG 2 strives to promote agricultural systems that become sustainable, and assist smallholder farmers, particularly in terms of access to land and technology, to get their food to the markets (UNDP 2021). Moreover, the UNDP (2021) mentions that to promote agricultural systems and food productivity, international assistance will be needed in terms of investment towards infrastructure and technology; therefore, agricultural production improvements remain an integral part of achieving SDG 2 (SDG Tracker 2021).

As discussed in Section 1.1.3, various factors could impede crop production and prevent the SDGs from being attained, leaving communities even more vulnerable to food insecurity (Muzhinji & Ntuli 2021). Some of these factors include pests, diseases and climate change (Gbashi et al. 2021). Fortunately, the plant material of GM crops has been GM to address and mitigate these factors using biotechnology (Gbashi et al. 2021; Muzhinji & Ntuli 2021). Such crops are thus tailored with agronomic characteristics that provide resistance to pests and diseases as well as climate change in terms of harsh weather conditions (Carzoli et al. 2018; Olabinjo et al. 2020; Ala-Kokko et al. 2021; Gbashi et al. 2021; Muzhinji & Ntuli 2021; Gbadegesin et al. 2022; Abdoul et al. 2023; Mmbando 2023). Higher crop yields can also be produced, thereby deeming GM crops and food products a possible solution to food security and SDG 2 (Gil et al. 2019; Gbashi et al. 2021; Aziz et al. 2022).

Attaining these goals can be particularly valuable to developing countries (Szenkovics et al. 2020; Maina 2021), such as SA, in promoting their food security status. Due to the modified traits of GM crops, it has been argued that these crops can enhance production efforts, thereby increasing the availability of food locally and worldwide (Qaim & Kouser 2013; Emede & Fasina 2020). Other attributes of GMFPs developed from GM crops – such as their potential to be sold at a reduced price, their improved nutritional value, longer shelf life, improved appearance and quality, and better taste – can entice consumers to purchase GMFPs (Popek & Halagarda 2017; Dovey & Ntuli 2020; Siddiqui et al. 2022), thereby contributing to the promotion of their food-secure status. Therefore, to address food insecurity and promote a sustainable food supply, many agree that the answer lies in the use of biotechnology and its application to develop GM crops and GMFPs due to their modified traits (Hulela et al. 2019; Ruth & Rumble 2019; Dovey & Ntuli 2020; Prianto et al. 2020; Muzhinji & Ntuli 2021; Rodriguez et al. 2022; Abdoul et al. 2023). However, although the integration of GM crops in agricultural practices can aid in alleviating food insecurity, biotechnology’s success in improving food

security will depend on farmers, producers, governments and consumers joining efforts, thereby ensuring that the population can be adequately fed (Muzhinji & Ntuli 2021).

From a consumer point of view, the reality of a compromised food security status has become a concern to the general consumer as well (Frewer 2017; Ala-Kokko et al. 2021). Evidently, sufficient food availability is concerning to both the producer and the consumer (Ala-Kokko et al. 2021). A recognised need for innovative solutions in food production to alleviate food insecurity thus emerged, including the adoption and production of GM technology, crops and food products (Hefferon 2016; Chagwena et al. 2019; Ehirim et al. 2020; Olabinjo et al. 2020; Gbashi et al. 2021; Abdoul et al. 2023; Zhaleh et al. 2023).

To illustrate consumers' views, studies were conducted in Nigeria and Ghana to determine scientists' perspectives on GM cassava; in Mexico to determine consumers' perceptions and attitudes towards GM organisms; in Botswana to determine consumers' knowledge and perceptions of GMFPs; in Florida (USA) to explore how consumers evaluate GM messages; and in Ghana to explore consumers' knowledge and awareness of GM food (Adenle et al. 2012; Lopez et al. 2016; Hulela et al. 2019; Ruth & Rumble 2019; Owusu-Gyan et al. 2023). The findings of these studies showed that consumers were optimistic that GMFPs could contribute to a more food-secure world. A consensus is thus demonstrated among producers and consumers that food insecurity can be addressed through the production of GMFPs.

1.1.6 The Significance of Exploring Consumers' Attitudes and Purchase Intention (PI) towards GMFPs

Although the use of GM crops and the consequent production of GMFPs has been put forward as a potential tool in enhancing food security, the consumer remains an integral part of this strategy's success (Muzhinji & Ntuli 2021; Owusu-Gyan et al. 2023). Therefore, it is important for consumers to have a favourable attitude toward GMFPs. This requires an evaluation of a product, which can be favourable or unfavourable, and is indicative of what a person thinks or feels about a product (Williams et al. 2017; Bakanauskas et al. 2020; Tormala & Rucker 2022), like GMFPs. Since attitudes are engraved in a person and can exist as either a single or dual attitude that has the potential to be changed, they contribute to individuals' behaviour toward a product in a particular way (Wilson et al. 2000; Albarracin & Shavitt 2017; Rehman et al. 2019; Sleboda & Lagerkvist 2022; Zhang et al. 2022). To study what constitutes the formation of attitudes, the Expectancy Value (EV) Model of Attitudes was a useful framework through which consumers' beliefs, values and expectations – the three components that make up the EV Model of Attitudes (Sheth & Tuncalp 1974) – of GMFPs were captured.

Attitudes play a significant role in PI – which refers to the desire to purchase something – and are therefore an important element when exploring consumers' intent to purchase a product as well as creating insight into the behaviour toward a product (McSporran 2017; Saha et al. 2021). The Theory of Planned Behaviour (TPB) provides a framework to gain improved insight into consumers' PI of a product through the integration of three elements, namely attitudes, subjective norms and perceived behavioural control (PBC) (Farah 2017; Saha et al. 2021). It is thus a useful framework to study and explore consumers' PI of GMFPs. Since the EV Model of Attitudes studies attitude formation through beliefs, values and expectations, it feeds and creates insight into the attitude element of the TPB. Thus, to explore consumers' attitudes toward GMFPs and their influence on PI, the EV Model of Attitudes and TPB framework were combined in this study, leading to the development of a framework that could be useful in advancing food security.

1.2 PROBLEM STATEMENT

Food insecurity poses a worldwide crisis, particularly in developing countries from southern Africa, including SA (Mlaba 2020; Hwang & Nam 2021; Muzhinji & Ntuli 2021; Abdoul et al. 2023). Food insecurity is largely influenced by the rapidly growing population, coupled with food shortages, hunger, malnutrition and inadequate access to sufficient and nutritious food (Deng et al. 2019). More recently, the COVID-19 pandemic and the Ukraine war have further threatened individuals' food security status due to job losses, unemployment, soaring food prices, and the unavailability of certain food products (Van Acker et al. 2017; van Wyk & Dlamini 2018; UNEP 2020; van Meijl et al. 2020; Rabbi et al. 2021; Bozsik et al. 2022; Harvey 2022; Hassen & Bilali 2022). Food insecurity is a significant issue that must be addressed to ensure people have access to adequate quantities of nutritious food (Van Acker et al. 2017). To address this concern, the plant material of crops has been GM to hold specific enhanced favourable traits, such as being resistant to harsh weather conditions and pests (Rosculete et al. 2018; Abdoul et al. 2023). This strategy can assist in promoting crop yields and subsequently aid in enhancing food security (Gbashi et al. 2021) and contribute to attaining SDG 2: Zero Hunger.

Due to the food security crisis and increased adoption and production of GM food crops worldwide (Mlaba 2020), the GM food industry has drawn significant interest from researchers. This interest resulted in different studies being conducted that have focused on consumers' views towards GMFPs. In SA, various researchers have also shown interest in the GM field and have subsequently conducted GM-related consumer studies that have focused on identifying consumers' acceptance, knowledge, attitudes, awareness, perception, perspective

or adoption of either one GMFP, biotechnology as a whole, or the factors that influence their purchase behaviour towards such food products (Joubert 2002; Pouris 2003; Vermeulen et al. 2005; Lanzillotti 2007; Peter & Karodia 2014; Gouse et al. 2016; Kotey et al. 2016; Jonker 2017; Gastrow et al. 2018; Van Zuydam 2020). The majority of these studies adopted a quantitative methodology, used survey questionnaires to obtain data, and included respondents who resided in both urban and rural areas respectively across SA (Joubert 2002; Pouris 2003; Vermeulen et al. 2005; Lanzillotti 2007; Peter & Karodia 2014; Gouse et al. 2016; Kotey et al. 2016; Jonker 2017; Gastrow et al. 2018; Van Zuydam 2020). Consequently, SA consumers have not yet had the opportunity to vocalise their views about GMFPs. These SA studies also did not approach the research topic using a particular framework; however, Van Zuydam (2020) used the Schiffman and Wisenblit (2019) consumer decision-making model as a framework to determine consumers' decision-making process regarding GMFPs. As a result, in the SA context, a gap remains regarding the salient aspects that constitute consumers' attitudes toward GMFPs.

Another stream of research has been conducted worldwide that focused on consumers' knowledge, perception, awareness, acceptance and opinions towards GMFPs, as well as consumers' attitudes towards GMFPs, attitudes towards GM-crop technology, and attitudes towards the adoption of GM crops (Chen & Li 2007; Todua et al. 2015; Vecchione et al. 2015; Lopez et al. 2016; Rzymski & Krolczyk 2016; Popek & Halagarda 2017; Brosig & Bavorova 2019; Chagwena et al. 2019; Deng et al. 2019; Kwade et al. 2019; Sanlier & Sezgin 2020; Amin et al. 2021). The majority of these studies included the benefits and risks of GMFPs to study consumers' attitudes towards these food products. These studies concluded that the benefits and risks associated with these food products or GM technology, together with culture and religion, were factors that significantly influenced consumers' attitudes towards GMFPs, whether positively or negatively. The studies showed that the benefits that positively influenced consumers' attitudes towards GMFPs included herbicide resistance, better taste, improved product quality, longer shelf life, lower prices, enhanced nutritional content, increased crop yields, and the potential to increase food supplies (Chen & Li 2007; Todua et al. 2015; Vecchione et al. 2015; Lopez et al. 2016; Rzymski & Krolczyk 2016; Popek & Halagarda 2017; Brosig & Bavorova 2019; Chagwena et al. 2019; Deng et al. 2019; Kwade et al. 2019; Sanlier & Sezgin 2020; Amin et al. 2021). Conversely, the risks or concerns consumers highlighted as negatively influencing their attitude toward GMFPs included the unnatural development of these food products, ethical concerns, conflict with their religion, the safety of such food products, possible allergic reactions, and potential harmful effects on the environment (Chen & Li 2007; Todua et al. 2015; Vecchione et al. 2015; Lopez et al. 2016; Rzymski & Krolczyk 2016; Popek & Halagarda 2017; Brosig & Bavorova 2019; Chagwena et

al. 2019; Deng et al. 2019; Kwade et al. 2019; Sanlier & Sezgin 2020; Amin et al. 2021). These results were echoed by Cui and Shoemaker (2018) as well as Rosculete et al. (2018), who emphasised the influential role that the benefits and risks of GMFPs play in forming consumers' attitudes towards such food products. Many of these consumer attitude studies toward GMFPs were conducted in conjunction with other aspects, namely knowledge, acceptance, perception and opinions. This shows that attitudes were not the main focus of many of these research studies.

Several of these studies also followed a quantitative approach, used questionnaire surveys as a data collection method, and mostly included an urban population (Chen & Li 2007; Todua et al. 2015; Vecchione et al. 2015; Lopez et al. 2016; Rzymski & Krolczyk 2016; Popek & Halagarda 2017; Brosig & Bavorova 2019; Chagwena et al. 2019; Deng et al. 2019; Kwade et al. 2019; Sanlier & Sezgin 2020; Amin et al. 2021). While the absence of frameworks in many SA studies was described, some international studies used models. Kwade et al. (2019) used the Innovative Adoption Theory as well as the attitude construct from the Attitudinal Models, as this study assumed attitude towards the adoption of GM technology is related to concepts within these models and thus aimed to explore this assumption. Brosig and Bavorova (2019) used the TPB framework to measure the relationship between young adults' GM food attitudes and the attitudes they perceive their referent people to have. Moreover, Deng et al. (2019) used the Choice Model in their study to measure consumers' attitudes toward GMFPs and farmers' choices between adopting and not adopting GM crops.

Evidently, extensive research has been conducted in the GM field to obtain more insight into consumers' views towards GMFPs and technology by showing which factors lead to a positive or negative attitude. However, results were obtained through survey questionnaires, and further explanations of consumers' GMFP views were not heard in these studies as the respondents had no opportunity to express their views. A gap thus remains in terms of the salient aspects of attitude formation. These aspects can emerge in a qualitative study by conversing with the participants and allowing for an in-depth exploration of consumers' attitudes toward GMFPs. As a result, many of the above-mentioned SA and international studies have remained superficial in determining consumers' attitudes toward GMFPs. Thus, while a global exploration into attitudes has been conducted, an internal, in-depth exploration to establish which salient aspects specifically constitute attitudes is missing.

Other international studies have aimed to determine consumers' attitudes toward GM plants and animals, GM food and organic food, food products developed from new plant breeding techniques, conventional plant breeding techniques for fruits and vegetables, GM foods and

attitudes towards the issues of GM food (Morris & Adley 2000; Magnusson & Hursti 2002; Costa-Font & Gil 2011; Todua et al. 2015; Larson 2018; Oz et al. 2018; Charlebois et al. 2019; Spendrup et al. 2021; Vindigni et al. 2022). Although these studies aimed to determine consumers' attitudes towards different GM-related aspects, a quantitative methodology was applied. Subsequently, these studies have not explored consumers' attitudes based on their lived experiences and have not applied qualitative methodologies; thus, the vocalised viewpoints of GMFPs have not been obtained.

Other studies, specifically focusing on consumers' attitudes toward GMFPs or a specific GMFP, used the Bredahl (2001) attitude model – which is based on the multi-attribute model – and therefore only focused on the perceived risks and benefits and its influence on attitudes toward GMFPs (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008). The majority of the above-mentioned studies did not explore attitudes towards GMFPs from rural consumers' points of view, where they are surrounded by an agricultural community, as more attention was placed on the urban population. Additionally, these studies were not conceptualised using the constructivist paradigm and phenomenological research strategy, of which an overview is given in Section 1.5. Therefore, consumers' attitudes towards GMFPs within the context of their reality or viewpoint and own lived experience, have not been researched yet. In addition, since other attitude models do not consider an expectation component as a driver of attitude formation, studies using other attitude models – specifically Bredahl's Attitude Model in the GM context (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Ramdhani et al. 2012; Jain 2014) – have not explored the role that expectations play in attitude formation.

Some quantitative studies have explored individual values – such as power (dominance, submission), hedonism, universalism, self-dominance, stimulation, achievement, security, conformability, tradition and benevolence (as suggested by the Schwartz Value Theory) – as determinants of attitudes towards GMFPs and how it affects consumers' purchase behaviour (Honkanen & Verplanken 2004; Dreezens et al. 2005; Tsakiridou et al. 2007; Costa-Font 2009; Spendrup et al. 2021). However, in terms of the EV Model of Attitudes, the four categories of task values, namely cost value, attainment value, intrinsic value and utility value, have not been used in exploring the values component (Sheth & Tuncalp 1974; Ajzen & Fishbein 2000; Ajzen 2001; Ajzen 2008; Ajzen 2011; Ahn et al. 2019; Meyer et al. 2019). Thus, a gap has been identified regarding the usefulness of these four task value categories within the values component of the EV Model of Attitudes when exploring attitude formation toward GMFPs.

Previous quantitative studies have used the EV Model of Attitudes to determine attitude formation from a social psychology point of view; to determine the attitudes of individuals with

schizophrenia in relation to their medication; to determine the attitudes of boycotters and non-boycotters towards products; and to establish attitudes towards source traits in message appeals (Sheth & Tuncalp 1974; Davidhizar 1982; Belch & Belch 1987; Ahn et al. 2019). Another quantitative study also explored whether values or expectations are important in attitude formation in terms of product brands, while another study used the values component of the EV Model of Attitudes to explore health values (Sheth & Talarzyk 1972; Zhang et al. 2008).

Many of the above-mentioned studies used a set of pre-determined statements regarding beliefs from which their values and expectations were subsequently measured; thus, the role that beliefs specifically play in attitude formation remains unknown. Nevertheless, an exploration into the influence of the three components of the EV Model of Attitudes (beliefs, values and expectations) on attitudes toward GMFPs from previous studies could not be found. Studies have consequently not used the EV Model of Attitudes, and its application and usefulness in providing a framework to explore consumers' attitudes towards GMFPs has not been investigated. Therefore, each of these three components' influence and role in attitude formation when it comes to GMFPs remains unknown.

In the GMFP context, a gap in literature has thus been identified in terms of whether beliefs, values or expectations need to be questioned when exploring consumers' attitudes toward GMFPs. It remains unknown which of these three components are influential drivers of attitudes; whether they have a varying state of prominence in driving consumers' attitudes; and whether all these components need to be considered important influencers of attitudes in the GMFP context. A gap remains in terms of which of these components have an impact on attitudes as the above-mentioned studies have not explored the salient aspects of attitudes. Further research is thus required to supplement existing studies regarding consumers' attitudes toward GMFPs.

Many studies have also shown that, although benefits can positively influence attitudes toward GMFPs, the risks adversely impact attitudes, and negative attitudes have thus been found among consumers (Bredahl 2001; Magnusson & Hursti 2002; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Todua et al. 2015; Ghoochani et al. 2017; Chagwena et al. 2019). This points to a problem between the consumer and their attitude, as negative attitudes about GMFPs could result in consumers' hesitancy toward these food products; various studies have indicated that consumers are reluctant to accept GMFPs (Rzymski & Krolczyk 2016; Larson 2018; Sanlier & Sezgin 2020; Pakseresht et al. 2021). Therefore, further

explorations into attitudes are required to reach a more positive stance and create consumer acceptance regarding GMFPs.

In Zambia and Zimbabwe, food aid (organisations or people donating food to people in need) to relieve food insecurity among their starving population comprising of GM maize was refused due to the risks perceived to be linked to GMFPs (Zerbe 2004; Herrick 2008; Dekkinga et al. 2022). This example points to another problem: negative connotations are linked to GMFPs. Although this example happened many years ago, it points to the hesitancy toward these food products, which could result in food-insecure consumers not receiving food as GMFPs are opined to be harmful. Not allowing GM maize into these countries could illustrate the presence of negative attitudes, perhaps among the government, producers, and consumers themselves. The need to specifically establish consumers' attitudes and areas of attention to remedy a negative attitude is thus required. This can reinforce positive attitudes to create a sense of acceptance and desire for GMFPs so that such a scenario does not occur again. Using the EV Model of Attitudes' components to investigate attitudes can possibly assist.

Moreover, it has been argued that consumers' knowledge influences their attitude toward GMFPs, and the sources of their information are influential in building consumers' attitudes (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Vecchione et al. 2015; Marx 2017; Zhang et al. 2018; Zhu et al. 2018; Conrow 2019; Hwang & Nam 2021). Several studies have aimed to determine knowledge's influence or effect on consumers' attitudes toward GMFPs or its influence on perceived benefits and risks of GMFPs, and thus their attitude towards such food products, as well as the sources from which information is acquired regarding GMFPs (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Wunderlich & Gatto 2015; Zhu & Xie 2015; Cormick & Mercer 2017; Cui & Shoemaker 2018; Kim & Choi 2018; Zhang et al. 2018; Zhu et al. 2018; McPhetres et al. 2019; Van Zuydam 2020; Hwang & Nam 2021). The influence and relevancy of knowledge on the development of beliefs and the sources from which information is obtained, which could influence the state of knowledge, has not been linked to the EV Model of Attitudes, nor has it been explored within the SA context. Therefore, although a study has looked at including emotions in the EV Model of Attitudes (Henning et al. 2012), knowledge has not been explored as a contributing component to the EV Model of Attitudes.

Regarding PI, studies have aimed to determine consumers' PI or behaviour towards GMFPs or specific food products for some time (Kim 2010; Ghasemi et al. 2013; Rodriguez-Entrena et al. 2013; Sleenhoff & Osseweijer 2013; Hudson et al. 2015; Hassan et al. 2016; Sharma & Kalyandurgmath 2016; Yao & Jiang 2016; Ghoochani et al. 2017; Zhu et al. 2018; Akbari et al. 2019; Hwang & Nam 2021; Sleboda & Lagerkvist 2022; Yang et al. 2022; Abdoul et al.

2023; Zhaleh et al. 2023). However, these studies followed a quantitative approach, thereby using survey questionnaires. Additional studies have focused on numerous aspects such as gender, age, education, socioeconomic variables and the relationship among such determinants and their influence on consumers' attitudes, PI or behaviour toward GMFPs (Xuan et al. 2012; Tongyang et al. 2015; Zhou et al. 2022). Although valuable information was attained on consumers' attitudes, PI and behaviour, these studies did not consider the TPB framework.

Some international studies have used the TPB framework's constructs (attitudes, subjective norms and PBC) to determine consumers' intent to purchase GMFPs (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Zhang et al. 2018; Saha et al. 2021); the majority used questionnaire surveys to do so. In SA, consumers' PI toward biotechnology and GM food has also been explored (Lanzillotti 2007); however, the TPB framework was not applied, and subjective norms and PBC were thus not considered. Therefore, ambiguity still exists in SA in terms of the influence that attitudes, subjective norms and PBC have on SA consumers' intent to purchase GMFPs.

To determine consumers' behaviour, quantitative studies have used the EV Model of Attitudes' assumptions to predict job behaviour; specifically establish normative beliefs and behaviour towards abortion; conserve water; and encourage individuals to participate in the planning of water allocation in specific regions (Alexander 1977; Smetana & Adler 1980; Kantola et al. 1982; Syme et al. 1991). Other quantitative studies have used the model's assumptions to specifically determine behaviour in terms of physicians prescribing medication; how they decide which medication to use; voting; and in-job searching (Harrell & Bennett 1974; Denig et al. 1988; Echabe et al. 1988; Varekamp et al. 2014). In addition, previous studies have combined Bredahl's (2001) attitude model with the TPB framework and established the combination is effective in determining the influence of attitudes on PI; other researchers alluded to the usefulness of merging the EV Model of Attitudes and the TPB framework to explore attitudes' influence on PI (Ajzen & Fishbein 2000; Ajzen 2001; Bredahl 2001; Verdurme & Viaene 2003; Ajzen 2008; Chen 2008; Ajzen 2011; Ghoochani et al. 2017). However, it could not be established whether the EV Model of Attitudes and the TPB framework have been combined and used together in previous studies to specifically explore consumers' attitudes and PI towards GMFPs. Furthermore, the above-mentioned studies did not conduct their respective research with the aim of providing valuable information to enhance food security.

Thus, uncertainty remains about what ultimately constitutes consumers' attitudes towards GMFPs in SA and how this influences their PI of GMFPs. As a result, the GM food industry in SA remains uncertain whether consumers' attitudes towards GMFPs can contribute to and promote the production of GM crops and GMFP purchases and assist in supporting food security efforts. The research questions for this study are therefore: "Which components of the EV Model of Attitudes (beliefs, values or expectations) contribute toward consumer attitudes regarding GMFPs, which components do attitudes consist of, how does it influence the purchasing of such food products, and what role will this play in food security?" Subsequently, the purpose of this study was to understand the role of each component of the EV Model of Attitudes and explore which of these components have a prominent influence on consumers' attitudes and their PI. The purpose of the study was further to explore which of these components can drive attitudes and the intent to purchase GMFPs, and if this can contribute towards attaining food security.

1.3 JUSTIFICATION FOR THE RESEARCH

GMFPs' production and availability are increasing worldwide and in SA; however, for the GM food industry to succeed in promoting food security, it is vital for consumers to hold favourable attitudes towards GMFPs that can positively influence their PI (Deng et al. 2019; Abdoul et al. 2023). However, negative attitudes have been found among consumers toward GMFPs; consumers are hesitant to accept GMFPs in various countries, and GM maize has been rejected as a food aid source in Zambia and Zimbabwe (Magnusson & Hursti 2002; Verdurme & Viaene 2003; Zerbe 2004; Herrick 2008; Todua et al. 2015; Rzymski & Krolczyk 2016; Larson 2018; Chagwena et al. 2019; Sanlier & Sezgin 2020; Pakseresht et al. 2021). This signifies the importance of gaining insight into consumers' attitudes towards GMFPs, thereby encouraging them to seek GMFPs in-store. The goal is to assist food-secure consumers to remain food secure while aiding the food-insecure consumer to become more food secure.

In terms of the formation of attitudes, other attitude models – specifically Bredahl's Attitude Model in the GM context (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Ramdhani et al. 2012; Jain 2014) – do not include expectations as a component in their models. Therefore, expectations have not been considered in attitude formation. In addition to exploring beliefs' and values' role in attitude formation toward GMFPs, this study can thus shed some light on the role that expectations play in forming attitudes toward these food products. Considering that the four categories of task values are not included in the EV Model of Attitudes (Sheth & Tuncalp 1974; Ajzen & Fishbein 2000; Ajzen 2001; Ajzen 2008; Ajzen 2011; Ahn et al. 2019; Meyer et al. 2019), this study's findings can also point to whether the four categories are useful

to include in the values component of the EV Model of Attitudes when exploring consumers' attitudes toward GMFPs.

Regarding attitude formation toward GMFPs, the study's findings can offer insight by exploring the three components of the EV Model of Attitudes (beliefs, values and expectations) and the most important salient aspects of each of these components that assist in forming consumers' attitudes towards GMFPs. It was important to explore the role each of these components played in establishing consumers' attitudes towards GMFPs, as it was not certain how influential each of these components was. It was also important to explore these three components to understand what occurs within consumers' attitudes toward GMFPs by specifically identifying which components make up an attitude, which of these components are the driving force behind consumer attitudes, and which of these components need specific attention to understand consumer attitudes to change a negative attitude or reinforce a positive one regarding GMFPs. The role that attitudes play in supporting food security in terms of GMFPs' use is also not fully understood, and the aspects that constitute attitudes need further investigation to create acceptance toward these food products and promote the purchasing of these items.

Knowledge is an important aspect to study as it is indicative of what a person thinks about a specific product (Siddiqui et al. 2022). The influence of consumers' knowledge on their beliefs toward GMFPs and the sources that create knowledge need to be explored. This information is required to understand where consumers' beliefs and attitudes originate – whether from a factually sound or unsound basis – if any advances are to be made in consumer education and marketing of such food products for the betterment of consumers in SA and address SDG 2. This study suggested that consumers' beliefs are influenced by knowledge about GMFPs, in turn influencing their attitude towards GMFPs. The role of these aspects influencing consumer beliefs within the EV Model of Attitudes needs to be established to come to a better understanding of the importance of knowledge and information sources in creating consumer beliefs about GMFPs, particularly since the EV Model of Attitudes proposes that consumers' attitudes emerge through these beliefs (Ajzen & Fishbein 2000). Even though consumers may not know enough about GMFPs (Marx 2017; Cui & Shoemaker 2018; Dirisu et al. 2020), it is important to change negative attitudes so that the consumer welcomes these food products on the market.

Since consumers' PI towards GMFPs is not fully understood within the SA context, it was important to explore the TPB and establish what role its three elements (attitudes, subjective norm and PBC) played in consumers' intent to purchase such food products. It is imperative

for the GM food industry to attain this information as it can reflect what aspects influence and promote or hinder consumers from engaging in purchasing and consuming GMFPs. As there is uncertainty regarding what leads to consumers' attitudes towards GMFPs, and how this, in turn, influences their intent to purchase, this study proposed that merging the EV Model of Attitudes and TPB frameworks could provide the information needed to address this ambiguity and provide a more confident understanding of consumers' attitudes and their PI. In addition, a better understanding of consumers' behaviour towards GMFPs is important to the food industry in SA if they want to become successful in their attempt to increase their production efforts to produce sufficient and nutritious food for the population while supporting SDG 2: Zero Hunger.

Consumers need to be informed about GMFPs so that they are not hesitant or afraid of these food products because they are being developed to assist all consumers with their food security status, whether in the form of food aid or general consumption. Consumers need to realise and become more sensitive and conscious about the benefits these food products offer in terms of becoming more food secure, and they need to become more informed in their food choices. Subsequently, consumers should become more GM-orientated, more accepting of GMFPs on the market, seek GMFPs to enjoy these food products at a better price (for example) (Siddiqui et al. 2022), become food secure or remain food secure, and promote the food production industry's production of GMFPs. Consumers also need to understand the scope of GMFPs' benefits. For instance, their production can benefit the producer – not just the consumer – and they need to be informed of locally-produced GMFPs, which could contribute to consumers becoming more supportive of GMFPs. With this information, consumers will know that if they do see a GM label on a food product and purchase that item, they are also potentially supporting the livelihood of a local small-scale farmer. Consumers ultimately need to have a desire for GMFPs, and they need to understand that there is a reason to purchase such food products. However, if we do not understand what drives consumers' attitudes towards these food products and their current position and view of GMFPs, their opinions cannot be changed, and they will not be assisting in food security efforts.

1.4 RESEARCH AIMS AND OBJECTIVES

This study aimed to explore consumers' attitudes towards GMFPs and their influence on PI. This study also aimed to develop a framework to reflect the components of the EV Model of Attitudes and salient beliefs, values and expectations that constitute consumers' attitudes

towards GMFPs, thereby reflecting attitudes' influence on the intention to purchase GMFPs and contributing to the advancement of food security.

To achieve these aims, the following research objectives were formulated:

Objective 1:

Describe what role the three components of the EV Model of Attitudes play on attitudes towards GMFPs in terms of:

1.1 Consumers' salient beliefs about GMFPs.

1.2 Consumers' salient value assigned to GMFPs in terms of:

- a. Cost relating to GMFPs.
- b. Attainment value relating to GMFPs.
- c. Intrinsic value relating to GMFPs.
- d. Utility value relating to GMFPs.

1.3 Consumers' salient expectations of GMFPs.

Objective 2:

Explore the influence of knowledge on consumers' beliefs about GMFPs by:

2.1 Exploring consumers' state of knowledge of GMFPs.

2.2 Identifying the sources where GM-related information is acquired that influence knowledge of GMFPs.

Objective 3:

Describe what role the three elements of the TPB play on the intention to purchase GMFPs in terms of:

3.1 Attitudes and behavioural beliefs' influence on attitudes.

3.2 Subjective norms and normative beliefs' influence on subjective norms.

3.3 PBC and control beliefs' influence on PBC.

Objective 4:

Propose a framework reflecting the components of the EV Model of Attitudes and the salient beliefs, values and expectations that constitute consumers' attitudes towards GMFPs and attitudes' influence on their intention to purchase GMFPs.

1.5 RESEARCH METHODOLOGY AND DESIGN

A qualitative methodology was used to explore consumers' attitudes toward GMFPs, PI and their knowledge of these food products. Verbal accounts of GMFPs were gained from 32 participants, which allowed the objectives of the study to be addressed and met. A constructivist paradigm was used to explore how participants viewed GMFPs, their subjective reality about such food, what they understood and have learnt about GMFPs, their image or idea about GMFPs (their knowledge), and the meaning they have assigned to these food products. A phenomenological research design was used to complement the constructivist paradigm through which an understanding was gained into the participants' lived experience of GMFPs, providing insight into how they experience GMFPs and, through their eyes, what the truth is about such food products. A descriptive and exploratory research design was also used to explore what constituted consumers' attitudes toward GMFPs, their PI and knowledge of such food products, since limited research has been conducted on these aspects in the SA context. These research designs allowed the participants to verbally describe their views of GMFPs. In this way, attitudes toward GMFPs and their influence on such food products were explored, as well as their GMFP knowledge, which further complemented the phenomenological research design.

The non-probability sampling strategies used for this study included purposive, convenience and snowball sampling. A social media platform, namely Facebook, was used to recruit participants for this study in the Midlands, KwaZulu-Natal. A post was created to invite eligible participants to contact the researcher via email should they be interested in participating. The Facebook post was also shared on a local community group where advertisements can be placed within the Midlands area. Participants interested in the study were asked to share the Facebook post with acquaintances, and snowball sampling was initiated.

To obtain demographic data, a link to a demographic questionnaire consisting of closed biographical questions – created on Google Docs – was emailed to each interested participant to access and complete. Categorical closed-ended questions were also used in the demographic questionnaire to determine how the participants related to GM crops. To collect data on consumers' attitudes toward GMFPs and their influence on PI, as well as their state of knowledge, online individual interviews were conducted on an online videoconferencing platform known as Microsoft Teams. An interview guide consisting of semi-structured questions was used to obtain information from the participants about their attitudes towards GMFPs and their influence on their intent to purchase these food products. The researcher specifically focused on their beliefs, values and expectations of GMFPs; their knowledge of

GMFPs and the sources where GM-related information was obtained; as well as their behavioural beliefs in terms of attitudes, control beliefs in terms of PBC, and normative beliefs in terms of subjective norms.

Descriptive statistics were used to analyse the demographic information obtained from the questionnaire, which were entered into an Excel spreadsheet. Thereafter, the data were analysed using frequencies and percentages. To analyse the information obtained from the interviews, an inductive approach was used to develop categories and themes. The recorded data were transcribed verbatim before a thematic analysis was performed. In the process, common ideas and patterns were identified by coding the data, then categories and themes were developed. Open coding was used, where similar patterns or ideas in the data were coded, and axial coding was used to make connections between the patterns and codes. In vivo coding was used, where the actual spoken words of the participants were focused on. Credibility, transferability, dependability, confirmability and reflexivity were considered to maintain trustworthiness during the data analysis process.

1.6 ETHICS

The ethical requirements stipulated by the University of South Africa (UNISA) in its policy on research ethics were conformed to by this study. The research proposal was approved by the College of Agriculture and Environmental Sciences Health Research Ethics Committee (CAES HREC) at UNISA. The CAES ethics approval letter is attached as Appendix A, with the research ethical clearance number 2021/CAES_HREC/145.

After approval and ethical clearance was obtained, the study commenced by gathering data. As seen in Appendix B, the participants were asked to complete and sign an informed consent form on Google Docs – should they have wished to participate in the study – and they were informed how their anonymity, confidentiality and privacy would be ensured. The informed consent form further stipulated the aims and objectives of the study; what their involvement in the study entailed; that participation was voluntary; that no incentives or compensation would be given; that they could withdraw from the study at any stage without any penalty; and that, upon completion of the study, feedback would be emailed to them.

1.7 OUTLINE OF THE THESIS

This thesis is presented over 10 chapters as follows:

Chapter 1 presents an introduction to the study, including the background of the study, the problem statement, the justification for the research, as well as the aims and objectives of the study. This is followed by a brief description of the methodology in terms of the paradigm used, the research designs, sampling strategies, data gathering methods, data analysis and trustworthiness. The chapter concludes by giving a description of the ethical clearance that was obtained.

Chapter 2 presents a literature review on GM crops and food products in terms of the concept of genetically modified organisms (GMOs); global GM crop production; the benefits of GM crops that can promote food security; the benefits of GM crops and GMFPs; risks and concerns related to GM crops and GMFPs; the use of biotechnology on animals; the labelling of GMFPs; and the biosafety frameworks and regulations of GMOs.

Chapter 3 presents a literature review on consumers' attitudes and PI. For consumer attitudes, a description of the concept of 'attitudes' is given in terms of how attitudes are formed, why attitudes can change, and the existence of dual attitudes. Thereafter, a description of attitude models is given, and the EV Model of Attitudes is presented together with its three components, namely beliefs, values and expectations. The relevancy of knowledge and sources of GM-related information within the 'beliefs' component of the EV Model of Attitudes is discussed. A discussion of the TPB framework and its three elements, namely attitudes, subjective norms, and PBC, follows. The chapter concludes by presenting the conceptual framework for this study.

Chapter 4 presents the research methodology used in the study, and a description of the research paradigm and design is given. This information is followed by the study location, sampling and recruitment strategy, the data gathering methods, the structure of the demographic questionnaire and interview guide, data analysis, and the operationalisation of the study. The chapter concludes by describing the study's trustworthiness and its ethical considerations.

Chapter 5 presents the descriptive results obtained from the research regarding the participants' demographic profiles and GM context-related information. The chapter also presents the findings and discusses the 'beliefs' data that were obtained regarding GM crops and food products. The beliefs findings are presented and discussed as set out by the study's aims and objectives.

Chapter 6 presents the findings and discusses the 'values' data of GM crops and food products obtained from the research. The discussion is guided by the study's aims and objectives.

Chapter 7 presents the findings and discusses 'expectations' data of GM crops and food products obtained from the research. The expectations findings are presented and discussed as set out by the aims and objectives of the study.

Chapter 8 presents the first part of the findings and discussion of the knowledge, sources of GM-related information and PI of GMFP data, as obtained from the research. The findings are presented and discussed as set out by the study's aims and objectives.

Chapter 9 presents the second part of the findings and discussion relating to the knowledge and PI data of GMFPs, as gathered from the research. The findings are presented and discussed, guided by the study's aims and objectives.

Chapter 10 concludes the research, and the study's findings are presented in terms of the stipulated objectives. A presentation of the study's newly proposed conceptual framework and a description of the study's contribution is provided. Based on the study's findings, recommendations are made to the GM food industry, to disseminate information about GMFPs, and to theory. The limitations of the study are presented, and the chapter concludes by suggesting where future research is needed.

1.8 ACADEMIC-RELATED INFORMATION

This thesis is a follow-up of the researcher's master's degree (exploring consumers' procedural knowledge and perception of genetically modified (GM) food products and the factors that influence their purchasing decision), where the topic in terms of the consumer and GMFPs was expanded on. This was done under the supervision of the same supervisor. In this study, the supervisor requested the researcher (student) to develop a framework. The researcher constructed the proposal for this study under the supervision of the supervisor, while in the thesis, the topic of study, focus area and methodology were discussed and decided on by the researcher and supervisor. The researcher gathered and analysed the data, drew conclusions from the data, and constructed each chapter – all of which was overseen by the supervisor of this study as the reviewer of the thesis.

Under the mentorship of the supervisor, corrections were made by the researcher and aspects that the researcher was uncertain of were discussed with the supervisor, when a joint decision was made and implemented by the researcher. In this thesis, the Harvard referencing style was used. Since there are variations to the Harvard referencing style, the guidelines suggested by the Department of Life and Consumer Sciences at UNISA were used and followed.

Internet sources were used in this thesis, in terms of presenting statistics (as seen in the current chapter). Sources focused particularly on the SA context relating to GMFPs are primarily internet sources available to SA researchers and consumers in the public domain, offering GM-related information in the country. The researcher determined that minimal scientific articles exist on GMFPs in the SA context; thus, internet references and fact sheets available on the internet were used where applicable. Information on new developments in the GM industry or research currently being conducted on GM crops in terms of trials was only available on websites and not yet published in scientific journals at the time of the thesis. These sources were, however, checked for credibility in terms of their information. The information from a majority of these sources was also confirmed on the ISAAA website, which is an international organisation that provides information about agricultural biotechnology and any recent developments in the field, specifically genetic engineering. All their information is peer-reviewed by experts in their respective fields.

The study also used information and reports from governmental and international organisations available on governmental and organisational websites. Institutions conducting research or disseminating findings based on research in the biotechnological field were also used as references. Other limited internet sources that were used in this study were first checked for credibility to ensure that their findings were based on factual information that had been researched or obtained from academic individuals within the current agricultural or biotechnological field. This insight was obtained by exploring what the website was about, its mission and aims. Some references were also used from articles published in magazines and newspapers available on the internet as internet sources; their credibility was also checked. Certain images to depict particular aspects discussed were also retrieved from online sources.

The above-mentioned sources were used in this thesis in the literature review chapter on GM crops and food products to create a thorough understanding and review of recent developments and ongoing research within the biotechnological industry on an international and national basis. Internet sources were used to support demographic data (Chapter 5) related specifically to the SA individual, since information on this population's demographics

is primarily available online. All statistics were obtained from Stats SA and the OECD indicators. However, all arguments, discussions and research used in this study came from scientific sources found in published books and scientific journal articles.

Artificial intelligence was not used to compile or assist the researcher in writing this thesis. Google Scholar was used to identify relevant articles for this research. The sources used in this thesis were obtained through the assistance of UNISA's databases, such as EBSCOhost; Emerald Journals; Sage Journals Online; ScienceDirect; SpringerLink: eJournals, eBooks and eReference; Taylor and Francis Online Journals; and Wiley Online Journals: eJournals, eBooks and eReference. This thesis was also submitted through the Turn-it-in plagiarism software program, and the certificate is included in Appendix F.

Two articles from this study will be submitted to internationally accredited journals as part of the requirement of a PhD degree at UNISA. The information related to each of the articles that will be drafted is provided in Table 1.1.

Table 1.1: Articles Intended for Submission to Internationally Accredited Journals

Name of Article	The Internationally Accredited Journal intended to be Submitted to	Reason for Submission to the Identified Journal
Food Security in South Africa Hinges on Consumers' Beliefs about GMFPs	South African Journal of Science	This article can contribute by showing that consumers' beliefs about GMFPs are important in promoting food security efforts. The information can illustrate whether the use of GMFPs can contribute to sustainable food systems to improve food security. This information can further be used to promote SA consumers' acceptance of GMFPs while remedying any concerns, thereby further promoting food security efforts.
The value of GMFPs can Play a Role in Consumers' Acceptance of GMFPs and Food Security Status	Frontiers in Sustainable Food Systems	Since this journal focuses on exploring solutions to global food security challenges through sustainable food production, this article can contribute by showing that, although GMFPs can be a useful tool in promoting food security efforts, the value consumers assign to these food

Name of Article	The Internationally Accredited Journal intended to be Submitted to	Reason for Submission to the Identified Journal
		products plays an important role in the success of GMFPs in terms of food security.

A local conference in Cape Town was attended in August 2023 (SAAFoST 25th Biennial Congress 2023 28–30 August), where information on a part of the study's findings was presented through a presentation called 'Can Consumers' Beliefs of Genetically Modified (GM) Food Products Advance Food Security in South Africa: Consumers Tell the Truth'. Other local and international conferences will also be considered where the information in this thesis can be presented.

1.9 SUMMARY

In this chapter, an introduction to the study was presented, including the background of the study, the problem statement, the justification for the research, the research aims and objectives, a brief description of the research methodology and design used in this study, and the ethical clearance that was obtained. An outline of the thesis was presented, as well as academic-related information. The following chapter is a literature review on GM crops and food products.

CHAPTER 2
LITERATURE REVIEW ON GENETICALLY MODIFIED CROPS AND FOOD PRODUCTS

This chapter presents a literature review on genetic modification, reflecting existing information about GM crops and food products. The review describes the concept of GMOs, illustrates the global production of GM crops, and presents the benefits of GM crops that can promote food security. The chapter also describes the additional benefits of GM crops and GMFPs, presents the risks and concerns of GM crops and GMFPs, and offers insight into the use of biotechnology on animals. Consumer studies on GMFPs are also presented to understand how such products are perceived among global consumers. The labelling regulations of GMFPs are also discussed, as well as the biosafety frameworks and regulations of GMOs, to create an understanding of the development process of the final GMFP available on the market.

2.1 INTRODUCTION

The rate at which the production and availability of GMFPs are growing worldwide and in SA is an indication that the future of GMFPs generally seems promising and the GM food industry, as a whole, has the potential to continue to grow (Muzhinji & Ntuli 2021; Zhaleh et al. 2023). However, food insecurity is becoming an imminent global problem, particularly affecting developing countries (Olabinjo et al. 2020). Many stakeholders have thus focused their attention on biotechnology, GM crops, and GMFPs' potential to address food insecurity challenges due to their beneficial modified traits (Olabinjo et al. 2020; Zhaleh et al. 2023). Although concerns and risks have been linked to GM crops and food products – which has contributed to the desire for mandatory GM labelling and appropriate biosafety frameworks and regulations – the increased production and availability of GMFPs can assist in supplying the population with an adequate amount of food (Jiang & Zhang 2021; Muzhinji & Ntuli 2021). This approach simultaneously aids in the fight against food insecurity (Muzhinji & Ntuli 2021) while addressing SDG 2: Zero Hunger. The application of biotechnology in animals has also been suggested to supplement the production of GM crops and food products to promote food security efforts (Kalds et al. 2019). A discussion on the concept of GMOs follows to explain how GMOs were developed, which led to the subsequent development of GM crops and GMFPs.

2.2 DESCRIBING THE CONCEPT OF GMOS

Scientists have been improving plant crops over many years through a process known as selective breeding and crossbreeding (Muzhinji & Ntuli 2021). Selective breeding refers to the identification of specific traits in parent plants to produce plants with desirable traits (Caradus 2023). Conversely, crossbreeding refers to a natural process where the existing traits of a crop are improved by hybridising the traits of two species (Anand et al. 2022). In addition to these processes, agricultural biotechnology, which refers to genetically modifying or engineering the plant material of plant crops through technology, allows crops to hold various traits that subsequently enhance the crop's quality (Ruiz et al. 2018). Agricultural biotechnology also allows for the development and production of different varieties of a traditional plant crop (Lamichhane 2014; Aziz et al. 2022). The use of biotechnology in agricultural practices has led to the agricultural industry being the main user of genetic modification (Aziz et al. 2022).

To develop GM plant crops, seeds must first be altered or modified in a laboratory and undergo stringent safety protocols (Akinbo et al. 2021), as discussed in Section 2.9. Modern biotechnological techniques, such as ribonucleic acid (RNA) interference (RNAi) and virus-induced gene silencing (VIGS) can be used to develop crops that are disease and pest-resistant (Chagwena et al. 2019; Zennah & Cyrus 2019). However, the most common gene-editing tool or technique used to manipulate the genes of organisms is known as The Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR-Cas9), which has been employed in various research fields and is also used to develop GM crops (Kalds et al. 2019; Aziz et al. 2022; Tome 2022).

These biotechnological techniques can be used in four different ways: (i) cisgenic, which is when deoxyribonucleic acid (DNA) – genetic material found in all living things (Puhan 2018) – is taken from a different species and placed into the genetic material of a crop; for instance, when a gene of maize is placed into a different variety of maize; (ii) intragenic, which is when DNA is taken from a similar, yet different species, such as barley to wheat; (iii) transgenic, which refers to DNA being taken from a completely different species; for example, when the DNA placed into *Bacillus thuringiensis* (*Bt*) maize is from *Bt* bacterium; and (iv) subgenic, which does not include the insertion of other DNA, but refers to the DNA of a crop being altered within the crop, which can include removing a specific gene from the crop (Ehirim et al. 2020). Therefore, the CRISPR-Cas9 technology can allow a gene to either be removed, silenced, introduced or transferred; subsequently, a plant crop or organism can either lose a gene, have its own gene altered, obtain a gene, or donate a gene (Gbashi et al. 2021; Redden 2021; Rathod & Hedaoo 2022).

When a plant crop or organism has its own gene altered, it is referred to as gene or genome editing, which is a new biotechnological technique used to target a particular gene more accurately (Muzhinji & Ntuli 2021). The process provides scientists with an opportunity to make minor alterations to the DNA of plant crops, which are considered to be more efficient than the DNA changes made by conventional genetic modification that involves the transfer or introduction of foreign DNA (Muzhinji & Ntuli 2021; Bearth et al. 2022). Thus, there is a difference between gene editing and genetic modification. Genetic modification involves the introduction of DNA from other organisms, whereas gene editing focuses on altering the existing DNA in an organism (Bearth et al. 2022). Notably, some countries view gene editing as being the same as genetic modification, while other countries do not (Tome 2022).

The genetic modification process leads to a product called GMOs; thus, a GMFP consists of GMOs and is derived from GMOs (Kubisz et al. 2021). GMOs are defined as "an organism in which one or more genes have been introduced into its genetic material from another organism" (Gbashi et al. 2021). Subsequently, a transgenic or the genetic modification or genetic engineering (GE) of plant food products refers to the science where plant-based foods have been produced from plant material where a genetic composition (a component of the plant material) has been altered to produce a particular characteristic through the insertion of foreign material (Ruiz et al. 2018; Bearth et al. 2022). Biotechnology has thus led to the genetic modification of crops, which involves the process of introducing a newly identified trait into the plant's DNA so that the plant has a specific characteristic – a process that does not occur naturally (Chagwena et al. 2019; Rathod & Hedaoo 2022; Abdoul et al. 2023; Ghimire et al. 2023). The transfer of valuable genes across different species has resulted in faster-growing crops, herbicide and pesticide-resistant crops, disease-resistant crops, and crops with enhanced nutritional content (Ehirim et al. 2020; Rathod & Hedaoo 2022; Abdoul et al. 2023).

The most common traits in GM crops worldwide are herbicide-tolerant (HT) and *Bt* traits (Kotey et al. 2016). HT traits focus on giving GM crops herbicide traits, whereas *Bt* traits focus on giving GM crops insecticidal traits, which is a naturally occurring bacterium (Kotey et al. 2016; Ala-Kokko et al. 2021). Additionally, components of crops are GM to produce food products that possess superior characteristics to their traditional counterparts, such as taste, colour and appearance (Sendhil et al. 2022). Therefore, consumers view biotechnology as a technology that contributes to improving their lives by providing and improving food products with particular characteristics (Bonny 2017; Olabinjo et al. 2020; Sendhil et al. 2022). Therefore, the improvement of food product characteristics, through the use of biotechnology, can entice and encourage producers to farm with GM crops due to the many benefits they can enjoy and

thus pass on to consumers (Ruiz et al. 2018; Dovey & Ntuli 2020), as discussed in Section 2.5.

The rapid advancements and adoption of biotechnology in the agricultural industry have led to an increase in the variety of GM crops authorised for commercial production, such as corn or maize, soybean, cotton, potato, papaya, summer squash, canola, apple, sugar beet, and alfalfa used in livestock feed (Miller 2021; FDA 2022). These crops are all produced in the United States of America (USA) (Thomas et al. 2020; FDA 2022). Other crops have recently been added to the GM crop list, including aubergines and the pink-fleshed pineapple (Thomas et al. 2020; Wray 2021). As Thomas et al. (2020) highlight, many food products have been made from ingredients derived from GM corn, soybeans, cotton, sugar beets and canola. Thus, unbeknownst to many consumers, various food products sold on local and international markets may contain a GM organism or component (Ndlovu 2016; Marx 2017; Kim & Choi 2018; Uddin et al. 2018; Olabinjo et al. 2020; Hwang & Nam 2021; Science for Sustainable Agriculture 2022; Abdoul et al. 2023). It has been claimed that such food products could include GM sweet corn, chips, biscuits, breakfast cereals, and sugar-containing food products made from GM sugar beets (African Centre for Biodiversity 2015a; Naturally Savvy 2019; Casselbury 2020; Dawling 2022; FDA 2022; CBAN 2023). Consequently, a variety of GMFPs could be available on the international market (Vermeulen et al. 2005; Charlebois et al. 2019; Hwang & Nam 2021; Siddiqui et al. 2022). However, it has also been claimed that certain food products remain in their natural state, such as popcorn, oats, sorghum, barley, and rice – with the exception of Golden Rice© in the Philippines (Dessinger 2013; Badore 2018; Bean 2019; Chandra 2019; Muzhinji & Ntuli 2021; CBAN 2022a). In terms of meat products, despite ongoing research in animal genetic modification and editing, animals have not been GM for their meat for direct human consumption, with the exception of the AquAdvantage Salmon© (Kalds et al. 2019; Weir & Sproul 2019), as discussed in Section 2.7. Dairy products also remain non-GMO (Idaho Milk Products 2023).

According to SA sources, although SA has approved GM wheat imports, wheat remains GMO-free, and bread and wheat flour do not contain GM ingredients (Biosafety Information Centre 2023; Nhlaysia Power Supply 2023). In terms of vegetables and fruits, only potatoes, papayas, summer squash, apples, sugar beets, aubergines and pink-fleshed pineapples have been GM on the international market (Thomas et al. 2020; FDA 2022). Most vegetables and fruits have thus not undergone genetic modification and remain in their natural form. As little research has featured the products that SA consumers know contain GM components, this study may shed some light on the matter to understand the extent of consumers' knowledge of the

products they believe contain GM components. The global production of GM crops is discussed next.

2.3 GLOBAL GM CROP PRODUCTION

Genetic modification technology has made a rapid entry into the agricultural industry, which has been attributed to GM crops being commercially cultivated since 1996 (Lamichhane 2014; Aziz et al. 2022). China was the first country to commercialise virus-resistant tobacco in 1992, after which the European Union (EU) allowed the commercialisation of tobacco after the plant was tested to be resistant to an herbicide known as bromoxynil (Abbas 2018). After virus-resistant tobacco, the Flavr Savr™ Tomato was developed in 1994, which was the first GM food crop approved by the Food and Drug Administration (FDA) for commercialisation and human consumption in the USA (Aziz et al. 2022). This variety of tomatoes had a slower ripening process and thus a longer shelf life (Islam et al. 2020; Blagoevska et al. 2021).

The adoption of biotechnology across the globe has led to the commercial production of GM crops for 25 years, with maize or corn, soybeans, cotton and canola being the major GM crops produced in 29 countries (Ala-Kokko et al. 2021; Heng et al. 2021). Thus, GM varieties of soybeans, maize, cotton and canola are the most widespread GM crops grown across the world, most of which are herbicide and pest or disease-resistant; other crops are being developed and undergoing trials, like banana, sorghum and lettuce (Ehirim et al. 2020; Ewa et al. 2022; Gbadegesin et al. 2022), to name a few. The production of GM crops is largely dominated by the USA, Brazil, Argentina, Canada and India, which produce GM crops on a large scale (Smyth 2020). In Argentina and Brazil, GM crop production is largely dominated by soybean; in Canada, canola is the most-adopted GM crop produced in the country; and in India, GM crop production is dominated by GM cotton (Baghbani-Arani et al. 2021). Paraguay, SA, China, Pakistan and Australia also contribute to the global GM crop production (Redden 2021).

The trends in the increased hectarage occupied by GM crops are noteworthy (see Figure 2.1). In 2010, 10% of the global land used for crop production was occupied by GM crops, and in 2015, the global area devoted to GM crop production was 179.7 million hectares, which increased to 185.1 million hectares in 2016 (Ghanian et al. 2016; Ehirim et al. 2020). In 2018, it was documented that 70 countries either produced GM crops or imported GMFPs, indicating that the commercialisation of such food products was readily accepted worldwide (Muzhinji & Ntuli 2021). The production of GM crops continued to grow, as can be seen between 1996 and 2019, when the total global area used for GM crop production increased from 1.7 million

hectares to 190.4 million acres; this translates to a 112/113-fold increase (ISAAA Inc. 2019; Gbadegesin et al. 2022), as shown in Figure 2.1.

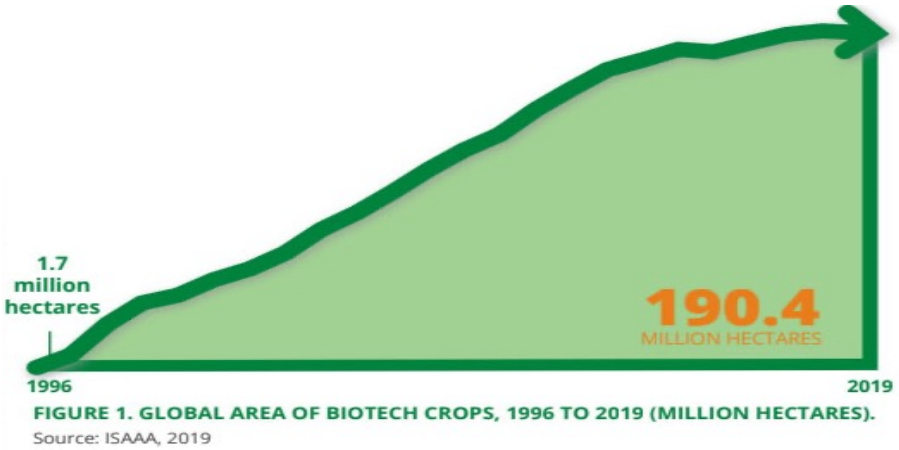

Figure 2.1: Global Area used for GM Crop Production from 1996 to 2019 (ISAAA Inc. 2019)

These statistics demonstrate that modern biotechnology is considered the fastest-adopted technology on the globe (Gbadegesin et al. 2022). To indicate the growth of GM crops, it was estimated that 60% of the crops planted in 2020 were GM HT crops (Brookes 2022). Moreover, in December 2022, China approved eight new GM crops for importing purposes, namely three GM cotton varieties, GM rapeseed, two GM sugarcane varieties, and two GM alfalfa varieties (McDonald 2023). In addition, an estimated 44 countries have accepted 40 GM crops from a regulatory point of view, and since January 2022, there have been 509 trials on the genetic modification of crops (Aziz et al. 2022). Such statistics point to the rapid rate at which countries are adopting biotechnology and producing GMFPs (Muzhinji & Ntuli 2021), illustrating the importance of understanding consumers' position toward GMFPs, as their views could impact the adoption and production of such food products.

2.3.1 GM Crop Production in Africa

In Africa, four countries, namely SA, Burkina Fuso, Egypt and Sudan, are engaged in the production of GM crops and have thus commercially cultivated these crops despite having fewer resources, infrastructure and finances than developed countries (Emede & Fasina 2020; Mmbando 2023). Among these African countries, SA was the first to commercialise GM crops and has thus significantly contributed to global GM food production (Gbashi et al. 2021). In recent years, countries on the African continent such as Ghana, Nigeria, Mauritius, Namibia and Zambia have imposed significant efforts to effectively implement their bio-safety regulations to join other African countries in conducting field trials and ultimately contribute to the production of GM crops (Ehirim et al. 2020). Ehirim et al. (2020) add that international

governments have assisted African countries in conducting research and confined field trials on GM crops such as cotton, maize, soybean, cassava, cowpeas, banana, sweet potato, sugar cane, and rice. The authors continue that resistance to droughts, high temperatures, diseases and pests are some of Africa's main areas of biotechnological research. Table 2.1 reflects the various GM crops that are tested or cultivated on the African continent.

Table 2.1: GM Crops Tested or Cultivated on the African Continent (Ehirim et al. 2020)

GM Crop	Trait	Country
Cotton	Insect resistance	Ethiopia, Kenya, Malawi, Tanzania, Uganda, Zimbabwe, SA, Nigeria
Maize	Insect resistance	Kenya, SA, Tanzania, Uganda
Soybean	Herbicide resistance	SA
Cassava	Nutrient density, disease resistance, virus resistance	Ghana, Kenya, Nigeria, Uganda
Cowpeas	Insect resistance	Burkina Faso, Ghana, Nigeria
Banana	Nutrient density, disease resistance, fungal resistance	Uganda
Sweet potato	Virus resistance	Kenya, SA
Sugar cane	Growth, sugar content, virus resistance	Mauritius, SA
Rice	Water efficient and salt tolerable	Nigeria, Ghana, Uganda

As seen in Table 2.1, significant progress in Africa is being made in GM crop production since more farmers are becoming GM crop practitioners. It will thus be beneficial to focus on the role that consumers can play in maintaining such progress. A discussion on the production of GM crops and research on such crops in SA follows.

2.3.2 GM Crop Production in South Africa

Since 1997, the South African Committee on Genetic Experimentation (SAGENE) has been researching the use of genetic modification in the agricultural industry, which contributed to SA being the first African country to adopt these GM crops, ranking within the top ten producers of such crops (Esterhuizen & Bonsu 2020; Gbashi et al. 2021). This is an indication that it will be advantageous for the country to understand consumers' views of these food products, thereby promoting SA's continuous contribution to the GM food industry.

Currently, three crops are cultivated in SA (maize, soya and cotton) to retain insecticide and herbicide-resistant traits (Gbashi et al. 2021; Kedisso et al. 2022). Insect-resistant (IR) cotton was the first GM crop to be grown in SA in 1997 and accounted for 100% of the cotton produced in the country in 2020, whereas HT soybean has been grown in SA since 2001

(Esterhuizen & Bonsu 2020). The authors add that soybean was grown on 705 000 hectares of land and contributed to 95% of all soybeans cultivated in 2020. Also, until 2008, SA was the only country to produce GM maize, GM cotton and GM soybean in Africa; since then, Egypt has embraced the production of GM maize, and Burkina Faso started growing GM cotton, as previously mentioned (Goitom 2014; Chondie & Kebede 2015; Mmbando 2023). However, SA remains the largest producer of GM crops with herbicide and insect-resistant traits on the African continent (Gbashi et al. 2021), showing that these attributes are of particular significance and relevance to the country. From a consumer point of view, it is unclear whether consumers are apprised of the current production status of GM crops within SA and whether they are aware that the sole focus of GM is herbicide and insect-resistant traits. The question also remains whether the focus on these two traits in SA will be enough to enhance food security.

In SA, GM yellow maize was accepted for commercial production in 1998-1999, and in 2001, GM white maize was commercialised, which was the first GM crop used for direct human consumption; it is known to be a food-to-plate crop (Gouse et al. 2016; Ala-Kokko et al. 2021). Due to SA's rapid progress in GM crop adoption, the country has been praised for leading by example by genetically modifying the components of one of their main staple foods (foods consumed frequently, in large quantities, and form an integral part of their daily diet) (Shew et al. 2021; Santos et al. 2023). In 2002, small-scale farmers in SA produced GM maize for their own consumption (Shew et al. 2021). Soon after adopting yellow and white GM maize, SA commercialised HT maize in 2003-2004 and *Bt* maize in 2007-2008 (Gouse 2012). In 2016, this resulted in the use of HT and *Bt* cultivars for 74% and 91% of the total maize produced in SA, respectively (Brookes & Barfoot 2020). In 2013, it was estimated that 86% of maize produced in SA was GM, and in 2017, an estimated 1.1 million hectares of land was used for the production of GM maize varieties for human consumption (Ala-Kokko et al. 2021; Shew et al. 2021).

Generally, a consensus has been reached that the production of GM crops in SA has increased; in 2001, the total GM crop area was 197 thousand hectares, which increased to approximately 2.7 million hectares in 2018 (Masehela et al. 2016; Lewis & Sirinathsinghji 2020). In 2020-2021, 2.9 million hectares of GM crops were grown in SA, and the average volume per hectare obtained from producing GM maize increased by 5.6 tonnes; an average of 2.4 tonnes per hectare was achieved before GM maize production was implemented in SA (Sihlobo 2022; Zambrano et al. 2022). Therefore, with the production of GM maize, it has been suggested that SA can contribute to alleviating food insecurity within the country and assist the population in becoming more food secure (Ala-Kokko et al. 2021). This view is echoed by

Shew et al. (2021), who conducted a study in SA focusing on the yields of GM maize. The researchers concluded that GM maize can adapt to climate change and be grown by producers in high and low-production regions, reiterating that GM maize can contribute to supporting food security in SA. The SA government also reported that they aim to continue producing even more maize using less land, enabling farmers to rely on fewer water resources while promoting soil quality (Goitom 2014).

To demonstrate the progress of GM-crop adoption in SA, the Agricultural Biotechnology Annual Report of 2020 indicated that there were 20 ongoing GM crop events in SA, and 44 field trial permits had been issued (Esterhuizen & Bonsu 2020). The country has exhibited its desire to incorporate GM technology and GM crops into its agricultural crop production, and SA is considered a leader of GM technology on the African continent; the country has devoted 30 years to biotechnology research and development in the area (Esterhuizen & Bonsu 2020; Zambrano et al. 2022). Therefore, it is vital to understand where consumers have positioned themselves in terms of GMFPs to ensure that the production of these food products is accepted, thereby aiding the country in remaining a prominent contributor to the GM food industry.

2.3.2.1 GM-Containing Food Products in SA

GM white maize is the only staple crop commercially grown in SA, making SA unique in this respect (Ala-Kokko et al. 2021). It has been stated that no other major GM staple food has been commercialised globally to the extent that GM maize has been in SA (Shew et al. 2021). Many of SA's milled maize products are sold through different companies, such as Ace, White Star, Iwisa Super Maize Meal, Tiger Brands, Pioneer Foods and Premier (Jaffer 2014; African Centre for Biodiversity 2015a). These products comprise 73% of the maize meal market in SA, and many South Africans are thus exposed to higher levels of GM ingredients (Vermeulen et al. 2005; Jaffer 2014; African Centre for Biodiversity 2015a). Figure 2.2 shows the percentage of GM components found in each of these maize products from the different brands.

Figure 2.2: South African Maize Products Containing a GM Component (Jaffer 2014)

Figure 2.2 shows various maize meal products in SA contain varying levels of GM ingredients and are readily available on the market. Ace Instant porridge – sold in SA supermarkets – also contains GM maize (African Centre for Biodiversity 2013). Furthermore, an array of white breads sold in SA contains GM soya flour, such as Checkers white bread, Woolworths white bread, Spar white bread, Blue Ribbon white bread, Pick n Pay white bread, Albany superior white bread, and Sunbake white bread (Gosling 2014; Faithful to Nature 2022). The GM content of the soya flour contained in these varieties of bread is depicted in Table 2.2.

Table 2.2: GM Content in Soya Flour in White Breads sold in SA (Faithful to Nature 2022)

White Bread Brand	GM Content in the Soya Flour
Checkers white bread	91.09%
Woolworths white bread	85.62%
Spar white bread	72.69%
Blue Ribbon white bread	64.90%
Pick n Pay white bread	42.82%
Albany superior white bread	23.23%
Sunbake white bread	20.46%

As shown in Table 2.2, Checkers white bread contains the highest GM soya flour content, and Sunbake white bread contains the lowest (Faithful to Nature 2022). A consumer study conducted in Athens, Greece, to explore the perceived risks and benefits associated with GMFPs similarly found that bread was identified as a food product containing GM ingredients (Arvanitoyannis & Krystallis 2005). In addition, an array of cereals sold in SA supermarkets could contain GM maize or soya, such as Rice Krispies (African Centre for Biodiversity 2015a; EWG 2022). Bokomo and Kellogg's Corn Flakes could also contain GM ingredients (Bokomo 2022; Kellogg's 2022). Thus, SA consumers could unknowingly consume various food products containing GM soya (GMOs in South Africa Series 2012).

Jonker (2017) conducted a study in SA to determine consumers' knowledge, attitudes, beliefs and actions toward GMFPs. The findings indicated that consumers thought GM fruits and vegetables were sold on the SA market. However, despite consumers' perception that components of fruits and vegetables have been GM, no GM fruits and vegetables are available on the SA market (African Centre for Biodiversity 2015b; Woolworths 2020). Two respective studies conducted in Australia to determine consumers' attitudes toward gene technology and in Pakistan to establish consumers' knowledge and attitudes of GMFPs also reported that consumers assumed vegetables and fruits were GM and available for purchase (Cormick & Mercer 2017; Amin et al. 2021); for example, potatoes and tomatoes, as found in the study carried out by Arvanitoyannis and Krystallis (2005).

This study's findings can reflect whether SA consumers also perceive vegetables and fruits as GM and if they know that various GM maize and soya-containing food products are available for consumption. This information can point to which food products consumers associate with genetic modification, which can assist in an understanding of their views and knowledge of GMFPs.

A discussion of GM crops' benefits in promoting food security follows.

2.4 BENEFITS OF GM CROPS THAT CAN PROMOTE FOOD SECURITY

SDG 2 was developed to address aspects such as poverty and hunger; however, various factors could impede crop production and prevent these goals from being achieved, thereby leaving communities even more vulnerable to food insecurity (Muzhinji & Ntuli 2021; Akora & Mishra 2022). Such factors could include pests, insects, diseases and climate change (Gbashi et al. 2021). Crop losses caused by pests and diseases have a devastating impact on the economy, as an estimated 15% of income is lost due to crop losses in developing countries (Gbashi et al. 2021). Many farmers in the SADC countries have experienced and reported crop losses due to insects, bacteria, fungi and viruses (Muzhinji & Ntuli 2021). Crops are typically infected by pests and diseases before they are harvested, which reduces the quality of the crops, damages the crops, and reduces the crop yield, thereby reducing the market value of these food products (Gbashi et al. 2021; Kovak et al. 2022). Subsequently, farmers experience annual crop losses of approximately 20-40%, which is directly linked to the invasion of pests and diseases (Raman 2017). The prevalence of pests and diseases is also becoming more evident due to changes in the weather, the emergence of different pathogen varieties, and the movement of plant materials between countries (Muzhinji & Ntuli 2021). To address this phenomenon, farmers have resorted to the use of herbicides and pesticides, but the use of these chemicals is not favourable to the surrounding environment and organisms in the soil (Ghanian et al. 2016).

Fortunately, advances in biotechnological innovations have led to crops being produced that are pest- and disease resistant, and thus less reliant on herbicides and pesticides, affording farmers the opportunity to reduce or completely refrain from spraying their crops with chemicals (Schutte et al. 2017; Smyth 2017; Aziz et al. 2022). The use of biotechnology has further allowed genes to be tailored to resist climate change, thus assisting in achieving SDG 2: Zero Hunger (Blakeney 2009; Gil et al. 2019; Aziz et al. 2022; Pardo et al. 2023). The application of biotechnology in agricultural production has increased crop yields by an

estimated 22%, which serves as a major economic benefit to farmers as food production can be increased (Komen et al. 2020). GM crops can thus promote production efforts, thereby increasing the local and global availability of food and posing as a possible solution to food insecurity (Qaim & Kouser 2013; Dizon et al. 2016; Conrow 2020; Islam et al. 2020; Rathod & Hedaoo 2022; Ghimire et al. 2023).

The various crops that have been GM to be resistant to pests, insects and diseases, as well as climate change, are discussed next.

2.4.1 Pest, Insect and Disease-Resistant GM Crops and Increased Crop Yields

An example of the advancements in biotechnology, in terms of creating pest and disease-resistant crops, can be seen in maize crops: *Bt* maize is produced in the EU, Spain, Portugal, SA, USA, Brazil, Argentina, Uruguay, Brazil, Canada, Honduras, Colombia and the Philippines, and are resistant to insects such as the European corn borer Lepidoptera, which has decreased crop losses and increased crop yields (Brookes 2019; Zennah & Cyrus 2019; Alvarez et al. 2021; Gbashi et al. 2021; Muzhinji & Ntuli 2021). Many small-scale farmers have reported an estimated 98% of sweet potato crop yield loss as a result of highly threatening diseases that specifically target these crops, such as the mild mottle virus, the chlorotic stunt virus, and the sweet potato latent virus (Zennah & Cyrus 2019), just to name a few. According to Zennah and Cyrus (2019), scientists in SA turned to biotechnology to remedy this devastating loss in crop yield by developing a different variety of sweet potato, known as the transgenic 'Blesbok', which has shown promising results in providing resistance to the pre-identified diseases. It has been argued that sweet potatoes are 'naturally genetically modified' as they contain *Agrobacterium* genes, which are the genes used in GM crops (Kyndt et al. 2015).

Globally, various other crop plants have undergone genetic modification to increase crop yields (Mabhaudhi et al. 2019). For example, *Bt* soybean was GM to control lepidopteran insects in Latin America; papaya in Hawaii to provide resistance to the ringspot virus; *Bt* brinjals in Bangladesh to retain resistance against insects such as the Brinjal Fruit and Shoot Borer; pigeon pea in India to attain resistance to pests; and IR sugarcane was GM in Brazil (Abbas 2018; Sekeli et al. 2018; Shelton et al. 2020; Szenkovics et al. 2020; Kubisz et al. 2021). In 2020, the Philippines announced that the borer-resistant *Bt* eggplant received approval for commercial cultivation (Cariaso 2022). In Kenya, *Bt* cassava has been approved for cultivation, and a component of the plant crop was GM to increase resistance to the cassava brown streak disease (CBSD) (Chikoti & Tembo 2022). China, India, Argentina,

Indonesia, Mexico, Pakistan, Nigeria, SA and the Philippines are also producing *Bt* cotton that is resistant to the pink bollworm (Christou & Twyman 2004; Qaim & Kouser 2013; Szenkovics et al. 2020; Akinbo et al. 2021; Gbashi et al. 2021; AgNews 2023a). Bangladesh has also approved two varieties of their second GM crop, namely *Bt* cotton, for increased yields, while Brazil has approved two varieties of transgenic cotton that are resistant to pests and diseases (Hossain 2022; ISAAA Inc. 2022). In Nigeria, *Bt* cowpea was approved for commercial release, which is resistant to the pod-borer insect (Gbashi et al. 2021). Ghana has also approved the environmental and market release of *Bt* cowpea, while the GM banana – which is resistant to the Panama disease – is in the approval process in Australia for commercial cultivation (Muthie 2022; Lu 2023). Continuous progress is thus being made in the adoption of pest and disease-resistant GM crops in numerous countries.

It is promising to note that increasingly more countries are applying GM technology to their existing farming practices to genetically modify components of plant crops that are pest and disease-resistant (Raman 2017; Nazir et al. 2018; Ala-Kokko et al. 2021; Blagoevska et al. 2021; Gbadegesin et al. 2022; Shen et al. 2022; Abdoul et al. 2023). Achieving these attributes across various crops can further limit farmers' dependence on spraying crops with chemicals (Gbashi et al. 2021). Growing crops with such traits contributes to increased crop yields, which imparts an additional benefit to food security (Taheri et al. 2017; Ala-Kokko et al. 2021; Blagoevska et al. 2021; Shen et al. 2022; Mmbando 2023). In terms of attaining higher crop yields, the field trials of the GM mustard DMH-11 in India showed that this variety of mustard seeds produces higher yields, and field trials on GM rice in China and GM potato in Nigeria, respectively, show similar results (Koshy 2022; Nnabuife 2023; Nulimaimaiti 2023). Field trials of GM wheat and barley, intended to have an increased yield, have also been approved in Australia, while GM maize and soybean have been approved in China (Department of Health and Aged Care 2023; Zuo 2023). These approvals demonstrate GM crops' and GMFPs' potential to produce more food. Therefore, higher yields allow farmers and producers to produce more food products, thereby making GMFPs more readily available and accessible to the population at a reduced price, contributing to food security (Qaim & Kouser 2013; Hassan et al. 2016; Sendhil et al. 2022). Research thus shows that pest, insect and disease-resistant traits, as well as crop yields, are important attributes of GM crops used in the agricultural industry. It is unknown whether these traits are important to the SA consumer and if they influence their attitudes towards GMFPs.

2.4.2 Climate Change

Concerns about food security are also amplified by global warming, which results in climate change (changes in weather patterns), leading to increased temperatures, unpredictable rainfall patterns, the emergence of diseases, and soil degradation, which directly influences farming practices (Quaye et al. 2012; Abbas et al. 2022). Climate change has led to a 21% reduction in global agricultural food production since 1961, translating to the loss of an average of seven years of food production (Watters 2021). In 2007, the UN predicted that in SSA, the land affected by severe droughts would increase from 60 million hectares to an estimated 90 million hectares by 2060 (Sasson 2012). Sasson (2012) continued to state that, in SA, it has been forecasted that the country could lose as much as 30% of its maize production from 2012 to 2030 to the effects of climate change. Climate change is thus posing a major concern to the agricultural food industry (Watters 2021). Furthermore, SSA is particularly concerned about the impact of droughts and flooding on maize production since maize is readily consumed in these countries (Ala-Kokko et al. 2021). Ala-Kokko et al. (2021) concur that the risk to maize production could further contribute to an already-burdened food-insecure scenario in countries such as Botswana, Eswatini, Lesotho and Namibia, which are already relying on the importation of maize from SA to meet their food demands.

Farmers are particularly vulnerable to climate change as the changes in weather patterns can cause havoc on the productivity of farmlands, resulting in crop losses and reduced yields and food supplies (Blakeney 2009; Pardo et al. 2023). These outcomes could lead to food shortages, exacerbating an already-burdened food-insecure scenario (Muzhinji & Ntuli 2021). These authors highlight that food shortages are further compounded by the fact that changes in weather patterns could potentially slow the onset of the growing season, placing even more strain on crop production. This can increase food prices and worsen individuals' food-security status, hunger and poverty (Quaye et al. 2012; Hendriks et al. 2022). Such occurrences are particularly concerning to the livelihoods of small-scale farmers who may not have the resources to adapt to climate change (Blakeney 2009).

Regrettably, the rate at which the human population has grown over the last 100 years has led to an estimated 60% increase in greenhouse gas carbon dioxide (CO_2), contributing to the increase in temperatures (Redden 2021). Redden (2021) adds that this is concerning to the agricultural industry, particularly since more than nine billion people will have to be fed by 2050. This could be a difficult task as the population is expected to continue growing, and climate change is predicted to become even more prevalent (Muzhinji & Ntuli 2021; Redden 2021). Climate change is thus presenting as an obstacle to the attainment of SDG 2.

Climate change can elicit droughts, flooding and tropical cyclones, which can potentially cause crop destruction, thereby adding a further dimension to the challenge of ensuring food security (Quaye et al. 2012; Hendriks et al. 2022). The food production situation is also worsened by water unavailability, which is a particular concern (Quaye et al. 2012). The authors continue that the United Nations' Intergovernmental Panel on Climate Change forecasts that rainfall may increase in some areas, but in subtropical land areas, it could decrease by an estimated 20%, leaving crop yields vulnerable. This could be particularly devastating to the agricultural producers in African countries who depend largely on rainfall due to the financial inability to install adequate irrigation (Muzhinji & Ntuli 2021). It is thus predicted that climate change can contribute to a lack of food, limited water access and extreme flooding, leaving many people vulnerable in their food-security status (Hendriks et al. 2022).

2.4.2.1 Use of Biotechnology to Address Climate Change

It is important for the agricultural sector to withstand climate change by adjusting the ways in which technology is incorporated and utilised in agricultural production (Quaye et al. 2012; Hendriks et al. 2022). Thus, in response to climate change issues, genetic engineering technology has been welcomed to genetically modify components of crops with specific traits to make them more tolerable and resistant to harsh weather conditions such as droughts and floods, increasing crop yields and stabilising food supply (Van Acker et al. 2017; Husaini & Sohail 2018; Nazir et al. 2018; Blagoevska et al. 2021; Kovak et al. 2022; Shen et al. 2022; Siddiqui et al. 2022; Mmbando 2023). Crops can further be GM to withstand frost, salinity and soil pH changes (Islam et al. 2020). Genetic modification technology can also genetically modify crops to retain traits that make them resistant to high temperatures while requiring less water and improving their ability to cope with wet monsoon seasons (Islam et al. 2020; Szenkovics et al. 2020). Components of plant crops can further be modified to grow in marginal lands and infeasible soil, in areas where traditional crops are not usually grown, thereby mitigating the agricultural challenges that farmers are experiencing due to climate change (Raman 2017; Van Acker et al. 2017; Nazir et al. 2018; Olabinjo et al. 2020; Blagoevska et al. 2021; Kovak et al. 2022; Shen et al. 2022).

To illustrate biotechnology's significance in combatting climate change, the African Agricultural Technology Foundation (AATF) established the TELA Maize Project to assist SSA in fighting climate change; it is aimed at commercialising variants of maize that are drought-tolerable (through biotechnology) (Gbashi et al. 2021). TELA maize has been adopted in SA, while Nigeria has approved trials to commence on TELA maize (Gbashi et al. 2021). Drought-tolerable soybean – also referred to as HB4® – has also been approved in the USA, Brazil,

Argentina, Paraguay, Canada and, most recently, in China (Bioceres Crop Solutions 2021; Bioceres Crop Solutions 2022). Researchers from the Kendal Hirschi Lab at Baylor College of Medicine in Texas, USA, received approval for a heat-resistant gene (Shalchi 2021). The author adds that tomato plant crops have been GM with the gene and have undergone trials. According to Shalchi (2021), results reflected that the crop produced fruit and did not wilt despite being subjected to high temperatures. The author is optimistic that these results are promising and could be largely beneficial in genetically modifying plant crops to withstand higher temperatures.

Argentina has welcomed the announcement of becoming the first country to approve drought-tolerable GM wheat production on an experimental basis, giving farmers much hope for dealing with climate change while promoting wheat crop yields, particularly considering that wheat is grown extensively in the country (Reuters 2020). This GM wheat is referred to as HB4® wheat, which will be imported from Argentina for food and feed use by countries such as Columbia, Australia, New Zealand, Nigeria, the USA and SA (Schroeder 2022; Bioceres Crop Solutions 2023). After Argentina, Brazil was the second country to approve the cultivation of HB4® wheat for commercialisation and cultivation purposes (Bioceres Crop Solutions 2023). Furthermore, in Australia, food products derived from HB4® wheat flour have been approved to be sold on their food market, which could include – but are not limited to – food products such as bread, biscuits and pasta (Jones 2022). This GM wheat variety has also been approved in Paraguay (AgNews 2023b). In addition, researchers at the Egyptian Atomic Energy Authority (EAEA) produced a GM wheat variety that is resistant to water scarcity (Egypt Today 2022), illustrating biotechnology's potential to create crops that resist climate change. Such research further demonstrates that the weather-resistant characteristics of GM crops are becoming increasingly popular in the agricultural industry. However, it is unclear whether these traits are important from an SA consumers' point of view and whether they impact their attitude toward GMFPs.

It is becoming increasingly clear that it is pertinent for the world to realise GM crops' value and subsequently invigorate countries' respective agricultural sectors to achieve food security by embracing GM crop production. Tailoring crops' plant material to foster resistance to pests, insects, diseases, and climate change contributes significantly to enhancing productivity and attaining increased yields. These factors could ultimately assist in increasing household incomes, reducing poverty and hunger, and increasing the food security status of households, thereby contributing to attaining SDG 2 (Smyth 2020; Aziz et al. 2022). Therefore, it remains critical to consider what role consumers play in achieving SDG 2 through the production of GMFPs, which the findings of this study can illustrate.

There are many other benefits linked to GM crops and GMFPs, which are subsequently discussed.

2.5 ADDITIONAL BENEFITS OF GM CROPS AND GMFPS

The genes of crops have been GM for the various reasons discussed earlier, and the development of GMFPs also retains particular consumer benefits. The most evident benefits of GM crops and food products, namely environmental benefits, economic benefits, health and nutritional benefits, as well as aesthetic and food processing benefits, are presented in the following sub-sections. Thereafter, consumer studies on the benefits of these crops and food products are presented to understand their position regarding such benefits.

2.5.1 Environmental Benefit of Producing GM Crops

The use of biotechnology in agricultural production fosters environmental benefits (Smyth et al. 2021). As discussed in Section 2.4.1, with the genetic modification of plant material, crops retain genes that make them resistant to pests and diseases, and the use of chemicals and herbicides is thus reduced (Pino et al. 2016; Raman 2017; Smyth 2017; Van Acker et al. 2017; Komen et al. 2020; Aziz et al. 2022; Kovak et al. 2022; Sendhil et al. 2022; Shen et al. 2022; Abdoul et al. 2023; Mmbando 2023). In turn, it is beneficial to the environment as less cropland is needed to produce the same quantities of crops (Morris & Adley 2000; Herman et al. 2019; Conrow 2020; Islam et al. 2020; Aziz et al. 2022; Siddiqui et al. 2022). Over the past 20 years, the global use of chemical pesticides has reduced by 37% (Komen et al. 2020). In SA, the South African National Biodiversity Institute (SANBI) reported that over a period of 20 years, the amount of chemical insecticides used on *Bt* crops has significantly decreased compared to the use on traditional varieties of crops (Gbashi et al. 2021). From 1996 to 2016, the use of pesticides worldwide reduced by an estimated 448 million kg, contributing to a reduction in the total amount of CO_2 emissions, which was reported to be the equivalent of removing 8.6 million cars from the planet (Brookes & Barfoot 2017). The reduced CO_2 emission released into the atmosphere is largely beneficial to the environment, and the production of GM crops is thus viewed as being environmentally friendly (Pino et al. 2016; Raman 2017; Van Acker et al. 2017; Herman et al. 2019; Islam et al. 2020; Sendhil et al. 2022). The reduced use of chemicals can also benefit farmers as their exposure to such chemicals is minimised (Raman 2017; Van Acker et al. 2017; Ala-Kokko et al. 2021; Kovak et al. 2022; Sendhil et al. 2022).

In terms of chemicals, Roundup-ready crops have been developed, which refers to crops that have been GM to retain a resistance to an herbicide known as glyphosate, which is commonly

sprayed on GM crops to assist with weed control (Novotny 2022). Roundup-ready crops thus assist with weed management as glyphosate herbicide can be used to kill weeds without risking any harm to the crops or compromising the crops, which has further been considered to have fewer human and environmental risks (Brookes & Barfoot 2017; Van Acker et al. 2017; Vicini 2017; Herman et al. 2019; Blagoevska et al. 2021). In SA, a Roundup-ready soybean was approved in 2001, while the approval of a new GM soybean trait in 2021 was announced, which is herbicide and insect resistant (Cilliers 2021). An herbicide-resistant soybean has also been approved in the USA, Argentina, Brazil, Romania, Mexico, Bolivia, Paraguay and Uruguay (Addey 2021; Baghbani-Arani et al. 2021; Brookes 2022). Roundup-ready cotton is also produced in SA, in addition to the *Bt* cotton variety (Louw 2022). Internationally, glyphosate-resistant or Roundup-ready sugar beet has been approved for consumption in the USA, while HT sugar beet is produced in Canada (Morishita 2016; Brookes 2022). Australia has announced the commercial release of herbicide-resistant GM canola, offering farmers much hope in their quest to control weeds (Redden 2021). China has also approved field tests on GM HT maize, Australia has allowed the commercial release of GM Indian mustard, which is also herbicide resistant, and India has approved confined field trials on GM HT cotton and maize (Reidy 2021; AgNews 2022; Kulkarni 2022). Thus, progress is being made in genetically modifying components of plant crops to retain herbicide-resistant traits (Redden 2021).

Moreover, the management of weeds allows land to retain moisture while promoting soil fertility, thereby enhancing the soil's productivity levels (Schutte et al. 2017; Kubisz et al. 2021). In terms of promoting soil health, field trials on GM barley have been approved in the United Kingdom (UK) to reduce the use of synthetic fertilisers (University of Cambridge 2022). The tobacco plant has also been GM with a gene from grey mangrove, making the tobacco plant more capable of dealing with soil stress, thereby benefiting the environment (Lamichhane 2014). The production of GM crops also benefits the environment by reducing waste as the soil is protected while reserving water and energy resources during its production stages, thereby promoting environmental sustainability (Ghanian et al. 2016; Olabinjo et al. 2020). Additionally, the adoption of GM crops in farming practices further promotes no-tillage, which lowers fossil fuels and helps farmers reduce their carbon footprint (Van Acker et al. 2017; Kubisz et al. 2021; Kovak et al. 2022). No-till systems further reduce soil erosion and encourage the use of less farming equipment and fuel, thereby reducing CO_2 emissions (Baghbani-Arani et al. 2021). No-till systems also assist soil to retain more carbon, which, in turn, benefits the surrounding environment as less CO_2 emissions are released (Brookes & Barfoot 2017; Schutte et al. 2017; Van Acker et al. 2017; Kubisz et al. 2021; Kovak et al. 2022).

The production of GM crops lends itself to the use of less land to produce more crops, which, in itself, benefits nature and the environment since fewer resources are needed during the production and harvest period (Ausubel et al. 2013; Masehela et al. 2016; Raman 2017; Taheri et al. 2017; Van Acker et al. 2017; Conrow 2020; Islam et al. 2020; Kovak et al. 2022; Shen et al. 2022; Zhaleh et al. 2023). The outcome is a reduction in CO_2 emissions and has thus been considered as promoting a 'greener' form of food production (Van Acker et al. 2017). It has also been argued that the use of less land, through GM crop production, contributes to the preservation of the environment for wildlife (Vicini 2017). To illustrate, based on the GM crop production in 2020, Brookes (2022) suggested that an extra 11.6 million hectares of soybean, 8.5 million hectares of maize, 2.8 million hectares of cotton, and 0.5 million hectares of canola would have to be planted to attain the same quantities of these crops. Evidently, modern biotechnology has the potential to produce GM crops that foster environmental benefits, which can contribute to enhancing food security. In the SA context, the findings of this study can show whether environmental benefits are an important trait of GM crops to consumers, and if it has any influence on their attitude towards GMFPs.

2.5.2 Economic Benefit of Producing GM Crops

The adoption of biotechnology and GM crops in agricultural farming practices has significant economic benefits (Ala-Kokko et al. 2021; Kubisz et al. 2021; Pardo et al. 2023). GM crop producers can benefit financially as profit margins can be increased due to lower production costs (Brookes & Barfoot 2017; Raman 2017; Taheri et al. 2017; Van Acker et al. 2017; Muzhinji & Ntuli 2021; Kovak et al. 2022). Increased profitability can further be attributed to the use of less land and water resources, reduced labour inputs, and the reduced use of pesticides and herbicides – all of which are costs crop farmers generally incur (Ghanian et al. 2016; Hassan et al. 2016; Schutte et al. 2017; Van Acker et al. 2017; Kubisz et al. 2021). Additional aspects such as improved tolerability, reduced crop damage and losses, resistance to pests, insects and diseases, and increased crop size and high-quality yields can further contribute to increased profitability (Taheri et al. 2017; Van Acker et al. 2017; Ala-Kokko et al. 2021; Kovak et al. 2022; Sendhil et al. 2022). Producing crops that grow at a quicker rate can also impart benefits to the producer, such as in the case of GM cherry tomatoes that are being developed in the Cold Spring Harbor Laboratory in New York (Budin 2023). Such traits are particularly beneficial to developing countries where limited resources and infrastructure could be an issue (Muzhinji & Ntuli 2021).

Due to the potential costs farmers save during the production stages of GM crops, consumers benefit as food products can be sold at a lower and more affordable price to the public (Chen

2008; Zhu et al. 2018; Dovey & Ntuli 2020; Prianto et al. 2020; Amin et al. 2021; Jiang & Zhang 2021; Sendhil et al. 2022; Siddiqui et al. 2022; Alalwan et al. 2023). This illustrates that the production of GM crops can be economically viable for both the producer and consumer.

2.5.2.1 Global Incomes from GM Crop Production

To illustrate global incomes from GM crops, it is estimated that in 2020, the farm income from HT maize was $1.55 billion (United States Dollar), $4.12 billion from HT soybean, and $134.8 million from HT cotton (Brookes 2022). The author adds that, in 2020, the production of HT canola contributed to an income gain of $38 per hectare in Australia and $58 per hectare in Canada. The author further continues that the global income of HT canola was $624 million, the income from sugar beet in the USA and Canada was $624 million, and $77.3 million, respectively. According to Brookes (2022), an increase in income of $3.7 billion and $3.8 billion was seen globally through the production of insect-resistant maize and cotton, respectively. The author also reported that between 1996 and 2020, farm incomes increased to $261.3 billion from the production of GM crops, with GM producers in the USA gaining an additional $111 billion due to increased yields. Brookes (2022) also highlights that for every dollar spent on GM crops, an estimated $3.00 was earned by GM farmers in developed countries. These findings demonstrate that farmers can benefit financially from the production of GM crops.

2.5.2.2 Incomes from GM Crop Production in Developing Countries

Vietnam reaped financial benefits from producing GM maize as farmers reported a reduction in their production costs of between $26.47 to $31.30 per hectare, compared to traditional maize varieties (Brookes & Dinh 2020). Bangladesh demonstrated a 21.7% increase in income from their *Bt* brinjal production, and in the Philippines, 835 thousand hectares of *Bt* maize was planted by 460 thousand families across the country, attributing to a total income gain of $189.4 million (Shelton et al. 2020; Alvarez et al. 2021). In 2018, the GM market in Africa was an estimated $615.4 million, and this share is expected to increase in value to an estimated $871 million by 2025 (Kedem 2019). In 2020, it was estimated that farmers in Africa earned $282 million from the production of GM crops (Opoku 2022). The GM market in Africa is thus strong, and GM crop production has significant potential on the continent (Gbashi et al. 2021).

SA has also reaped the economic benefits of producing GM crops; in 1998-2015, the country gained an income of $2.1 billion and reported an income of $237 million in 2015 alone (Brookes & Barfoot 2017). In 1998-2016, producers' income from GM crops in the country was estimated to be $2.3 billion, and 97% of this profit was attributed to GM maize (Brookes &

Barfoot 2020). From 2001 to 2018, GM white maize production in SA contributed to income benefits of an estimated $695 million (Ala-Kokko et al. 2021). The adoption of biotechnology in SA's already-existing food systems has evidently led to increased incomes in the agricultural food industry (Dinneny 2018). Qaim and Kouser (2013) also explained that these income gains improved small-scale farmers' household food security status. It has thus been argued that farmers who farm with GM crops could potentially increase their household income, thereby giving their households the financial means to purchase food and increase their food consumption, which ultimately leads to an improved household food security status (Adeyeye & Idowu-Adebayo 2019). The authors add that, in 2020, 55% of the income earned globally by GM producers was made by producers in developing countries; thus, the GM crop farmers' income in developing countries amounted to $136.6 billion between 1996 and 2020. The authors also referred to the fact that for each dollar spent on GM crops by farmers in developing countries, an estimated return of $5.22 was made.

Adopting genetic modification technology can evidently have a positive economic impact on developed and developing countries (Ala-Kokko et al. 2021). Thus, the implementation of biotechnology in farming systems can assist in increasing the economic growth of small-holder farmers, which can aid in promoting their food security (Brookes & Barfoot 2016; Gbashi et al. 2021). Embracing biotechnology in agricultural farming practices can yield financial benefits to producers and consumers, while promoting food security. This could be an important aspect for the SA consumer in terms of their views of and their attitudes towards GMFPs.

2.5.3 Health and Nutritional Benefits of GMFPs

The prevalence of nutritional deficiencies has called for the production of healthy, nutritious and affordable food choices (Muzhinji & Ntuli 2021). Various food products have consequently been bio-fortified to enhance their nutritional value – a process that refers to increasing the existing levels of macronutrients (carbohydrates, proteins, fibre and lipids) and micronutrients such as vitamins and minerals in food products through a natural process (Dizon et al. 2016; Islam et al. 2020; Smyth 2020). In turn, the production of nutritional food products can assist in managing nutritional deficiencies (Hirschi 2020; Smyth 2020; Muzhinji & Ntuli 2021; Rathod & Hedaoo 2022). For example, the orange-fleshed sweet potato and orange maize have been bio-fortified through crossbreeding to enhance their vitamin A content (Adenle et al. 2012; Yao et al. 2023). This has proven successful as these food products are widely accepted and consumed in rural Mozambique, where vitamin A deficiency is a problem (Adenle et al. 2012; Yao et al. 2023). Providing individuals, particularly children, with nutritionally enhanced foods can promote their immune systems and reduce stunting (Dizon et al. 2016).

To supplement food products' biofortification, biotechnology is used to specifically assist in reducing the prevalence of vitamin A deficiency (Muzhinji & Ntuli 2021). A component of rice was thus GM by inserting corn and a soil microorganism gene respectively into the rice grain, thereby allowing the rice grain to contain and promote the synthesis of beta-carotene, which is a precursor of vitamin A; when consumed, the human body converts beta-carotene into vitamin A (Dubock 2017; Van Acker et al. 2017; Muzhinji & Ntuli 2021). This variety of rice is known as Golden Rice© and has been approved in the Philippines (Van Acker et al. 2017; Muzhinji & Ntuli 2021; Aziz et al. 2022; Gbadegesin et al. 2022). Farmers in seven provinces of the Philippines received Golden Rice© seeds to plant in 2022, with the intention to distribute the rice to the Philippine population (Sumangil 2022). In December 2022, it was reported that approximately 100 tons of Golden Rice© was harvested in the Philippines and distributed first to households with school-going children suffering from vitamin A deficiency, pregnant women, and lactating women (Gonzales 2022). Gonzales (2022) adds that it is hoped Golden Rice© will be commercialised fully in 2024. Consuming this enriched variety of rice can ultimately improve Filipino families' dietary and nutritional intake (ISAAA Inc. 2021a). Due to the increased nutritional content attributed to the beta-carotene contained in Golden Rice©, this GM rice variety has a more yellow-gold colour than traditional rice varieties (Dubock 2017; Sendhil et al. 2022), as shown in Figure 2.3.

Figure 2.3: Deep Yellow Genetically Modified Rice and Traditional White Rice Grains (Nosowitz 2021)

Scientists in Uganda are also using genetic modification to produce bananas with enhanced vitamin A, iron, zinc and folic acid content (Kozicka et al. 2021). It is envisaged that the adoption of biotechnology in agricultural production is an effective way to enhance the micronutrient availability in these products, allowing individuals to consume nutritionally enhanced diets (Datta 2013; Smyth 2020; Muzhinji & Ntuli 2021). However, if consumers do not have favourable attitudes toward GMFPs, it could hinder their acceptance of food aid containing GMFPs and could stifle the purchasing of these food products, leaving their food security status vulnerable.

In terms of biotechnology's potential contribution to promoting individuals' health, the production of GM crops and GMFPs offer strategies to address disease-causing health issues (Zennah & Cyrus 2019). Traditional maize varieties contain toxins such as fumonisins and mycotoxins, which can be carcinogenic to humans and are linked to neural tube defects when consumed in large quantities (Ala-Kokko et al. 2021). These toxins target maize kernels and subsequently enter the food chain (Smyth 2020). As Smyth (2020) highlights, this is concerning since maize is a main food source for many households, particularly in developing countries, and is therefore consumed daily. Fortunately, modern approaches in the field of biotechnology have led to the genetic modification of *Bt* maize, which contains lower levels of these toxins due to their reduced dependence on chemicals; *Bt* maize contains 31% less fumonisins and 29% less mycotoxins compared to traditional maize (Van Acker et al. 2017; Smyth 2020; Ala-Kokko et al. 2021). The lower concentrations of such toxins in *Bt* maize are particularly beneficial to the health of individuals who consume high maize-based diets (Ala-Kokko et al. 2021). In addition, the use of fewer pesticides and herbicides on crops is also beneficial to human health as the foods consumed contain fewer chemicals (Herman et al. 2019).

Furthermore, the GM non-browning gene in GM potatoes – as discussed in Section 2.5.4 – reduces the by-product referred to as acrylamide when fried, which is known to be carcinogenic (Herman et al. 2019). According to these authors, this non-browning gene thus contributes to protecting human health. In Tokyo, Japan, a company altered the existing genes (gene-editing) of the traditional tomato with the intention of increasing the content of gamma-aminobutyric acid (GABA) four to five times more than the conventional tomato variety (Nagamine & Ezura 2022). The authors state that this is an amino acid aiding in reducing blood pressure levels and is known as the "Sicilian Rouge High Gaba" tomato. Similarly, the GM purple tomato – discussed in Section 2.5.4 – was GM with two genes from the snapdragon plant to increase its anthocyanins (antioxidant) levels (John Innes Centre 2022). Food Stuff South Africa (2022) explains that anthocyanins occur in fruits and vegetables that are red, purple or blue in colour, such as strawberries or blueberries. The purple pigments from the snapdragon plant promote the production of antioxidants throughout the tomato, not just in the skin, thereby increasing the tomato's nutritional value (John Innes Centre 2022). Scientists at the John Innes Centre in the UK have also used gene editing techniques to increase the vitamin D content of tomatoes, thereby making a variety of tomatoes more nutritious, which is hoped to reach the UK shelves in due course (Green 2022). Additionally, researchers from the University of Punjab have gene-edited potatoes to reduce their sugar content, making them healthier (Yasmeen et al. 2022). Such advancements through biotechnology

demonstrate the potential of using genetic modification to produce nutritional food products while promoting human health (Food Stuff South Africa 2022).

These biotechnological developments also showcase the continuous evolution of biotechnological techniques, and components of crops are being GM or edited to express health and nutritional benefits, thereby developing healthier food products (Hefferon 2015; Van Acker et al. 2017; Nazir et al. 2018; Ala-Kokko et al. 2021; Amin et al. 2021; Blagoevska et al. 2021; Siddiqui et al. 2022; Abdoul et al. 2023; Ghimire et al. 2023). In this regard, biotechnology has proven to manifest nutritional and health benefits, and thus aid in providing consumers – particularly in developing countries – with food products that contain sufficient amounts of vitamins and minerals to improve their nutritional status and promote their health (Hefferon 2015; Nazir et al. 2018; Blagoevska et al. 2021; Gbadegesin et al. 2022). This strategy could be largely beneficial in attaining SDG 2: Zero Hunger (Aziz et al. 2022), further emphasising the importance of understanding whether increased nutritional value and health benefits are traits that can be used to create a favourable consumer position toward GMFPs.

2.5.4 Aesthetic and Food Processing Benefits of GMFPs

Genetically modifying plant-based crops and food products has significant potential and benefits (Smyth 2020). Genetic modification has resulted in plant-based food products with improved food processing properties, which makes these products appealing to the consumer (Wunderlich & Gatto 2015; Nazir et al. 2018). As mentioned in Section 2.3, the DNA of the Flavr Savr™ Tomato was altered to slow its ripening process and retain a longer shelf life, which can significantly benefit consumers (Aziz et al. 2022). To illustrate the food processing benefits that can be achieved through biotechnology, the GM potato was developed to provide potatoes with a non-bruising, non-browning trait, known as the White Russet potato, developed under the Innate® potato brand (Goldberg 2018; Richael 2020; Kubisz et al. 2021). The CONICET gene-edited potato, in which the browning trait has been silenced, is in the process of getting released into the market in Latin America (ISAAA Inc. 2023). The GM apple, known as the Arctic® Apple variety, in which a gene was silenced to prevent the apples from bruising and turning brown when exposed to air, was also commercially approved in 2015 (Maxmen 2017; Lobato-Gomez et al. 2021). Slices of the Arctic® Apple are sold in the USA and Canada, but they are not sold as whole apples (CBAN 2020). In addition, gene-edited bananas in the Philippines to reduce browning have been approved for production (Tropic 2023). The use of biotechnology can thus allow consumers to enjoy food products that last longer without spoiling or inhibiting the quality of the item, thereby allowing the consumer to

store such food products for a longer period (Nazir et al. 2018; Dovey & Ntuli 2020; Olabinjo et al. 2020; Sendhil et al. 2022; Siddiqui et al. 2022; Abdoul et al. 2023).

Consumers can enjoy further aesthetic and food processing benefits of GMFPs since genetic modification can be used to improve product quality and produce better tasting and flavoured food products than their conventional counterparts (Verdurme & Viaene 2003; Hassan et al. 2016; Bray & Ankeny 2017; Nazir et al. 2018; Shetty et al. 2018; Dovey & Ntuli 2020; Blagoevska et al. 2021; Aziz et al. 2022; Gbadegesin et al. 2022; Sendhil et al. 2022). Although consumers have viewed improved taste as a benefit of GMFPs, it has also been suggested that the taste of traditional food varieties should be preserved (Sendhil et al. 2022). Further to the aesthetic benefits of GMFPs, optimism is also shown in the application of genetic modification to produce food products that are larger in size, have a better shape and appearance, and potentially hold a better aroma (Hassan et al. 2016; Shetty et al. 2018; Lefebvre et al. 2019; Kubisz et al. 2021).

The use of biotechnology can also allow consumers to purchase traditional food products in different colours, such as pink pineapples; a component of the yellow pineapple has been tailored to ensure the pineapple remains pink in colour by reducing the enzymes that change the pineapple's pink colour (lycopene) to yellow (beta-carotene) (Gentner 2017; Lobato-Gomez et al. 2021). By reducing these enzymes, the pineapple retains its pink-coloured flesh (CropLife International 2021). Although existing enzymes are altered and no foreign genes have been inserted into the pink pineapple, this variety of pineapple is considered to be a GMFP and is grown in Costa Rica by the Fresh Del Monte company (Fox 2016; Pomranz 2016; Gentner 2017; Del Monte 2020). The pink pineapple is called "Rosé", is marketed as the PinkGlow™, and labelled as "extra sweet pink flesh pineapple" to distinguish it from other varieties; it became available to American consumers in 2020 (Pomranz 2016; Gentner 2017; CropLife International 2021). The PinkGlow™ pineapple is also available on the Canadian market (PinkGlow Pineapple 2020). Figure 2.4 shows the pink flesh of the PinkGlow™ pineapple.

Figure 2.4: Pink-fleshed Pineapple known as the PinkGlow™ (CropLife International 2021)

The GM purple tomato that was GM with genes from the snapdragon plant to change its colour from red to purple can be seen in Figure 2.5 (John Innes Centre 2022). According to the John Innes Centre (2022), seeds became available to purchase and grow in the USA in the spring of 2023.

Figure 2.5: GM Purple Tomato compared to the Traditional, Red-Coloured Tomato (John Innes Centre 2022)

In Halle, Germany, scientists at the Leibniz Institute of Plant Biochemistry (IPB) have experimented with genetic engineering methods where the red pigment of beetroot (known as betanin) was inserted into tomatoes to allow tomatoes to retain a deep purple colour (Seed World 2021). The authors explain that the scientists have received promising results; however, the project is still underway. In Figure 2.6, the deep purple-coloured tomato and traditional red-coloured tomato can be seen, as illustrated by the Leibniz Institute.

Figure 2.6: Deep Purple-Coloured Tomato compared to Traditional Red-Coloured Tomato (Seed World 2021)

Such developments illustrate the potential of developing food products of different colours through the use of biotechnology (Kubisz et al. 2021). The authors add that genetic engineering techniques have also been used for another purpose, specifically aimed at providing the consumer with a food product that can be enjoyed. For instance, a woman became lactose intolerant but did not want to exclude cheese from her plant-based diet (Innovature 2021). Fortunately, genetic modification came to her aid when scientists discovered that GM soybean could produce casein, a protein commonly found in cow's milk that gives cheese its stretching and melting properties (Broekaert 2021). The scientists discovered that GM soybean can produce 'cheese' with the same taste and smell as that made from animal protein (Innovature 2021). Innovature (2021) added that this breakthrough

discovery in the field of biotechnology offers lactose-intolerant consumers the option to still incorporate cheese into their diets, while reducing the number of animals in the food system and subsequently contributing to minimising greenhouse gas emissions. Innovature (2021) highlights that scientists have mentioned they are specifically focused on producing mozzarella and cheddar cheese using GM soybean, scheduled to be available in the marketplace in 2023 in the USA. However, publications in this regard have not been made yet. Scientists are also researching how to produce varieties of wheat and peanuts that retain less allergic properties through genetic engineering techniques (Chakravorty 2021). It has also been announced that gene-edited strawberries with improved taste, longer shelf life and a longer growing season will be produced in the USA and are forecasted to be available to American consumers in the next few years (Ridler 2021).

Biotechnological scientists are evidently continually striving to develop new varieties of food products that retain improved aesthetic and food processing qualities than traditional varieties, specially tailored to the consumer's enjoyment (Shetty et al. 2018). Although such traits are at the disposal of the GM food industry to lure consumers to GMFPs, it is unclear whether these traits are enticing to SA consumers, if they know about these traits to aid them in the identification of GMFPs, and whether they promote a favourable attitude toward these food products. A discussion on consumer studies about the benefits of GMFPs follows to see how such food products are viewed from a consumer point of view.

2.5.5 Consumer Studies on the Benefits of GMFPs

Numerous consumer studies have been conducted globally to understand consumers' position towards GMFPs. For example, studies were conducted in the USA to explore consumers' approval of GMFPs, in China to explore the potential for GM rice, and in the USA to determine consumers' perception of GMFPs; these studies found that consumers opined biotechnology holds the potential to positively influence their lives by providing them with food products with specific traits (Hossian et al. 2003; De Steur et al. 2015; Wunderlich & Gatto 2015). Australian consumers also supported this view (Cormick & Mercer 2017). Studies were also conducted by Kim and Fang (2020) in the USA to determine how scientists' perceptions of GMFPs affected their choices; by Emmanuel et al. (2021) in Nigeria to determine consumers' perceptions and acceptability of GMFPs; and by Jiang and Zhang (2021) in China to determine consumers' PI of GMFPs; they established that consumers perceived GMFPs are cheaper than their traditional counterparts. Another study in SA to determine consumers' acceptance of GMFPs found that consumers were in favour of biotechnology as it can be used to produce cheaper food products (Peter & Karodia 2014). American consumers had the same

view (Hossian et al. 2003), showing that the reduced price of GMFPs was a common benefit among consumers, which could also be the case in this study. However, due to the lower price of GMFPs, Gheysen et al. (2019) found in their study conducted in Belgium (to determine consumers' knowledge and attitudes toward GMFPs) that such food products were considered inferior to traditional varieties of food products; a sense of scepticism towards a lower-priced food product thus prevails. Another consumer study conducted in SA to explore consumers' perceptions of biotechnology determined they perceived GMFPs can lead to an economic benefit to consumers (Gastrow et al. 2018). The financial benefit was thus perceived as a positive attribute of GMFPs among consumers across the globe.

Studies conducted in Georgia, USA, to explore consumers' attitudes towards GMFPs and in Nigeria to determine consumers' perceptions of GMFPs found that the increased nutritional value of GMFPs was considered a benefit of using biotechnology in the genetic modification of food products (Todua et al. 2015; Eneh et al. 2016). This was also the case in SA and the USA (Peter & Karodia 2014; Wunderlich & Gatto 2015), while Chinese consumers were of the opinion that GMFPs had a lower fat content than other food products and thus had an improved nutritional value (Jiang & Zhang 2021). Other studies from Turkey to determine consumers' attitudes towards biotechnology and GMOs; and in Malaysia to explore perceptions and PIs related to GMFPs, established these products were deemed beneficial to human health (Ozdemir & Duran 2010; Hassan et al. 2016). The same finding was reported among Australian and Belgian consumers (Cormick & Mercer 2017; Gheysen et al. 2019).

These studies show that health and nutritional benefits are favourable aspects of GMFPs attained through the use of biotechnology. These factors are particularly appealing to consumers (Dovey & Ntuli 2020) and may be the case in the current SA study. A study conducted in London to examine consumers' awareness, opinions and attitudes towards GMFPs established that biotechnology's use to enhance the longevity of GMFPs was considered beneficial to consumers (Popek & Halagarda 2017). This was also the case in America and Ghana (Hossian et al. 2003; Owusu-Gyan et al. 2023).

A study conducted in Australia to explore female consumers' attitudes toward GMFPs found that the enhanced taste of these food products was considered a benefit of GMFPs (Bray & Ankeny 2017), which was also found in studies conducted in SA, Malaysia and China, respectively (Peter & Karodia 2014; Hassan et al. 2016; Jiang & Zhang 2021). Lefebvre et al. (2019) found in their study conducted in the USA, to examine consumers' perceptions of GMFPs, that genetic modification can lead to the development of larger food products. In Malaysia, consumers believed the smell of food products can be altered and thus enhanced

through the process of genetic modification (Hassan et al. 2016). Consumers from Athens felt that GMFPs had a more uniform shape (Arvanitoyannis & Krystallis 2005). The findings of these global studies illustrate that consumers have associated various benefits with GMFPs, which they can benefit from as consumers. This finding may also emerge in this study.

Exploring the benefits of GM crops, studies from Malaysia, Australia and London reflected that GM crops' resistance to pests and their potential for attaining higher yields were beneficial traits to consumers (Hassan et al. 2016; Cormick & Mercer 2017; Popek & Halagarda 2017). A study in Ghana also found that consumers linked higher yields to GM crops (Owusu-Gyan et al. 2023). Thus, it has been argued that resistance to insects, pests and diseases and achieving successful and enhanced crop yields are deemed beneficial traits among consumers (Verdurme & Viaene 2003; Brookes & Barfoot 2017; Ghoochani et al. 2017; Raman 2017; Taheri et al. 2017; Van Acker et al. 2017; Vicini 2017; Nazir et al. 2018; Ala-Kokko et al. 2021; Amin et al. 2021; Blagoevska et al. 2021; Kovak et al. 2022; Shen et al. 2022). Therefore, Malaysian and Ghanaian consumers perceived that GMFP production could contribute to the enhanced availability of food, particularly due to higher crop yields (Hassan et al. 2016; Owusu-Gyan et al. 2023). Two respective studies conducted in Malaysia and London determined that GM crops were opined by consumers to resist harsh weather conditions (Hassan et al. 2016; Popek & Halagarda 2017). Another study in Australia found that GM crops were deemed beneficial due to their drought-resistant attributes (Cormick & Mercer 2017). Such findings illustrate that these traits are not only beneficial to the farmer but are important to the consumer as well.

The environmental benefit of GM crops is important to consumers, as seen in a study conducted in the USA to determine consumers' opinions about GMFPs and global warming (McFadden 2016). That study found that the production of GMFPs was deemed environmentally friendly among consumers, and thus beneficial to the environment. These findings were echoed in studies conducted in Malaysia, Belgium and China (Hassan et al. 2016; Gheysen et al. 2019; Jiang & Zhang 2021). Consumer studies from the USA, China and Ghana found that consumers associated the production of GM crops with the use of fewer pesticides (Wunderlich & Gatto 2015; Jiang & Zhang 2021; Owusu-Gyan et al. 2023). A study carried out in China to determine managers' perceptions and attitudes toward biotechnology also found that consumers associated farmers' increased profitability with the production of GM crops (Deng et al. 2019). Research to establish agricultural experts' attitudes toward GMFPs in Iran found that farmers' financial gains as a result of incorporating GM crops into their farming practices were a beneficial aspect of GMFPs (Ghanian et al. 2016). Similar results in a Malaysian study were also reported (Hassan et al. 2016). The results of these

studies show that global consumers acknowledge the benefits of GM crop production, illustrating that consumers are not only concerned with the final GMFP but with the process of its development as well. However, SA consumers' views about this topic are unclear.

Although the production of GMFPs advocates vast benefits, stakeholders – including consumers – have expressed concerns regarding the possible risks associated with the production of GM crops and food products. This topic is discussed next.

2.6 RISKS AND CONCERNS OF GM CROPS AND FOOD PRODUCTS

Biotechnology's application in existing agricultural systems can contribute immensely to increasing food production, thereby aiding in food security and SDG 2 (Akora & Mishra 2022). However, risks and concerns are also associated with this modern technology and the production of GM crops and GMFPs, which could pose a hindering factor to the acceptance of such technology, crops and food products among farmers and consumers (Smyth 2020). Such risks and concerns could also impede developing countries from adopting modern technologies in their farming practices (Zennah & Cyrus 2019). In particular, resistance and hesitancy towards biotechnology are driven by the debate about whether the production of GM crops poses any environmental risks (Popek & Halagarda 2017). Implications regarding the use of GM seeds from specific GM seed companies are other factors that could be contributing to producers' and consumers' reluctance and opposition towards biotechnology (Muzhinji & Ntuli 2021). Additional significant aspects raised, especially by consumers, are the ethical issues related to producing GMFPs, and the potential health risks coupled with the consumption of such food products (Dizon et al. 2016; Popek & Halagarda 2017). These aspects could impede food security efforts and the acceptance of food aid. This study can show whether these concerning aspects influence SA consumers' attitudes toward GMFPs. These risks and concerns are discussed in the sections that follow.

2.6.1 Environmental Concerns

Consumer concern has been exhibited towards the damaging effect that GM crop production may have on the environment (Siipi 2015; Ghanian et al. 2016; Ruth & Rumble 2019; Prianto et al. 2020; Pakseresht et al. 2021; Sendhil et al. 2022; Siddiqui et al. 2022; Abdoul et al. 2023; Alalwan et al. 2023; Ghimire et al. 2023; Zhaleh et al. 2023). Environmental concerns include the possible emergence of super-weeds and viruses, resistance to weed-killing chemicals, cross-pollination and disruption of the fungi and bacteria in soil, as well as on the food chain, biodiversity and the ecosystem (Maghari & Ardekani 2011; Ghanian et al. 2016; Ghoochani et

al. 2017; Taheri et al. 2017; Van Acker et al. 2017; Dovey & Ntuli 2020; Islam et al. 2020; Russo et al. 2020; Sanlier & Sezgin 2020; Pakseresht et al. 2021; Aziz et al. 2022; Sendhil et al. 2022; Ghimire et al. 2023). Such concerns could be hindering consumers' acceptance of GM crop production.

Another concern related to farming with GM crops is that it could lead to monoculture, which refers to growing the same crop seasonally, thereby refraining from growing other types of crops (Van Acker et al. 2017; Rodriguez et al. 2022). The concern is that this could potentially lead to a loss in biodiversity (Rodriguez et al. 2022). Similar apprehensions have been shown towards the production of GM crops in that it could lead to altered genes being transferred to other organisms or plants, which can result in genetic contamination (Karalis et al. 2020; Sendhil et al. 2022). Gene flow between species has subsequently been highlighted as a safety concern with GM crop production as this occurrence could cause natural species and crops to be contaminated by GM species, thereby threatening their existence and the existence of wild plant varieties (Ghoochani et al. 2017; Van Acker et al. 2017; Karalis et al. 2020; Gbashi et al. 2021; Pakseresht et al. 2021; Aziz et al. 2022; Sendhil et al. 2022; Ghimire et al. 2023). Compromising the prevalence of wild plant varieties could inadvertently limit the production and export of natural crops and food products (Zennah & Cyrus 2019). To mitigate gene flow between GM and non-GM plant crops, it has been suggested that GM crops should be planted 50 metres from non-GM crops (Aziz et al. 2022).

In addition, it has been argued that the unpredictable effects of gene transfers and disruption of biodiversity could promote the development of pesticide-resistant pests and the formation of new viruses and diseases, with unpredictable consequences (Zhang et al. 2016; Van Acker et al. 2017). The monarch butterfly has been at the centre of environmental debates as it has been reported these organisms can be harmed by the toxins from an herbicide known as glyphosate (commonly used on *Bt* maize) if used excessively (Raman 2017; Zennah & Cyrus 2019; Aziz et al. 2022; Ghimire et al. 2023). Concern about the harmful effects that the production of GM crops could have on bees is another topic of debate (Dovey & Ntuli 2020; Arpaia et al. 2021). It has been argued that the *Bt* protein found in herbicide-resistant crops could be found in pollen, which could be harmful to bees, and the excessive use of glyphosate can promote the growth of a fungus commonly referred to as *Fusarium*, which can infect plants and cause vascular wilts (Dadgarnejad et al. 2017; Libardoni et al. 2021).

Evidently, the production of GM crops could endow unfavourable effects on the environment and hinder certain countries from adopting biotechnology into their farming practices. However, to protect the environment, bio-safety regulations have been developed to assess

the environmental risk of GM crops before they are approved for field trials (Zennah & Cyrus 2019; Ehirim et al. 2020; Muzhinji & Ntuli 2021), as discussed in Section 2.9. Although environmental risk assessments are conducted on GM crops, it is also recommended that the government should enhance the frequency with which it reports favourable findings to the public to remedy any environmental concerns among farmers and consumers (Ghanian et al. 2016).

Various organisations have aimed to mitigate concerns about the safety of GM crops, including the FAO, World Health Organisation (WHO), the National Academics of Science, Engineering and Medicine, the American Medical Association, and more than 500 independent organisations (Gbashi et al. 2021; Redden 2021). They have claimed – based on research – that there is no evidence to suggest GMOs, GM crops and GMFPs pose any health or environmental risks (Gbashi et al. 2021; Gbadegesin et al. 2022). The authors add that other governmental and regulatory bodies agree with these organisations' views. The continuous supply of such information and communicating with the public about modern technology can significantly combat GM crop safety concerns (Ghanian et al. 2016; Aziz et al. 2022). However, the question remains whether the dissemination of information about the safety of GMFPs is important for SA consumers.

2.6.2 GM Seeds and GM Companies

Farmers are required to purchase GM seeds from legitimate organisations; a contract needs to be signed with the company, thereby requiring the farmers to pay a royalty fee that is referred to as a 'technology fee' (Francescon 2006; Zilberman et al. 2018; Fischer 2021). Such contracts have been developed to inform farmers about the process of growing GM crops, it gives the companies the right to inspect the farms, and it obligates farmers to re-purchase GM seeds every season (Farm Aid 2016). For small-scale farmers, the acquisition of GM seeds may not be feasible due to their financial constraints, which is further exacerbated by the fact that GM seeds are only viable for one season and thus need to be purchased annually (Akumo et al. 2013; Ghanian et al. 2016; Zennah & Cyrus 2019; Fischer 2021; Wray 2021). This could lead to commercial farmers growing the majority of GM crops, as small-scale farmers in developing countries may not be able to keep up financially with such requirements (Akumo et al. 2013; Fischer 2021). The inability to regrow GM seeds for a second season and the consequent termination of such seeds is concerning for GM producers and has been considered an infringement on their rights (Akumo et al. 2013; Islam et al. 2020; Pakseresht et al. 2021; Wray 2021; Aziz et al. 2022). Subsequently, GM seeds are called 'terminator seeds' (Aziz et al. 2022).

Intellectual property and patenting of GM seeds are additional issues that could prohibit countries – particularly in the SADC regions – from adopting biotechnology and producing GM crops and food products (Bonny 2017; Van Acker et al. 2017; Islam et al. 2020; Pakseresht et al. 2021; Aziz et al. 2022). Their concern is that the production of GM crops will lead to the cessation of conventional varieties, thereby threatening the availability of natural seed banks (Bonny 2017; Van Acker et al. 2017; Islam et al. 2020). As a result, farmers could end up relying entirely on private seed companies, such as Corteva, Syngenta, Bayer, Monsanto, Dow and Du Pont, for GM seed purchases (Fischer 2021; Muzhinji & Ntuli 2021; Redden 2021). Farmers have thus voiced their concern that restricted access to GM seeds could lead to the excessive prices of such seeds, a hindering factor to developing countries in terms of fully embracing GM technology in their farming practices (Chen 2008; Azadi et al. 2016; Ghanian et al. 2016; Bonny 2017; Lemarie et al. 2017; Taheri et al. 2017; Van Acker et al. 2017; Islam et al. 2020; Muzhinji & Ntuli 2021; Wray 2021). This phenomenon could also be a hindering factor to consumers supporting the production of GM crops.

However, to financially assist farmers in acquiring GM seeds, it has been suggested that governments enact policies that ensure private companies keep GM seed prices reasonable so that these seeds are affordable to farmers from developed and developing countries (Quaye et al. 2012). In the SA context, small-scale SA farmers are experiencing a drawback to cultivating GM crops due to the cost of GM seeds, resulting in commercial farmers dominating GM crop production (Fischer 2021). Thus, the cost poses a financial challenge to small-scale farmers in terms of purchasing *Bt* maize seeds every season (Zennah & Cyrus 2019). Fortunately, the Land Bank of SA offered rural farmers in SA financial support to produce GM crops (Wray 2021). Moreover, although GM seeds are more expensive than conventional seeds, solace can be found in the premise that the production of GM crops could result in greater profitability compared to the income generated from conventional crop production (Zilberman et al. 2018), as seen in Section 2.5.2.

A further concern linked to the GM seed industry is GM seed companies' dominating power and control over the seed market (Bonny 2017). There is scepticism whether these companies are controlling the GM seed industry for profit purposes and to acquire a monopoly, which could lead to GM companies having further control over the production of food (Weale 2010; Dibden et al. 2013; Bonny 2017; Raman 2017; Van Acker et al. 2017; Islam et al. 2020; Russo et al. 2020; Pakseresht et al. 2021; Aziz et al. 2022; Idris et al. 2022). Such an example can be seen in SA, where Monsanto, a company that supplies GM seeds, constitutes a significant proportion of the maize seed market (Fischer 2021). Therefore, concern has been raised about the mandatory termination of GM seeds and GM seed companies' power.

2.6.3 Ethical Concerns

Ethics can be defined as standards of right or wrong, which appeal to a person's beliefs, values and morals (Dizon et al. 2016; Mokgoantle 2021). Ethics could cause opposition towards human and technological interference with the food supply as well as the foods that are available for purchase and consumption (Hingston & Noseworthy 2018; Siddiqui et al. 2022). Due to genes being altered and inserted into plant material to produce a specific trait, many individuals are concerned that the production of GMFPs is unethical and immoral (Chen & Chern 2004; Loureiro & Hine 2004; Lanzillotti 2007; Phillips 2008a; Costa-Font & Gil 2011; Lucht 2015; Raman 2017; Gastrow et al. 2018; Chagwena et al. 2019; Gatew & Mengistu 2019; Abdoul et al. 2023). Consumers have raised particular concerns that other materials are injected into food products, thereby creating 'Frankenstein' food (Deane-Drummond et al. 2001; Bearth et al. 2022).

Concerns have also been reported that the production of GMFPs tampers with the environment (Weale 2010; Lucht 2015). This concern is further driven by the fact that altered plant material disrupts the natural process of growing and producing crops and food, leading to unnatural and artificial foods being supplied to the population (Chen 2008; Siipi 2015; Dizon et al. 2016; Kotze 2016; Tsatsakis et al. 2017; Hingston & Noseworthy 2018; Larson 2018; Chagwena et al. 2019; Lefebvre et al. 2019; Dovey & Ntuli 2020; Russo et al. 2020; Kubisz et al. 2021; Pakseresht et al. 2021; Siddiqui et al. 2022). Another concern is that the production of GMFPs could contribute to the reduced production of natural food products (Bonny 2017). The potential consequences that occur through the use of biotechnology in producing a food product have also been highlighted as a concern (Akumo et al. 2013; Van Acker et al. 2017; Dovey & Ntuli 2020; Sutkovic et al. 2020; Gbashi et al. 2021; Pakseresht et al. 2021). Therefore, it has been argued that, ethically, scientists and producers do not have the right to produce GM crops and food products if they are aware of possible negative effects that their production could have on humans or the environment (Dizon et al. 2016). Consumers opine that the safety of GM crops and food products is further aggravated by the fact that alterations to their DNA occur within laboratories, and according to consumers, the genes of GMFPs are thus 'tinkered' with (Deane-Drummond et al. 2001; Verdurme & Viaene 2003; Phillips 2008a). It has also been argued that introducing technology into food is 'playing God' and 'tampering with God's plan' (Phillips 2008a; Glasgow 2015; Kotze 2016; Frewer 2017; Ghoochani et al. 2017; Gatew & Mengistu 2019; Pakseresht et al. 2021; Aziz et al. 2022).

Hence, society questions whether humans have the right to use technology to create food and biotechnology's use in the production of GMFPs has thus been raised as a concern (Lucht

2015; Zhang et al. 2016; Raman 2017; Cui & Shoemaker 2018; Hingston & Noseworthy 2018; Aziz et al. 2022). Harbouring such feelings can have moral implications, causing conflict with religious belief and further hindering the acceptance of GMFPs (Hossian et al. 2003; Myskja 2006; Chen 2008; Phillips 2008a; Glasgow 2015; Lucht 2015; Dizon et al. 2016; Larson 2018; Islam et al. 2020; Pakseresht et al. 2021; Aziz et al. 2022; Ghimire et al. 2023). Ethical concerns have been raised about the process involved in producing GM crops and food products, which could hinder GMFPs' use as a tool to advance food security. However, little research exists on whether ethical concerns influence SA consumers' attitudes toward GMFPs.

2.6.4 Health Concerns

Technology's use in food production – particularly referring to the insertion, alterations and disruption in the genetic makeup of plant crop material – has been argued to increase potential health risks (Siipi 2015; Pino et al. 2016; Raman 2017; Van Acker et al. 2017; Vicini 2017; Oz et al. 2018; Singhal 2018; Pham & Mandel 2019; Ruth & Rumble 2019; Prianto et al. 2020; Siddiqui et al. 2022; Abdoul et al. 2023; Ghimire et al. 2023; Zhaleh et al. 2023). Concern has been raised about the allergic effects that could occur after consuming a GMFP (Maghari & Ardekani 2011; Raman 2017; Van Acker et al. 2017; Nazir et al. 2018; Lefebvre et al. 2019; Pham & Mandel 2019; Islam et al. 2020; Blagoevska et al. 2021; Emmanuel et al. 2021; Kubisz et al. 2021; Sendhil et al. 2022). This refers to a pathological immune reaction that occurs in response to an antigen present in a food component (Delaney et al. 2018). Such concerns are fuelled by the fear that the genetic modification of plant material can result in the creation of new proteins to which humans may be allergic (Zennah & Cyrus 2019).

Resistance to antibiotics is an additional concern that has emerged relating to the consumption of GMFPs (Maghari & Ardekani 2011; Van Acker et al. 2017; Islam et al. 2020; Blagoevska et al. 2021; Aziz et al. 2022; Sendhil et al. 2022; Ghimire et al. 2023). This could potentially occur when antibiotic-resistant bacteria are inserted into a plant crop material (Bawa & Anilakumar 2013). The authors state that the concern is that the antibiotic-resistant genes are transferred to the bacterial microflora tract of the human body, which could result in disease-causing pathogens becoming resistant to antibiotics as these bacteria develop resistance to antibiotics. Concern has also been demonstrated towards the possibility of developing new antibiotic strains during the genetic modification process, which is then transferred to bacteria and then to humans when consumed, which could, in turn, reduce the efficacy of antibiotics (Nesser et al. 2021).

Cancer development is another health risk commonly associated with the consumption of GMFPs (Ozkok 2015; Aziz et al. 2022; Gbadegesin et al. 2022; Shen et al. 2022). It has been alleged that the glyphosate used on GM crops could be ingested, thus contributing to the development of cancer (Tarazona et al. 2017; Peillex & Pelletier 2020). Research is being conducted to determine whether glyphosate contributes to cancer development, which may prove to be difficult as there are various contributing factors to cancer, including smoking, alcohol abuse and obesity (Tarazona et al. 2017; Peillex & Pelletier 2020; Chen et al. 2023). Additional health risks linked to GMFPs include toxicity, abnormal body and organ function, infertility, changes in human DNA, and food poisoning (Maghari & Ardekani 2011; Deffor 2014; Kaya et al. 2014; Ozkok 2015; Raman 2017; Van Acker et al. 2017; Gheysen et al. 2019; Lefebvre et al. 2019; Keshani et al. 2020; Blagoevska et al. 2021). It has also been alleged that genes from GMFPs can be transferred to humans after consumption; however, this allegation is unsubstantiated (Freedman 2013; The Royal Society 2016; Blagoevska et al. 2021).

Despite concerns about the possible health risks that could arise from consuming GMFPs, studies conducted thus far could not identify any major hazards linked to the consumption of GMFPs (Nicolia et al. 2014; Pham & Mandel 2019; Prianto et al. 2020; Russo et al. 2020; Addey 2021; Rodriguez et al. 2022). It has further been argued that no verdict has been reached about the health hazards of GMFPs, particularly considering that GMFPs have been available for human consumption for 23 years, yet no safety or health issues have been reported from consuming such foods during this period (Addey 2021; Muzhinji & Ntuli 2021). As a result, it has been suggested that food products developed from GM crops have not shown any greater risks than their traditional counterparts (Muzhinji & Ntuli 2021). Nevertheless, the debate around GM health risks continues, and controversy around GM crops' and food products' safety remains (Addey 2021; Redden 2021; Gbadegesin et al. 2022; Siddiqui et al. 2022; Pardo et al. 2023). The debate could be further attributed to animal studies reporting stomach inflammation and intestinal adenoma lesions from consuming GMFPs (Shen et al. 2022), though this has not been the case with humans.

To alleviate GM safety concerns, researchers are continually conducting studies on GM technology to gain more information and ensure the production of GM crops and consumption of GMFPs continue to be safe for humans and the environment (Pham & Mandel 2019; Islam et al. 2020; Olabinjo et al. 2020; Nesser et al. 2021; Aziz et al. 2022). Disseminating such information can bring comfort to the public to remedy their GM safety fears and might contribute to GMFPs' acceptance on a local and international level (Muzhinji & Ntuli 2021; Aziz et al. 2022). To illustrate, Cormick and Mercer (2017) conducted a study in Australia to

determine consumers' attitudes toward gene technology and established there is a need among consumers to be informed about the safety of GMFPs. GM crops also undergo risk assessment through the bio-safety regulations that are implemented to ensure their safety for human consumption, and solace can thus be found in such regulations (Ehirim et al. 2020; Muzhinji & Ntuli 2021), as discussed further in Section 2.9.

The risks and concerns that were discussed need to be remedied if food security and SDG 2 are to be successfully attained since such concerns could delay the rate at which countries embrace GM technology and the production of GM crops and food products. These concerns could also directly impact consumers' views of such food products, which could be detrimental as the consumer plays an essential role in determining whether food security can be achieved through GMFPs (Ghanian et al. 2016; Owusu-Gyan et al. 2023). To understand consumers' position toward GMFPs, a discussion of consumer studies about the risks and concerns of GMFPs follows.

2.6.5 Consumer Studies on the Risks and Concerns of GMFPs

Based on global consumer studies relating to GMFPs, numerous concerns have emerged among consumers. For example, studies were conducted in Europe to determine experts' attitudes toward the use of GMOs in food and feed products; in India to determine the factors that influence consumers' acceptance of GMFPs; and in Sweden to explore how regulatory policies of GMFPs influence consumers' cognitive information processing (Aleksejeva 2014; Kajale & Becker 2014; Pakseresht et al. 2021). These studies found that consumers were opposed to GMFPs due to the possible negative effect that their production could have on the environment; similar findings were reported among Georgian consumers (Todua et al. 2015). Studies conducted in Turkey by Kaya et al. (2014) to determine consumers' attitudes towards GM foods, and by Sanlier and Sezgin (2020) to establish consumers' knowledge levels, attitudes, behaviours and acceptance of GMFPs, reported that consumers thought GM crops could be harmful to the ecology and biodiversity of the environment. A study conducted in China to determine consumers' attitudes towards GM foods revealed concerns about the harmful effects that GM crops could have on the soil and ecology (Ma 2015). These studies demonstrate consumers' opposition towards GMFPs due to the possible negative environmental effects in their production stages.

A study carried out in the USA further established consumers perceived GM crop production poses a risk to living things (Wunderlich & Gatto 2015), while consumers from London opined that the production of GM crops could encourage the development of toxins that could harm

the environment (Popek & Halagarda 2017). Consumers from Iran also raised concerns regarding the environmental impact of such crops' production (Ghanian et al. 2016). These studies show that consumers are concerned about the possible harm that the production of GMFPs could have on the surrounding environment (Todua et al. 2015; Ghanian et al. 2016; Gatew & Mengistu 2019; Prianto et al. 2020; Sendhil et al. 2022) and may be the case in this study.

Regarding GM companies, a study conducted in China established that consumers remain concerned that GM companies are encouraging the production of GMFPs for financial gain since GM seeds are sold at excessive prices (Deng et al. 2019). From an ethical point of view, studies were conducted in SA to determine consumers' attitudes towards food biotechnology; in Spain to determine consumers' attitudes towards GMFPs; and in Zimbabwe to determine consumers' knowledge, attitudes and perceptions regarding GMFPs (Lanzillotti 2007; Costa-Font & Gil 2011; Chagwena et al. 2019). These studies concluded that consumers perceived GMFPs as unethical due to technology's use in the production process, which was a notable concern to them; Gastrow et al. (2018) reported similar results in their study in SA. A study conducted in Europe to explore consumers' attitudes towards GMFPs revealed that GMFPs were identified as artificial and unnatural (Verdurme & Viaene 2003); these views were shared in respective studies conducted in Nigeria, Zimbabwe and the USA (Eneh et al. 2016; Chagwena et al. 2019; Lefebvre et al. 2019). Another study conducted in China to determine consumers' perceptions' of GMFPs established they were concerned that the production and prevalence of natural food products could be compromised by GMFPs (Cui & Shoemaker 2018). Results from a study in London showed that consumers were concerned that unfavourable consequences could occur from changing the genes of GMFPs (Popek & Halagarda 2017).

Further to the ethical connotation made to GMFPs, a European study reported that the production of GMFPs is viewed as playing God, which was particularly concerning to consumers (Verdurme & Viaene 2003). Another study in Iran, which aimed to explore stakeholders' attitudes toward *Bt* rice, determined that the production of GMFPs was regarded as unethical by consumers as it goes against the natural process of growing food products in the manner in which God intended (Ghoochani et al. 2017); a study in Europe also concurred (Verdurme & Viaene 2003). Further studies carried out in four countries (Denmark, Germany, Italy and the UK) to determine consumers' attitudes towards GMFPs; in Germany to explore the adoption of GM oilseed; in Malaysia to explore consumers' ethical perception of GMFPs; in Taiwan to explore consumers' preference to purchase GMFPs; in Mexico to determine consumers' attitudes and perceptions of GMFPs; in Poland to explore consumers' attitudes

towards GMFPs; and in the USA to explore consumers' attitudes towards GM and organic food products established that consumers' religion could compromise their acceptance of GMFPs (Bredahl 2001; Breustedt et al. 2008; Amin et al. 2011; Chiang et al. 2012; Lopez et al. 2016; Rzymski & Krolczyk 2016; Larson 2018). These ethical aspects could explain the results from a study in SA that explored consumers' preference for GMOs, which revealed consumer opposition towards using biotechnology to produce GMFPs (Dovey & Ntuli 2020). Peter and Karodia (2014) found the same phenomenon in their study in SA, while Chinese consumers perceived that using technology to produce GMFPs was a form of bioterrorism (Cui & Shoemaker 2018). These studies demonstrate that ethics and the process of developing GMFPs are of particular concern for consumers and could cause some hesitancy when it comes to such food products, which food security efforts can ill-afford. Such pertinent concerns need to be negated for GMFPs to become a successful tool in advancing food security.

Regarding the health risks of GMFPs, studies from Uganda to determine consumers' attitudes, perceptions and trust toward GM bananas, and Poland to establish consumers' knowledge and attitudes, reported that consumers were concerned about possible health risks after the consumption of GMFPs (Kikulwe et al. 2011; Kubisz et al. 2021). Studies in Georgia, the USA, Nigeria, Turkey and Sweden echoed these findings (Todua et al. 2015; Wunderlich & Gatto 2015; Eneh et al. 2016; Sanlier & Sezgin 2020; Pakseresht et al. 2021). These studies suggest that consumers generally associate GMFPs with health risks. In terms of specific health risks, studies conducted in Poland to determine consumers' attitudes toward GMOs showed that allergic reactions after the consumption of GMFPs emerged as a concern among consumers (Rzymski & Krolczyk 2016), which was also found among Pakistani consumers (Amin et al. 2021). Studies in London, the USA, Nigeria and Poland obtained similar results (Popek & Halagarda 2017; Lefebvre et al. 2019; Emmanuel et al. 2021; Kubisz et al. 2021), while consumers in Turkey were found to associate antibiotic resistance with GMFPs (Kaya et al. 2014).

Two respective studies in China to examine the social diffusion of rumours regarding GMOs and in Florida to explore how GM food messages were evaluated by consumers found that consumers were particularly anxious about developing cancer after consuming GMFPs (Jiang & Fang 2019; Ruth & Rumble 2019). Similar fears were echoed in other studies conducted in Turkey, Poland, the USA and Pakistan (Kaya et al. 2014; Rzymski & Krolczyk 2016; Lefebvre et al. 2019; Amin et al. 2021). A study in Uganda established that pesticides could contribute to GM crop production's harmful effect on human health (Kikulwe et al. 2011). Another study in Poland found that consumers perceived kidney function could be compromised, and fertility

and their immune system could be threatened by consuming GMFPs, while American consumers were concerned that the functioning of their bodies would be impaired through GMFP consumption (Rzymski & Krolczyk 2016; Lefebvre et al. 2019).

Further to the specific health risks of GMFP consumption, Deffor (2014) conducted a study in Ghana to determine consumers' acceptance of GMFPs; findings reflected that consumers were concerned that their bodies could be harmed from consuming GMFPs. Other studies in Turkey found that consumers were concerned about infertility, organ damage and toxicity (Kaya et al. 2014); consumers in Pakistan demonstrated concerns about infertility (Amin et al. 2021); while organ damage was a concern among Polish consumers (Kubisz et al. 2021).

Results from a study carried out in Turkey to determine consumers' perceptions about GMFPs and their PI demonstrated that consumers perceived such food products were unsafe for human consumption, which studies in Nigeria and China also reported (Celik & Dagistan 2016; Eneh et al. 2016; Deng et al. 2019). These studies reflect that consumers are concerned about the potential health risks linked to GMFPs. Numerous illnesses have also been perceived to originate from the consumption of GMFPs, and health concerns could be problematic in terms of gaining consumers' approval and acceptance of GMFPs. Such concerns need specific attention to create a sense of comfort when consuming GMFPs. In terms of the SA consumer, it is unclear whether they are also concerned about their health when consuming GMFPs and whether certain illnesses are specifically linked to GMFPs.

While various advancements have been made in GM crop and food product production – which has led to debates about its many benefits and risks – an additional advancement in biotechnology and ongoing research into the genetic modification and editing of animal genetics could help in addressing food insecurity concerns. A discussion on animal genetic modification and gene editing follows to offer insight into the current advancements in this field.

2.7 USE OF BIOTECHNOLOGY ON ANIMALS

Biotechnological research on animals has sparked the interest of many scientists, which is evident in the advances made in genetically modifying and editing animals' DNA (Olabinjo et al. 2020). In terms of animal genetic modification, the GM Atlantic salmon was the first animal to be GM (Benessia & Barbiero 2015). It was patented by Canadian scientists who inserted a growth hormone from Chinook salmon and a promoter sequence from the Ocean Out fish into the Atlantic salmon's genetic makeup (Voelker 2016). This resulted in promoting GM Atlantic

salmon's growth rate, leading to the salmon reaching maturity more quickly while requiring less feed than traditional Atlantic salmon (Benessia & Barbiero 2015). The GM Atlantic salmon, which is marketed as the AquAdvantage Salmon©, has been sold in the form of fillets in countries such as the USA, Canada, Argentina, Brazil and India (Weir & Sproul 2019; Waiblinger et al. 2023). Currently, the AquAdvantage Salmon© is the only GM animal sold for human consumption (Weir & Sproul 2019; Fedoroff et al. 2022). Although GM pork has been approved by the FDA for human consumption in the USA, the meat is unavailable on the market (The National Agricultural Law Centre 2022). Gene-edited pigs were developed by Washington State University in the USA for breeding purposes, and it has been reported that meat from gene-edited cattle will be available on the American market in the future (Choi 2022; Fedoroff et al. 2022; Zaske 2023).

In Japan, the DNA of the "Madai" Red Sea Bream has also been genetically altered through genome editing to remove a protein that halters muscle growth and development (The Fish Site 2021). Subsequently, according to The Fish Site (2021), the edible part of the "Madai" fish variety, namely the fillet, is larger; it has been increased by approximately 20%. In Japan, the Tiger puffer fish, known as "torafugu", was also gene-edited to accelerate its growth by enhancing its appetite gene (Loew 2022). These two gene-edited fish varieties are available on the Japanese market (ISAAA Inc. 2021b; The Fish Site 2021; Loew 2022). Although the DNA of the Tilapia fish was altered through gene-editing (as seen with the "Madai" Red Sea Bream and Tiger puffer fish) and is thus not considered a GMO fish (The Fish Site 2018), it does illustrate the progress that is being made through the use of biotechnology in creating fish with improved genetics. Furthermore, research is being conducted on animals such as cows, sheep and goats to promote certain traits such as muscle mass and provide animals with resistance against harsh weather conditions (Kalds et al. 2019; Olabinjo et al. 2020; Hallerman et al. 2022).

From a consumer point of view, studies conducted in Athens to establish beliefs, attitudes and intentions regarding GMFPs found that consumers opined meat products sold in supermarkets contain GM ingredients (Arvanitoyannis & Krystallis 2005). Another study in SA that explored knowledge, attitudes, beliefs and practices regarding GMFPs found that consumers thought chickens and eggs were GM (Jonker 2017). Such findings indicate that consumers were of the opinion that GM meat products are available on the market, which could be the case in this study, and further point to the extent of their knowledge of food products that contain GM components.

Although advancements in biotechnology supplement the agricultural production of GM crops, GMFP labelling remains a concern (Adeyeye & Idowu-Adebayo 2019). Since labelling plays an integral role in GMFP identification (Chagwena et al. 2019), the labelling of such food products and the respective regulations regarding labelling in different countries are discussed next to offer insight into the current global labelling laws as well as consumers' views of GMFP labelling.

2.8 LABELLING OF GMFPS

Labelling refers to words, phrases, brand names or symbols that appear on the packing of food products to communicate information about the product to the consumer (Jiang & Zhang 2021). In the GM context, labelling on food products is important to ensure that consumers are aware of GMFPs in store and to assist them in identifying such food products (Oh & Ezezika 2014; Sebastian-Ponce et al. 2014; Wunderlich & Vecchione 2014; Chagwena et al. 2019; Macall et al. 2021; Delgado-Zegarra et al. 2022). The presence of labels on food products can further contribute to educating consumers about GMFPs through the information presented on such labels (Chagwena et al. 2019; Hakim et al. 2020). It has been argued that consumers have a right to know what ingredients the food products they purchase contain, and labelling is thus pertinent, particularly in the case of GMFPs (Phillips 2008a; Huffman & McCluskey 2014; Oh & Ezezika 2014; Tanius and Seng 2015; Wunderlich & Gatto 2015; Gostin 2016; McFadden & Lusk 2016; Popek & Halagarda 2017; Adeyeye & Idowu-Adebayo 2019; Gheysen et al. 2019; Lefebvre et al. 2019; Islam et al. 2020; Sanlier & Sezgin 2020; Zhang et al. 2021; Rodriguez et al. 2022). As a result, consumers have appealed for any food product containing GM ingredients to have a GM label (Sleenhoff & Osseweijer 2013; Popek & Halagarda 2017; Gheysen et al. 2019; Sanlier & Sezgin 2020). It has been argued that the source where the food product was produced and the process involved in producing the food product should be stipulated on the labels; this can be achieved by using bar codes to offer additional information about such food products (Jaffe 2017; Sanlier & Sezgin 2020; Macall et al. 2021; Delgado-Zegarra et al. 2022).

Although GM labelling laws have been developed internationally, the mandatory use of GM labels has been a controversial topic, and it is still often argued that GM labelling is inadequate (Popek & Halagarda 2017; Chagwena et al. 2019; Kolodinsky et al. 2019; Yeh et al. 2019; Jiang & Zhang 2021; Kim et al. 2022; Rodriguez et al. 2022). The debate around mandatory GM labels has been attributed to consumers not frequently reading labels due to habitual buying, insufficient time, lack of interest, and being more concerned with the price (Koen 2016; Basson 2018). There is also a concern that GM food labels will be misinterpreted by

consumers and that the presence of GM labels will cause confusion, thereby hindering consumers from purchasing the product (Jonker 2017; Popek & Halagarda 2017; Goyal & Deshmukh 2018; Lefebvre et al. 2019; Sanlier & Sezgin 2020; Macall et al. 2021). It has been opined that negative connotations could be made to GM-related wording on labels, creating hostility towards GMFPs (African Centre for Biodiversity 2015b; Hassan et al. 2016; Yeh et al. 2019; Jiang & Zhang 2021; Oselinsky et al. 2021; Kim et al. 2022). Thus, the appropriate use of wording on GM labels has been suggested; however, consumers' hostility to GM-related wording on labels could be attributed to their lack of knowledge regarding GMFPs (Sanlier & Sezgin 2020; Shtulman et al. 2020; Macall et al. 2021). Although many concerns have been raised in terms of refraining from implementing mandatory GM labelling due to questions about the usefulness of such labels, mandatory labelling has been implemented by various countries (CBAN 2022b).

2.8.1 GM Labelling in Different Countries

Currently, 64 countries around the world have implemented some type of mandatory GM labelling laws, including the EU, Japan, South Korea, Indonesia, Australia, New Zealand, Brazil, Ukraine, SA, China and Russia (see Table 2.3) (Wunderlich & Vecchione 2014; CBAN 2022b; Macahilo 2022).

Table 2.3: Countries with Mandatory GM Labelling Laws (CBAN 2022b)

List of Countries with Mandatory GM Labelling Laws			
Australia	Estonia	Latvia	Senegal
Austria	Ethiopia	Lithuania	Slovakia
Belarus	Finland	Luxemburg	Slovenia
Belgium	France	Malaysia	South Africa
Bolivia	Germany	Mali	South Korea
Bosnia and Herzegovina	Greece	Malta	Spain
Brazil	Hungary	Mauritius	Sri Lanka
Bulgaria	Iceland	Netherlands	Sweden
Cameroon	India	New Zealand	Switzerland
China	Indonesia	Norway	Taiwan
Croatia	Ireland	Peru	Thailand
Cyprus	Italy	Poland	Tunisia
Czech Republic	Japan	Portugal	Turkey
Denmark	Jordan	Romania	Ukraine
Ecuador	Kazakhstan	Russia	United Kingdom
El Salvador	Kenya	Saudi Arabia	Vietnam

Although various countries have implemented some form of mandatory GM labelling laws, their thresholds for GM labelling vary (CBAN 2022b). For example, the EU has implemented

a strict labelling policy resulting in any food product containing a value of 0.9% GM components to be labelled; Australia's labelling policy requires a value of more than 1%, as in New Zealand; and Japan requires a 5% value of GM components to be labelled (Byrne et al. 2019). It is, however, evident from Table 2.3 that increasingly more countries are implementing labelling policies specifically pertaining to GMFPs.

Even though the USA was not added to the list of countries with mandatory GM labelling, the country's GM labelling laws have been updated (Oselinsky et al. 2021). According to the authors, as of 1 January 2022, the National Bioengineered Food Disclosure Law stated that bioengineered food products – meaning "those that contain detectable genetic material that has been modified through certain lab techniques and cannot be created through conventional breeding or found in nature" – or those referred to as food products containing GMOs, need to be labelled by producers. The new GM labelling law stipulates that the words 'genetically engineered' or 'genetically modified' do not have to be used; instead, a bioengineered (BE) disclosure is permitted either in the form of a text, symbol, contact number, electronic link or web address (Sheldon 2022). However, it has been proposed that any GM-related abbreviations used on food products may not be understood by consumers, which could hinder the efficacy of these labels (Delgado-Zegarra et al. 2022).

2.8.2 GM Labelling Regulations in SA

In 2004, GM labelling regulations were established in SA under the Foodstuffs, Cosmetics and Disinfectants Act (1972), making GM labelling mandatory in SA if the GMFP contains GM components (Esterhuizen & Bonsu 2020). In 2008, the labelling laws on GMFPs evolved in SA, and the current labelling policy states that if a food product contains more than 5% GM components, it is mandatory for the food product to be labelled as such (Wunderlich & Vecchione 2014). Figure 2.7 is an example of a mandatory GM label on an SA maize product containing GM components.

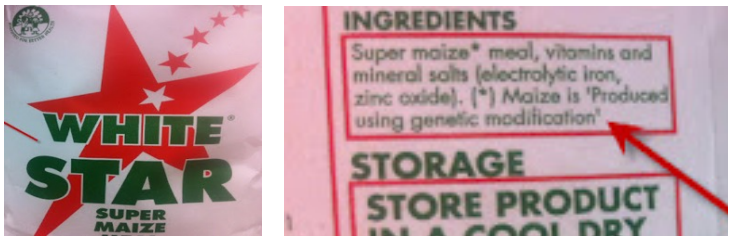

Figure 2.7: An example of a Mandatory GM Label on White Star Super Maize Meal (Sustain Me 2013)

Figure 2.7 illustrates a mandatory GM food label and further indicates that the maize used in the food product was produced using genetic modification, thus informing the consumer that the food product contains GM components. Three types of mandatory labels are commonly used to indicate the presence of a GM ingredient, namely “containing GMOs” if the GM value is 5% or more; “produced using genetic modification” (as seen in Figure 2.7 above) if the food was produced straight from a GMO source; and “may contain GMOs” when it is not practical to test for a GM component or ingredient in the specific food product (African Centre for Biodiversity 2015b; Biosafety South Africa 2015). There is, however, also voluntary labelling regarding GMFPs; if the GM value is less than 1%, the food products can be labelled as “does not contain GMOs”; if the GM value ranges between 1% and 5%, the label could say “GM content is less than 5%”; and if GM content cannot be found in the food product, the label could say “may contain genetically modified ingredients” or “may be genetically modified” (Biosafety South Africa 2015). Figure 2.8 is an example of a voluntary GM label on a food product (Pick n Pay Soya Mince) sold in SA (Pick n Pay 2022).

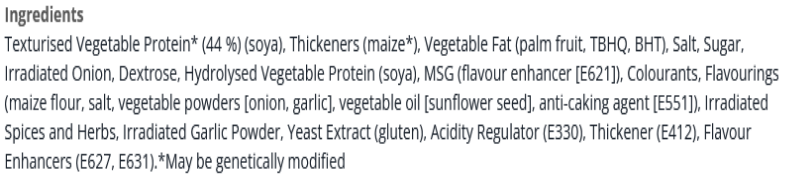
Ingredients
Texturised Vegetable Protein* (44 %) (soya), Thickeners (maize*), Vegetable Fat (palm fruit, TBHQ, BHT), Salt, Sugar, Irradiated Onion, Dextrose, Hydrolysed Vegetable Protein (soya), MSG (flavour enhancer [E621]), Colourants, Flavourings (maize flour, salt, vegetable powders [onion, garlic], vegetable oil [sunflower seed], anti-caking agent [E551]), Irradiated Spices and Herbs, Irradiated Garlic Powder, Yeast Extract (gluten), Acidity Regulator (E330), Thickener (E412), Flavour Enhancers (E627, E631).*May be genetically modified

Figure 2.8: An Example of a Voluntary GM Label on Pick n Pay Soya Mince (Pick n Pay 2022)

In addition to the presence of GM labels, it has also been suggested that the text used on GM labels needs to be easily understood by consumers, thereby promoting the usefulness of such labels (Yeh et al. 2019). Evidently, SA has demonstrated a desire to label food products containing GM ingredients, which could give SA consumers solace in knowing that they have the opportunity to identify a GM-containing food product in SA supermarkets. In SA, the question remains whether consumers are concerned with GMFP labelling and whether it plays a role in their views about these food products.

2.8.3 Genetically Modified Symbols

Since many GM labels are placed on the back of food packaging, it has been proposed that the use of an icon, symbol, sign or simple wording – in a suitable size, style, font and colour placed on the front of food products – would make the GM label clear to consumers, thereby assisting consumers to distinguish between GM and non-GMFPs (Oh & Ezezika 2014; Yeh et

al. 2019; Jiang & Zhang 2021; Zhang et al. 2021; Delgado-Zegarra et al. 2022; Sheldon 2022). Therefore, the design of GM labels needs to be carefully considered to ensure that consumers react to GM labels in a favourable way (Kim et al. 2022). In terms of the use of symbols on GM labels, two symbols have been developed and approved by the United States Department of Agriculture (USDA) to be used on the packaging of GMFPs (Shreeves 2018), as seen in Figure 2.9.

Figure 2.9: Two Symbols Approved by the USDA for Foods made with Bioengineered (BE) Ingredients (Shreeves 2018)

The use of these two symbols on the packaging of GMFPs will allow consumers to recognise products that contain GM ingredients more easily (Shreeves 2018). Furthermore, Brazil mandates the use of a particular caution sign to indicate the presence of GM components in food products (Jaffe 2017). Jaffe (2017) adds that the sign can be identified as a yellow triangle with a T inside, which stands for 'transgenic', as illustrated in Figure 2.10.

Figure 2.10: The Transgenic Caution Sign used on GM Labels in Brazil (Hakim et al. 2020)

As shown in Figure 2.10, the yellow transgenic sign used on GM labels in Brazil acts as a warning to consumers that the food products contain GM components (Jaffe 2017). The author adds that, although it is a caution sign, it aids consumers in identifying GMFPs in-store. GM labels therefore play a crucial role in communicating the presence of GM ingredients to the consumer, and as a result, consumers have demonstrated a desire for GMFPs to be labelled accordingly (Popek & Halagarda 2017; Sanlier & Sezgin 2020).

2.8.4 Consumer Studies on GM Labelling

Numerous studies have been conducted to determine consumers' views and opinions about GM labels. Studies were carried out in the USA, Iran, and Malaysia to determine which aspects

affected consumers' decision to purchase food products containing GMOs; in China to determine consumers' perception of GMFPs and explore the mandatory labelling of such food products; and another study in China to explore how consumers view GM and non-GM labelling systems (Wunderlich & Gatto 2015; Ghanian et al. 2016; Uddin et al. 2018; Zhang et al. 2021; Zheng & Wang 2021). These studies established that GM labelling was important, and consumers wanted GMFPs to be labelled, thereby providing them with the information to differentiate between GM and conventional food products. Results from a study in Malaysia to explore consumers' awareness of GMFPs and in Botswana to establish what knowledge and perception consumers have of GMFPs showed that consumers wanted to know when a food product contained GM ingredients (Tanius & Seng 2015; Hulela et al. 2019). A clear need for GM labels was thus demonstrated among global consumers, but it is unclear whether this is the case in SA.

Studies conducted in Vermont by Kolodinsky et al. (2019), to explore the way in which consumers use mandatory labels on GMFPs; and in Canada by Macall et al. (2021), to determine the choices that consumers make in terms of GMFPs, found that consumers did not read food labels to determine if a food product contains GM components. Studies in SA and South Korea reported similar findings (Jonker 2017; Kim & Choi 2018). Results from a study conducted in SA to determine consumers' knowledge of the nutritional information on food product labels found that price and habitual buying led to their refrainment from reading food labels, but consumers also did not trust the information included on food product labels (Basson 2018). In terms of the interpretation of the information on GM labels, another study conducted in Brazil to explore consumers' knowledge, trust and perceived risk of GM labels established that consumers struggled to interpret the meaning of GM symbols on GMFPs (Hakim et al. 2020). However, results from a study in Vermont established that the location of GM labels was important to them, that labels placed on the front of food products were read more frequently, and that GM labels would save them time in terms of having to search for information to establish whether a product contains GM ingredients (Kolodinsky et al. 2019). These studies show that GM labels are important to consumers, but ignorance and the absence of reading food labels could impact the effectiveness of GM labels, thereby fuelling the ongoing debate on the need and efficacy of GMFP labelling.

The biosafety frameworks and regulations of GMOs are discussed next to provide an overview of the procedures that must be followed to produce a GM crop to arrive at a final GMFP available for the consumer to purchase.

2.9 BIOSAFETY FRAMEWORKS AND REGULATIONS OF GMOS

GM crop producers are required to comply with stringent regulations and policies before any GM crop can be produced to ensure that health, environmental and safety standards are met (Muzhinji & Ntuli 2021; Ghimire et al. 2023). This means that all GM crops need to be tested either in field tests or laboratories before biosafety regulatory authorities can approve a GM crop for commercialisation through the Biosafety Act and Regulations (Akinbo et al. 2021). The data obtained is then used to assess the risk of each GM crop (Muzhinji & Ntuli 2021). Therefore, the authors add that stringent processes must be followed before the respective GMO-containing crop receives approval to be produced and released onto the market.

The biosafety regulations and processes that countries and producers of GM crops subsequently need to follow are intricate, and the approval process for any GM crop can be time-consuming (Muzhinji & Ntuli 2021). These factors could hinder the initial production of GM crops, thereby compromising food security efforts, as seen with Golden Rice©, which took 10 years to gain approval (Potrykus 2010). An overview of the biosafety frameworks and regulations employed in Africa and South Africa follows.

2.9.1 Biosafety Frameworks and Regulations in Africa and South Africa

Although regulatory frameworks are expensive, the African Union Commission has made an effort to implement regulatory frameworks by developing the African Model Law on Biosafety, which was later redrafted and is now known as the African Biosafety Strategy (Gbashi et al. 2021). African countries are encouraged to use the aforementioned strategy together with the Cartagena Protocol on Biosafety (CPB), which is an extension of the Convention on Biodiversity (CBD) protocols concerning GMOs (Muzhinji & Ntuli 2021). The authors state that the CPB protocol took effect in 2003. It was designed as an international agreement to manage and control GMOs, to ensure that biodiversity remains protected at all times, and to manage the movement of GMOs between countries (Karalis et al. 2020; Muzhinji & Ntuli 2021). Such a protocol could offer consumers concerned with the environment's well-being solace.

In the SA context, the country enacted its first GM technology legislation through the Genetically Modified Organisms (GMO) Act in 1997, which aims to ensure that GMOs are developed, produced and used in an appropriate way (Department of Agriculture South Africa 2004; Wray 2021). In 1999, this act allowed SA to develop regulations allowing the country to hand out GM permits and conduct risk assessments and field trials on GM crops (Wray 2021). The SAGENE was also developed, which aimed to guide and assist the government, the

industry, and the public regarding the safety of GMOs (Okeno et al. 2013). The African Centre for Biodiversity (ACB) was thus established in SA to monitor GMO activity in terms of environmental and safety risks (African Centre for Biodiversity 2020). In addition, the National Environmental Management Biodiversity Act, which was established in 2004, comprises of legislation giving the Minister of Environment, Forestry and Fisheries the authority to disapprove a permit if any threat towards the environment or indigenous species is suspected (Esterhuizen & Bonsu 2020).

SA therefore has well-established biosafety regulations and is striving to ensure that all GM crops in the country are produced in a way that protects human health and environmental well-being. SA's demonstrated effort in protecting the consumer and the environment can offer a sense of comfort for those consumers who are specifically concerned with their health and the environment when it comes to GMFPs; however, due to limited research, it remains unclear whether these regulations are important to the SA consumer where GMFPs are concerned.

2.10 SUMMARY

Food insecurity is becoming compromised across the globe, particularly in developing countries on the African continent, as these countries are already facing food-shortage prospects. To address and overcome this challenge, many stakeholders have placed their trust and confidence in biotechnology, particularly since this technology has the ability to modify the plant materials of crops to retain specific traits that can aid in producing larger quantities of nutritious GMFPs for the population. Thus, the production of GM crops has caught the attention of numerous countries, which have embraced the production of GM crops, thereby illustrating that research is increasingly focused on such crops to further promote and facilitate their production.

Although various benefits have been coupled with GM crops and food products, such as having resistant traits while protecting the environment and providing consumers with nutritionally adequate food products that are appealing and have specific food processing qualities, risks and concerns have been demonstrated. These concerns relate to the environment, the acquisition of GM seeds, control of GM seed companies, ethical issues relating to the development of GM crops and food products, and human health. In terms of promoting food security, biotechnology's role in animal genetic modification and editing has also gained interest, and the mandatory labelling of GMFPs is becoming another important topic in the GM food industry.

To address food insecurity threats and increase food security, it is vital for countries to implement bio-safety frameworks and policies to promote the production of GM crops. SA has implemented various GM regulations and policies, showing that the country is a proud practitioner of GM crop production, particularly maize. A literature review on consumers' attitudes, PI and the proposed conceptual framework for this study is presented in the next chapter.

CHAPTER 3
LITERATURE REVIEW ON CONSUMERS' ATTITUDES AND PURCHASE INTENTION

To present existing information on consumers' attitudes and PI toward GMFPs, this literature review chapter discusses how attitudes are developed and what contributes to the formation of an attitude to understand the meaning and conceptualisation of attitudes. The chapter also describes how and why an attitude can be altered and the promise this holds for the GM food industry, and explains how and why two attitudes towards a product can exist. This information will lead to subsequent improved insights into attitudes. Thereafter, various attitude models are considered to understand the various postulations on how attitudes are developed. A discussion on the EV Model of Attitudes in this study and its components (beliefs, values and expectations) follow, offering insight into what this attitude model posits in terms of attitude formation. The consideration and relevancy of knowledge and sources of GM-related information within the beliefs component of the EV Model of Attitudes is also discussed. A further discussion on the results of consumer-related studies is provided to offer insight into consumers' knowledge of GMFPs and which sources are visited for GM-related information. The TPB framework is presented to gain an improved understanding of how attitudes, subjective norms and PBC influence PI. Consumer-related studies are also discussed to gain insight into the information obtained related to attitudes, subjective norms and PBC in relation to consumers' intention to purchase GMFPs. The chapter concludes with a presentation of the conceptual framework for this study.

3.1 INTRODUCTION

In the previous chapter, literature on GM crops and food products was presented. In this chapter, consumer attitudes are discussed. Consumer attitudes are intricate due to the various aspects that can influence attitude formation, their ability to be altered, as well as the possibility of having more than one attitude towards the same product at the same time (Wilson et al. 2000; Bohner & Dickel 2011; Albarracin & Shavitt 2017; Tormala & Rucker 2022; Zhang et al. 2022; Abun et al. 2023). Various attitude models have been developed to investigate attitude formation, one of which is the EV Model of Attitudes adopted in this study (Sheth & Tuncalp 1974; Jain 2014). To understand attitudes toward a product, consumers' knowledge has been suggested to play a role (Hoque et al. 2018). GM-related consumer studies have explored this phenomenon by investigating where consumers obtain information about GMFPs to understand their level of knowledge (Marx 2017; Hoque et al. 2018; Zhaleh et al. 2023).

Various platforms have also been suggested to share information about GMFPs with consumers, thereby facilitating their improved knowledge of such food products (Olabinjo et al. 2020). Prior studies to investigate PI and behaviour toward GMFPs used the TPB framework (Chen 2008; Zhang et al. 2018; Saha et al. 2021), and it was used as a framework in the current study. An understanding of consumer attitudes is important to better understand their assessments and judgements toward a product (Bohner & Dickel 2011; Ledgerwood et al. 2018), such as GMFPs. This factor is described next.

3.2 CONSUMER ATTITUDES

To understand the various aspects of consumer attitudes and what influences the development of attitudes, the conceptualisation of consumer attitudes in terms of attitude formation is discussed. A discussion on attitude change and dual attitudes is also provided to consider the reasons for potential attitude changes and the proposed reasons for the presence of dual attitudes.

3.2.1 Conceptualisation of Consumer Attitudes in terms of Attitude Formation

Attitudes are an important topic and have thus been debated and explored by various researchers for years (Bohner & Dickel 2011). The authors add that the intention is to best understand the concept of attitudes, particularly by investigating how attitudes are formed or developed and how and why they change. Therefore, the conceptualisation of attitudes has been difficult to understand due to its complexity (Abun et al. 2023). This study aimed to shed some light on what constitutes consumers' attitudes toward GMFPs, thereby assisting in understanding how consumers develop their attitudes, specifically towards such food products. Generally, attitudes are thought to consist of three basic aspects, namely a (i) cognitive aspect, which is mainly comprised of thoughts, beliefs and the information an individual has about a product, and is influenced by the experience the individual has had with the product; (ii) an affective aspect, which is comprised of feelings, emotions or habits; and (iii) a behavioural aspect, which refers to how consumers behave or act (Marcinkowski & Reid 2019; Bakanauskas et al. 2020; Abun et al. 2023; Maddocks 2023).

Attitudes further involve what a person thinks about something, such as an object or product, meaning how a person feels about something (Bakanauskas et al. 2020). According to the authors, these feelings can be positive or negative, such as what consumers think about GMFPs. Essentially, an attitude reflects an individual's overall evaluation of a product (referring to the assessment of a product, thereby guiding a preference to or against a

product), and is thus commonly referred to as the degree of favour or disfavour with which an individual assesses or thinks about a product; it is a reflection of an individual's outlook on a particular product (Al-Debei et al. 2015; Ledgerwood et al. 2018; Vossen et al. 2018; Bakanauskas et al. 2020; Tormala & Rucker 2022; Verplanken & Orbell 2022; Abun et al. 2023). This study aimed to explore consumers' evaluations of GMFPs and whether they have a favourable or unfavourable attitude towards such food products. Drawing an analogy to the constructivist paradigm discussed in Chapter 4, this information can provide a lens through which consumers' viewpoints of GMFPs can be explored.

Since an attitude can be viewed as a positive or negative tendency towards a product or object that generally arises from upbringing, exposure or marketing-related initiatives, it can be argued that an attitude is the product of various personal-related factors that, in turn, steer an individual to act or behave in a particular way (Albarracin & Shavitt 2017; Williams et al. 2017; Rehman et al. 2019; Abun et al. 2023; Maddocks 2023). This further contributes to the complexity of attitudes (Bohner & Dickel 2011; Abun et al. 2023). Consumers refer to or rely largely on their attitudes when a judgement is made about an object or product (Marcinkowski & Reid 2019). Attitudes thus affect individuals' intention to purchase a specific product, thereby driving their behaviour towards the product (Marcinkowski & Reid 2019; Abun et al. 2023). This is largely based on whether their attitude towards the identified product is of a positive or negative nature, through which a judgement about the product is made (Al-Debei et al. 2015; Marcinkowski & Reid 2019; Verplanken & Orbell 2022), such as towards GMFPs. In terms of PI, the attitude element within the TPB framework is discussed further in Section 3.6.1.1.

Many researchers have their own opinions about attitudes, particularly regarding their memory-based interpretation of attitudes. According to Sherif and Cantril (1947), once attitudes have been developed, "they are more or less enduring states of readiness". Allport (1935) suggests that "attitudes are often as rigid as habits", and attitudes commonly continue throughout a person's life and remain the same as when the attitude was developed during childhood. Conversely, Tesser (1993) stated that attitudes could also have an innate aspect to them, meaning that such attitudes are particularly difficult to alter. It is noteworthy to highlight that researchers agree attitudes include an evaluative component (evaluating a product), which is stored in memory and enduring over a long period (Petty et al. 2007). Moreover, over the years, researchers have suggested that there could be another aspect to evaluations – and subsequent attitudes – stored in memory, in that these evaluations or attitudes can cross an individual's mind automatically (Wilson et al. 2000). This view was supported by Fazio et al. (1986), who theorised individuals can easily gain access to their memory, which requires minimal control. Various researchers agree that the automatic trigger

of attitudes is “a highly replicable phenomenon”, meaning that the attitude is consistent and, once an attitude is triggered or activated, the individual will act impulsively in terms of their behaviour; product alternatives are thus not considered (Hermans et al. 1994; Fazio et al. 1995; Bargh et al. 1996; De Houwer et al. 1998). It remains debatable whether the automatic trigger of attitudes only applies to attitudes about which individuals feel strongly (Wilson et al. 2000). Wilson et al. (2000) also add that the various opinions of numerous authors point to the complexity of understanding consumer attitudes. However, the above-mentioned authors are in agreement that once an attitude is activated, individuals’ stored evaluation of a product will influence their behaviour towards that particular product.

By exploring attitudes in this study, insight was gained into consumers’ attitudes towards GMFPs and how their attitudes were formed. This information was important to establish as it is essential – from a food security point of view – for consumers to have favourable attitudes toward GMFPs, creating a desire for such food products. A discussion on the possibility of changing an attitude toward a product follows.

3.2.2 Attitude Change

Although attitudes develop throughout a person’s life and are thus challenging to modify or alter, it has been argued that attitudes can be changed (Wilson et al. 2000). This entails the alteration or amendment of an existing attitude that is presently stored in the memory (Wilson et al. 2000; Wang et al. 2021). Thus, attitude change incorporates both the stored evaluations in memory and any new information an individual is exposed to or comes across (Bohner & Dickel 2011; Tormala & Rucker 2022). The Anchoring-and-Adjustment Model of Attitude Change also proposes that attitudes can be recalled from memory or can be formed due to a current situation, so when an individual encounters a specific product, their stored evaluation of the product (in their memory) is retrieved instantaneously (Cohen & Reed 2006). Individuals could then consider the stored evaluations in their memory of a product and what they are currently thinking about the product after being presented with specific information about the product (Wilson et al. 2000). In such instances, the individual could assess their stored evaluation and current thoughts, and could then replace or alter their stored evaluation with what they are currently thinking about the product – their attitude then changes (Wilson et al. 2000; Wang et al. 2021). In some cases, an individual may have a weak attitude towards the product, and their evaluation of that product may thus be formed from what they are currently thinking about the product (Hovland 1959). However, Hovland (1959) adds that individuals could also have strong, founded attitudes towards the product, and their evaluation of the product is then based on their stored evaluation in memory. In these cases, what they are

currently thinking about the information presented regarding the product would have no influence over their attitude, and their attitude towards the product thus remains unchanged (Wilson et al. 2000).

It has, therefore, been suggested that the strength of an attitude, meaning "the extent to which attitudes manifest the qualities of durability impactfulness", should be considered as a contributing factor to how individuals react and process new information about products (Bohner & Dickel 2011). Moreover, strong attitudes are presumed to be more stable in nature, regardless of the situation or context in which an individual finds themselves (Wilson et al. 2000). As a result, strong attitudes can be retrieved from memory more easily, while weak attitudes are more difficult to retrieve, and the possibility that weak attitudes can be altered is thus higher than that of a strong attitude (Wilson et al. 2000; Verplanken & Orbell 2022; Yuan et al. 2023).

Although a pertinent attitude can be difficult to change (Yuan et al. 2023), this study proposed that a potentially unfavourable attitude towards GMFPs can be changed, which is promising for the GM food industry's aim to enhance food security. This is because unfavourable attitudes can be addressed and subsequently altered to more favourable ones through the dissemination of accurate and beneficial information about GMFPs, contributing towards consumers becoming more aware of these food products and seeking them in-store. However, this also suggests that a favourable attitude can change, thus signifying the importance of sharing adequate information with consumers to ensure they retain positive attitudes toward GMFPs. This can further be facilitated by sharing the benefits of such food products, thereby facilitating consumers' acceptance of these products on the market.

Various researchers agreed with the Anchoring-and-Adjustment Model of Attitude Change that attitudes can be replaced or altered (Carlston & Skowronski 1986; Petty & Cacioppo 1986; Fazio 1990; Wilson et al. 2000). These include the Elaboration Likelihood Model (ELM), the Heuristic-Systematic Model (HSM), the Motivation and Opportunity as Determinants (MODE) Model, and the model of Trait Versus Behaviour Memory (Carlston & Skowronski 1986; Petty & Cacioppo 1986; Fazio 1990; Wilson et al. 2000). Fazio (1990) illustrated through the MODE Model that if an individual's stored evaluation is easily accessible, the likelihood increases significantly that the stored evaluation will be activated automatically and may subsequently be difficult to change when presented with new information about the product. Additionally, the MODE Model and the Meta-Cognitive Model (MCM) both suggest that attitudes remain in an individual's memory over a long period (Fazio 1990; Petty et al. 2007). The ELM and the HSM propose that when the original evaluation or attitude is of a strong nature, then the

individual could react to new information in a way that ensures their original attitude remains (Petty & Cacioppo 1986; Wilson et al. 2000). However, the authors add that if the original evaluation or attitude is weak, it can be altered when exposed to new information about the product. The authors also pointed out that the ELM and HSM further postulate that when an individual has strong motivations, they will process new information more carefully, which can result in the development of a strong attitude towards the product. However, according to Petty and Cacioppo (1986) as well as Wilson et al. (2000), if the motivation is weak, the individual may not process new information extensively, meaning their original attitude could change, but temporarily. Other researchers have indicated that they agree with the approach to attitude change as illustrated by the MODE Model, ELM and HSM, because when an individual's original attitude towards something is weak, the likelihood of forming a new attitude is high (Tesser 1993; Fazio 1995; Petty & Krosnick 1995).

In the case of this study, the aim was not to explore how consumers' attitudes have changed toward GMFPs nor to determine the strength of their attitudes. Instead, the study aimed to explore which aspects stand out or emerge as meaningful drivers of attitude change that can subsequently be used to rectify or negate any unfavourable attitudes towards GMFPs. This information could help build consumers' confidence in their attitude, which can change a possible unfavourable attitude into a positive one. This exploration can point to the type of information and the aspects that need to be focused on in the dissemination of information, such as the risks and benefits of GMFPs, which can be made available to consumers to either negate their concerns or associated risks with these food products or, alternatively, to substantiate and confirm the benefits coupled with GMFPs. The type of information provided can thus change potentially unfavourable attitudes toward GMFPs to favourable ones or help reaffirm consumers' favourable attitudes, thereby encouraging consumers to purchase GMFPs. This outcome is critical as consumers' acceptance of GMFPs plays a significant role in these products' success (Owusu-Gyan et al. 2023) in combatting food insecurity.

Furthermore, attitude changes can occur when an individual is confronted with information about a product on numerous occasions (Wegener et al. 2001; Wang et al. 2021; Sleboda & Lagerkvist 2022). Thus, it is important for the GM food industry to supply ample information to consumers about GMFPs using various platforms, including television, the internet, magazines and newspapers (Dirisu et al. 2020; Russo et al. 2020; Macall et al. 2021). Consumers will thus continuously be exposed to GM-related information, which can, in turn, lead to increased knowledge and awareness about GMFPs. This information could promote the formation of factually sound beliefs that influence and assist in forming favourable attitudes towards such food products, while also changing an unfavourable attitude to a more

favourable one. As a result, the exploration into which sources of information consumers consult about GMFPs – which this study aimed to do – and which sources they trust offered a deeper insight into which sources the GM food industry should focus on and use to disseminate information to the consumer on a continuous basis to alter unfavourable attitudes towards GMFPs. A further discussion of the sources consumers consult to gain GM-related information is presented in Section 3.5.4. Further to the possibility of changing attitudes, it has been proposed that individuals could hold dual attitudes towards a product (Ajzen 2001; Zhang et al. 2022), as discussed next.

3.2.3 Dual Attitudes

It has been argued that individuals could either have single or dual attitudes, meaning only having one attitude towards something or holding more than one attitude towards a specific object or product (Wilson et al. 2000; Ajzen 2001; Zhang et al. 2022). According to Ajzen (2001), there is a notion that attitudes already exist towards particular products, and individuals only have one attitude towards something. However, Ajzen (2001) states that attitudes can be altered, and the new attitude can conceal the original one, but may not necessarily supersede or entirely displace the original attitude. Thus, the author adds that the original attitude will remain in an individual's memory, and the original attitude is thus not replaced completely by a new one. The result is that an individual can then simultaneously hold two or more attitudes, which subsequently affects their behaviour (Serenko & Turel 2019). To this effect, the model of dual attitudes was devised, which illustrates and suggests that individuals can have more than one attitude towards a product simultaneously (Wilson et al. 2000; Yuan et al. 2023).

However, some attitude theories disagree that an individual can hold two different evaluations, and subsequent attitudes, towards the same object or product at the same time (Wilson et al. 2000). This is suggested in the Anchoring-and-Adjustment Model (AAM), which posits that a change in attitudes is temporary and original attitudes are replaced when an individual assumes a new attitude towards a particular object or product (Cohen & Reed 2006). However, the Dual Model of Attitudes (DMA) argues that individuals can quickly return to their original attitude towards something, suggesting that an individual's original attitude is not entirely removed or replaced but is rather stored in memory (Serenko & Turel 2019; Yuan et al. 2023). The DMA further postulates that when an individual does change their attitude, they could be reminded about their original attitude but realise that their original attitude does not accurately reflect how they feel about that product any longer (Wilson et al. 2000). According to Wilson et al. (2000), an individual could also develop a new attitude towards something, and over time, the new attitude will fade away, and the old attitude will subsequently resurface.

The authors therefore state that these are possible explanations of why attitude changes could be temporary. However, the authors posit through their DMA that the original attitude never goes away; instead, it will be retained in memory, and the old attitude will thus coexist with the new one. As a result, Wilson et al. (2000) state that dual attitudes towards the identified object or product will arise.

In the case of this study, scientific literature has shown that consumers have associated various risks and benefits with GMFPs (Todua et al. 2015; Wunderlich & Gatto 2015; Hassan et al. 2016; Rzymski & Krolczyk 2016; Popek & Halagarda 2017), suggesting that consumers could have more than one evaluation of GMFPs. For example, consumers have associated GMFPs with a longer shelf life, enhanced nutritional value, and potential in terms of providing the wider population with sufficient and affordable food, thereby promoting communities' food security status (Lopez et al. 2016; Gheysen et al. 2019; Ruth & Rumble 2019; Dovey & Ntuli 2020). However, consumers have also associated the production and consumption of GMFPs with possible environmental and health risks, such as allergic reactions and cancer (Todua et al. 2015; Cormick & Mercer 2017; Popek & Halagarda 2017; Ruth & Rumble 2019). In SA, it is unclear if SA consumers hold such optimism and concern at the same time regarding GMFPs.

The benefits and risks have been found to influence consumers' attitudes toward GMFPs positively and negatively (Morris & Adley 2000; Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Lopez et al. 2016; Rzymski & Krolczyk 2016; Ghoochani et al. 2017; Jonker 2017; Deng et al. 2019; Amin et al. 2021), which could lead to dual attitudes toward GMFPs. By exploring consumers' attitudes toward GMFPs, in this study, favourable and unfavourable evaluations of GMFPs could emerge, and dual attitudes toward these food products could be present. Therefore, in this study, the possibility of the dual effect emerging from the risks and benefits of GMFPs was considered instead of a single attitude towards such food products.

In the context of this study, although an unfavourable attitude towards GMFPs can be held based on the risks associated with these products, the benefits linked to such products can be used, through information sharing, to change existing unfavourable attitudes and thus develop a new, favourable attitude that coexists with the unfavourable one. Thus, this study suggests that although it could be challenging to alter unfavourable attitudes, there is potential that an unfavourable attitude can be complemented by a favourable attitude development, thereby holding a dual attitude towards GMFPs instead of a single unfavourable attitude. This could aid in the acceptance of GMFPs while reducing consumers' hesitancy toward these food

products. The study further proposes that, in the case of dual attitudes, an unfavourable attitude can be altered to become more favourable in nature, potentially leading to a more favourable overall attitude toward GMFPs. To explore the possible presence of dual attitudes, it was important to see what constituted consumers' attitudes towards GMFPs and their salient beliefs, values and expectations. A discussion on this topic follows in Section 3.4.

Although the complexity of attitudes has been highlighted (Abun et al. 2023), various attitude models have been developed to explore and better understand how attitudes are developed toward a product. The most recognised attitude models are discussed next.

3.3 RECOGNISED ATTITUDE MODELS

Many models have been developed to explore attitudes (Ramdhani et al. 2012; Jain 2014). According to the authors, some of the best-recognised attitude models include the Tri-Component Attitude Model, Vector Model, Tripartite Model, the Cognitive-Affective-Conative Model, Bredahl's Attitude Model, the Multi-Attribute Model of Attitude, which consists of the Attitude-towards-Object Model, and the EV Model of Attitudes. The Tri-Component Attitude Model (ABC model) posits that an individual's cognitive, affective and behavioural responses influence their attitude (Marcinkowski & Reid 2019). The Vector Model comprises an affective and cognition component, which is proposed to lead to the development of an attitude, while the Tripartite Model and the Cognitive-Affective-Conative Model posit that attitudes are formed through feelings, beliefs and behaviour (Jain 2014). Although these attitude models have proven useful in exploring consumer attitudes, it has been argued that there could be cognitive-affective inconsistencies – even though it has not received much attention (Jain 2014; Conner et al. 2021). This means that individuals' beliefs about an object may not be consistent with their emotions about the same object, thereby contributing to the inconsistency between beliefs and emotions (Conner et al. 2021). Emotions can include fear, anger or joy towards a product and are indicative of whether a product is liked or disliked (Netzer et al. 2018). However, emotions were not important in this study as it did not explore consumers' emotional connotations to GMFPs, and it was not the study's intention to explore the influence of personal-related factors in consumers' attitudes toward GMFPs. The study did not seek to explore an emotionally based attitude toward GMFPs; therefore, the study did not explore whether consumers like or dislike GMFPs, or the various emotions such as fear, anger or joy toward these food products. Therefore, the affective component of attitudes was not considered in this study. As a result, the Tri-Component Attitude Model, the Vector Model, the Tripartite Model, and the Cognitive-Affective-Conative Model were not applicable to this study as these attitude models consider emotions' influence on attitudes.

In addition, Bredahl's Attitude Model is also commonly used in research specifically to determine consumer attitudes towards genetic modification, biotechnology or GMFPs, which postulates that consumer attitudes are determined by the perceived risks and benefits of GMFPs (Bredahl 2001; Chen 2008). However, Bredahl's Attitude Model was not applicable to the current study as this study did not seek to only focus on and explore the perceived risks and benefits of GMFPs to gain insight into consumers' attitudes toward these products. Instead, the study aimed to explore additional aspects that can contribute to the formation of consumers' attitudes, namely values and expectations. Thus, the values and expectations linked to the possible risks and benefits of GMFPs – which could emerge in this study by exploring consumers' beliefs – were considered in the current study, which Bredahl's Attitude Model omits.

Furthermore, the Multi-Attribute Model of Attitude, which is referred to as an EV Model-based Attitude Model, postulates that an individual's perception, together with their beliefs regarding the most important product attributes or characteristics of an object, as well as the assessment or evaluation of those important attributes, leads to an attitude (Ramdhani et al. 2012; Jain 2014). In addition, the Attitude-Towards-Object Model posits that consumers' attitudes are formed based on the presence or absence of particular attributes as well as the evaluation of those attributes (Ramdhani et al. 2012). The Multi-Attribute Model of Attitude and the Attitude-towards-Object Model considers beliefs towards product attributes and the subsequent evaluation of those product attributes (meaning the value given to each product attribute); however, according to the explanations of these two respective models, an expectations component is not mentioned (Ramdhani et al. 2012; Jain 2014). This indicates that these models do not consider the influence of beliefs and values on product attribute expectations, meaning that consumers' expectations towards the object are not considered; however, the EV Model of Attitudes does (Sheth & Tuncalp 1974; Ahn et al. 2019), as discussed in Section 3.4. This shows that the EV Model of Attitudes considers an additional component to beliefs and values, namely expectations. Therefore, to better understand attitude formation, these two models were not considered in this study as they only consider two components rather than three.

This study explored consumers' beliefs and values about GMFPs, as well as their expectations of these food products. An exploration of the expectations component is important and can lead to insight into which product attributes consumers expect GMFPs to have. Regarding the expectations of GMFPs, it could not be established whether previous studies have explored such an aspect within attitude development towards GMFPs, and ambiguity exists on what

consumers expect of these products. This gap in knowledge needs to be filled to clarify what is expected of a GMFP, which can be achieved by including an expectations component in the exploration of consumers' attitudes toward GMFPs.

As discussed in Section 3.4.4, literature concurs that an expectations component is important because it contributes to understanding what consumers believe a specific product needs to offer in terms of characteristics, what they want in a product, and what outcome a product is expected to have (Panchal et al. 2012; Cohen et al. 2014; Olsson et al. 2022). Expectations are therefore important to consider as they allow for an in-depth exploration into consumer attitudes and could result in deeper insight into consumer attitudes towards GMFPs. As a result, it was important to include an expectations component in this study, since this insight can assist the GM food industry in determining which food product features should be focused on and incorporated into GMFPs. This information could contribute to favourable attitudes and encouragement towards the desire for and purchasing of such food products. This can, in turn, increase food security for the SA population.

Considering the postulations of the above-mentioned attitude models, none were viable options for the current study as they do not consider an expectations component in attitude formation (Chen 2008; Ramdhani et al. 2012; Jain 2014). The EV Model of Attitudes was deemed the only viable and useful attitude model for this study. It considers expectations by positing that attitudes are constructed around beliefs (product attributes coupled with GMFPs), values (the value given to these attributes), and expectations (which product attributes GMFPs should have) (Sheth & Tuncalp 1974; Cohen et al. 2014). A discussion of these aspects follows.

3.4 EV MODEL OF ATTITUDES

The EV Model of Attitudes was adopted in this study to explore consumers' attitudes toward GMFPs. A discussion of the structural assumptions of the EV Model of Attitudes follows.

3.4.1 Structural Assumptions of the EV Model of Attitudes

Dr Martin Fishbein developed the EV Model of Attitudes in the 1970s to explain attitudes and better understand how attitudes are developed and formed toward an object (Sheth & Tuncalp 1974; Ajzen & Fishbein 2000). To do so, this model postulates that product attributes are an integral aspect to consider in attitude formation, and the model is thus largely focused on product attributes, referring to the traits of a product and its offerings (Robertson et al. 2018).

Regarding the EV Model of Attitudes, the term 'attribute' is used in a generic sense and can refer to any distinguishable characteristic of a product (Ajzen 2008). In terms of the EV Model of Attitudes, Sheth and Tuncalp (1974) as well as Psynso (2018a) – who makes use of psychological research and theory (Psynso 2018b) – and Ahn et al. (2019) identified that Fishbein theorised three primary aspects contribute to overall attitudes, namely beliefs, values and expectations. Notably, authors discussing the EV Model of Attitudes have used different terminology to refer to beliefs, values and expectations, respectively, as illustrated in Table 3.1.

Table 3.1: Different Terminology used to refer to Beliefs, Values and Expectations

Beliefs	Values	Expectations
Fishbein refers to beliefs as 'salient beliefs' (Sheth & Tuncalp 1974).	Fishbein refers to values as 'value' (Sheth & Tuncalp 1974).	Fishbein refers to expectations as 'expectations', 'subjective probability' and 'perceived instrumentality' (Sheth & Tuncalp 1974).
Ajzen and Fishbein (2000) refer to beliefs as 'accessible attributes'.	Ajzen and Fishbein (2000) refer to values as 'subjective values' or as 'evaluations'.	Ajzen and Fishbein (2000) refer to expectations as 'subjective probability' and 'strength of the belief'.
Ajzen (2001) refers to beliefs as 'accessible beliefs'.	Ajzen (2001) refers to values as 'evaluations' and 'values.	Ajzen (2001) refers to expectations as 'attitude strength'.
Ajzen (2008) refers to beliefs as 'attribute beliefs'.	Ajzen (2008) refers to values as 'evaluations'.	Ajzen (2008) refers to expectations as the 'likelihood' that a product has an attribute.
Ajzen (2011) refers to beliefs as 'accessible attributes'.	Ajzen (2011) refers to values as 'subjective values'.	Ajzen (2011) refers to expectations as 'subjective probability'.

To summarise, terms such as 'salient beliefs', 'accessible attributes', 'accessible beliefs', and 'attribute beliefs' relate to beliefs and the attributes associated with a product and thus represent the beliefs component of the EV Model of Attitudes. Terms such as 'value', 'subjective values', and 'evaluations' refer to an evaluation of product attributes in terms of the value of each product attribute, thereby representing the values component of the EV Model of Attitudes. Terms such as 'expectations', 'subjective probability', 'strength of the belief', 'attitude strength', and 'likelihood' are all indicative of the product having the identified attribute, and thus refer to the expectations component of the EV Model of Attitudes – all of which is illustrated in Table 3.1.

Using different terminology to refer to beliefs, values and expectations (Sheth & Tuncalp 1974; Ajzen & Fishbein 2000; Ajzen 2001) could contribute to the difficulty in understanding and interpreting the structural assumptions of the EV Model of Attitudes. Beliefs are not specifically referred to as a component in this model but rather as a crucial underlying structure from which the values and expectations components are studied in terms of the formation of attitudes within the EV Model of Attitudes (Sheth & Tuncalp 1974; Ahn et al. 2019). However, Table 3.1 reflects three components are considered within the EV Model of Attitudes; therefore, for the purpose of this study, the three components are referred to as beliefs, values and expectations, and were explored in this study. To illustrate Fishbein's theory in terms of beliefs, values and expectations, which led to the development of the EV Model of Attitudes, a formula was developed. This formula demonstrates the link between beliefs, values and expectations and the role that these three aspects play in contributing to an overall attitude towards an object. The formula can be seen in Figure 3.1.

$$A_0 = \sum_{i=1}^{n} B_i a_i$$

A_0 = Attitude toward the object or concept,

B_i = Subjective probability of a belief i about the object or concept

a_i = Evaluative aspect of belief i

n = Number of salient beliefs about the object

Figure 3.1: Fishbein Expectancy-Value Model of Attitudes Formula (Sheth & Tuncalp 1974)

According to the formula (see Figure 3.1), A_o represents the attitude toward the object; B_i represents the subjective probability of a belief (expectation); a_i represents the evaluative aspect of a belief (values of those beliefs); and n represents the beliefs about an object (Sheth & Tuncalp 1974). Thus, as Sheth and Tuncalp (1974) explain, an expectation about an object is developed based on the beliefs and values that have been assigned to the object, meaning that an expectation is formed after an association has been made between the consumer's beliefs and values of the product's attributes. Since the use of different terminology contributes to the complexity with which the EV Model of Attitudes is explained and discussed in scientific articles, Ahn et al. (2019) aimed to simplify these discussions on how an attitude is formed. Ahn et al. (2019) explain a belief has to be developed first (associating a product with a specific attribute), then a value is assigned to each attribute associated with an object, before an expectation is formed, which is subsequently based on both beliefs and values. Therefore, Fishbein theorised that expectations occur after a belief is multiplied by the value of the

attribute (Sheth & Tuncalp 1974). As stated by Zhang et al. (2008), an overall attitude is evaluated by individuals' values (assigned to each belief) and expectations, meaning that values (stemming from beliefs) and expectations work together to form an attitude. However, it remains unknown whether consumers' beliefs and subsequent values of GMFPs lead to a specific expectation of these food products and whether each component plays a role in forming an attitude towards GMFPs.

Although Fishbein developed the above formula to illustrate the EV Model of Attitudes, another formula representing this model is commonly used by other authors, as depicted in Figure 3.2.

$$A \propto \sum_{i=1}^{n} b_i e_i$$

Figure 3.2: Expectancy-Value Model of Attitudes Formula (Ajzen & Fishbein 2000; Ajzen 2008)

As seen in Figure 3.2, A represents the attitude toward the object; i represents the product attribute; b_i represents the strength of the belief that the object has the attribute (expectation); e_i represents the evaluation of the attribute (values of the beliefs); and n represents the number of accessible beliefs (beliefs) (Ajzen & Fishbein 2000; Ajzen 2008). According to this formula, overall attitude is the result of a person's beliefs about a specific object and a person's ultimate attitude is also established by their evaluations or values of the product attributes and the association between them (Ajzen & Fishbein 2000). The authors add that evaluations (value) of product attributes (belief) influence consumers' attitudes, which is directly linked to an individual's subjective probability or expectation that the object has the attribute, meaning that the attitude is influenced by beliefs and values as well as expectations. Evidently, the two formulas signify the role that beliefs, values and expectations play in contributing to individuals' overall attitude toward an object. However, beliefs, values and expectations' role in the formation of attitudes towards GMFPs is unknown. In addition, the two formulas are further indicative of the different terminology used to refer to the beliefs, values and expectation components of the EV Model of Attitudes, respectively.

Though its usefulness remains unknown in the GMFP context, numerous authors agree that the EV Model of Attitudes is valuable for exploring how attitudes are formed (Sheth & Tuncalp 1974; Ajzen & Fishbein 2000; Ajzen 2001; Ajzen 2008; Ajzen 2011; Ahn et al. 2019). However, the model has also received criticism for not including an affective component that is influential in attitude formation; meaning that factors such as emotions and mood are not considered

(Ajzen 2001). Various authors have argued that affect plays an important role in attitudes and should thus be considered when exploring attitudes towards an object (Eagly & Chaiken 1993; van der Pligt et al. 1998; van den Berg et al. 2005; Fischer et al. 2015; Perry et al. 2020). However, it has also been argued that if non-cognitive or affective aspects were found to influence attitudes, it could have resulted from the methodology adopted in the study (Ajzen 2001). Further criticism of the EV Model of Attitudes has focused on the beliefs and values components (Ajzen 2001). It has been proposed and argued that beliefs and values could be seen as two independent aspects that function independently from each other (Yi 1989; Ajzen 2001). However, the EV Model of Attitudes considers the association between beliefs and values (Sheth & Tuncalp 1974). Although this attitude model has been challenged, it is used in research as it provides a framework that allows an exploration into what constitutes the ultimate formation of an attitude – in terms of beliefs, values and expectations – and is therefore used to gain a deeper understanding of attitudes (Ajzen & Fishbein 2000). This could also be the case with attitudes towards GMFPs.

To illustrate the model's usefulness in exploring consumers' attitudes toward GMFPs, the components of the EV Model of Attitudes are discussed next, starting with beliefs, followed by values and expectations.

3.4.2 Beliefs Component of the EV Model of Attitudes

Within the beliefs component of the EV Model of Attitudes, beliefs are referred to as the cognitive structure of the model (Rosenberg 1956; Sheth & Talarzyk 1972; Ahtola 1973; Sheth & Tuncalp 1974). The EV Model of Attitudes proposes that accessible beliefs influence an overall attitude based on the premise that such beliefs are readily available and accessible from memory (Ajzen 2001). Beliefs within the EV Model of Attitudes entail associating an object or product with a particular attribute, serving as the basis of a person's attitude (Ajzen & Fishbein 2000). Therefore, a belief is indicative of what an individual feels about the attributes of a product, and thus reflects an individual's opinion regarding a specific product (Osterlie et al. 2018). Beliefs can also be regarded as individuals' current evaluation of product attributes and are therefore more focused on the present (Osterlie et al. 2018; Jones & Hite 2020). In terms of GMFPs, their attributes can include a longer shelf life, increased nutritional value, reduced price, increased yields and allergic reactions (Rzymski & Krolczyk 2016; Popek & Halagarda 2017; Siddiqui et al. 2022), among others. These attributes could potentially be linked to GMFPs in the current SA study. Thus, the EV Model of Attitudes provided a lens through which the study explored which traits consumers coupled with GMFPs, thereby gaining insight into their beliefs about GMFPs.

It has further been suggested that the importance of a belief – meaning a belief that is deemed important to an individual – influences their attitude, which can result in either a positive or negative attitude; consequently, beliefs and attitudes are related in that beliefs influence attitudes (Ajzen 2001; McSporran 2017). The EV Model of Attitudes thus postulates that attitudes follow in a reasonable manner from beliefs (Ajzen 2008). Therefore, according to Ajzen (2008), the more positive the belief is, the more strongly the belief will be held, leading to a more favourable attitude toward the product. In essence, an attitude toward a product stems from the set of beliefs associated with it (Brousmiche et al. 2016). However, it has been suggested that not all beliefs carry the same prominence in attitude formation due to their complexity, which can be attributed to the strength of beliefs (Sheth & Tuncalp 1974). In this study, the aim was not to determine the strength of beliefs; instead, beliefs were explored to see which attributes of GMFPs were more influential or prominent in attitude formation towards these food products. Moreover, people can develop different beliefs about a particular product and ultimately have different attitudes and behaviours towards a product, thereby reiterating that individuals can hold dual attitudes towards a product (Wilson et al. 2000; Ajzen 2001; Ajzen 2008; Zhang et al. 2022), as discussed in Section 3.2.3, and may be the case in this study. With regard to GMFPs, numerous authors have opined that consumers have various attitudes towards such food products (Todua et al. 2015; Wunderlich & Gatto 2015; Hassan et al. 2016; Rzymski & Krolczyk 2016; Popek & Halagarda 2017), suggesting that different beliefs are associated with these products, since beliefs are the core element of attitude development (Ajzen & Fishbein 2000). The beliefs individuals have formed towards a product become imprinted in their memory, which can affect their attitude at any time (Ajzen 2008). This finding emphasises the importance of establishing consumers' beliefs toward GMFPs if food insecurity is to be addressed. To illustrate the importance of beliefs in attitude formation, a study conducted in the USA – on abortion – found that beliefs have a positive influence on attitudes (Smetana & Adler 1980).

However, criticism has also emerged regarding the beliefs component of the EV Model of Attitudes (Ajzen 2008). According to Ajzen (2008), some claim this component does not consider rationality but rather relies on internal consistency – meaning that the source from which the belief originated, together with their veridicality (the 'truthfulness' of the belief), are not considered. Drawing from the criticism this model received regarding the absence of affective factors' consideration in attitude development, it has been argued that the development of a belief toward a product may be biased in nature (Ajzen 2001; Ajzen 2008). Therefore, beliefs could be influenced by emotions or the desire to satisfy personal needs, and the author proposed that beliefs are not developed through a logical process of reasoning

(Ajzen 2008). Additionally, it has further been suggested that contextual factors such as age, gender and personal interests could also influence beliefs about an object (Ajzen 2001).

Despite the criticism, various authors have agreed that beliefs are an integral aspect of exploring and understanding consumers' attitudes toward a product (Sheth & Tuncalp 1974; Ajzen 2001; Ajzen 2008; Brousmiche et al. 2016; McSporran 2017). Therefore, according to the EV Model of Attitudes, to better understand the basis of an attitude towards a product, the individual's beliefs toward that product need to be explored first (Ajzen 2008). It is thus important to explore consumers' beliefs about GMFPs to discover which beliefs are considered important and which features consumers couple with GMFPs, thereby better understanding their attitude towards such food products. For this study, the beliefs component of the EV Model of Attitudes was thus studied to explore the salient beliefs that emerge and influence consumers' attitudes toward GMFPs. This approach assisted in obtaining a better understanding of the beliefs component's role and influence in attitude formation toward such food products. A discussion on the values component of the EV Model of Attitudes follows.

3.4.3 Values Component of the EV Model of Attitudes

A further aspect that contributes to the development of attitudes is the values that individuals assign to a product, and values form a component of the EV Model of Attitudes (Sheth & Tuncalp 1974; Ahn et al. 2019). This model proposes that after a product has been associated with an attribute (belief), the attribute is evaluated in terms of its value (Ajzen & Fishbein 2000; Ajzen 2011; Ahn et al. 2019). In essence, an individual assigns a value to a product based on their beliefs; therefore, values emanate from beliefs (Ajzen 2001; Ahn et al. 2019). Thus, the individual's overall attitude is also influenced by the value assigned to each product attribute, referred to as a belief x evaluation (value) interaction (Ajzen 2001). As a result, beliefs and values are connected and thus collaborate to influence the ultimate attitude (Ajzen & Fishbein 2000; Ajzen 2008). This view is re-iterated by Sjoe and Montgomery (1999), who suggest that beliefs and values play an important role in the attitude an individual holds towards a product (Ajzen & Fishbein 2000). However, it is unclear if this connection between beliefs and values is evident in the case of GMFPs, but through this association, the valued attributes of a product can be explored (Ajzen 2001). Some have argued that values are more indicative of individual differences (such as personality) instead of driving a specific attitude, which could make the values component less useful in exploring consumer attitudes (Sheth & Tuncalp 1974). In the exploration of consumers' attitudes toward GMFPs, it is unclear whether the values component would be useful. Nevertheless, the EV Model of Attitudes provides a framework that allowed this study to explore the value that consumers attach to GMFPs' traits.

While values form an integral part of the EV Model of Attitudes, authors discussing the structural assumptions of this attitude model have failed to discuss the concept of values in detail (Sheth & Tuncalp 1974; Ajzen & Fishbein 2000; Ajzen 2001; Ajzen 2008; Ajzen 2011; Ahn et al. 2019). Others have merely stated that values refer to the importance of an attribute (Rosenberg 1956; Cohen et al. 1972; Sheth & Talarzyk 1972); these authors have not addressed what the true meaning of values is. It is important to consider what values entail in order to grasp the value component's role in the EV Model of Attitudes.

Drawing from various authors, values are referred to as the value ascribed to a product as well as what an individual feels is important to them – meaning which traits are worthy, in their opinion – in addition to the worth they feel a product holds (Mahajan 2020; Goedegebure et al. 2022). Therefore, Mahajan (2020) adds that valuing something refers to the worth or importance of something and essentially relates to the overall worth an individual assigns to a product. Drawing an analogy to the EV Model of Attitudes, values refer to the product attributes that are important to the individual, as well as the general value an individual assigns to an attribute they believe the product holds. Within the GMFP context, values are subsequently indicative of which GMFP traits consumers feel are important and the value they ascribe to these traits. Based on this evaluation, a favourable or unfavourable attitude could arise. Therefore, the values component of the EV Model of Attitudes provides insight into the worth consumers attach to GMFPs due to their traits, and it remains unknown whether the SA consumer finds specific value in these food products. To better understand the values component's role in the EV Model of Attitudes, the four categories of task values were considered and are subsequently discussed.

3.4.3.1 Four Categories of Task Values within the Values Component of the EV Model of Attitudes

When values were presented within the EV Model of Attitudes (Sheth & Tuncalp 1974; Ajzen & Fishbein 2000; Ajzen 2001; Ajzen 2008; Ajzen 2011; Ahn et al. 2019), the authors did not consider or present the four categories of task values, namely cost value, attainment value, intrinsic value, and utility value (Meyer et al. 2019) in their discussions. This omission is possibly attributed to their lack of elaboration on what each component entails and what the purpose of each component is. Nevertheless, these categories refer to an individual's incentive for doing something (Yurt 2015) or, in the case of this study, purchasing a GMFP.

Drawing from the Expectancy-Value Model of Motivation, developed by Eccles, Wigfield and colleagues (Wigfield & Eccles 2000), numerous authors agree that the four categories of task values need to be considered when exploring the value that is assigned to something as the proposed values are based on these categories or the amalgamations of these categories (Wigfield & Eccles 2000; Yurt 2015; Biedenbach & Jacobsson 2016; Seals 2016; Fielding-Wells et al. 2017; Dietrich et al. 2019; Loh 2019; Meyer et al. 2019; Bostrom & Palm 2020; Jones & Hite 2020; Umarji et al. 2021). Therefore, this study included the four categories of task values to explore the values component of the EV Model of Attitudes, thereby gaining an improved understanding of what consumers value about GMFPs, and investigating whether these four categories of task values are useful in exploring consumers' value and attitude towards these food products. A discussion of the four categories of task values follows.

The cost refers to what an individual is willing to give up in order to obtain a product, such as psychological, financial, time or energy costs (Umarji et al. 2021; Tang et al. 2022; Shang et al. 2023). The cost therefore also refers to the effort expected to be applied to acquire a product, referred to as effort cost (Dietrich et al. 2019; Schweder & Raufelder 2022). These aspects are important to consider in order to explore which resources consumers are willing to give up, what they think they need to give up, and what effort they feel is required of them as consumers to purchase and acquire GMFPs. Attainment value refers to how relevant an object is to an individual's identity or core personal values (Dietrich et al. 2019; Tang et al. 2022; Wang & Xue 2022). It also refers to the degree to which the identified object signifies an important aspect of themselves, thereby encouraging a certain behaviour (Yurt 2015; Shang et al. 2023). Personal values refer to what an individual feels is meaningful and important to them and can thus propel them towards purchasing something (Gamage et al. 2021), such as acquiring GMFPs. In addition, the authors add that personal values develop from childhood and are thus embedded in an individual; as a result, personal values guide an individual in their everyday life to behave or not behave in a certain way. It was important to explore attainment value to see how relevant GMFPs were in terms of consumers' personal values and whether GMFPs' attributes, such as environmental protection, reduced food prices, increased food security, longevity and increased nutritional value (Rzymski & Krolczyk 2016; Popek & Halagarda 2017; Rosculete et al. 2018; Siddiqui et al. 2022) compliment their values and contribute to their attainment.

Since personal values refer to guiding behaviour towards something, it has been argued that, in terms of behaving towards something in a particular way, personal values and ethics are interrelated (Manchiraju & Sadachar 2014; Abdullah & Anees 2016; Saunders et al. 2022; Bhardwaj et al. 2023). It has also been suggested that personal values and emphatic concern,

which refers to an individual's welfare or concern when behaving in a certain way, also influence behaviour (Jang & Cho 2022), such as purchasing and acquiring GMFPs. Therefore, in the current GMFP study, ethics could play a role in consumers' personal values regarding the attainment of such food products, particularly since consumers have demonstrated ethical concerns toward GMFPs (Dizon et al. 2016; Gastrow et al. 2018; Islam et al. 2020). Such ethical concerns include factors like human and technological interference with the genetic material of food, the unnaturalness of such food products, and conflicts with individuals' religion (Lucht 2015; Gatew & Mengistu 2019; Lefebvre et al. 2019). However, the question remains whether such ethical aspects and others could emerge in a GM study where consumers' personal values about GMFPs are explored in terms of the attainment value of GMFPs.

Intrinsic value can be defined as the actual value of a product, meaning the value a product has "in its own right" (Biedenbach & Jacobsson 2016). This value is assigned to a product based on the reward or enjoyment a consumer experiences of a product (Loh 2019; Tang et al. 2022; Shang et al. 2023). It could spark an interest towards the product and result in value being bestowed upon the product, ultimately affecting individuals' attitudes towards it (Seals 2016; Dietrich et al. 2019). Moreover, if a product holds an intrinsic value to a person, they will be more encouraged and focused on purchasing the product (Yurt 2015). It was important to explore the intrinsic value category in the GM context to see which traits consumers deem rewardable and from which they can enjoy a positive experience. In the GMFP context, such aspects include, but are not limited to, increased nutritional value, longer shelf life, better taste and improved product quality (Deffor 2014; Popek & Halagarda 2017; Siddiqui et al. 2022; Abdoul et al. 2023); however, it is unclear if these are valuable attributes to the SA consumer.

Utility value refers to the consequence after a product has been purchased as well as the usefulness of a product, which relates back to the reward or enjoyment experienced of a product, and the intrinsic and utility value categories are thus closely related (Bostrom & Palm 2020; Tang et al. 2022; Wang & Xue 2022). In terms of GMFPs, it was important to consider their utility value to explore the usefulness consumers couple with these food products. Utility value further relates to the functionality of a product (Biedenbach & Jacobsson 2016). The authors add that this refers to the function of a product, meaning if the product is performing in the way it was intended or designed to do (purpose of the product). The authors explain that a product's functionality contributes to its usefulness. In the GM context, the functionality and subsequent usefulness of GMFPs could include, but are not limited to, reduced use of herbicides and pesticides, increased crop yields, resistance to pests, ability to address food insecurity, improved taste, longer shelf life, improved product quality, and increased nutritional

value (Deffor 2014; Popek & Halagarda 2017; Rosculete et al. 2018; Siddiqui et al. 2022). It is proposed in this study that these aspects could, in turn, shape consumers' attitudes towards GMFPs in a favourable manner. But the question is whether these aspects are valuable to the SA consumer; whether these consumers find any usefulness and functionality in GMFPs; whether such aspects can influence the value and subsequent attitudes among SA consumers towards such food products, and propel consumers toward GMFPs, thereby assisting with their food security status. It was, therefore, important to include this category in the values component of the EV Model of Attitudes to explore whether consumers opine that GMFPs are functioning the way they were created to do, thereby exploring whether the consumers couple value to GMFPs in terms of their usefulness. Additionally, the attainment, intrinsic and utility value categories are associated and connected with each other, which has led to many researchers placing these categories into "an overall value scale" (Dietrich et al. 2019). However, it remains unknown whether combining these three task value categories in the GMFP context will be useful in exploring the value given to such food products.

By considering and exploring the four categories of task values, a better understanding of the values contributing to consumers' attitudes toward GMFPs could be attained. This information could subsequently lead to improved insight into their attitudes towards such food products. For this study, the EV Model of Attitudes' values component – with the consideration of the four categories of task values within this component – was studied to explore the salient values that emerge and influence consumers' attitudes toward GMFPs. By doing so, more insight into the values component's role in consumers' attitude formation of GMFPs and the four task value categories' usefulness in the exploration of food products' value was gained. The third component of the EV Model of Attitudes, namely expectations, is discussed next.

3.4.4 Expectations Component of the EV Model of Attitudes

Within the EV Model of Attitudes, as previously mentioned, Fishbein proposed that an expectation is formed after the occurrence of a belief and value (Sheth & Tuncalp 1974). Evidently, an expectation is directly influenced by an attribute, which has been associated with the product as well as the value given to the identified attribute (Ajzen 2001). In terms of the EV Model of Attitudes, an expectation refers to the likelihood that a product holds the attribute in question (Fishbein & Ajzen 2000). Thus, the authors add that, after a product has been coupled with a specific attribute and evaluated in terms of its values, an individual then assesses whether the product holds the associated attribute. Due to studies not using the EV Model of Attitudes to explore consumer attitudes toward GMFPs, it is unclear, when it comes

to GMFPs, whether a belief and its subsequent value influence and contribute to expectations about GMFP attributes.

Although authors have not addressed the meaning of an expectation when discussing the EV Model of Attitudes (Sheth & Tuncalp 1974; Ajzen & Fishbein 2000; Ajzen 2001; Ajzen 2008; Ajzen 2011; Ahn et al. 2019), it is important to draw from literature to gain insight into what an expectation entails to understand its role in this model. Expectations refer to beliefs regarding which attributes a product should offer and are therefore indicative of which attributes an individual seeks in a particular product (Panchal et al. 2012; Cohen et al. 2014). Cohen et al. (2014) add that expectations further relate to the standard that is expected from a product's attribute. In the context of this study, the model's expectations component thus refers to which attributes individuals feel GMFPs should offer, or which attributes they would like such food products to offer based on their current beliefs of the product attributes and the value assigned to each attribute – confirming that expectations are the result of beliefs and values (Ahn et al. 2019).

Expectations also relate to the prediction that a product attribute will have a specific outcome or consequence; therefore, a product is judged before the product is actually purchased or consumed (Fu et al. 2020; Olsson et al. 2022; Suvittawat 2022). As a result, individuals may choose to purchase a product based on what they expect the product to be or offer (Panchal et al. 2012). It is questioned in this study whether SA consumers expect a specific outcome or consequence from a certain GMFP attribute. Previous experiences can also influence expectations of an activity or a product; thus, the expectation assigned to a product attribute can only be confirmed once an individual has experienced the product; thereafter, an evaluation can be made (Hansen 2008; Cohen et al. 2014; Razak et al. 2020; Olsson et al. 2022). If the expectation of the product is not met, it could result in a lowered expectation of the product, causing an individual to refrain from purchasing it in the future (Deliza & MacFie 1996; Fu et al. 2020). Conversely, the authors continue that if the product does meet their expectations, future expectations of the product could increase, subsequently driving behaviour and encouraging the re-purchase of the identified product.

In terms of GMFPs, in the context of this study, it is suggested that – for example – if a product is associated with improved taste and taste is deemed a valuable trait to be enjoyed, an expectation is created that when the product is consumed, an improved taste will be experienced. However, if this attribute is absent, it could lead to a proposed unfavourable attitude, thus preventing the consumer from purchasing the same GM food product again. A further illustration can be found in the enhanced shelf life of GMFPs. If longevity is coupled

with GMFPs and is believed to be a feature that is useful and valuable to the individual, an expectation of longer shelf life can be created. Thus, if a GMFP is purchased and, in fact, does last longer after being purchased, it can subsequently lead to a favourable attitude towards the product, thereby encouraging a re-purchase of the product. Evidently, expectations of product attributes and the subsequent confirmation or disconfirmation of these expectations ultimately influence and shape an individual's attitude toward the identified product (Williams et al. 2017), such as GMFPs. Therefore, expectations directly influence attitudes, which then influence the decision to purchase or not purchase a product (Jia et al. 2023). However, the question remains whether the SA consumer has had enough experience with GMFPs to create an expectation that can prominently influence their attitudes.

It has been argued that expectations aim to explain and identify which expectations encourage individuals to purchase a product based on what attributes a product is predicted to have; thereafter, the success of the product's outcome can be assessed (Panchal et al. 2012). Therefore, expectations influence and shape consumers' overall attitude toward an activity or product, and a positive or negative attitude can directly be linked to the expectations consumers have toward a product (Zhang et al. 2008; Williams et al. 2017). However, it is unclear if attitudes toward GMFPs are also directly linked to consumer expectations. For this study, the EV Model of Attitudes' expectations component was studied to explore the salient expectations that emerge and influence consumers' attitudes toward GMFPs, thereby gaining insight into the expectations component's role in GMFP attitude formation. Three respective consumer studies were conducted to determine the influence of the expectations component on attitude formation (Sheth & Talarzyk 1972; Sheth & Tuncalp 1974; Ahn et al. 2019). These studies found that expectations were more influential in attitude formation compared to values with regards to product brands (who used the consumer mail personnel of Market Facts, Inc.), hair shampoo (Illinois, USA) and toward persuasive messages used in advertising (Florida, USA). Another quantitative study conducted in the USA to explore boycotters' and non-boycotters' attitudes towards consumer products found that values had a more positive influence on attitude than expectations (Belch & Belch 1987). These studies show that expectations generally have a more positive relationship with attitude formation than values. A discussion of consumers' knowledge, the information sources they employ to influence their knowledge regarding GMFPs, and the proposed role of knowledge in the construction of beliefs follow.

3.5 KNOWLEDGE AND SOURCES OF INFORMATION

In this study, consumers' knowledge of GMFPs and the sources where GM-related information is obtained, which can influence their state of knowledge, were explored. The study aimed to explore knowledge's influence on beliefs to understand from which basis beliefs and attitudes were formed. A discussion of these two aspects' inclusion in this study follows. Knowledge's role in attitude formation is discussed first, followed by a consideration of knowledge's influence on beliefs. Consumers' knowledge regarding GMFPs is also described, and the sources of GM-related information are reviewed. The results from consumer-related studies on consumers' knowledge of GMFPs and the sources visited for GM-related information are integrated into the discussion.

3.5.1 Role of Knowledge in Attitudes

In general, knowledge is defined as the information a person acquires through experience, and therefore refers to what a person knows or what they think – in their own opinion – they know (Bolisani & Bratianu 2018; Lin 2019; Edet & Ekeh 2022; Siddiqui et al. 2022). Knowledge is thus a reflection of what a person is aware of, what they are certain about, and the understanding they have of something (Edet & Ekeh 2022). It is therefore a reflection of an individual's familiarity and awareness of a product (Owusu-Gyan et al. 2023). Since knowledge is such a big part of what a person thinks, it is interwoven with attitudes and the opinions a person forms, which affects an individual's decision whether to purchase a product (Rathod & Hedaoo 2022; Siddiqui et al. 2022; Owusu-Gyan et al. 2023; Zhaleh et al. 2023). Knowledge thus plays a part in how attitudes are formed (Hoque et al. 2018). Furthermore, knowledge also assists a person in their decision to purchase, as their decision is largely based on the knowledge they attained about the identified product (Zhu et al. 2018; Siddiqui et al. 2022). Individuals also refer to their knowledge when they are presented with a new product (Ogbamichael & Warden 2018), such as GMFPs.

Although this study did not aim to explore the role of knowledge on attitudes or the role of knowledge on PI (instead, it explored the role of knowledge on beliefs regarding GMFPs), it has been argued that knowledge influences attitudes, as attitudes act as a basic knowledge function that helps individuals arrange large quantities of information about something, such as a product, so that it makes more sense (Hoque et al. 2018). Therefore, attitudes assist individuals in making rapid decisions without having to revert to information that assisted in the formation of their original attitude (Sharma & Chan 2017). As a result, knowledge towards a product affects the attitude toward that product, which, in turn, affects the PI (Bredahl 2001;

Verdurme & Viaene 2003; Chen 2008; Zhang et al. 2018; Zhu et al. 2018; Hwang & Nam 2021). The authors further suggest that if an individual can increase their knowledge about a product, the formation of their attitude towards that product can be founded upon a solid knowledge foundation, as the presence of awareness and familiarity of such food products are increased. In contrast, if an individual has low or insufficient knowledge of the product, the attitude formation may be founded upon an inaccurate foundation, which may decrease their confidence in purchasing the identified product (Wunderlich & Gatto 2015; Siddiqui et al. 2022). The authors thus propose that insufficient knowledge or ignorance of a product could contribute to a lack of confidence towards the product, and can also result in consumers not being fully aware of or familiar with such food products' attributes. In the GMFP context, it is unclear whether SA consumers are confident in their position regarding GMFPs and familiar with the traits of these food products. The consideration of knowledge's influence on and role in beliefs is discussed next.

3.5.2 The Consideration of Knowledge's Role in Beliefs

Many theorists such as Haungtvedt (1997), Miniard and Barone (1997), Priester and Fleming (1997), and Schwarz (1997) argued that beliefs are only one possible aspect that influences attitudes, meaning that attitudes can be influenced by other aspects too, such as knowledge (Ajzen 2001). This view is echoed by numerous other authors who suggest that knowledge plays an important role in attitudes (Makanyeza 2014; Recker & Saleem 2014; McSporran 2017; Bakanauskas et al. 2020; Siddiqui et al. 2022; Owusu-Gyan et al. 2023). Evidently, many authors agree that knowledge should be considered and included as an important aspect influencing attitudes. However, these authors have a linear approach in their opinion that knowledge influences attitudes, as there is a step in between these two aspects, namely beliefs, which the EV Model of Attitudes considers fundamental in the development of attitudes (Sheth & Tuncalp 1974; Ajzen 2001). Nevertheless, the EV Model of Attitudes does not consider nor explore knowledge as a contributing aspect in beliefs and attitude formation, and therefore does not explore knowledge in relation to beliefs. The foundation from which beliefs emanate, in the GMFP context, thus remains unknown.

According to Southerland et al. (2001), there are two schools of thought regarding knowledge and beliefs. The authors add that one group postulates that these two aspects are the same and thus equate them, whereas the other group hypothesises that they can be differentiated. Irrespective of these two groups of opinions, it can be argued that knowledge and beliefs cannot function without each other (Griffin & Ohlsson 2001). According to Baruwa and Shutaleva (2022), knowledge is based on facts and aspects the individual must be certain

about, whereas beliefs may not originate from a certain basis; as a result, knowledge and beliefs cannot be regarded as being the same. It was not the intention of this study to explore whether knowledge and beliefs can be equated or differentiated; instead, this study aimed to explore knowledge in relation to beliefs. Thus, the relevancy of consumers' knowledge of GMFPs in their development of beliefs towards such food products was explored. Through this exploration, it was important to see if knowledge has a place in establishing beliefs about GMFPs, understand if knowledge has an influential role in consumers' beliefs about these food products, and explore if beliefs about GMFPs cannot be considered without considering consumers' knowledge. Subsequent to this, an improved insight into consumers' attitudes toward GMFPs can be gained as there could be a better understanding of where beliefs stem from. A discussion on consumers' knowledge of GMFPs, through the exploration of numerous studies, follows.

3.5.3 Consumers' Knowledge of GMFPs

In the GM context, it has been argued that consumers are ignorant of GMFPs, and they do not understand what the concept of genetic modification entails (Ezezika et al. 2012; Wunderlich & Gatto 2015; Celik & Dagistan 2016; Marx 2017; Cui & Shoemaker 2018; Shtulman et al. 2020; Siddiqui et al. 2022; Owusu-Gyan et al. 2023). This was evident in a study conducted in SA to establish whether consumers accept GMFPs; it revealed that consumers did not know what the term 'genetic modification' meant, and they did not know which food products contained GM ingredients (Peter & Karodia 2014). However, a study in Ghana that explored consumers' knowledge of GMFPs found that consumers were aware of what the term genetic modification meant (Owusu-Gyan et al. 2023). Results from another study conducted in Ghana to determine consumers' acceptance of GMFPs showed that consumers had not heard about GMFPs (Deffor 2014). Moreover, a study in Sri Lanka to establish how consumers perceived GMFPs found that they had heard about such food products (Jayasuriya & Rathnayaka 2016). Further investigations into consumers' GMFP knowledge in SA, Switzerland, and the USA found that consumers were ignorant of such food products and were unaware which food products available in supermarkets had been GM (Pouris 2003; Lucht 2015; Wunderlich & Gatto 2015). Another two studies in SA, Canada and Nigeria found similar results (Jonker 2017; Marx 2017; Charlebois et al. 2019; Dirisu et al. 2020). More recently, van Zuydam et al. (2023) also determined that consumers were ignorant of GMFPs in-store. These studies suggest that, generally, consumers lack knowledge when it comes to GMFPs. This study can point to whether a lack of GMFP knowledge exists among SA consumers.

Other studies conducted in Malaysia by Tanius and Seng (2015) to determine consumers' awareness of GMFPs and in SA by Gastrow et al. (2018) to determine their perception towards biotechnology found a lack of awareness regarding such food products. Evidently, consumers' lack of GMFP knowledge leads to ignorance about which GMFPs are available to purchase in supermarkets, further contributing to an inability to differentiate between GM and non-GMFPs (Glasgow 2015). The lack of GMFP knowledge, as evident in these studies, could be attributed to a lack of interest in seeking information about such items (Bonah et al. 2017), which could further result in consumers thinking that they know something about GMFPs, but their perception could be based on unsubstantiated information (Marx 2017). Due to consumer ignorance, studies conducted in China to determine consumers' perception of GMFPs and the factors that affect their purchasing of such food products; in Canada to determine consumers' attitudes towards GE food products; in Pakistan to establish consumers' knowledge and attitudes towards GMFPs; and in Peru to explore the labelling of GMFPs found that consumers were not aware they were purchasing GMFPs (Kim & Choi 2018; Charlebois et al. 2019; Amin et al. 2021; Delgado-Zegarra et al. 2022). These studies show that consumers lack familiarity with GMFPs, which could stem from their lack of knowledge. However, in a study conducted in Botswana to determine consumers' knowledge and perception of GMFPs, Hulela et al. (2019) reported that consumers admitted they could be purchasing such food products unknowingly. Another study carried out in Athens to explore the perceived risks and benefits associated with GMFPs revealed that consumers felt they were consuming GMFPs on a regular basis (Arvanitoyannis & Krystallis 2005). Thus, ignorance of GMFPs could result in consumers thinking they are purchasing and consuming GMFPs, which may or may not be the case. In SA, the question remains whether consumers are aware of GMFPs, if they are able to identify GM-containing food products in-store, and what their position towards the purchasing and consuming of these food products is.

To remedy consumers' ignorance of GMFPs, it is essential that consumers be educated about such food products (Marx 2017; Emede & Fasina 2020; Kubisz et al. 2021). This can be achieved by sharing GM-related information with consumers through various platforms (Bonah et al. 2017; Kim & Choi 2018), of which a discussion follows.

3.5.3.1 GMFP Information Dissemination

The perceived lack of information dissemination about GMFPs has led consumers to question their trust in the government, thereby increasing suspicions about GMOs while questioning any GM-related information that is distributed by the government (Frewer 2017; Hunt & Wald 2020; Science for Sustainable Agriculture 2022; Zhaleh et al. 2023). This was seen in a study

conducted in Australia to determine consumers' attitudes toward gene technology, which found that consumers were anxious about the misinformation that was disseminated to them regarding GMFPs (Cormick & Mercer 2017). Miscommunication about GMFPs is often attributed to government and policy-makers refraining from communicating with consumers and disseminating information about these products, thereby creating and aggravating misconceptions and creating scepticism towards GMFPs (Ezezika et al. 2012; Ghanian et al. 2016; Hassan et al. 2016; Cormick & Mercer 2017; Frewer 2017; Marx 2017; Zennah & Cyrus 2019; Dovey & Ntuli 2020; Emede & Fasina 2020; Hunt & Wald 2020; Sanlier & Sezgin 2020; Amin et al. 2021; Van Stekelenburg et al. 2021). The misconceptions and scepticism among consumers regarding GMFPs indicate the importance of sharing GM-related information with consumers, which can be achieved by disseminating data received from GMO-risk assessments to the public to create comfort (Adenle et al. 2012; Cui & Shoemaker 2018; Siddiqui et al. 2022).

It has been suggested that consumer organisations, environmental groups and scientists should communicate with consumers about GMFPs as these sources are generally trusted by consumers (Cormick & Mercer 2017; Kim & Choi 2018; Deng & Hu 2019). This was illustrated by two respective studies conducted in Australia to determine consumers' attitudes toward gene technology and in South Korea to determine consumers' perceptions of GMFPs (Cormick & Mercer 2017; Kim & Choi 2018). These studies established that consumers trusted GM-related information distributed by the Department of Agriculture and environmental groups.

Other platforms that can be used to disseminate information to the public about GMFPs include videos and infographics, radio, television, written materials and presentations, social media, and the distribution of GM food product samples in supermarkets (Cormick & Mercer 2017; Cui & Shoemaker 2018; Hulela et al. 2019; Dirisu et al. 2020; Russo et al. 2020; Macall et al. 2021). Two studies conducted in Australia and Botswana found that consumers trusted the GM-related information shared on television (Cormick & Mercer 2017; Hulela et al. 2019). However, two other studies carried out in Italy to determine consumers' knowledge and trust in various information sources, and in South Korea to determine how consumers perceive GMFPs, established that the information disseminated on social media was not trusted by consumers; in particular, South Korean consumers were cynical about the GM-related information shared on the radio (Kim & Choi 2018; Russo et al. 2020). It has been opined that scepticism towards GM-related information on social media could be driven by the perception that such information is factually and scientifically unproven (Kim & Choi 2018; Russo et al. 2020; Hwang & Nam 2021). Results from another study conducted in Italy by Russo et al.

(2020) revealed that consumers demonstrated trust in the GM-related information distributed by physicians. These studies suggest that the platforms used to share information with consumers about GMFPs should be carefully considered to ensure the information is deemed reliable. It has further been suggested that the curriculums at schools can be used to share GMFP information with children and educate them (Dirisu et al. 2020), who are our future consumers.

In addition, when disseminating information, it has been suggested that the benefits of GMFPs should also be communicated to consumers to increase their acceptance of these food products (Olabinjo et al. 2020; Heng et al. 2021; Aziz et al. 2022; Rodriguez et al. 2022). A study carried out in India by Sendhil et al. (2022) explored how consumers perceive GMFPs as well as their preference for such food products after receiving information about the benefits of GMFPs, and they found consumers became more positive towards these items.

If food security is to be addressed, consumers' education about GMFPs is essential to enhance their knowledge and encourage the purchasing of GMFPs. This can be achieved by sharing information about such food products with consumers through the use of numerous platforms (Olabinjo et al. 2020; Abdoul et al. 2023). It has also been suggested that farmers need to be educated about GM crop production before GM crops and GMFPs can be successfully employed to attain food security (Adeyeye et al. 2017). Nevertheless, it is evident that education and scientific literacy are important in building knowledge, and GMFP information sources that consumers consult thus play an important role in increasing their knowledge about such food products (Vecchione et al. 2015; Marx 2017), as discussed next.

3.5.4 Sources of GM-Related Information

In the GMFP context, sources of information such as acquaintances, scientific journals, social media, environmental groups, television, the internet, magazines and newspapers have been explored in studies to determine consumers' knowledge of GMFPs and which sources were consulted by consumers to gain GM-related information (Wunderlich & Gatto 2015; Cormick & Mercer 2017; Jonker 2017; Cui & Shoemaker 2018; Russo et al. 2020; Amin et al. 2021). Various studies were conducted in Latvia, SA, China, and Pakistan to determine which sources consumers consulted to attain GM-related information, and it was reported that the internet was the primary consulted source (Wunderlich & Gatto 2015; Jonker 2017; Cui & Shoemaker 2018; Amin et al. 2021). However, it has also been proclaimed that the information shared on the internet is unreliable (Cui & Shoemaker 2018), as seen in two studies carried out in Australia and Italy, in which the results showed that consumers did not trust information

on the internet (Cormick & Mercer 2017; Russo et al. 2020). Although researchers and academic scientists were considered to provide reliable information about GMFPs (Science for Sustainable Agriculture 2022) – as seen in a study conducted in Italy (Russo et al. 2020) – academic individuals were not a desirable source of information among Latvian consumers in the context of GMFPs, but consumers were willing to communicate with knowledgeable individuals about such food products (Wunderlich & Gatto 2015). Although word-of-mouth has been raised as a possible source of disseminating GM-related information (Russo et al. 2020), Australian, SA and Chinese consumers did not frequent friends and family as a source for GM-related information (Cormick & Mercer 2017; Jonker 2017; Cui & Shoemaker 2018). This finding could be attributed to distrust in the information presented by friends and family, as seen in the study conducted by Russo et al. (2020) in Italy. It has also been opined that farmers are not a reliable source of information as many are not sufficiently educated about GMFPs themselves (Adenle et al. 2012; Ezezika et al. 2012; Quaye et al. 2012).

Media sources, as well as educational platforms at colleges and universities, have been suggested as possible sources consumers consult to gain information about GMFPs (Jonker 2017; Hulela et al. 2019). This was demonstrated in a study conducted in Botswana, where the results revealed that college platforms were consulted, in addition to media sources (Hulela et al. 2019). However, university platforms were not a popular GM-related information source among SA consumers (Jonker 2017). Documentaries have also been suggested as a source frequented by consumers to attain more GM-related information (Cui & Shoemaker 2018), as seen among Australian consumers (Cormick & Mercer 2017). In addition, newspapers and magazines were visited by Latvian and Botswanan consumers to attain GM-related information (Wunderlich & Gatto 2015; Hulela et al. 2019), while SA consumers did not (Jonker 2017). As Russo et al. (2020) found in their study, carried out in Italy, this finding could be attributed to the untrustworthiness of the information received from such sources. Although books and blogs were highlighted as sources of GM-related information, it was not frequented by Chinese and Pakistani consumers, and blogs were also not a popular source consulted by Korean consumers in the GM context (Cui & Shoemaker 2018; Amin et al. 2021; Nam & Lee 2022). These studies suggest that there are numerous sources consumers have visited to gain GM-related information, but the reliability of sources could be questionable.

The above-mentioned studies illustrate the importance of consumers consulting accurate sources of information to build knowledge and subsequently form a more confident belief and attitude towards GMFPs. This can lead to a more confident purchase decision, PI and behaviour because knowledge is influenced by information (Wunderlich & Gatto 2015; Abdoul et al. 2023). The inclusion and exploration of sources that consumers consult to acquire GM-

related information in this study can assist in understanding the basis from which their knowledge is formed. This information can point to their state of knowledge, thereby better understanding its relevance in forming their beliefs about GMFPs.

The EV Model of Attitudes does not include and explore knowledge or sources of information in relation to beliefs, but to better understand the influences on the model's beliefs component, knowledge was included in this study. As knowledge is created through information that reaches the consumer (Marx 2017), the identification of sources of information from which GM-related information is obtained was also considered an influential element of knowledge. It was suggested that including both knowledge and the sources that provide information will lead to a better understanding of how consumers' beliefs are constructed and whether they stem from a factually sound basis or not, thereby leading to improved insight into consumers' attitudes towards GMFPs.

The EV Model of Attitudes posits that attitudes are the product of consumers' beliefs, values and expectations; thus, attitudes subsequently result in and lead to PI and, ultimately, behaviour (Sheth & Tuncalp 1974; Ajzen & Fishbein 2005; Ahn et al. 2019). It was important to explore and uncover how consumers' attitudes toward GMFPs influence their PI of such food products, as it remains essential for consumers to purchase these food products if they are to be successful in their role of promoting food security. However, to better understand consumers' PI of GMFPs, their subjective norms and PBC were also considered and explored in this study, in addition to their attitudes. PI was therefore an important aspect in this study, addressed through the TPB, and is discussed in the next section.

3.6 PI OF GMFPS

This study aimed to explore the influence of attitudes on consumers' PI of GMFPs to assist in the promotion of food security. To gain further insight into this topic, the study also explored consumers' subjective norms and PBC in the GM context. To do so, the TPB's framework was used, and its structural assumptions are subsequently discussed.

3.6.1 Structural Assumptions of the TPB

Theorists in various fields and disciplines have investigated the origin of purchasing or behavioural intention, which can be defined as an individual's plan and the extent of their desire to purchase a specific product (Kian et al. 2017; McSporran 2017; Arifani & Haryanto 2018). The TPB was originally developed by Icek Ajzen in 1985 and is one of the most popular

theories used to explain purchase and behavioural intention, largely due to its simplicity, flexibility, and easy nature to operationalise in studies (Ajzen 1985; Aride & Pamies-Pallise 2019). As a result, the TPB has been adopted in various fields, such as accounting, consumer behaviour, health-related industries, business ethics, and education to investigate intentions (Zakaria et al. 2016). The TPB has also been adopted in research to explore consumers' intent to purchase products (Akbari et al. 2019), such as GMFPs (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Zhang et al. 2018; Saha et al. 2021).

The TPB's adoption in a study can assist in forecasting and describing behaviour by identifying intentions, thereby showing the extent to which an individual is prepared to behave in a particular manner; this is indicative of the amount of effort an individual is willing to put into a behaviour (Boguszewicz-Kreft et al. 2020; Zhang et al. 2020). Therefore, the stronger the intention to take part in a behaviour, the greater the possibility that the behaviour will be executed (Boguszewicz-Kreft et al. 2020). The TPB therefore postulates that, in terms of PI, a stronger intention will lead to an increased probability of purchasing behaviour (Bakti et al. 2020). Although this study did not aim to determine the strength of consumers' PI toward GMFPs, it can be proposed that a strong intention towards GMFPs can subsequently result in an increased probability of consumers purchasing such food products.

The TPB extends from the Theory of Reasoned Action (TRA) (Farah 2017). It posits that intentions are based on attitudes and subjective norms, while the TPB is believed to be more comprehensive as it proposes that intention is influenced by attitudes, subjective norms, and PBC (Farah 2017; Nickell & Hinsz 2023). The TPB thus allows the model to describe variations in behaviour more precisely (Sanne & Wiese 2018). The TPB has, however, received criticism from researchers since it does not take affective aspects of attitudes into account and only considers personal beliefs (Spence & Townsend 2006; Li & Bautista 2020). Therefore, the authors add that the TPB assumes that emotions and feelings do not play an influential part in attitudes and, ultimately, PI, which has also been highlighted as a drawback in the EV Model of Attitudes (Ajzen 2001). However, researchers agree that the TPB is an effective framework to use in research to explore consumers' PI and subsequent behaviour (Ajzen 1985; Zakaria et al. 2016; Farah 2017). Although this could be the case, the frameworks' usefulness in exploring consumers' PI of GMFPs in the SA context remains limited.

The TPB proposes that PI is influenced by three primary elements, namely attitudes, subjective norms and PBC, which then lead to actual behaviour (Farah 2017; Nickell & Hinsz 2023) (see Figure 3.3).

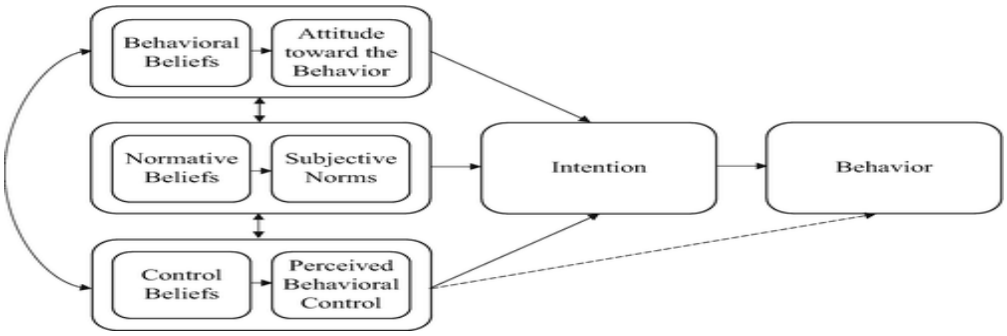

Figure 3.3: Theory of Planned Behaviour (Ajzen 1985)

As illustrated in Figure 3.3, the TPB postulates that attitudes, subjective norms and PBC determine individuals' intentions, and these intentions, in turn, influence behaviour (Farah 2017; Nickell & Hinsz 2023). A discussion on the elements of the TPB, namely attitudes, subjective norms and PBC, follow, along with a discussion on consumer studies focusing on behaviour toward GMFPs.

3.6.1.1 Relationship between Attitudes and PI

Attitudes encompass different beliefs that influence an individual's behavioural intention, particularly due to attitudes being interwoven into each individual, thus affecting the way they think, act and behave (Ajzen 1985; Farah 2017; Vossen et al. 2018). Drawing from Section 3.2 in this chapter, attitudes are representative of one's psychological inclination to judge a particular behaviour, and attitudes thus play a significant role in the development of either a positive or negative intention (Farah 2017). Thus, an attitude towards a behaviour refers to a person's positive or negative judgement of the identified behaviour (Boguszewicz-Kreft et al. 2020; Verplanken & Orbell 2022). A more positive or favourable attitude towards a specific product contributes to the intent to purchase the identified product (Hassan et al. 2016; Nam et al. 2017). In the GMFP context, the TPB suggests that consumers with a positive attitude towards GMFPs will have a stronger intention to purchase and consume these products than consumers with a negative attitude. It has been argued that attitude is the strongest forecaster of behaviour and intention; therefore, a person's attitude towards performing a particular activity will influence their PI (Ajzen 1985; Recker & Saleem 2014; McSporran 2017; Abdoul et al. 2023). Two respective studies in Iran to explore consumers' PI of GMFPs found that attitudes were a strong predictor of PI (Ghoochani et al. 2017; Akbari et al. 2019); therefore, it is valuable to explore attitudes to determine consumers' PI of GMFPs (Bredahl 2001; Spence & Townsend 2006; Zhang et al. 2018). The TPB is widely used in research to better understand the relationship between attitudes, intention, and, ultimately, behaviours (Aride & Pamies-Pallise 2019). Therefore, attitudes are an important behavioural process to explore in

terms of GMFPs. In the context of this study, the findings can show whether attitudes are influential on SA consumers' PI of GMFPs.

An individual's attitude towards a behaviour or intention is based on their behavioural beliefs and an evaluation of the ultimate outcome (Zakaria et al. 2016). Drawing an analogy to the EV Model of Attitudes, behavioural beliefs directly influence attitudes, as seen in Figure 3.3 above. Behavioural beliefs are established by an individual's beliefs pertaining to the behaviour and are indicative of the possibility that behaving in a specific way will translate into either a positive or negative outcome (Bakti et al. 2020). Therefore, behavioural beliefs refer to the perceived benefits and risks linked to a particular behaviour (Zakaria et al. 2016), such as purchasing GMFPs. Perceived benefits refer to an individual's belief that a particular behaviour will result in a positive outcome, whereas perceived risks refer to the belief that a particular behaviour will result in a negative outcome (Farah 2017). Therefore, behaviour is indicative of a person's perceived usefulness or enjoyment of a product (Sanne & Wiese 2018).

Research conducted in Taiwan and Iran to determine consumers' attitudes and PI of GMFPs revealed that perceived benefits positively influenced attitudes, while perceived risks negatively influenced attitudes (Chen & Li 2007; Ghoochani et al. 2017). In terms of perceived benefits and risks, it has been opined that the perceived benefits of GMFPs may not outweigh the perceived risks of these products, and both therefore need to be considered as predictors of consumers' attitudes towards such food products (Verdurme & Viaene 2003; Zhang et al. 2018). However, other authors have opined that the perceived risks of GMFPs are more influential in establishing attitudes when it comes to PI (Bredahl 2001; Verdurme & Viaene 2003; Hassan et al. 2016; Zhang et al. 2018). Various studies have ultimately explored the perceived benefits and risks of GMFPs (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Zhang et al. 2018; Saha et al. 2021), and a discussion on the topic follows.

3.6.1.1.1 Perceived Benefits of GMFPs

Numerous perceived benefits have been used in studies to explore consumers' attitudes and PI towards GMFPs (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Zhang et al. 2018; Saha et al. 2021). These perceived benefits include improved taste, improved appearance, improved colour, reduced price, longer shelf life, increased nutritional value, and improved health benefits (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Hassan et al. 2016; Popek & Halagarda 2017; Shetty et al. 2018; Zhang et al. 2018; Zhu et al. 2018; Gheysen et al. 2019; Dovey & Ntuli 2020; Prianto et al.

2020; Sendhil et al. 2022; Abdoul et al. 2023). These attributes could positively influence the consumer's attitude towards GMFPs and increase their intent to purchase such food products (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Zhang et al. 2018; Zhu et al. 2018). Studies conducted in SA and Australia to establish consumers' attitudes toward GMFPs; another study in SA to determine consumers' preference for GMOs; in Nigeria to determine consumers' perception and acceptability of such food products; and in Canada to determine consumers' opinions of the food they purchased, found that improved health benefits and enhanced nutritional value positively influenced consumers' attitude and intent to purchase GMFPs (Peter & Karodia 2014; Bray & Ankeny 2017; Dovey & Ntuli 2020; Emmanuel et al. 2021; Macall et al. 2021). The reduced price of GMFPs was emphasised in studies from SA, Nigeria and Canada to positively influence consumers' intent to purchase GMFPs (Dovey & Ntuli 2020; Emmanuel et al. 2021; Macall et al. 2021). A study conducted in Jordan to determine the main drivers prompting consumers to adopt GM food also found that the reduced price of such products played a role in consumers' PI (Alalwan et al. 2023). Although the improved taste of GMFPs would contribute toward Australian consumers' PI, these products' longevity was not influential in SA consumers' intent to purchase (Bray & Ankeny 2017; Dovey & Ntuli 2020).

Other aspects, such as resistance to pests and harsh weather conditions, have also been proposed as perceived benefits of GMFPs (Ghoochani et al. 2017; Popek & Halagarda 2017). Moreover, increased food productivity, increased yields, environmental benefits, using less herbicides, and addressing food insecurity have also been considered to be perceived benefits positively influencing consumers' attitudes and PI regarding GMFPs (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Ghoochani et al. 2017; Zhang et al. 2018; Hwang & Nam 2021). The above-mentioned aspects could emerge as perceived benefits in the current study in the context of SA consumers' attitudes and their influence on PI.

Evidently, various perceived benefits of GMFPs could lead to a positive attitude and thus promote consumers' PI of such food products (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Kim 2010; Ghasemi et al. 2013; Rodriguez-Entrena et al. 2013; Khouloud & Sameh 2018; Zhang et al. 2018; Hwang & Nam 2021; Saha et al. 2021; Sleboda & Lagerkvist 2022). As indicated in a study by Hassan et al. (2016), conducted in Malaysia to determine consumers' perception, attitude and PI of GMFPs, the perceived benefits of GMFPs had a positive influence on consumers' attitudes and PI. These studies indicate that the perceived benefits of GMFPs can positively influence attitude and thus the intent to purchase GMFPs.

3.6.1.1.2 Perceived Risks of GMFPs

Perceived risks of GMFPs, such as health risks including possible allergic reactions, toxicity, antibiotic resistance, the onset of cancer and infertility – among others (Rzymski & Krolczyk 2016; Popek & Halagarda 2017; Raman 2017; Lefebvre et al. 2019; Ruth & Rumble 2019; Islam et al. 2020; Keshani et al. 2020; Emmanuel et al. 2021; Kubisz et al. 2021; Shen et al. 2022; Abdoul et al. 2023; Zhaleh et al. 2023) – could negatively influence consumers' attitudes and intent to purchase GMFPs (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Chen 2008; Hassan et al. 2016; Ghoochani et al. 2017; Zhang et al. 2018; Hwang & Nam 2021; Alalwan et al. 2023). The unnaturalness of GMFPs, ethical concerns, religious concerns, and the environmental impact of producing GMFPs have also been considered as perceived risks that could negatively influence consumers' attitudes and PI of GMFPs (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Chen 2008; Hassan et al. 2016; Ghoochani et al. 2017; Zhang et al. 2018; Akbari et al. 2019; Hwang & Nam 2021; Zhaleh et al. 2023). Concerns about genetically modified seed companies and their perceived control and quest for profitability, as well as the termination of GM seeds and their excessive prices, have been raised by consumers in terms of producing GMFPs (Ghanian et al. 2016; Bonny 2017; Van Acker et al. 2017; Wray 2021). In the current SA study, these aspects could emerge as perceived risks influencing consumers' attitudes and subsequent PI of GMFPs.

Evidently, there are perceived concerns and risks related to GMFPs that could negatively influence consumers' attitudes and PI of these products (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Kim 2010; Ghasemi et al. 2013; Rodriguez-Entrena et al. 2013; Ghoochani et al. 2017; Zhang et al. 2018; Hwang & Nam 2021; Saha et al. 2021; Sleboda & Lagerkvist 2022; Yang et al. 2022). A consumer study conducted in Iran to determine consumers' intention to consume GMFPs found that health and environmental risks influenced consumers' intent to purchase such food products (Akbari et al. 2019). Results from a study conducted in Europe to establish consumers' awareness, opinions and attitudes towards GMFPs revealed that allergic reactions negatively influenced their intent to purchase GMFPs (Popek & Halagarda 2017).

In the context of this study, the perceived benefits and risks of GMFPs were not only explored to investigate the influence of consumers' attitudes on their intention to purchase GMFPs, but also to explore consumers' state of knowledge about GMFPs (which was discussed in Section 3.5). In terms of the EV Model of Attitudes, attitudes form the entire model; therefore, this model feeds into the attitude element of the TPB, adding salient beliefs, values and expectations to the attitude element of the TPB's framework. Attitudes were thus used to

explore consumers' PI towards GMFPs based on salient beliefs, values and expectations. This approach assisted in gaining insight into the role that the attitude element played in consumers' PI of GMFPs and whether the beliefs, values or expectations components of the EV Model of Attitudes (attitude) contribute to consumers' PI of GMFPs.

Furthermore, in this study, behavioural beliefs – based on perceived benefits and risks of GMFPs – were also explored to determine their influence on attitude. Therefore, the data (aspects) that emerged from an exploration of beliefs, values and expectations were compared to the data (aspects) related to behavioural beliefs (in terms of the depth of data relating to the extent of elaboration) to explore the influence of attitudes on consumers' PI of GMFPs. In addition, although researchers have combined the EV Model of Attitudes with the TPB to explain the effect that attitudes have on PI and behaviour (Ajzen & Fishbein 2000; Ajzen 2001; Ajzen 2008; Ajzen 2011), this strategy's usefulness within the SA context in terms of GMFPs remains unknown.

3.6.1.1.3 Concerns about the Attitude Construct

Although the attitude construct of the TPB has proven to be useful in exploring consumers' PI of GMFPs (Bredahl 2001; Spence & Townsend 2006; Zhang et al. 2018), it has been challenged. Concern was raised about attitudes' inability to explain social behaviour, meaning that an individual may say or feel one thing but then do another, referred to as the attitude-behaviour gap (Ajzen & Fishbein 2005; Caruana et al. 2016). Therefore, theorists have questioned whether an individual's attitude and behaviour are always consistent (Ajzen 2011). Investigators have, however, defended the attitude construct by challenging the validity of the instruments that were used in the studies conducted to investigate this concern (Ajzen & Fishbein 2005). It was pointed out that these studies relied significantly on quantitative surveys, which could have probed respondents to rationally answer questions instead of giving them the opportunity to voice their opinions and explain their choices on a more meaningful level (Caruana et al. 2016). These methodological factors could mediate the outcome of attitude-behaviour studies, thereby further questioning the validity of these studies (Marcinkowski & Reid 2019). Investigators have also defended the attitude construct by referring to the TPB and have thus suggested that attitude is indeed a construct that can be used to predict behaviour (Ajzen 1985), and its usefulness has been demonstrated in numerous studies (Phillips 2008b; Al-Swidi et al. 2014; Zakaria et al. 2016; Farah 2017; Boguszewicz-Kreft et al. 2020; Jung et al. 2020). These researchers investigated the attitude construct and its ability to influence behaviour by conducting studies in numerous different fields of research and have found, and thereby confirmed, that attitude does influence

behaviour (Ajzen & Fishbein 2005). Therefore, the attitude construct is still considered an important and useful element that is used by various researchers to explore its influence on PI and thus behaviour (Ajzen & Fishbein 2005), and also in the GM context (Bredahl 2001; Spence & Townsend 2006; Zhang et al. 2018).

A discussion of the second element of the TPB, namely subjective norms, follows.

3.6.1.2 Relationship between Subjective Norms and PI

Subjective norms constitute one element of the TPB and is considered a driver of PI (Farah 2017). Subjective norms refer to an individual's perception that referent people – people whose opinion an individual regards as being important, such as friends, family and spouses – expect them to perform a particular behaviour (Ajzen 1985; Abdoul et al. 2023). As a result, referent people's influence can lead to an individual behaving in a certain way to ensure they are liked and accepted (Boguszewicz-Kreft et al. 2020). Drawing an analogy to the EV Model of Attitudes, subjective norms are determined by normative beliefs about referent individuals' expectations (Phillips 2008b; Farah 2017; Nickell & Hinsz 2023). Therefore, as seen in Figure 3.3 above, the beliefs that underlie subjective norms are normative beliefs (Phillips 2008b). They refer to an individual's belief that each of their referent people expects them to behave in a particular way and approve of a particular behaviour (Phillips 2008b; Jung et al. 2020; Abdoul et al. 2023). Normative beliefs also refer to the belief an individual has regarding how their referent people will view them if they indulge in a particular behaviour and what they think about the outcome of a behaviour (Al-Swidi et al. 2014). Subjective norms are, furthermore, influenced by an individual's motivation to comply with the expectations of their referent people and their willingness to act or behave in an expected manner (Zakaria et al. 2016; Abdoul et al. 2023).

Studies have established that subjective norms have a positive influence on PI regarding GMFPs and have therefore been used as a construct to predict PI (Cook et al. 2002; Spence & Townsend 2006; Chen 2008; Ghoochani et al. 2017; Zhang et al. 2018). This finding could be attributed to the influence that friends and family could have on individuals' decisions to purchase GMFPs (Huang 2018). Two respective studies in Tunisian and Senegal found that subjective norms positively influenced consumers' PI of GMFPs (Khouloud & Sameh 2018; Abdoul et al. 2023). Although subjective norms' positive influence on PI has been demonstrated, results from other studies revealed that subjective norms were not a prominent driver of consumers' PI of GMFPs (Bredahl 2001; Chen 2008; Zhang et al. 2018). Further investigations into consumers' intent to purchase GMFPs showed that subjective norms did

not emerge as being influential in Italian and Canadian consumers' PI in the GM context (Prati et al. 2012; Huang 2018). Huang (2018) suggested that subjective norms were not a significant determinant of consumers' PI in their study due to the limited knowledge that referent people had of such food products.

It has also been opined that consumers may not have the urge to hear their referent people's opinions about GMFPs, which could contribute to their insignificant influence on consumers' PI of such food products (Huang 2018). It was found that Latvian consumers would only consult with acquaintances who were knowledgeable about GMFPs (Wunderlich & Gatto 2015) as the reliability of their information about such food products was questioned (Cormick & Mercer 2017; Cui & Shoemaker 2018; Russo et al. 2020). Regarding consumers' referent people, a study conducted in the Czech Republic and Russia, to determine the relationship between consumers' attitudes and PI through their referent people, demonstrated that mothers influenced consumers' intent to purchase GMFPs more than friends, and subjective norms influenced PI (Brosig & Bavorova 2019). A study in Iran found that if referent people perceived GM crops as beneficial, it would prompt consumers to purchase such food products (Ghoochani et al. 2017). These studies possibly suggest that subjective norms could have a positive influence on PI but may not be a significant determinant of consumers' PI in the GMFP context. The findings of this study can reflect whether subjective norms play a prominent role in SA consumers' intent to purchase GMFPs.

In this study, the aim was to explore whether consumers were influenced by referent people in their purchasing of GMFPs, and whether normative beliefs influenced their subjective norms. This study intended to better understand the role that the subjective norm element plays in consumers' PI and behaviour towards such food products. The third element of the TPB, namely PBC, is discussed next.

3.6.1.3 Relationship between PBC and PI

PBC refers to an individual's perception of the degree to which they feel they can engage in a particular behaviour and the control they perceive to have over the behaviour (Ajzen 1985). PBC can therefore be defined as an individual's perception of the ease or difficulty associated with performing a particular behaviour (Boguszewicz-Kreft et al. 2020). Drawing an analogy to the EV Model of Attitudes, as seen in Figure 3.3 above, PBC is directly influenced by control beliefs, which refer to the perception that certain factors are present that could promote or hinder a particular behaviour (Al-Swidi et al. 2014; Nickell & Hinsz 2023). Control beliefs also refer to an individual's perception about the presence or absence of the necessary

opportunities or resources needed to perform the behaviour of interest, thereby facilitating or impeding the behaviour (Farah 2017). Thus, individuals are inclined to have more behavioural control if they feel they have the ability and possess sufficient resources to mitigate any challenges that may arise during the behaviour (Jung et al. 2020). In contrast, if an individual feels that they do not have the ability or necessary resources to perform a specific behaviour, their PBC will subsequently decrease, which could result in them refraining from engaging in a specific behaviour (Farah 2017), such as purchasing GMFPs. In the GMFP context, the study can show the opportunities or resources that consumers believe they have or do not have to purchase such food products. Furthermore, each control factor's ability to encourage or discourage indulging in a behaviour is assumed to contribute to an individual's subjective perception that the control factor is indeed present (Ajzen 2011).

To illustrate the PBC element's usefulness in exploring consumers' PI in the GM context, studies in Taiwan, India and China found that PBC was a predictor of consumers' PI of GMFPs (Chen 2008; Saha et al. 2021; Yang et al. 2022). However, a study conducted in Denmark, Germany, Italy, and the UK; and others conducted in Iran and China, established that PBC was not an important predictor in consumers' PI of such food products (Bredahl 2001; Ghoochani et al. 2017; Zhang et al. 2018). These studies possibly suggest that the PBC construct of the TPB may not be the most significant predictor of consumers' PI in the GMFP context compared to the attitude construct. Nevertheless, various aspects have been identified as influential in PBC, as discussed next.

3.6.1.3.1 Aspects Influencing PBC of GMFPs

It has been suggested that the availability of food products, knowledge, consumers' time, habitual buying, and brand loyalty could influence PBC and the intent to purchase GMFPs (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Zhu et al. 2018; Alalwan et al. 2023). A lack of information or absence of information, price, support for locally produced food products, product quality, and access to food products have also been considered as aspects influencing PBC and PI of various food products (Wong et al. 2018; Shahtahmasbi & Rooch 2019; Aitken et al. 2020; Kim & Kuo 2022; Sutanto & Wulandari 2023). It has been suggested that a lack of knowledge creates hesitancy when purchasing GMFPs, thus influencing consumers' intent to purchase these items (Tanius & Seng 2015; Gastrow et al. 2018; Jiang & Zhang 2021; Delgado-Zegarra et al. 2022). Studies from Japan to investigate consumers' PI of GMFPs; Iran to determine consumers' knowledge, attitudes and behavioural intentions toward GMFPs; and Korea to determine how consumers' knowledge affects their reactions to GMFPs

confirmed this finding (Kim 2010; Ghasemi et al. 2013; Hwang & Nam 2021). These aspects could emerge in this study as well.

It has also been suggested that labelling plays a role in consumers' PBC and PI in the context of GMFPs (Verdurme & Viaene 2003; Chen 2008). The omission of GM labels on food products and lack of GMFP labelling makes it difficult for consumers to determine whether a product contains GM ingredients, thereby affecting their behaviour (Oh & Ezezika 2014; Sebastian-Ponce et al. 2014; Wunderlich & Vecchione 2014; Popek & Halagarda 2017; Chagwena et al. 2019; Jiang & Zhang 2021; Macall et al. 2021; Delgado-Zegarra et al. 2022). To illustrate, a study conducted in Britain to investigate consumers' intent to purchase GMFPs found that the presence of labelling increased consumers' PBC over purchasing these products (Spence & Townsend 2006). It has also been suggested that consumers do not actively read food labels and they are unable to grasp the meaning of the information on GM labels, which could be attributed to consumers' ignorance of GMFPs (Ezezika et al. 2012; Wunderlich & Gatto 2015; Celik & Dagistan 2016; Marx 2017; Cui & Shoemaker 2018; Goyal & Deshmukh 2018; Shtulman et al. 2020; Macall et al. 2021). It remains unclear whether GMFP labelling influences SA consumers' PBC as well. In this study, the PBC element was explored to see what PBC consumers perceived they had when it came to purchasing GMFPs. This information helped to explore what makes it easy or difficult for consumers to purchase such food products and what influence control beliefs had on PBC.

Drawing from Sections 3.6.1.1 to 3.6.1.3, in terms of constructs of the TPB, the framework claims that individuals will behave in a particular way if they are confident that a certain beneficial result will be obtained, referent people will approve of their behaviour, and the individual is confident that they possess the ability, resources and opportunities to behave in a particular manner (Boguszewicz-Kreft et al. 2020). In essence, the TPB suggests that behavioural intentions are influenced by a person's attitude about the probability that the behaviour they perform will result in a particular outcome, given their evaluation of the risks and benefits of that outcome (Farah 2017). Furthermore, as seen in Figure 3.3 above, within the context of this study, the TPB suggests that consumers' intention to purchase GMFPs is influenced by their attitude towards these products (salient beliefs, values and expectations); the degree of social pressure they perceive referent people will place on them for purchasing or not purchasing GMFPs (subjective norms); and the degree of control the consumer feels they have over purchasing or consuming GMFPs (PBC). Therefore, the TPB was used as a theoretical underpinning in this study to explore consumers' PI of and ultimate behaviour towards GMFPs by exploring each element's role in the intent to purchase such food products

in SA. To better understand how consumers behave toward GMFPs, a discussion on consumer studies follows.

3.6.1.4 Consumer Studies Regarding the Behaviour toward GMFPs

Consumers could unknowingly be purchasing and consuming GMFPs regularly, which could be causing some concern and anxiety (Raman 2017; Charlebois et al. 2019; Ruth & Rumble 2019; Kubisz et al. 2021) as seen among Canadian consumers (Macall et al. 2021). However, two studies conducted in Europe to determine consumers' choices regarding GMFPs and in Switzerland to determine the acceptance of biotechnology and GM crops found that consumers did not attempt to avoid purchasing GMFPs (Sleenhoff & Osseweijer 2013; Lucht 2015). A study conducted in Korea by Kim et al. (2018) that explored methods to communicate with consumers about GMFPs found that if consumers could refrain from purchasing GMFPs, they opted to do so. Consumers expressed that they would rather purchase non-GMFPs (Sebastian-Ponce et al. 2014; Glasgow 2015; Sanlier & Sezgin 2020; Heng et al. 2021), which was evident in studies conducted in China to determine consumers' perceptions of GMFPs; in SA and Peru to explore the labelling of GMFPs, which showed that there was a preference for natural food products rather than GMFPs (Cui & Shoemaker 2018; Dovey & Ntuli 2020; Delgado-Zegarra et al. 2022). A preference for organic food products also emerged, as seen among Canadian consumers who prefer purchasing organic food products from farmers' markets rather than GMFPs from supermarkets (Macall et al. 2021). Results from another study in Nigeria revealed that consumers would rather purchase locally produced food products than GMFPs (Dirisu et al. 2020). These studies suggest that, although consumers did not have a specific PI towards GMFPs, traditional food products were preferred.

The lack of understanding of what constitutes consumers' attitudes toward GMFPs and their influence on PI is discussed next in the conceptual framework for this study.

3.7 CONCEPTUAL FRAMEWORK FOR THIS STUDY

The purpose of a conceptual framework is to describe the path a study will take by placing the conceptual framework into theoretical components (Adom et al. 2016) that represent the important elements of the study. The conceptual framework for this study is presented in Figure 3.4.

The study was framed within the constructivist paradigm, represented as the outer edge of the conceptual framework, and the phenomenological research design formed the inner approach

to the study's research methodology (see Figure 3.4). The constructivist paradigm focuses on individuals' subjective reality (from their own point of view) of something, what they understand and have learnt about a product through their experiences with that product, and their views, ideas (knowledge) and meaning of something (Creswell 2008; Fox 2008; Qutoshi 2018; Kaushik & Walsh 2019; Neubauer et al. 2019; Omodan 2022). Moreover, the phenomenological research design describes the lived experience people have had with a particular product and the truth of something (Tomaszewski et al. 2020). These two frameworks were thus combined within this study. The conceptual framework proposes that what people understand about GMFPs, their views, ideas, subjective reality, meaning, and the truth they have developed around GMFPs, as well as their experiences with GMFPs, could contribute to a better understanding of their attitudes toward such food products and their intention to purchase these items. Both these frameworks are discussed further in Chapter 4, Sections 4.2.2 and 4.3.1.

The conceptual framework for this study explored the EV Model of Attitudes to gain insight into consumers' attitude formation (Sheth & Tuncalp 1974; Ajzen & Fishbein 2000). The model consists of three components, namely beliefs, values and expectations (Sheth & Tuncalp 1974; Psynso 2018a). These components are positioned in the conceptual framework in terms of their role in consumers' attitudes towards GMFPs. Therefore, Ajzen's (2001) explanation is used to express the association between beliefs and values, in that values stem from beliefs and beliefs and values thus work in collaboration (indicated through the double-sided arrow) (Ajzen 2008). This collaboration then leads to the development of expectations (indicated through the single arrow) (Sheth & Tuncalp 1974; Ahn et al. 2019), as proposed in Figure 3.4. Through an exploration of salient beliefs, the attributes consumers associate with such food products will become evident (Ajzen & Fishbein 2000). It was important in this study to research the extent to which consumers' beliefs (beliefs component) influence their attitude towards GMFPs to see what role they play in forming an attitude toward these food products. Furthermore, knowledge was an important aspect to be studied to explore its relevancy, importance and influence on consumers' beliefs about GMFPs. It has also been argued that sources of information influence consumers' knowledge (Vecchione et al. 2015; Wunderlich & Gatto 2015; Cormick & Mercer 2017; Cui & Shoemaker 2018; Kim & Choi 2018). To that effect, it was important to explore the sources from which consumers build their knowledge of GMFPs, as it could have an important influence on consumers' beliefs about GMFPs. For this study, knowledge, through the influences of sources of GM-related information, was studied in relation to the beliefs component of the EV Model of Attitudes to better understand the role knowledge plays in influencing consumers' beliefs about such food products.

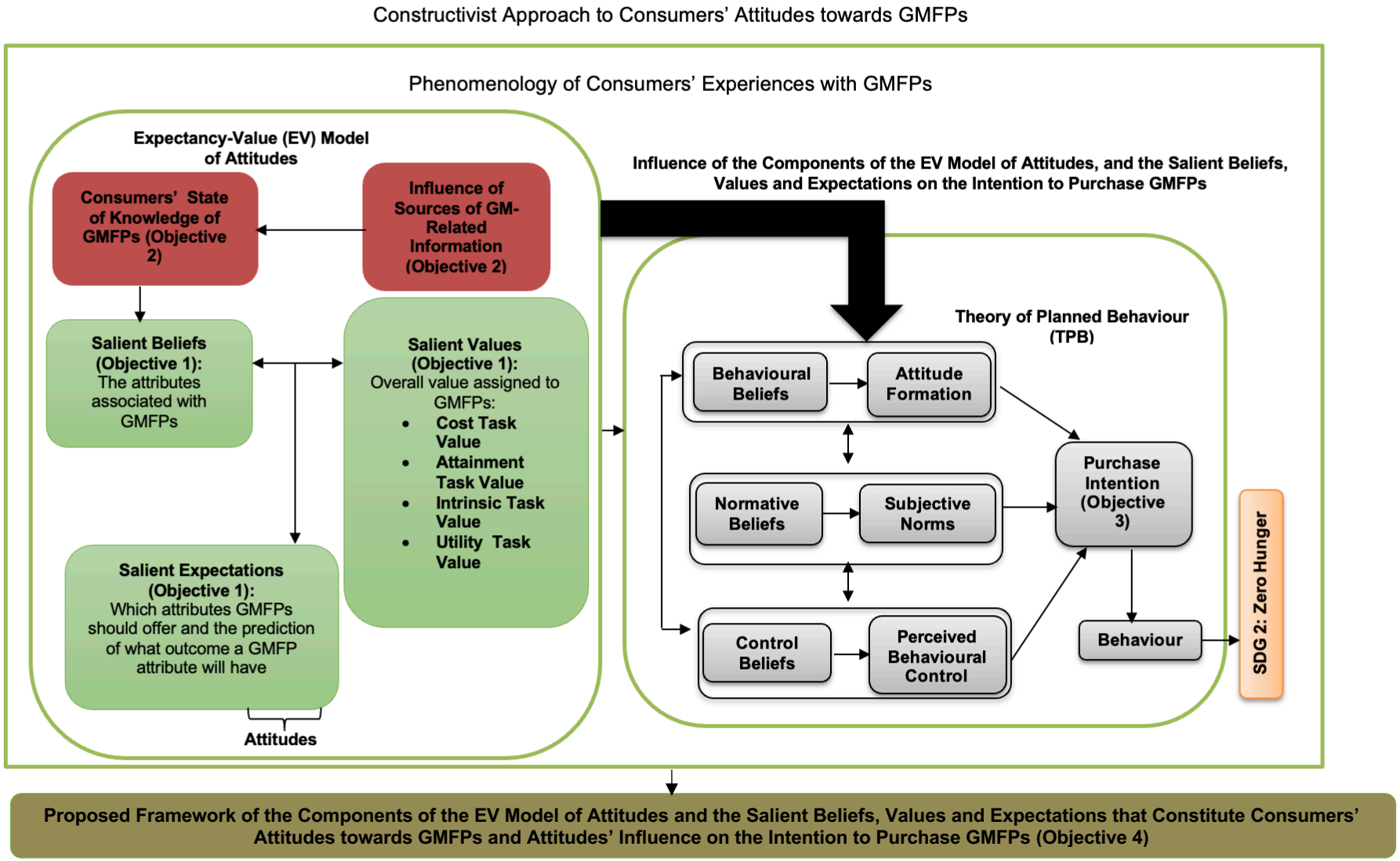

Figure 3.4: Proposed Schematic Conceptual Framework for this Study

The values component of the EV Model of Attitudes, included in the conceptual framework, was also studied by exploring the cost, attainment, intrinsic and utility task values (Meyer et al. 2019). Researchers suggest that these four categories of task values need to be explored to better understand the overall value consumers assign to a product (Yurt 2015; Biedenbach & Jacobsson 2016; Seals 2016; Fielding-Wells et al. 2017; Dietrich et al. 2019; Loh 2019; Meyer et al. 2019; Bostrom & Palm 2020; Jones & Hite 2020; Umarji et al. 2021). Therefore, values' influence and role – and the usefulness of the categories of task values within the values component – was integral to this study in establishing consumers' attitudes towards GMFPs.

Expectations are the third component of the EV Model of Attitudes, which is used to better understand which product attributes consumers feel or believe GMFPs should offer and the predicted expectation of the outcome a GM food product's attribute will have (Panchal et al. 2012; Suvittawat 2022). Thus, it was important for this study to explore the role that consumers' expectations played in terms of their attitudes towards GMFPs. In this study, as indicated in Figure 3.4, the influence of the combined effect of salient beliefs and values on consumers' expectations towards GMFPs was proposed, resulting in consumers' attitudes towards GMFPs.

The study was based on the premise that the EV Model of Attitudes (the three components, in terms of the salient beliefs, values and expectations) provides a framework through which consumers' attitudes towards GMFPs can be studied. From this understanding of attitude, it was suggested that the insight gained from the EV Model of Attitudes feeds into the attitude element of the TPB, resulting in a detailed explanation of the components that constitute consumers' attitudes towards GMFPs and their influence on consumers' intent to purchase these food products. It has been proposed that a favourable attitude produces a stronger intention to purchase, whereas an unfavourable attitude results in a weaker intention to purchase (Farah 2017). Therefore, it was proposed that by combining the EV Model of Attitudes and the TPB framework, an increased understanding of consumers' favourable or unfavourable attitudes (or both in terms of dual attitudes) could possibly be achieved, which, in turn, can lead to an understanding of consumers' PI (Ajzen 1985) towards GMFPs. Furthermore, the EV Model of Attitudes is a framework used to explore how consumers' attitudes are formed and how consumers make decisions and behave in a specific way based on their beliefs, values and expectations (Sheth & Tuncalp 1974; Ajzen & Fishbein 2000; Psynso 2018a; Ahn et al. 2019). Thus, combining the EV Model of Attitudes and the TPB framework was important to better understand how consumers' attitudes influence their PI of GMFPs.

Since the TPB also includes subjective norms and PBC, these two elements were explored in this study to understand the influence of all the TPB's elements on the intention to purchase GMFPs, as the TPB is commonly used to determine consumers' PI (Ajzen 1985). The different belief aspects associated with each of the TPB's elements were also included in this study. To this effect, behavioural beliefs directly influence attitudes, normative beliefs directly influence subjective norms, and control beliefs directly influence PBC (Farah 2017; Nickell & Hinsz 2023), as seen in Figure 3.4. These beliefs' influence on the elements of the TPB was therefore important to further explore the elements' influence on the intention to purchase GMFPs.

Since the TPB leads to actual behaviour (Farah 2017), it was proposed that an exploration of the three elements of the TPB framework would lead to a better understanding of consumers' behaviour towards GMFPs. It is important to have a clear understanding of this behaviour as it can affect the way in which SDG 2: Zero Hunger is addressed. Since SDG 2 is concerned with ensuring that hunger is ended and food security is achieved by 2030 (Gil et al. 2019; Akora & Mishra 2022), it was proposed that the outcome of this study could reflect the current state of consumers' attitudes towards GMFPs and the influence this state may have on attaining SDG 2. In essence, through an understanding of all the components and elements that make up the EV Model of Attitudes and TPB, a framework was proposed that identifies the salient aspects that influence consumers' attitudes and PI towards GMFPs to address SDG 2: Zero Hunger.

3.8 SUMMARY

This chapter illustrated that attitudes are an involved and complicated concept developed through the influence of various aspects. However, attitudes can be changed through exposure to information, and there is the possibility of individuals holding more than one attitude towards a product at the same time, thereby suggesting that an individual can have a positive and negative attitude toward GMFPs. Additionally, numerous attitude models have been devised over the years to gain insight into consumer attitudes. The EV Model of Attitudes' usefulness, which this study used, was presented. It provides a lens through which to explore what constitutes consumers' attitudes towards GMFPs by exploring consumers' salient beliefs, values and expectations. The influential role of knowledge regarding GMFPs and the sources of information where knowledge is created, in the development of beliefs, was also considered. The TPB framework's usefulness was discussed in exploring consumers' PI. This framework was thus used in this study to explore consumers' PI of GMFPs by exploring attitudes, subjective norms and PBC. Consumer-related studies on the aspects addressed in

this chapter were also considered. Furthermore, the conceptual framework for this study was presented, which allowed for an exploration of consumers' attitudes towards GMFPs and their influence on PI by merging the EV Model of Attitudes and the TPB framework. The research methodology followed in this study is presented in the next chapter.

CHAPTER 4
RESEARCH METHODOLOGY

This chapter presents the pathway in which the study procedures were implemented and performed to meet the research objectives. Thus, the methodology used in this study is described in terms of the research paradigm and design. The location of the study, sampling and recruitment strategy used, data gathering methods, the structure of the demographic questionnaire and the interview guide, operationalisation of the study, and the data analysis process are discussed. The study's trustworthiness and the ethical considerations adhered to in this study are also presented.

4.1 INTRODUCTION

The previous chapter presented a discussion on consumers' attitudes and PI. In this chapter, the methodology that was adopted to achieve the research objectives is presented. The topic called for an exploration and description of what constitutes consumers' attitudes towards GMFPs and if their attitudes influence their PI of such food products. Knowledge's influence on beliefs about GMFPs was also considered, along with the sources of information from which knowledge is built. To date, international and SA studies have not explored consumers' salient beliefs, values and expectations using the EV Model of Attitudes. There is thus a lack of understanding in terms of how consumers form their attitudes towards GMFPs based on beliefs, values and expectations, and how this, in turn, influences their PI. An understanding of consumers' PI of GMFPs also remains limited, as well as the influence of GMFP knowledge on beliefs. Therefore, the study aimed to understand the role of the EV Model of Attitudes' components in forming attitudes toward GMFPs. The role that the elements of the TPB play in PI was also explored to develop a framework identifying the components of the EV Model of Attitudes and the salient beliefs, values and expectations that influence consumers' attitudes towards GMFPs and its influence on their intent to purchase such food products. The study also aimed to illustrate the influence of knowledge on beliefs regarding GMFPs.

Since studies have not used a constructivist paradigm and a phenomenology research design to establish consumers' attitudes in the GMFP context, there is also ambiguity regarding consumers' reality related to GMFPs and how GMFPs are seen through their eyes. Therefore, a qualitative methodology within a constructivist paradigm and a phenomenological research design were used in this study. The study explored consumers' attitudes towards GMFPs by gaining more insight into their reality of GMFPs, what they have learnt and understand about

such food products, how they view these food products, and what meanings they ascribe to these food products based on their lived experience with GMFPs.

In this chapter, the descriptive, exploratory and phenomenological research design and the research setting are presented to describe how the research topic was explored. The non-probability sampling strategies, namely purposive, convenience and snowball sampling applied to recruit participants and obtain data are described in this chapter to show how the participants were selected. The inclusion criteria that were developed to reach specific participants who could provide valuable information to successfully address the study's objectives, and the recruitment strategy to reach potential participants, are also discussed. To show how information was gathered, this chapter presents the data collection methods (individual interviews) and the structure of the demographic questionnaire and the interview guide. The operationalisation of the study and the sample size are also described. The data analysis methods applied to the study are discussed, as well as the presentation of the findings. To illustrate how the study aimed to be trustworthy and ethical, the chapter concludes by outlining the trustworthiness aspects of credibility, transferability, dependability, confirmability, reflexivity and researcher bias, as well as the ethical considerations applicable to this study. A visual depiction of the methodology followed in this study is summarised in Figure 4.1.

As seen in Figure 4.1, the study followed a qualitative approach, conducted within the constructivist paradigm. The phenomenological, descriptive and exploratory research design was used, as discussed in Sections 4.3.1 to 4.3.3. The collaboration of these methodological approaches allowed insight into consumers' views, understanding, ideas (knowledge), and what they have learnt about GMFPs. Insight was also gained into the subjective reality they have constructed about GMFPs through their experience with such food products, which subsequently led to an exploration into the participants' "lived experiences" of GMFPs and the meaning they assigned to GMFPs. To recruit participants for this study, non-probability sampling methods, such as purposive, convenience and snowball sampling, were used, as discussed in Section 4.5.1.1 to Section 4.5.1.3. Specific inclusion criteria were used to select participants who warranted inclusion in the study in terms of being able to answer the research questions and hold a conversation with the researcher regarding GMFPs. Data were gathered through individual interviews and are discussed in Section 4.6.2, while the demographic data were gathered using a demographic questionnaire (see Section 4.6.1). A thematic analysis was conducted to analyse the data obtained from the participants, as discussed in Section 4.8.2.

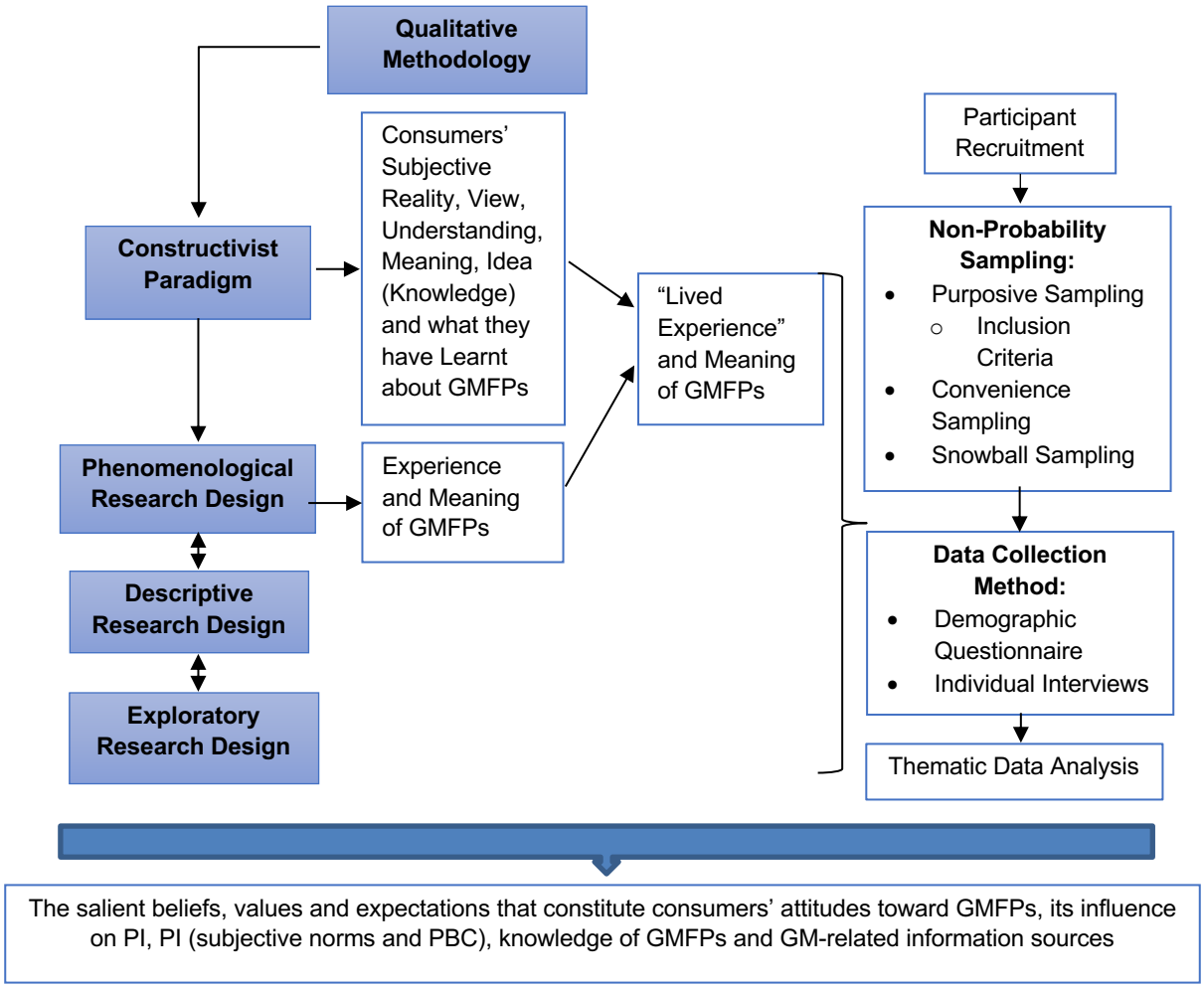

Figure 4.1: A Visual Depiction of the Methodology used in this Study

By following this methodology, insight was gained into what constituted consumers' attitudes (in terms of their salient beliefs, values and expectations) towards GMFPs, the influence attitudes had on PI, the role that subjective norms and PBC played in their PI, their state of knowledge, the influence of knowledge on beliefs, and the sources consulted for GM-related information which created knowledge. Going forward in this chapter, all of these aspects are referred to as consumer attitudes. The justification for the selected methodology is presented in the following sections.

4.2 RESEARCH PARADIGM

A research paradigm guides the manner in which the research process is conducted and thus leads the study to address a specific research problem (Park et al. 2020).

4.2.1 Qualitative Research Methodology

This study followed a qualitative methodology, defined as research conducted in a natural setting (Mohajan 2018). It is primarily used when the researcher seeks in-depth insight into a complex issue or phenomenon; the researcher is unsure of the kind of data that are required to successfully address the objectives for the study; or when the researcher wants to explore a phenomenon, rather than focusing on validity and accuracy (Jameel et al. 2018; Lester et al. 2020). Qualitative research thus allows the researcher to gain data from participants that can assist in describing or clarifying the research topic, with the intention of gaining more insight into the topic being explored (Queiros et al. 2017; Denny & Weckesser 2022). Therefore, the qualitative methodology is particularly useful and valuable when a study seeks to explore individuals' opinions, beliefs, feelings, emotions, thoughts, behaviours, values and attitudes towards a specific phenomenon (Queiros et al. 2017; Jameel et al. 2018), as was the case in this study in terms of what constitutes consumers attitudes toward GMFPs. The qualitative methodology further acts as an umbrella for various data collection methods, such as personal experiences, individual interviews, focus groups and observations to explore a particular issue based on individuals' meaning of a pre-identified issue (Aspers & Corte 2019; Morgan 2022). In this study, the qualitative methodology supported the use of individual interviews to attain insightful information about consumers' attitudes towards GMFPs.

In qualitative research, information is usually obtained through words, not numbers (Busetto et al. 2020; Thakur 2021; Morgan 2022). This approach, in turn, gives the researcher an opportunity to speak to people who get to voice their opinions, thereby making sense of how individuals see something and the meaning that they link to the identified object or product (Aspers & Corte 2019). The intention of the qualitative research methodology is thus to allow individuals to articulate their meaning and reality ascribed to a phenomenon through which the phenomenon can be explored in depth (Asenahabi 2019). By following a qualitative research methodology in this study, participants had an opportunity to vocalise their views about GMFPs through which their attitudes could be investigated. Furthermore, qualitative research can provide insightful information regarding why individuals behave in a certain way towards a phenomenon (Rahman 2017). Qualitative research can also be used to explore the reasons for individuals' behaviour towards the phenomenon, particularly underlying reasons that cannot be seen and are thus not easily distinguishable (Busetto et al. 2020). Therefore, in the context of this study, the qualitative research methodology facilitated the capturing of the dynamics of consumers' attitudes towards GMFPs.

A qualitative research methodology is also particularly beneficial when the study aims to explore individuals' knowledge about a phenomenon based on what they have learnt through their experience with the given object or product, as qualitative research aims to focus on how individuals view and experience the world around them in relation to a specific phenomenon (Aspers & Corte 2019; Morgan 2022). Qualitative research therefore also provides value to a study when the study seeks to explore individuals' lived experience with a phenomenon, and the qualitative approach works in collaboration with a phenomenological research design (Rahman 2017). Thus, to gain a more in-depth understanding of consumers' attitudes towards GMFPs, the constructivist paradigm and phenomenological research design were combined and used in this study.

4.2.2 Constructivist Paradigm

A research paradigm is the framework in which the research study will be conducted, enabling the researcher to select appropriate data collection methods and participants (Denzin & Lincoln 2000; Ponterotto 2005; Omodan 2022). A paradigm is indicative of a worldview, which can be defined as "a basic set of beliefs that guide action" (Creswell 2008), thereby enabling the researcher to explore participants' worldviews of a given phenomenon (Omodan 2022), such as GMFPs. Various paradigms can be used in qualitative studies, including the constructivist paradigm (Ponterotto 2005; Omodan 2022). This study was conducted within a constructivist paradigm, defined as a "set of interrelated assumptions about the social world which provides a philosophical and conceptual framework for the organised study of that world" (Ponterotto 2005).

The constructivist paradigm, also called the interpretivist paradigm, was developed by Kant (1881/1966), who based his work on the premise that reality is formed in a person's mind (Sciarra 1999). He therefore proposed that the reality experienced by a person or someone in the process of experiencing the reality needs to be considered (Sciarra 1999; Omodan 2022). The constructivist paradigm also posits that an individual's understanding of the reality around them is formed by the respective individual's point of view towards a phenomenon (Omodan 2022). Therefore, using a constructivist paradigm in this study allowed the researcher to explore consumers' reality of GMFPs from their own point of view. It has been suggested that learning also plays an important part in the constructivist paradigm as individuals develop their understanding and knowledge based on what they have learnt about a phenomenon through their experiences with the given phenomenon and interactions with it (Adom et al. 2016; Omodan 2022).

The learning aspect within the constructivist paradigm was a concept developed by Jean Piaget (1896-1980), who posited that learning is “transformative rather than a cumulative process”, meaning that people do not learn something little by little until they form an understanding about something (Ponterotto 2005). Instead, Ponterotto (2005) adds that people take what they currently know in order to make sense of something or understand something. The author thus suggests that, as a result, people’s understanding of something can continually change due to the acquisition of new knowledge through experiences. Thus, the constructivist paradigm can lead to improved insight into consumers’ current understanding – in terms of their interaction with the identified phenomenon – and what they have learnt about the phenomenon based on their experience with it (Alzhrani 2022; Omodan 2022). In this study, conversations with the participants allowed the researcher to explore what consumers have learnt about GMFPs, what they understood about GMFPs, and what their interaction was with these food products. These conversations could lead to an improved understanding of where consumers’ attitudes towards GMFPs come from and what they currently are.

It is further proposed that knowledge influences the learning process, and knowledge thus forms an integral part of constructivism (Omodan 2022). Within the constructivism paradigm, knowledge refers to a person’s own individual ideas about a phenomenon (Kim 2005). Therefore, the constructivist paradigm provides a meaningful way in which individuals’ understanding of a difficult phenomenon can be explored based on their experience and own ideas of the phenomenon (Kim 2005; Omodan 2022). In this study, the constructivist paradigm assisted the researcher in exploring consumers’ ideas of GMFPs, which assisted in the exploration of their attitudes toward these food products.

The constructivist paradigm also proposes that the meaning individuals ascribe to something is concealed and needs to be revealed and exposed through in-depth reflection (Schwandt 2000). Such a reflection can be initiated through a collaborative conversation between the participant and the researcher (Ponterotto 2005). Therefore, within a constructivist paradigm, the interaction between the researcher and participant is essential to explore the deeper, underlying meaning that participants have of something (Ponterotto 2005; Van Der Walt 2020). The authors propose that, through the engaged conversation, the researcher and participant can interpret and formulate findings. To encourage such a conversation, this study conducted individual interviews with each respective participant to embark on an in-depth conversation and explore how the participants viewed GMFPs from their reality, to gain insight into what GMFPs meant to them, thereby contributing to understanding their attitudes towards these food products. Through such a conversation, the application of the constructivist paradigm

aims to gain insight into the “lived experiences” through the eyes of those individuals who live and experience the phenomenon on a daily basis (Schwandt 2000; Burns et al. 2022).

According to Dilthey (1894/1977), the lived experience of an individual is also influenced by social reality, which refers to the attitudes, views or beliefs held by particular social groups, which, in turn, affect an individual’s understanding of a phenomenon (Ponterotto 2005; Mohajan & Mohajan 2022). Dilthey (1894/1977) thus proposed that an individual may not be aware of their lived experience; however, the lived experience could be brought to light, and the individual could become aware or conscious of their lived experience by engaging in an interactive conversation (Ponterotto 2005). Subsequently, the conversations with the participants led to further exploration into their lived experiences with GMFPs and how they experienced these food products. To better understand what the constructivist paradigm entails, a discussion of the paradigm’s ontology, epistemology and axiology follows.

4.2.2.1 Ontology

In terms of ontology, which refers to the “nature of reality and being” (Mertens 2019), constructivists propose that reality is subjective (Mertens 2019; Ayton et al. 2023). This means that aspects such as experiences, feelings, viewpoints, the social environment, beliefs, values, negotiations with the phenomenon, and the communication between the researcher and participant influence an individual’s reality and knowledge, further contributing to the development of subjective knowledge (Ponterotto 2005; Priya 2021; Handema et al. 2022; Omodan 2022). Therefore, interactions with other individuals can also influence the way in which an individual views something (Omodan 2022). Thus, the social world influences the way an individual views a particular phenomenon from their reality, contributing to their subjective knowledge in terms of individuals’ images of a phenomenon (Creswell 2008; Fox 2008; Van Der Walt 2020; Omodan 2022). The application of the constructivist paradigm therefore allowed the study to explore consumers’ subjective reality in terms of their attitudes towards GMFPs to better understand their ideas about these food products. Furthermore, it has been argued that individuals do not find knowledge; instead, they develop their own knowledge, and the constructivist paradigm thus allowed the participants to share what was important to them about a phenomenon, thereby giving the researcher insight into how the participants had constructed their own knowledge or understanding about the given phenomenon in terms of their experiences and social interactions with others (Mertens 2019; Handema et al. 2022; Omodan 2022) regarding GMFPs. Constructivists, therefore, believe that knowledge is socially developed (Mertens 2019; Godwin et al. 2021; Handema et al. 2022).

It has been proposed that there are two ways in which knowledge is constructed, namely accommodation and assimilation (Kim 2005). The author explains that accommodation refers to a process where an individual positions their own individual ideas about the world to align with any new experiences. Conversely, Kim (2005) adds that the process of assimilation refers to individuals adding any new experiences to their existing experiences within their present mental framework without changing their current mental picture of a phenomenon. Kim (2005) continues to say that these experiences merge and co-exist with each other. However, the author states that the individual's idea of the world may not necessarily change after the acquisition of a new experience. As a result, the constructivist paradigm aims to explore the topic of a study based on the experiences that individuals have with the identified topic (Adom et al. 2016), such as GMFPs. Framing this study within the constructivist paradigm thus presented an opportunity to further explore how consumers have constructed their knowledge (own mental image) about such food products through their experiences of and social interaction regarding GMFPs.

Constructivists further argue that individuals try to understand and make sense of the world in which they live, and therefore construct subjective meanings based on their experiences with something (Adom et al. 2016; Mohajan & Mohajan 2022). Constructivists thus aim to explore the actual meanings held by the individuals towards a specific phenomenon (Fox 2008; Van Der Walt 2020; Ayton et al. 2023), such as GMFPs. These meanings are developed by experiencing something and the ideas that individuals have about a phenomenon (knowledge) (Mohajan & Mohajan 2022). As Creswell (2008) states, individuals can hold various meanings about something, and it is thus important to explore how the individuals view the phenomenon in order to better understand the meanings ascribed to the phenomenon. Therefore, it has been proposed that researchers working within a constructivism paradigm could decide to interview a smaller group of individuals, but engage in an in-depth conversation to uncover the various meanings an individual has assigned to the phenomenon being studied and obtain a more in-depth insight into their lived experience (Ponterotto 2005). Using open-ended questions is also important to explore the participants' views and meanings of a phenomenon (Creswell 2008; Ayton et al. 2023). As suggested by Ponterotto (2005) and Creswell (2008), individual interviews were conducted in this study, and open-ended questions were asked to explore the meanings participants ascribed to GMFPs, resulting in an increased understanding of how they viewed such food products. The process enabled the researcher to explore what constituted consumers' attitudes towards GMFPs.

In terms of interpreting the meaning that individuals have given a particular phenomenon, conducting research within a constructivist paradigm allows the researcher to interpret

participants' meanings of the world and gain insight into their context by asking questions to explore their current situation (Creswell 2009; Van Der Walt 2020) with GMFPs. Regarding interpretation, the constructivist paradigm emerged from the studies conducted by German theorists such as Edmund Husserl and Wilhelm Dilthey, who aimed to study interpretive understanding, which is referred to as hermeneutics (Mertens 2019). Mertens (2019) clarifies that hermeneutics refers to the study of the meaning that is assigned to something. According to Mertens (2019), constructivists use hermeneutics to interpret participants' meaning of a given phenomenon from their current situation. The author thus argues that an interpretation of findings is an important aspect within the constructivist paradigm. Furthermore, Mertens (2019) highlights that through such interpretations, the researcher needs to keep their own views and experiences in mind and how this could influence the researcher's interpretations of participants' views. In the current study, the researcher's opinion was voiced in the interpretation of the data; however, personal reflections of GMFPs were not integrated into the interpretations as the researcher aimed to give a factual account of the data.

It has been argued that researchers who conduct their research within a constructivism paradigm do not consider the findings of other similar studies when analysing the acquired data, since these researchers do not aim to discover one particular truth and thus do not prove or substantiate their analysis and findings against other studies (Ponterotto 2005). Based on Ponterotto's (2005) explanation, the findings of similar studies do not play a role in the current study and are therefore insignificant to the findings. However, although Ponterotto (2005) suggested excluding other similar studies within the constructivist paradigm, this study did include a discussion of the findings from similar studies to explore how different or similar the findings were to previously conducted research. To provide educational guidance to address consumers' attitudes towards GMFPs through this study, the study intended to determine one particular truth as the study also aimed to understand how different the participants' realities were from other studies.

4.2.2.2 Epistemology

Epistemology refers to exploring something to make more sense of it (Idha et al. 2022). Since the constructivist paradigm takes a subjective position, thereby positing that reality is socially influenced, the in-depth conversation between the researcher and participant is imperative to discover and explore their lived experience through the eyes of the participant (Ponterotto 2005; Omodan 2022). Therefore, to make more sense of how the participants viewed GMFPs and what their reality of such food products was, the relationship between the researcher and the participant was important (Ponterotto 2005; Mohajan & Mohajan 2022; Ayton et al. 2023).

Subsequently, a researcher conducting research within the constructivist paradigm typically uses a data collection method that is of a personal nature, giving the researcher the opportunity to interact with the participants (Mertens 2019; Idha et al. 2022). Such a data collection method is individual interviews, which were used in this study and are discussed further in Section 4.6.2. It is also suggested that direct quotations can be used to support the interpretations and conclusions drawn by the researcher (Mertens 2019), which was done in this study's data discussion chapters.

4.2.2.3 Axiology

Axiology refers to the values and ethics that the researcher needs to consider in the research process (Ayton et al. 2023). Thus, axiology relates to the right or wrong decisions that are made in terms of behaviour when conducting research (Kivunja & Kuyini 2017). Axiology further refers to the value used when conducting research and the value the researcher brings to the research, the participants in the study, and the conclusions (Kivunja & Kuyini 2017). The authors add that, integral to axiology, human values need to be considered during the research process; the ethical considerations for this study are further discussed in Section 4.10. Furthermore, according to Ponterotto (2005), although a researcher's values and biases should be "bracketed", they should not be set aside. The author states that this is based on the suggestion that the researcher engages in a prolonged conversation with the participant, and the researcher's biases and values could emerge during this interactive process. Although the researcher engaged in an in-depth conversation with the participants in this study, the researcher aimed to remain neutral to avoid any bias. A further discussion on trustworthiness, reflexivity, bracketing, and ethical considerations follow in Sections 4.9, 4.9.5, 4.9.6 and 4.10. Furthermore, Ponterotto (2005) suggests that when findings are discussed, the researchers' personal experiences should be incorporated into such discussions. However, as previously mentioned, in the current study, the researcher aimed to obtain data from the participants to give a factual exploratory account of their attitudes towards GMFPs. The researcher did not aim to integrate their personal reflections of GMFPs in the study's findings.

The constructivist paradigm is used to better understand a learning experience of a given phenomenon (Kaushik & Walsh 2019). By framing the study within the constructivist paradigm, more insight was thus gained in terms of how consumers viewed GMFPs, the reality and ideas they had constructed of GMFPs, and the meanings that participants assigned to GMFPs. The approach also allowed the researcher to gain a deeper insight into the participants' lived experience of the world, in terms of GMFPs, from their viewpoint. Acquiring such insight

subsequently led to a more profound understanding of their attitudes towards GMFPs. A discussion of the research design follows.

4.3 RESEARCH DESIGN

The purpose of the research design is to provide structure to the study (Abutabenjeh & Jaradat 2018). The authors add that it incorporates the decisions that are devised throughout the planning of the study, which encompasses the methods that were used to obtain and analyse data.

4.3.1 Phenomenological Research Design

There are five qualitative research designs, one of which is phenomenology (Creswell et al. 2007). This study adopted this research design, complemented with a descriptive and exploratory research design. It has been argued that phenomenology began with the philosophers Kant and Hegel (Groenewald 2004); however, according to Vandenberg (1997), the German Mathematic philosopher known as Edmund Husserl (1859-1938) was "the fountainhead of phenomenology in the twentieth century". When Husserl embarked on exploring other phenomena, this philosopher aimed to incorporate both objective and subjective experiences (Neubauer et al. 2019). Therefore, the authors add that Husserl challenged positivism by suggesting that a phenomenon should be explored by focusing on how individuals perceive that phenomenon in their own consciousness instead of focusing on "objective observations of external reality", which positivism proposes. Drawing an analogy to the constructivist paradigm, Husserl thus proposed that phenomenology explores individuals' subjective experiences of a phenomenon to give a description of the phenomenon being studied (Van Der Walt 2020; Burns et al. 2022).

Therefore, phenomenology guides researchers to gain a better understanding of a phenomenon based on individuals' subjective reality of the phenomenon (Qutoshi 2018; Burns et al. 2022). Qutoshi (2018) states that subjective experiences or reality revolve around the emotional and cognitive influence that experiences have on an individual, and thus refer to the perceptions, feelings or ideas that an individual has of an object in the world. Qutoshi (2018) added that phenomenology aims to explore the realities of a phenomenon based on individuals' subjective lived experiences. The author continues that this is also a fundamental aspect of the constructivist paradigm, and phenomenology thus works in collaboration with the constructivist paradigm. However, phenomenology only took root in the 1970s when phenomenological philosophers recognised and accepted it as a theory; thereafter, various

philosophers built on Husserl's work regarding phenomenology, including Heidegger, Sartre, and Merleau-Ponty (Stones 1988; Creswell et al. 2007). Creswell et al. (2007) explain that since a praxis was established by phenomenological philosophers, phenomenology has been used in various disciplines such as psychology, education, sociology, and nursing and health sciences.

Husserl aimed to explore another aspect of reality, thereby seeking to give meaning to something (Staiti 2012; Neubauer et al. 2019; Burns et al. 2022). However, to comprehend a phenomenon, an understanding of the phenomenon as it is "lived" by an individual needs to be achieved first (Neubauer et al. 2019; Tomaszewski et al. 2020). This subsequently refers to the actual experience of the phenomenon, which Husserl proposed was an aspect of "being", which the philosopher believed was still unknown (Staiti 2012). Groenewald (2004) highlights that many other philosophers like Kvale (1996), Green (1997), Holloway (1997), and Robinson and Reed (1998) supported Husserl's opinion about lived experience as they also agreed that the primary focus of a phenomenological study is the lived experience that the participants had with a given phenomenon within the world. Welman and Kruger (1999) added to Husserl's view of lived experience by saying that phenomenology refers to the manner in which individuals in society go about something in their everyday lives. Therefore, the term 'lived experience' is indicative of the 'human experience' with something (Asenahabi 2019; Neubauer et al. 2019; Burns et al. 2022), such as GMFPs.

In this study, phenomenology allowed an exploration of the participants' actual experiences with GMFPs. This information provided a better understanding of whether the participants had any experience with GMFPs and whether their attitudes towards GMFPs stem from an experienced or inexperienced foundation. This was important, as it gave the researcher further insight into whether the attributes linked to GMFPs were identified based on an actual experience with GMFP attributes. Furthermore, phenomenology also seeks to explore the social and psychological aspects of a phenomenon from the participants' viewpoints, and it aims to explore and understand the true nature of social phenomena from individuals who have experienced them (Welman & Kruger 1999; Atara 2020; Burns et al. 2022). Therefore, phenomenology explains a phenomenon as it appears to individuals and revolves around the experiences that individuals live on a daily basis (Creswell et al. 2007). Thus, a description of the true nature of their subjective experiences with a phenomenon can be developed (Creswell et al. 2007; Cudjoe 2023). Once again, phenomenology complemented the constructivist paradigm because exploring the actual meaning participants assigned to something, their views of something, and their experiences with something are also important features of the constructivist paradigm.

Husserl also aimed to answer the question, 'What is it for an individual to know or be conscious of a phenomenon?' (Neubauer et al. 2019). According to the authors, the philosopher argued that a phenomenon could be studied to further explore individuals' experiences, feelings or ideas about something (such as GMFPs). Phenomenology thus aims to answer the 'what, why and how' of individuals' experiences with a given phenomenon (Irarrazaval 2020). As a result, a phenomenological research design is readily adopted in qualitative research as it allows the researcher to obtain a better understanding of more complex phenomena or issues (Bhar 2019; Burns et al. 2022), such as what constitutes consumers' attitudes towards GMFPs. As proposed by Creswell et al. (2007), phenomenology aims to acquire what views participants have of an object, then a description is given regarding the similarities among all the participants in terms of their experience with something. Following a phenomenological research design thus promoted the exploration of common aspects that the participants shared about GMFPs and created an opportunity to understand how the participants ascribed meaning to their experiences and, ultimately, to GMFPs. Thus, the researcher could use the participants' experiences and meanings attached to GMFPs to better understand consumers' attitudes towards GMFPs. Furthermore, since phenomenology incorporates the perception and understanding that people have of the given phenomenon as a result of their subjective experience with it (Atara 2020), it also allowed the researcher to explore consumers' understanding of GMFPs, which promoted further insight into how their attitudes toward these food products were formed.

Since phenomenology aims to describe participants' experiences of a phenomenon, the word 'describe' forms an integral part of a phenomenological study (Groenewald 2004; Creswell et al. 2007; Burns et al. 2022). Subsequently, phenomenology aims to "describe the meaning" of individuals' experiences with a phenomenon (Teherani et al. 2015; Neubauer et al. 2019; Tomaszewski et al. 2020). Due to the word 'describe' being an operative word in phenomenology, phenomenology focuses on individuals' written or spoken words (Neubauer et al. 2019). Evidently, in the current study, experiences are the verbal accounts participants gave, which were used to explore consumers' attitudes towards GMFPs as their attitudes are embedded in their experiences.

To work with the information gained through the use of phenomenology, it has been stated that a phenomenon is chosen, then information is gathered from participants who have had experience with this phenomenon (Creswell et al. 2007; Burns et al. 2022). Within a phenomenological study, the researcher has to stay close to the facts participants presented in order to describe the research phenomenon as closely as possible (Groenewald 2004). Therefore, once the data has been obtained, the researcher works closely with each

participant statement, thereby allowing the researcher to consider all the participants' experiences with the phenomenon in order to provide a description of the crux of their experiences, which is the main objective of phenomenology (Creswell et al. 2007; Burns et al. 2022). The authors thus highlight that phenomenologists work with the experiences of all participants, not just a few individual participants, thereby allowing the researcher to describe the view that participants have of the phenomenon based on their experiences. Thus, the information participants shared regarding their experiences with GMFPs enabled an exploration of their attitudes towards these food products. This also led to an exploration of how the participants see the world around them in terms of GMFPs.

It has been argued that it is important for a researcher to set aside their own attitudes, beliefs, ideas or feelings about the phenomenon in order to pay close attention to the participants' experiences, thereby enabling the researcher to discover and explore the true nature of the phenomenon being studied (Neubauer et al. 2019). In essence, a phenomenological research design creates an opportunity to learn from others' experiences (Irarrazaval 2020), such as what drives consumers' attitudes towards GMFPs.

In this study, the phenomenological research design enabled the researcher to use the experiences (how participants lived with GMFPs) participants shared to explore their attitudes. By engaging in the participants' experiences with GMFPs, a more profound understanding of their attitudes towards GMFPs was gained. The descriptive nature of phenomenology also allowed the exploration of the truth of GMFPs through the eyes of the participants. A discussion of the descriptive research design follows.

4.3.2 Descriptive Research Design

The descriptive research design was also applied in this study within the phenomenological research design. The phenomenological research design aims to describe a phenomenon from the viewpoint of participants' experience with the phenomenon, and the descriptive research design contributed to such a description as this particular research design aims to describe a current phenomenon as closely as possible (Creswell et al. 2007; Priya 2021; Thakur 2021). The descriptive research design subsequently supplemented the phenomenological research design as a common purpose of both designs is to describe the phenomenon being explored (Creswell et al. 2007; Atmowardoyo 2018). Both phenomenological and descriptive research designs strive to obtain facts from participants to explore the meanings that these participants give to a phenomenon (Atmowardoyo 2018; Neubauer et al. 2019), and these two research designs worked in collaboration in this study.

The exploration of participants' meanings ascribed to the phenomenon encourages researchers to remain close to their data to ensure that the topic is described and explained accurately, an aspect the phenomenological research design also aims to achieve (Groenewald 2004; Atmowardoyo 2018).

Furthermore, the descriptive research design created an opportunity to speak to the participants, thereby attaining factual information about their views, opinions and experiences (Hunter et al. 2018) about GMFPs, which supplemented the phenomenological research design. The participants had the opportunity to share their lived experiences, thereby allowing the researcher to explore their attitudes toward GMFPs. Subsequently, a detailed description of the study's topic could be given. Speaking to the participants also led to the acquisition of a variety of data, which assisted with inductive analysis (as discussed in Section 4.8.2) in terms of developing categories and themes, and linking concepts together to create an improved sense of consumers' attitudes towards GMFPs.

4.3.3 Exploratory Research Design

In addition to the phenomenological and descriptive research design, an exploratory research design was also applied in this study. The exploratory research design is used in research when the phenomenon is not clearly known or understood (Rendle et al. 2019), which was the case in this study. An understanding of what constitutes consumers' attitudes towards GMFPs through their beliefs, values and expectations and its influence on PI remains limited. The main intention of an exploratory research design is not to provide a conclusive answer to the topic being studied; it simply affords the researcher an opportunity to explore and describe the research topic to gain more clarity on the phenomenon under study (Akhtar 2016).

Since the exploratory research design was followed within the phenomenology research design, it enabled the researcher to use the descriptions participants gave to explain their experiences with and the meaning of GMFPs. Thus, the participants' explanations were used to explore the study's topic and make sense of the information that was obtained. An exploratory research design also allows for research problems or questions to be developed that can be further explored in future research studies (Priya 2021). In this study, research problems were identified regarding consumers' attitudes – in terms of beliefs, values and expectations – their PI and knowledge, and suggestions were made for future studies; all of which are discussed in Chapter 10. This research design also assisted the researcher in choosing the most appropriate data collection method and suitable participants in order to collect and obtain information that was relevant to the topic being researched (Kalu & Bwalya

2017). Therefore, the exploratory research design helped select the most suitable data collection method – individual interviews (as discussed in Section 4.6.2) – and participants to obtain information and address this study's research objectives.

Following a descriptive, exploratory, and phenomenological research design led to the acquisition of data that assisted in exploring the study's topic. It enabled the researcher to give a description of GMFPs through the eyes of the participants in terms of their attitudes towards these food products. The three research designs thus complemented and supported each other, leading to a broader understanding of what drives consumers' attitudes towards GMFPs. The location of the study is discussed next.

4.4 STUDY LOCATION

This study was conducted in the Midlands, which is a scenic inland area situated in KwaZulu-Natal, SA (Midlands Meander 2020). The Midlands is surrounded by the Drakensberg and is a big tourist attraction, offering a vast array of activities, accommodation, restaurants and wedding venues, while hosting an array of top schools (Midlands Meander 2020; Seeff 2023). The Midlands is home to many of SA's small-scale farmers, ranging from maize, potatoes and eggs to dairy, beef, pigs, sheep and poultry (KwaZulu-Natal Top Business 2021). According to KwaZulu-Natal Top Business (2021), the Midlands is thus known as a great contributor to the agricultural industry in SA.

The majority of GM-related consumer studies in SA (Joubert 2002; Pouris 2003; Vermeulen et al. 2005; Lanzillotti 2007; Peter & Karodia 2014; Gouse et al. 2016; Kotey et al. 2016; Jonker 2017; Gastrow et al. 2018; Van Zuydam 2020) and internationally (Vecchione et al. 2015; Lopez et al. 2016; Rzymski & Krolczyk 2016; Popek & Halagarda 2017; Brosig & Bavorova 2019; Chagwena et al. 2019; Deng et al. 2019; Kwade et al. 2019; Sanlier & Sezgin 2020; Amin et al. 2021), were conducted in urban areas, whereas this study included participants residing in a rural setting. This is referred to as "sparsely populated areas in which people farm or depend on natural resources, including villages and small towns that are dispersed through these areas" (National Treasury 2011). Including a rural sample in this study added their voices to already existing studies in terms of consumers' attitudes toward and views of GMFPs. In addition, since the Midlands is inland and known for its agricultural diversity (Midlands Meander 2020; The Midlands Magazine 2020), it is assumed that individuals residing in this area are exposed to a surrounding farming and agricultural community. This may result in them understanding the potential of GM farming, but may also innately show some sensitivity, and possibly a different understanding about the cultivation of crops

compared to urban consumers. This could potentially reflect a different attitude towards GMFPs and the influence it has on their PI compared to urban consumers. However, this study was not designed to compare the attitudes of urban consumers to that of rural consumers.

There are various reasons why it was also important to explore the lived experiences of rural consumers in relation to the GMFP research. It is assumed that their opinions and views may differ from urban consumers. For example, consumers residing in rural areas lead different lifestyles and may therefore not have any actual, physical experience with a given phenomenon (Mahdi & Zin 2018). Subsequently, the authors add that they could have different feelings, views and knowledge of a phenomenon compared to consumers residing in urban areas with an increased possibility of having experienced a given phenomenon due to their increased accessibility. Rural consumers may also not have the same resources compared to the urban population and could thus face many other challenges absent in the urban population (Pelletier et al. 2020), such as access to adequate and nutritious food. This could contribute to the development of different viewpoints, opinions, knowledge and feelings toward a specific phenomenon (Mahdi & Zin 2018). Conducting this study in a rural setting illuminated information regarding these consumers' attitudes toward GMFPs, which could contribute and add to existing theory by understanding the rural consumer (surrounded by an agricultural community) in relation to GMFPs. Individuals residing in rural areas are commonly not included in research as they do not reside close to where research is conducted, which makes it difficult to reach such participants (Pelletier et al. 2020). However, the use of purposive, convenience and snowball sampling, as discussed in Section 4.5, led to the inclusion of individuals from the Midlands, where the researcher was based.

4.5 SAMPLING STRATEGY

The sampling strategy is an established plan that the researcher follows to include and recruit participants from whom to obtain data (Elfil & Negida 2017). The discussion that follows explains the use of the non-probability sampling strategy followed in this study, namely purposive, convenience and snowball sampling strategies, to recruit the participants for the study.

4.5.1 Non-Probability Sampling Strategy

For this study, a non-probability sampling strategy was used, which allowed the researcher to decide which groups of the population would form part of the sample (Taherdoost 2016;

Stratton 2021). The current study incorporated three non-probability sampling strategies, namely purposive sampling, convenience sampling and snowball sampling.

4.5.1.1 Purposive Sampling

Purposive sampling gives the researcher the option to choose participants who they feel warrant inclusion in the study, thereby giving the researcher the opportunity to create samples that will most likely provide optimal and valuable information in the quest to explore the research topic (Etikan et al. 2016; Campbell et al. 2020). Thus, the researcher chose a variety of participants that could lead to the acquisition of varied information (Palinkas et al. 2015) to describe consumers' attitudes towards GMFPs from the participants' points of view and their reality of such food products. Participants were therefore chosen based on their relevance to the study, which subsequently allowed the researcher to reach participants with specific characteristics who met the inclusion criteria of the study (Wassenaar 2016; Andrade 2021a). However, the findings might not be representative of the entire population (Maree & Pietersen 2016) and are therefore only specific to the study sample.

Since the current study followed a constructivist paradigm, together with a phenomenological research design, purposive sampling aided in selecting and attaining participants who could share their experiences with GMFPs in their everyday lives, thereby gaining more insight into their reality of GMFPs. Valuable information was acquired, which allowed the researcher to position the participants in terms of their lived experience of GMFPs, thereby giving a detailed description of consumers' attitudes towards GMFPs. The information led to an in-depth understanding of consumers' attitudes towards GMFPs from the participants' view of such food products. To recruit participants via purposive sampling, specific inclusion criteria were used.

4.5.1.1.1 Inclusion Criteria

As mentioned in Section 4.5.1.1, the purposive sampling strategy was used to recruit participants for this study. To do so, inclusion criteria were applied, which included male or female participants above the age of 18 who resided in the Midlands, who had heard of GMFPs, who had been in contact with GMFPs, thought they had formed a certain opinion about GMFPs, thought they knew something about GMFPs, or who had experience with GMFPs. It was important that the participants met one or all of these criteria so that they were able to answer the interview questions and voice their experiences and viewpoints about GMFPs while conversing with the researcher. By engaging in a conversation, an exploration

into the participants' reality of GMFPs emerged. Having the background of the aforementioned criteria assisted the participants in answering the interview questions, thereby providing valuable information for the purpose of this study.

4.5.1.2 Convenience Sampling

Convenience sampling is an inexpensive sampling strategy that allows a researcher to find participants who are accessible; for example, individuals may be included in a study due to their geographical proximity to where the research is set to be conducted or due to the participants' available time to participate in the study (Etikan et al. 2016; Maree & Pietersen 2016; Andrade 2021a; Stratton 2021). When researchers select potential participants, it has been advised that they exercise caution towards researcher bias (Taherdoost 2016; Stratton 2021). Although convenience sampling is commonly used in descriptive and exploratory studies, it cannot be representative of the target population, and the findings obtained cannot necessarily be generalised to the entire population (Etikan et al. 2016; Raifman et al. 2022). However, convenience sampling allowed the researcher to find and include potential participants who met the inclusion criteria of the study and therefore depended on participants who were accessible and willing to participate (Wassenaar 2016; Golzar et al. 2022). In the context of the current study, convenience sampling assisted the researcher in locating and gaining access to participants who resided in the Midlands area and were available to participate in the study's individual interviews.

4.5.1.3 Snowball Sampling

Purposive and convenience sampling were supplemented with snowball sampling, where the researcher located an initial set of participants who were then asked to identify other potential participants with similar characteristics, who met the inclusion criteria of the study, and who could participate in the study (Geddes et al. 2017; Stratton 2021). The snowball effect subsequently occurred when one referral was obtained from another, resulting in the identification of more participants (Kirchherr & Charles 2018; Raifman et al. 2022). Thus, the researcher could ask participants who were identified through purposive and convenience sampling to encourage other individuals to take part in the study, thereby increasing the sample size (Etikan & Bala 2017). However, due to the likelihood of an initial participant suggesting a potential participant who is similar to them, the results cannot be representative of the entire population (Wassenaar 2016; Raifman et al. 2022). Nevertheless, snowball sampling was used in this study and assisted the researcher in locating and assessing the desired population (Sharma 2017) in the Midlands to participate in this study. Snowball

sampling was subsequently used until an adequate number of participants was reached (Naderifar et al. 2017) to ensure data saturation and complement purposive and convenience sampling by including additional participants who met the inclusion criteria. Data saturation was achieved after employing snowball sampling.

4.5.2 Recruitment of Participants

Participants were recruited through a social media platform known as Facebook (Lobe et al. 2020). Social media is an easy, effective and inexpensive technique that researchers can use to make contact with interested participants while remaining physically separated (Gelinas et al. 2017). This was particularly important considering the COVID-19 restrictions that were in place at the time of data collection for this study.

To recruit participants via the purposive and convenience sampling strategy, the researcher created a post for the research on Facebook to invite individuals who met the inclusion criteria to participate in the study. The researcher also placed the Facebook post on a local community group that accepts posts relating to advertisements in the Midlands area. Snowball sampling was initiated through participants who had participated in the study or individuals who were interested in the study sharing the Facebook post for the research with their friends or family, or telling them to view the post on the local community Facebook group. This assisted the researcher to continue recruiting participants for the study. The researcher included a short description of the study's purpose and the inclusion criteria in the post. The researcher created a Gmail email account purely for this study, which was included in the post, and the interested participants used it to contact the researcher, thereby giving the researcher permission to use their email address for correspondence regarding participation in the study should they have been willing and eligible to participate. In addition, for ethical purposes and to ensure that the participants remained anonymous, the Facebook post indicated that the interested participants should not respond or comment on the post, but must contact the researcher directly via the Gmail address provided.

4.6 DATA COLLECTION METHODS

Data collection is an important aspect of research and involves the process of obtaining information from participants to answer the study's objectives (Jameel et al. 2018; Taherdoost 2021). To collect data in this study, a demographic questionnaire was completed, and individual interviews were conducted using an interview guide.

4.6.1 Structure of the Demographic Questionnaire

A demographic questionnaire was designed to acquire demographic information from the study's participants. The demographic questionnaire consisted of closed biographical questions to elicit information regarding the participants' gender, age, household income, education, marital status and employment status (Maree & Pietersen 2016). These closed biographical questions had categories from which the participants could choose: for example, gender included categories such as male or female; and age included categories such as 18-24 years, 25-30 years, 31-40 years, 41-50 years or 51 years or older; household income included R1 000 or less, R1 001-R1 999, R2 000-R6 000, R6 001-R6 999, R7 000-R15 000, R15 001-R15 999, R16 000-R20 000 or R20 000 or more. To determine participants' educational status, categories such as lower than matric/Grade 12, matric/Grade 12 and Grade 12 + a degree/diploma were used, whereas marital status included categories such as single, married/living with a partner, divorced/separated and widow(er). Furthermore, the categories for employment status included permanent full-time, permanent part-time, contract work, self-employed and unemployed. Thus, the questions were constructed as categorical closed-ended questions (Maree & Pietersen 2016).

The demographic questions assisted in compiling a profile of the participants who formed part of this study. Categorical closed-ended questions were also devised to determine the context from which the participants related to GM crops as they were recruited from a rural agricultural community. This was done by determining if the participants farmed with GM crops, if they had family or friends who farmed with GM crops, if they knew someone who farmed with GM crops, and if they were aware of GM farming in the vicinity of where they live. The purpose of these questions was to obtain a better description of the participants' relation to the GM context. The demographic questions can be seen in Appendix C.

4.6.2 Individual Interviews

As a result of the COVID-19 pandemic, UNISA encouraged interaction with participants on an online platform basis, using individual or group interviews. The study initially intended to use focus groups and individual interviews. However, focus groups posed difficult to initiate because recruiting participants for a specifically scheduled online group interview was challenging, all participants were required to have access to a technological devise and internet connectivity (Lathen & Laestadius 2021), and be available at the same time, thus making it difficult to group potential participants in time slots. Such hindrances are limitations when conducting focus groups (Moore et al. 2015). The different load-shedding time

schedules among participants also presented as a hindrance to grouping potential participants together at the same time in this study.

Working within the constructivist paradigm and following a phenomenological research design, individual interviews were conducted as interviews are predominantly used in this paradigm and research design (Creswell 2008). To gain more insight into the participants' reality and view of a phenomenon, and to interpret the participants' meanings and experience of the phenomenon – such as GMFPs – interaction between the researcher and participants is essential (Omodan 2022). Therefore, interviews are recommended as a data collection instrument when conducting research within the constructivist paradigm (Mertens 2019; Omodan 2022). Although the researcher aimed to remain objective and not voice their own opinions or views about GMFPs, it was important for the researcher to interact with the participants based on what they said to obtain as much information as possible regarding their reality of GMFPs. Additionally, due to the COVID-19 restrictions, this researcher conducted synchronous sessions in real-time (Saarijarvi & Bratt 2021) by using online individual interviews that were facilitated through videoconferencing. This allowed the researcher to refrain from physically interacting with the participants (Dodds & Hess 2021).

Conducting online individual interviews, which is a qualitative data collection instrument, is a fast, effective and reliable method of obtaining qualitative data (Adom et al. 2020; Busetto et al. 2020). Adopting an online approach to gain data from participants is effective as the researcher could conduct individual interviews and the participants could join the interview session from any suitable location; therefore, the researcher did not need to take factors such as travel and distance into consideration (Dodds & Hess 2021; Saarijarvi & Bratt 2021).

Individual interviews are an effective data collection instrument as the researcher can engage in an interactive dialogue with the participant, and can attempt to gain a better understanding of a given phenomenon from the participant's point of view (Almutrafi 2019; DeJonckheere & Vaughn 2019). As a result, the researcher could probe the participants to share their experiences regarding the phenomenon, which assisted the researcher in uncovering the meaning of their experiences (Almutrafi 2019; DeJonckheere & Vaughn 2019) with GMFPs. Working within the constructivist paradigm, probing allowed the researcher to explore the participants' reality of GMFPs and how they view such food products. Since this study aimed to follow a phenomenological research design, probing the participants in an open dialogue also gave the participants an opportunity to reflect on their experiences (Irarrazaval 2020) with GMFPs. Irarrazaval (2020) further proposes that engaging in an open dialogue with participants encourages participants to describe their experience of something in their

everyday lives, such as GMFPs. Such descriptions of GMFPs were essential to explore what drives consumers' attitudes towards GMFPs, thereby leading to a description of consumers' attitudes towards GMFPs.

Individual interviews typically unfold as the researcher asks the participant more questions, thus obtaining more information about a phenomenon (Busetto et al. 2020). As Mertens (2019) suggests, when conducting research within a constructivist paradigm, interviews allow the researcher to ask additional questions in order to explore the meaning that the participants give to a phenomenon, such as GMFPs; this subsequently led to a deeper understanding of their attitudes towards such food products. Mertens (2019) thus states that research questions evolve as the interview session progresses, thereby allowing the acquisition of in-depth data. The purpose of individual interviews is, therefore, to gather information and gain insight into the participants' opinions, views, feelings, knowledge, perceptions or attitudes about the phenomenon of interest (Guest et al. 2017). As a result, individual interviews allow researchers to target a particular idea, feeling or thought presented by the participant; accordingly, the researcher has more control over the interview process (Adhabi & Anozie 2017; Busetto et al. 2020). Thus, conducting individual interviews allowed the researcher to engage in a conversation with each participant about GMFPs, and allowed the participants to share verbal accounts of their experiences with and reality of GMFPs, through which their attitudes towards GMFPs were explored.

The individual interviews were conducted using semi-structured questioning. This approach allowed the researcher to develop and ask any additional questions (based on the research topic) during the course of the individual interview sessions, thereby helping the researcher to engage in an open dialogue with the participants and gain ample information (Adhabi & Anozie 2017; Denny & Weckesser 2022). As suggested by Irarrazaval (2020), this further allowed the participants to share their views of GMFPs and how they experienced GMFPs in their everyday lives. Thus, semi-structured interviews are particularly useful when a study is of an exploratory nature (Dejonckheere & Vaughn 2019), which is one of the research designs this study adopted. Semi-structured interviews, which are commonly used in qualitative research, therefore allowed the researcher to explore the participants' attitudes towards a particular phenomenon (DeJonckheere & Vaughn 2019); in this case, GMFPs. As a result, semi-structured interviews produced thick data, which offered insight into the phenomenon being researched (O'Keeffe et al. 2016).

By speaking to each participant, the researcher had the opportunity to ask probing questions to either clarify a statement or gain additional information about a statement that was made.

This strategy led to the acquisition of further information, thereby allowing the researcher to make sense of what each participant shared and develop a comprehensive picture of consumers' attitudes towards GMFPs. Since some of the same questions were asked to explore various aspects of the research topic, the researcher could further probe and confirm the context in which their verbal accounts of GMFPs were given, thereby establishing to which research objective their answers were applicable. Therefore, probing participants' answers to a particular question enabled the researcher to establish which data were most applicable to address the research objectives. Interviewing the participants thus allowed the researcher to confirm their responses and ensure that their answers reflected the context of the research objectives. The researcher also ensured that sufficient data were obtained from the participants to address the research objectives. Furthermore, by joining in an in-depth conversation with each participant, the researcher had an opportunity to hear their ideas about GMFPs first-hand. This promoted the researcher's insight into their experiences with GMFPs, thereby aiding in creating and sketching an image and reality of consumers' attitudes towards GMFPs. The researcher could thus use the participants' spoken words (Neubauer et al. 2019) to describe what constituted consumers' attitudes towards GMFPs.

Since this study used a videoconferencing platform to collect data, participants had to meet the technological requirements stipulated by Lobe et al. (2020). This included downloading Microsoft Teams and accessing either a mobile device, tablet, laptop or desktop, internet connection, speakers, microphone, camera and headphones (if needed). The structure of the demographic questionnaire and the interview guide is discussed next.

4.6.3 Structure of the Interview Guide

The interviews were conducted using an interview guide to acquire information from the participants through individual interviews to address the objectives of the study. Therefore, the questions used in the interview guide (see Section 4.7 and Appendix D) were self-developed to best address each of the objectives indicated in the operationalisation of the study. As suggested by Irarrazaval (2020), phenomenological interviews focus on asking questions to acquire subjective information from the participants. In this study, it meant obtaining information that illustrated what the identified phenomenon meant to the participants and what the participants' experiences were with the phenomenon of interest, such as GMFPs, through which their attitudes towards GMFPs were explored. Irarrazaval's (2020) suggestion was thus kept in mind when constructing the questions for this study. Furthermore, the questions devised in the interview guide were designed to guide the participants to vocalise their views of GMFPs and their reality of such food products. It also enquired about their everyday

experiences with GMFPs, through which their attitudes could be further explored. By constructing the interview questions in such a way, the participants could give a description and explanation of how they viewed GMFPs and what meaning they had assigned to GMFPs. Their reality of these food products and their experiences with GMFPs emerged, which broadened the researcher's understanding of what drives consumers' attitudes regarding GMFPs.

The interview guide was divided into five sections. Section A elicited information regarding consumers' salient beliefs towards GMFPs as well as their behavioural beliefs (attitudes). Section B elicited information regarding consumers' knowledge about GMFPs and the sources from where GM-related information was acquired, together with consumers' PBC and control beliefs. Section C elicited information regarding consumers' salient values towards GMFPs. Section D elicited information regarding consumers' salient expectations of GMFPs. Section E elicited information regarding consumers' subjective norms and normative beliefs towards GMFPs.

Although the salient beliefs, values and expectations emerged from the questions developed in Sections A, C and D, a confirmation question about the most important salient beliefs, values and expectations, respectively, was included. Therefore, in addition to probing the participants on their answers to the questions, it was important to ask a confirmation question on their beliefs, values and expectations, respectively, to explore if any additional salient beliefs, values and expectations of GMFPs emerged from the participants' responses. The confirmation question thus led to the acquisition of information specifically pertaining to the participants' most important beliefs, values and expectations of GMFPs. Asking a confirmation question also contributed to achieving trustworthiness by providing credibility to the view and experience that was shared by the participant.

4.6.4 Data Gathering

A specific data-gathering process was followed to recruit and obtain information from eligible participants to participate in the study, as depicted in Figure 4.2.

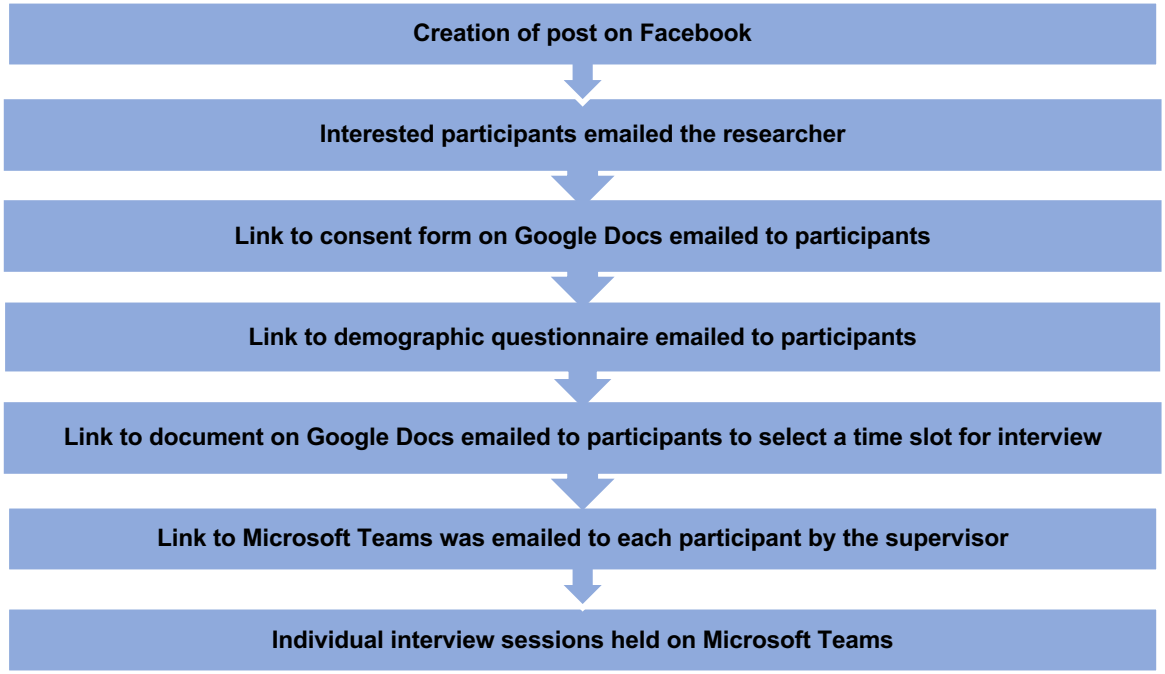

Figure 4.2: Summary of the Data Collection Process Followed

Drawing from Section 4.5.2, after a post was created on Facebook inviting eligible participants to participate in the study, the interested participants emailed the researcher using the study's email address. A link to complete the consent form on Google Docs was emailed to them (see Appendix B). As seen in Figure 4.2, a document was created on Google Docs to obtain demographic information from the participants, and a link was emailed to each participant for them to complete. This was done after the participants had contacted the researcher via email and completed and signed the consent form (as discussed in Section 4.10), thereby agreeing to participate in the study. A link was then emailed to them where they had to select an appropriate time slot on Google Docs for the interview.

The online synchronous individual semi-structured interviews were conducted via Microsoft Teams, which is a reliable videoconferencing platform many researchers use to collect data while remaining physically separated from their participants (Microsoft 2022). Archibald et al. (2019) add that gathering data electronically through an online platform could be a more attractive option for participants and encourage more participants to take part in a study, as opposed to meeting face-to-face due to the convenience of such platforms. Additionally, due to the COVID-19 pandemic at the time of the study, UNISA issued a document outlining COVID-19 regulations for researchers after ethics clearance was given (UNISA 2020). When the researcher commenced data collection by conducting individual interviews, SA was on adjusted alert level 1. For alert level 1, UNISA's COVID-19 regulations stipulated that "online platform interaction with human participants" and "research requiring interaction with human

participants in close proximity" was permitted if specific requirements were met (UNISA 2020). Thus, the researcher proceeded with individual interviews on an online platform, namely Microsoft Teams, to ensure the health and safety of both the researcher and the participants.

As suggested by Lobe et al. (2020), the researcher asked the participants to keep their phones on silent and minimise any potential distractions that could affect the individual interview session. In addition, if any participant was unsure how the Microsoft Teams platform worked, the researcher offered a 'practise session' so that the participants could familiarise themselves with the features. Furthermore, as seen in Figure 4.2, a link to the interview was sent to the respective participants via email (with their permission) to join the session on Microsoft Teams before the actual session commenced. However, due to the researcher being a student and not having full access to the Microsoft Teams platform, the researcher could not set-up the individual interviews, could not email the meeting link to each participant, and could not record the individual interview sessions. The supervisor of this study had full access to the Microsoft Teams platform, and as a result, the researcher and the supervisor liaised. The researcher gave the supervisor the necessary information to schedule meetings and email the link to each participant and the researcher, as depicted in Figure 4.2. However, this was only identified at the time of the pilot interview, and this information was therefore not included in the informed consent form. Nevertheless, the role that the supervisor played in setting up the interview was communicated to each participant through email (by the researcher) so that they were fully informed. Thus, the researcher informed each participant that the link to their respective individual interview session would have to be emailed to them from the supervisor. The participants were asked by email to allow the researcher to send their respective email addresses to the supervisor. The supervisor of this study was not involved in the interview sessions held on Microsoft Teams and did not interact with the respective participant during the interview session; however, the supervisor recorded each interview session, and each respective recording was emailed to the researcher.

4.7 OPERATIONALISATION OF THE STUDY

The purpose of a study's operationalisation is to illustrate how concepts were explored (Andrade 2021b). A discussion of the information that emerged from each section of the interview guide is presented below.

4.7.1 Operationalisation of the Interview Questions

As discussed in Section 4.6.3, an interview guide was constructed to address the study's objectives. A table of the study's operationalisation, through the development of an interview guide to address the objectives, can be seen in Table 4.1.

Each of the sections (A, B, C, D and E) indicate related questions that were designed to explore each of the objectives relevant to the section and the data analysis procedure used for each of the objectives.

Table 4.1: Operationalisation of the Study

Section A: Consumer Salient Beliefs, Attitudes and Behavioural Beliefs about GMFPs

Section	Objective Number	Data Gathering Instruments	Data Analysis Procedure	Research Objective	Question	Question Number
A	Objective 1 Objective 1.1	Online individual interviews	• Inductive approach • Thematic analysis	Describe what role the three components of the EV Model of Attitudes play on attitudes towards GMFPs in terms of: Consumers' salient beliefs about GMFPs.	When you hear the words 'genetically modified', what comes to mind?	1
					When you hear the words 'genetically modified food products', what comes to mind?	2
					How do you feel about GM food products in general?	3
					What do you believe is true about GM food products?	4
	Objective 1.1			Consumers' salient beliefs about GMFPs.	If you could point to the most important belief you hold about GM food products, what would that be?	7
	Objective 3 Objective 3.1			Describe what role the three elements of the TPB play on the intention to purchase GMFPs in terms of: Attitudes and behavioural beliefs' influence on attitudes.	What do you believe will be your experience of GM food products after you have purchased and consumed them?	5
					What do you think are the rewards or benefits of purchasing GM food products?	20
					What do you think are the risks of purchasing GM food products?	6

Section B: Consumer Knowledge, Sources of GM-Related Information, PBC and Control Beliefs regarding GMFPs

Section	Objective Number	Data Gathering Instruments	Data Analysis Procedure	Research Objective	Question	Question Number
B	Objective 2 Objective 2.1	Online individual interviews	• Inductive approach • Thematic analysis	Explore the influence of knowledge on consumers' beliefs about GMFPs by: Exploring consumers' state of knowledge of GMFPs.	Do you know of any GM food products that you purchase on a regular basis?	8
					Do you specifically look to purchase GM food products?	9
					What do you think are the rewards or benefits of purchasing GM food products?	20
					What do you think are the risks of purchasing GM food products?	6
					What would you say is the most important thing you know about GM food products?	12
	Objective 2.2			Identifying the sources where GM-related information is acquired that influence knowledge of GMFPs.	Where do you get your information about GM food products from?	16
	Objective 3 Objective 3.3			Describe what role the three elements of the TPB play on the intention to purchase GMFPs in terms of: PBC and control beliefs' influence on PBC.	Do you know of any GM food products that you purchase on a regular basis?	8
					Do you specifically look to purchase GM food products?	9
					How do you feel about the fact that you have purchased GM food products and you perhaps did not know it?	10

Section B: Consumer Knowledge, Sources of GM-Related Information, PBC and Control Beliefs regarding GMFPs

Section	Objective Number	Data Gathering Instruments	Data Analysis Procedure	Research Objective	Question	Question Number
	Part of Objective 3.3				Is there something that prevents you or makes it difficult for you to purchase GM food products?	11
					What would you say is the most important thing you know about GM food products?	12
				Control beliefs (specific questions on control beliefs)	What do you think will prevent you from purchasing GM food products?	13
					What do you think will encourage you to purchase GM food products?	14
					Do you think you are in control or not in control over the GM food products you purchase?	15

Section C: Consumer Salient Values of GMFPs

Section	Objective Number	Data Gathering Instruments	Data Analysis Procedure	Research Objective	Question	Question Number
C	Objective 1	Online individual interviews	• Inductive approach • Thematic analysis	Describe what role the three components of the EV Model of Attitudes play on attitudes towards GMFPs in terms of:	Will you be willing to purchase GM food products if they cost less than their traditional counterparts?	17
	Objective 1.2			Consumers' salient value assigned to GMFPs in terms of:	In your opinion, what effort does it take to determine whether the product you purchase is in fact a GM food product?	18
	Objective 1.2a			Cost relating to GMFPs.		
	Objective 1			Describe what role the three components of the EV Model of Attitudes play on attitudes towards GMFPs in terms of:	In your mind, what does GM food products go against in terms of what you believe or hold dear?	19
	Objective 1.2			Consumers' salient value assigned to GMFPs in terms of:	What would you say is the most important thing you know about GM food products?	12
	Objective 1.2b			Attainment value relating to GMFPs.		

Section C: Consumer Salient Values of GMFPs

Section	Objective Number	Data Gathering Instruments	Data Analysis Procedure	Research Objective	Question	Question Number
	Objective 1 Objective 1.2 Objective 1.2c			Describe what role the three components of the EV Model of Attitudes play on attitudes towards GMFPs in terms of: Consumers' salient value assigned to GMFPs in terms of: Intrinsic value relating to GMFPs.	What do you think are the rewards or benefits of purchasing GM food products?	20
	Objective 1 Objective 1.2 Objective 1.2d			Describe what role the three components of the EV Model of Attitudes play on attitudes towards GMFPs in terms of: Consumers' salient value assigned to GMFPs in terms of: Utility value relating to GMFPs.	In your opinion, what functional use does GM food products have? (If you think of the characteristics of GM food products, are these food products doing what they were intended to do or originally designed to do?)	21
					How differently do you use GM food products to any other food products you purchase and use?	22
	Objective 1.2			Consumers' salient value assigned to GMFPs.	If you could point to the most important value you hold about GM food products, what would that be?	23

Section D: Consumer Salient Expectations of GMFPs

Section	Objective Number	Data Gathering Instruments	Data Analysis Procedures	Research Objective	Question	Question Number
D	Objective 1	Online individual interviews	• Inductive approach • Thematic analysis	Describe what role the three components of the EV Model of Attitudes play on attitudes towards GMFPs in terms of:	What do you expect of a GM food product?	24
	Objective 1.3			Consumers' salient expectations of GMFPs.	In your mind, what are the consequences of using GM food products?	25
	Objective 1.3			Consumers' salient expectations of GMFPs.	If you could point to the most important expectation you hold about GM food products, what would that be?	26

Section E: Consumer Subjective Norms and Normative Beliefs regarding GMFPs

Section	Objective Number	Data Gathering Instruments	Data Analysis Procedures	Research Objective	Question	Question Number
E	Objective 3 Objective 3.2	Online individual interviews	• Inductive approach • Thematic analysis	Describe what role the three elements of the TPB play on the intention to purchase GMFPs in terms of: Subjective norms and normative beliefs' influence on subjective norms.	To what extend do your friends, family and other parties pressure you to purchase or not to purchase GM food products?	27
					From which source does this pressure come?	28
					Which social groups or individuals encourage you to purchase GM food products?	29
					Which social groups or individuals discourage you to purchase GM food products?	30
	Part of Objective 3.2			Normative beliefs (specific question on normative beliefs)	To what extent do you feel other people who have a positive influence on you, are important to consider when deciding whether or not to purchase GM food products and why?	31
					How do you think your friends and family will feel if they know you have purchased GM food products?	32

As seen in the operationalisation tables, the questions in the interview guide (Appendix D) were developed to flow and did not address the objectives in the order in which they were listed in Chapter 1, Section 1.4.

4.7.2 Piloting the Interview Guide

The interview guide was piloted with a pilot participant on Microsoft Teams. The supervisor also attended this session but did not interact with the participant or the researcher. After the session, the researcher discussed the interview and interview guide questions with the supervisor. Thus, the proposed questions were piloted before the actual study, and two questions were reconsidered. Question 22 stated: 'In your opinion, what functional use does GM food products have?'; however, the pilot participant was unsure about the words 'functional use'. Therefore, a description of the words 'functional use' was added to the question to promote clarity. Question 22 was thus changed to: 'In your opinion, what functional use does GM food products have? (If you think of the characteristics of GM food products, are these food products doing what they were intended to do or originally designed to do?)'. Question 21 asked: 'What is most important to you where GM food products are concerned?' The question was similar to Question 12, which asked, 'What would you say is the most important thing you know about GM food products?' Therefore, Question 21 was removed as the question delivered the same response as Question 12. As a result, Question 22 was changed to Question 21 in the amended interview guide that was used. The remaining questions were found to elicit answers that addressed the objectives of the study, were understood by the pilot participant, and therefore remained unchanged. The interview guide for the data-gathering instrument can be seen in Appendix D. The amended version of the interview guide is reflected in the operationalisation tables (Table 4.1).

4.7.3 Sampling Size

In qualitative research, sampling size is associated with data saturation, which refers to the point at which the data obtained does not provide any new or suitable information that can contribute to the study (Guest et al. 2020; Denny & Weckesser 2022). It has been suggested that a sufficient number of interviews should be conducted to obtain rich data and assist in generating new data, thereby creating and developing an increased understanding of the phenomenon being studied (Vasileiou et al. 2018). The authors also mention that the level of questioning in the interview sessions, as well as the use of open-ended questions, generally lead to thick and rich data. Thick data enable an exploration into consumers' daily lives and how they feel, whereas rich data refers to the degree to which the data obtained reflects

consumers' behaviour, thereby allowing an increased understanding of the context of the results or findings of the study in terms of the phenomenon being studied (Latzko-Toth et al. 2017; Bearman 2019). However, many factors play a role in data saturation, such as the quality of the data, the phenomenon being studied, the amount of relevant data gathered from each participant, and the type of study design used (Guest et al. 2020). These aspects were considered when participants were recruited for the study by asking the participants a majority of open-ended and additional questions through the process of probing to gain rich, in-depth data about consumers' attitudes towards GMFPs.

It has been suggested that it is essential to assess the available data in terms of patterns, codes, themes and categories to ensure the data has depth (Moser & Korstjens 2018). The authors go on to say that the data obtained should include a variety of information about the phenomenon being studied, which also lends itself to the depth and richness of the data. Additionally, it is also essential to describe each of the aspects that form part of the methodology of a study so that all the processes followed in the study are presented, and the findings can be placed into context (Earnest 2020). The quality of the participants' information and the acquired data were thus analysed, and the findings were reviewed. Thereafter, the researcher decided whether data saturation had been achieved, as recommended by Moser and Korstjens (2018).

For the purpose of this study, inductive thematic saturation was used to determine when a sufficient amount of data had been acquired, which relates to identifying new codes or themes, meaning that saturation depends on the number of these codes or themes (Saunders et al. 2018). Therefore, when the codes or themes illustrated that no new codes or themes emerged from the data, inductive thematic saturation was achieved (Sebele-Mpofu 2020). According to various authors, individual interviews can range between five to 30 participants (Sim et al. 2018; Vasileiou et al. 2018; Kindsiko & Poltimae 2019; Guest et al. 2020). In the current study, after 20 interviews were conducted, thematic saturation was achieved. However, the researcher and supervisor decided to conduct an additional 10 to 15 interviews to ensure no new additional codes or themes emerged. Thus, in this study, 32 individual interviews were conducted, and it was confirmed that no new analytical information and no new codes and themes emerged from the data; therefore, inductive thematic saturation was reached. The 32 individual interviews also led to the acquisition of ample, relevant data to analyse and develop codes and themes that supported the data. Acquiring such in-depth information from the participants enhanced the depth of the individual interviews and the data obtained, thereby creating a better understanding of the formation of consumers' attitudes towards GMFPs, which subsequently allowed the researcher to draw conclusions.

4.8 DATA ANALYSIS

Data analysis refers to systematically arranging and condensing information or data obtained with the intention to increase the understanding of the data (Watson 2015). The descriptive statistics used to analyse the demographic data are discussed, as well as the inductive approach used to analyse the data from the interview guide questions for this study.

4.8.1 Descriptive Statistics

Descriptive statistics are used in a study to assist in summarising and organising the data obtained from the participants (Kaur et al. 2018; Fulk 2023). For this study, descriptive statistics were used to analyse the participant's demographic data, as discussed in Section 4.6.1. Participants' demographic information was important as it was used to describe the participants who took part in the study (Nieuwenhuis 2016). The demographic data were entered into an Excel spreadsheet which allowed for the data to be analysed using frequencies and percentages. To present the data in a meaningful way, the demographic data output was then converted to a single table and represented as frequencies (n) and percentages (%) (In & Lee 2017; Fulk 2023).

4.8.2 Qualitative Data Analysis

In terms of data analysis, this study assumed an inductive approach, which refers to the process of analysing data that were steered by specific objectives, meaning that categories and themes were developed based on the study's objectives (Azungah 2018). An inductive approach allowed the use of raw data to develop categories, before the raw data were interpreted, thereby assisting in making links between the study's objectives and the interpretation of the raw data (Ravindran 2019). This strategy assisted in developing themes based on the raw data that had emerged, which refers to the process of characterising particular ideas or views that applied to the research question (Wolceshyn & Daellenbach 2018).

In this study, each respective online interview was recorded on the Microsoft Teams platform; thereafter, the data were transcribed verbatim on Microsoft Word. To assist with data analysis, each participant received an identification number – the researcher emailed the identification number to the participant after consent was given to participate in the study before the interview session commenced. All data pertaining to each participant was marked accordingly with the identification number, as suggested by Nieuwenhuis (2016). Once the data had been

transcribed, the researcher used thematic analysis, a common approach in qualitative studies, and refers to the process of explaining the dataset by identifying recurrent patterns, such as common ideas or important features that emerged from the given data set after it had been placed into categories (Nowell et al. 2017). The approach assisted the researcher in interpreting and understanding the given dataset and the meaning that the participants gave to the research question, as suggested in hermeneutic phenomenology (Creswell et al. 2007; Kiger & Varpio 2020). Thematic analysis therefore created a sense of familiarity with the data in terms of establishing the key ideas or views that occurred as presented by the participants (Lester et al. 2020; Lochmiller 2021) regarding their attitudes towards GMFPs.

It has been suggested that, within phenomenology, the researcher should seek common aspects that arise from the participants' vocalised information in order to broaden the understanding of the phenomenon being studied (Creswell et al. 2007). Establishing such key features within the dataset assisted in exploring consumers' attitudes towards GMFPs. Lochmiller (2021) adds that thematic analysis is also indicative of what the participants or respondents perceived as being important in terms of the research question. As suggested by Lochmiller (2021), the approach was therefore used to explain participants' views of the research question or topic by using their spoken words during their individual interview sessions. Moving through this process of thematic analysis allowed the researcher to explore the meaning that the participants assigned to GMFPs, gaining an understanding and description of consumers' attitudes towards GMFPs through their eyes.

Thematic analysis meant transcripts and data were read numerous times to ensure that the analysis and conclusions were of a high standard (Dawadi 2020; Lester et al. 2020). Dawadi (2020) adds that thematic analysis is particularly valuable when experiences, ideas or behaviours need to be explored through the data, and thematic analysis thus complements a study that uses a phenomenological research strategy. Since this study followed a constructivist paradigm, together with a phenomenological research design, thematic analysis assisted in exploring the participants' reality of GMFPs based on their experience with these products, which resulted in an improved understanding of what constituted consumers' attitudes towards GMFPs. Thematic analysis therefore aided in grouping similar ideas or information together, thereby creating an understanding of which aspects of GMFPs were important to the participants. Through the process of thematic analysis, the researcher also gained a sense of what fuelled consumers' attitudes towards GMFPs.

Thematic analysis is a process that involves coding the data, placing data into categories, followed by themes, thereby organising the data in a meaningful manner (Nowell et al. 2017).

Coding the data is an analytical technique that entails identifying and marking segments of the transcribed data by using various codes such as symbols, words or phrases, thereby breaking the data into segments to make sense of it (Linneberg & Korsgaard 2019; Lochmiller 2021; Mende 2022). Coding made the data more meaningful and allowed the researcher to make sense of the collected data, which entailed moving backwards and forwards between the data to establish if any new ideas emerged (Azungah 2018; Elliott 2018; Khokhar et al. 2020). Thus, coding involves taking the data, pulling it apart, and putting it back together in a way that creates a better understanding of the data set and offers comparisons within the data set (Khokhar et al. 2020; Lochmiller 2021).

For this study, the researcher used both open and axial coding to code the data. Open coding was done by establishing patterns in the data, subsequently labelling similar patterns with appropriate codes, thereby breaking up the data (Richards & Hemphill 2017). Axial coding was done to organise and make connections between the codes or patterns already assigned to the data through open coding, which essentially allowed the researcher to group similar codes and patterns to further categorise the data by developing categories and, subsequently, themes (Costa et al. 2016; Mende 2022). The coding process can be referred to as the building blocks that lead to the development of categories and themes (Dawadi 2020). Thus, drawing an analogy to the phenomenological research design, the coding process allowed the researcher to explore similarities among all the participants relating to GMFPs, thereby also exploring the meaning that the participants assigned to GMFPs as suggested by Creswell et al. (2007) and Neubauer et al. (2019). In vivo coding was also applied in this study, where the specific words spoken by the participants were considered (Manning 2017), thereby gaining insight into how the participants viewed a particular object – such as GMFPs – and the meaning and reality of such food products through the words they used in their conversations during the individual interview sessions. A code derived from in vivo coding thus represents a word or a phrase spoken by the participants (Jugessur 2022). The use of in vivo coding assisted the researcher in using the actual spoken words of the participants and grouping these together to form salient and sub-salient aspects, which are discussed in Section 4.8.3.

A category refers to a process where patterns within the given data set are identified; it refers to an idea or statement that occurred in the data on numerous occasions (Lochmiller 2021). Lochmiller (2021) continues that it is important to establish these patterns in the data as it is indicative of relationships within the data. A category is therefore also referred to as a group or segment of data that shares similarities and is therefore related (Erlingsson & Brysiewicz 2017). A category thus organises the data, thereby illustrating the dataset, which then highlights underlying variables that subsequently act as a foundation from which themes are

developed (Kiger & Varpio 2020; Lochmiller 2021). Categories were ultimately developed so the researcher could gain a better understanding of the collected data (Watson 2015) in order to use the participants' statements to provide a description of GMFPs from their points of view. Furthermore, a theme refers to the underlying meaning of one or more categories, demonstrating reoccurring ideas that emerged from the data in relation to the research question (Vaismoradi et al. 2016; Kiger & Varpio 2020). Each theme subsequently illustrates something interesting in the dataset and captures a specific feature of the data (Maguire & Delahunt 2017; Dawadi 2020). It is vital to establish and create themes that are significant to the research question (Maguire & Delahunt 2017). Identifying themes through thematic analysis thus led to an increased understanding of the data, which assisted in creating a sense of consumers' attitudes towards GMFPs.

As suggested by Creswell et al. (2007), following a phenomenological research design suggests that the researcher moves through each participant statement systematically to ensure that the true essence of the information is grasped. Moving through the coding process, developing categories and themes thus led to a description of the essence of the participants' attitudes toward GMFPs, as proposed by Creswell et al. (2007).

4.8.3 Presentation of the Data

In the current study, the data are presented over several chapters, and figures and tables are used to give a visual depiction of the salient and sub-salient aspects that emerged from the data. Quotes were also used and included in the write-up of the data chapters. However, not all the quotes were used – only a few were selected to illustrate and explain the salient and sub-salient aspects. The remainder of the quotes are available in Appendix E. Some of the salient aspects presented in the data chapters were developed based on quotes that emerged during the conversations with the participants; therefore, some of the salient aspects have quotes. Other salient aspects were self-developed by grouping words that emerged through conversations, and thus did not have any quotes. However, the sub-salient aspects had quotes and were used to develop some of the salient aspects.

A colour code was used to represent the prominence of each sub-salient aspect. Therefore, colour coding was used to indicate the frequency with which specific reference was made to the exact words participants used to express the sub-salient aspects that formed and represented the salient aspect. This was done to indicate the importance of specific expressions or words participants used to explain the sub-salient aspect. Based on the re-occurrence and use of these words that emerged through in vivo coding (as discussed in

Section 4.8.2) they were considered important expressions that captured the salient beliefs, values, and expectations, as well as the PI and knowledge of the participants. Even though the participants did not use the exact same words in some instances, some of the salient aspects emerged from different expressions that had a related meaning. Therefore, colour coding could not be used to indicate the frequency with which specific words or phrases were used since various explanations were presented that all had an underlying meaning as captured in the salient aspect. To assist with the identification of the salient aspects that emerged from the data, and to allow for an easier read, such aspects were presented in bold.

It is important to note that in Chapters 6 (data regarding the value assigned to GM crops and food products) and 7 (data regarding the expectations of GM crops and food products), respectively, a lack of data emerged from the interview sessions with the participants. Therefore, parts of the data were not elaborated on, and there was not a lot of depth in the data (particularly in Chapter 7) compared to the depth of data in Chapter 5 (data regarding the beliefs about GM crops and food products). As a result, in some cases, only a few quotes were acquired from the data for some of the salient and sub-salient aspects in Chapters 6 and 7. Although some of the salient and sub-salient aspects only had a few quotes and were thus not reflecting the opinion of all the participants, the aspects were still important to consider as they created insight into how the participants viewed their values and expectations of GMFPs. In the context of Chapter 6, it was found that the participants struggled to answer some of the questions regarding the value of GMFP, such as, 'In your opinion, what functional use does GM food products have?' (although a description was given) and 'If you could point to the most important value you hold about GM food product, what would that be?' When these questions were asked, some of the participants went into a different direction in their conversations. This could indicate that they perhaps did not understand what the word 'value' entailed in terms of assigning it to GMFPs; which could have contributed to the lack of data in some parts of the chapter.

Regarding Chapter 7, many participants were confused by the words 'expect' or 'expectation' and struggled to explain which attributes they expected GMFPs to offer. Some participants thus found it difficult to engage with the questions and hold a conversation about their expectations of GMFPs, thereby contributing to the lack of data in Chapter 7. Although the researcher provided an explanation of what expectations are to the participants who were unsure during the course of the interview session, and although they were further probed in terms of expectations, a sense of confusion remained regarding their expectations of GMFPs. The lack of data in certain parts of Chapter 6, and specifically in Chapter 7, could indicate that some participants struggled to value GMFPs and identify what they expected of GMFPs. The

ample amount of data obtained regarding the participants' beliefs about GMFPs, as presented in Chapter 5, could indicate that they felt more comfortable answering questions about their beliefs regarding such food products as opposed to questions about their values and expectations of GMFPs.

The data on the participants' knowledge and PI of GMFPs are presented in two chapters, namely Chapters 8 and 9, to split the data and allow for a more conducive presentation of the findings. The data in Chapter 8 and the first two sections in Chapter 9 pertain to the participants' knowledge and PI concerning GMFPs, while the remaining sections of Chapter 9 only focus on PI aspects.

Although the questions asked in the interview sessions related to GMFPs, they led the participants to express their beliefs, values and expectations of GM crops during the conversation. Therefore, although the data were used to explore the participants' attitudes toward GMFPs, the data has been written up in terms of GMFPs and GM crops.

4.9 TRUSTWORTHINESS

In qualitative research, trustworthiness – meaning the "truthfulness" of the study – in terms of data analysis, findings and conclusions are important aspects to consider (Nieuwenhuis 2016; Stahl & King 2020). Four criteria are considered to assess trustworthiness in research, namely credibility, transferability, dependability, and confirmability (Stahl & King 2020); of which a discussion follows. Reflexivity and researcher bias are also discussed to show the role that the researcher plays during the study in terms of achieving trustworthiness.

4.9.1 Credibility

Credibility relates to internal validity and relies on the richness of information obtained as well as the analysis of the information (Gunawan 2015). Member checking is a technique that is used to check the credibility of data findings, increase rigour within the study, and ensure that the participants' views and opinions are represented accurately by the data and conclusions (Birt et al. 2016; Stahl & King 2020). Member checking was implemented in this study. According to Birt et al. (2016), member checking can occur in two ways: participants can be questioned in the initial interview to clarify or re-iterate what was originally stated, or the analysed data can be returned to the participants for checking purposes. In this study, information was summarised, and participants were probed and questioned further in their individual interview sessions to recap and confirm what was originally stated. Thus, focus was

placed on questioning the participants until clarity was attained regarding what was said, thereby giving the participants the opportunity to confirm whether the researcher's interpretation of their information was accurate. As a result, credibility was addressed (Korstjens & Moser 2018). As further suggested by Stahl and King (2020), the supervisor remained engaged in the analysis process to review the respective codes, categories and themes devised by the researcher as they emerged from the data to ensure credibility.

According to Nieuwenhuis (2016), the credibility of a study is also increased through well-defined sampling and data collection methods, as discussed in Section 4.5 and Section 4.6 of the thesis. Nieuwenhuis (2016) highlights that other measures could also be adopted to enhance credibility. In this study, for example, the researcher liaised with the supervisor on a regular basis, debriefing took place, and reflective notes were shared, which is part of the relationship between the supervisor and the student. As suggested by Korstjens and Moser (2018), other strategies were also used to achieve creditability, namely prolonged engagement, where the researcher remained present and engaged in long interviews and set aside enough time to become familiar with the environment, thereby contributing to the acquisition of thick, rich data, as previously discussed in Section 4.7.3. It was therefore important for the researcher to remain engaged in each respective interview to obtain thick, rich data, thereby gaining insight into consumers' attitudes towards GMFPs. Korstjens and Moser (2018) further state that the process of prolonged engagement in the interview session also leads to persistent observation. The authors add that this refers to determining which aspects are most applicable to the study, thereby allowing the identified aspects to be focused on. Prolonged engagement subsequently aided in probing each participant in their respective individual interview sessions.

4.9.2 Transferability

Transferability relates to external validity, which refers to the generalisation of a study's findings (Stahl & King 2020). However, it has been argued that qualitative research does not seek to generalise results or findings; instead, samples are selected on a random basis (Nieuwenhuis 2016). Instead of generalising the results or findings of a study, transferability rather encourages the reader to make their own link between the underlying variables of the study and incorporate their individual experiences (Stahl & King 2020). Since transferability also refers to the degree to which the findings of a study can be relayed from the current study to another study with a similar context, transferability can be attained by giving an in-depth explanation of the research context and the underlying variables of the study (Elo et al. 2020).

In this study, the researcher applied thick description, which means that a detailed description of the study's context, the participants, as well as the research design was given (Korstjens & Moser 2018; Stahl & King 2020). Additionally, as suggested by Lester et al. (2020) and Earnest (2020), prolonged engagement with the interviews was essential to acquire an adequate amount of information that created context. This information was used in this study to thoroughly address the research questions and explain the research topic. Providing such information allows the reader to draw their own decision regarding transferability and to determine whether the current study can be conveyed to their present situation (Korstjens & Moser 2018; Maher et al. 2018).

4.9.3 Dependability

In qualitative research, dependability relates to reliability, which refers to the degree to which another researcher can follow the decisions that were made by the researcher of the study; the extent to which the study can be conducted again; and the trust that the researcher has with each aspect when moving through the research process (Gunawan 2015; Nyirenda et al. 2020; Stahl & King 2020). Dependability was established through the research design and its adoption; therefore, the data collection method (namely individual interviews) was stipulated and thoroughly explained (Nieuwenhuis 2016) so the decisions taken in the study could be clearly followed and allow the study's replication. To achieve dependability, it has further been suggested that the data analysis process should be thoroughly explained and that the themes developed in the data should be presented and fully described (Elo et al. 2020), which was done in this study. Dependability – in terms of the researcher's trust in the study – can also be established by requesting that a peer researcher read through the researcher's notes and interpretations to see if they agree with what the researcher had interpreted (Stahl & King 2020). In this study, the supervisor reviewed all the researcher's interpretations.

4.9.4 Confirmability

Confirmability refers to neutrality and the researcher's objectivity, meaning that the results or findings of the study should not be influenced by researcher bias and that the findings are not made up by the researcher (Nieuwenhuis 2016; Elo et al. 2020; Nyirenda et al. 2020; Stahl & King 2020). In order to mitigate researcher bias, an audit trail was undertaken. This refers to a record signifying and showing all the decisions and processes undertaken from the start of the research to the stage where the conclusions were drawn and reported on (Earnest 2020). The audit trail is also a source of evidence demonstrating that the data have gone through a process of data analysis, further contributing to the restriction of researcher bias (Korstjens &

Moser 2018). An audit trail thus gives a reader the opportunity to follow each step taken and every decision made in the research (Nowell et al. 2017). Furthermore, as recommended by Nowell et al. (2017), all records of the data and transcripts were kept for audit trail purposes. In addition, the researcher aimed to remain objective and neutral at all times during this study – when the online individual interviews were conducted, when data analysis was done, and when conclusions were drawn – thereby achieving confirmability (Korstjens & Moser 2018; Earnest 2020). It has further been suggested that other researchers could be involved in the study – particularly in terms of data analysis – to ensure that the interpretations were created in an objective manner (Elo et al. 2020; Stahl & King 2020). In this study, data analysis and interpretations were overseen by the supervisor. To show that findings are not invented and that the findings are indicative of what the participants in the study stated, it is suggested that quotations are used in the discussion of the data to illustrate the link between the data and the interpretations (Elo et al. 2020), which was done in this study.

4.9.5 Reflexivity

The researcher forms an integral part of a study, particularly in the data collection process, and it is therefore important for any researcher to reflect on themselves as they could influence the data and the subsequent outcome of findings (Unger 2021; Jamieson et al. 2023). Therefore, the researcher must reflect on their own identity in terms of biases, beliefs, gender, education and culture in relation to the research topic, which could have affected the study in any way; this is a process referred to as reflexivity (Earnest 2020). Therefore, the process of reflexivity also refers to the relationship that the researcher had with the participants, whereby the researcher established whether their own beliefs or opinions about the research topic could have affected the answers participants provided, the interpretation of the data, and conclusions drawn (Johnson et al. 2020; Jamieson et al. 2023). Jamieson et al. (2023) add that the process of reflexivity is essential as it allows the researcher to establish their position within the research and how their position regarding the research topic impacts each aspect of the study.

According to Earnest (2020) and Olmos-Vega et al. (2023), in order to maintain reflexivity, the researcher adopted a ‘bracketing interview’ where the researcher aimed to conduct each individual interview in an open-minded fashion. It has been suggested that researchers should strive to keep their personal feelings, views or knowledge regarding the topic separate from the information obtained from the participants. It has also been recommended that a reflexive journal be kept, documenting the steps taken during the research, any changes in terms of methodology that occurred, and the researcher’s self-reflective notes in terms of previous

experiences and opinions or views about the phenomenon being researched (Nowell et al. 2017). Reflexivity was initiated at the beginning of the study and continued throughout the research to contribute to trustworthiness, as suggested by Jamieson et al. (2023).

4.9.6 Researcher Bias

To avoid researcher bias – which refers to any influences that could affect the findings of a study (Galdas 2017; Alhazmi & Kaufmann 2022) – the researcher refrained from voicing their own opinions and personal feelings about GMFPs. Researcher bias is closely related to 'bracketing', which refers to reducing any assumptions a researcher may have regarding the phenomenon being studied (Earnest 2020; Alhazmi & Kaufmann 2022). Subsequently, the researcher aimed to ask the questions in the interview guide, together with additional questions through probing, solely based on the participants' statements. The researcher did not aim to ask any questions based on their own thoughts about GMFPs, and participants were not influenced in any way in terms of their responses. Additionally, bracketing further assists researchers in reflecting on their possible influence on the research process (Taherdoost 2021); to this effect, the researcher aimed to analyse the data and draw conclusions based on the information presented by the participants. While working with the data, the researcher refrained from influencing the data and findings by keeping their personal feelings about GMFPs aside. The researcher merely worked with the data at hand, as given by the participants.

4.10 ETHICAL CONSIDERATIONS

It was essential for the researcher to take note of any ethical implications or aspects that may have been encountered throughout the process of conducting this research. The approved proposal for this study was presented to the CAES HREC for ethics approval before data collection commenced (Research Ethical Clearance Number: 2021/CAES_HREC/145) (see Appendix A). An informed consent form, as seen in Appendix B, was sent to each participant via email, which informed the participants about the purpose and objectives of the study. However, the title on the informed consent form is different to the current title of the study. Participation in the research project was voluntary, and no incentives or compensation was awarded to the participants. The researcher also informed the participants which steps had been put into place to ensure that the information shared would remain confidential, anonymous and private at all times. As highlighted by Harriss and Atkinson (2013), it was important to consider and address ethical aspects such as confidentiality, anonymity and privacy. Confidentiality refers to not sharing any personal information with others, such as a

third party; anonymity refers to presenting acquired information in such a manner that the information cannot be connected to a particular participant in any way; and privacy refers to participants deciding and establishing “when, how, and to what extent” data about themselves is shared with others (Adarmouch et al. 2020; Bos 2020; Dougherty 2021).

As proposed by Bos (2020) and Dougherty (2021), confidentiality and anonymity were addressed by informing the participants how their shared data would be used. This information was conveyed to the participants in the informed consent form, in which they were informed that their personal information and information shared during their respective interview sessions would be used in this thesis, publications, journal articles and conference presentations. The informed consent form also indicated that each participant would be assigned an identification number that would then be used in the previously mentioned research reporting methods; thus, their names were not used and will not be used for future reference, and the data cannot be linked to any participant, thereby maintaining confidentiality and anonymity. However, the identification numbers were only used when transcribing and analysing the data, and not in the presentation of the data in the thesis. By ensuring that the data were protected by using no personal names, privacy was also addressed (Adarmouch et al. 2020).

The participants were also asked to keep their cameras off during the sessions to remain unfamiliar or unrecognisable and respect the privacy of their personal space (i.e. the researcher and the participants were not able to see each other’s backgrounds) (Roberts et al. 2021). The names they signed up with were therefore the only identifiable aspect about the participant; however, the identification of each respective participant was emailed to them, which they could use to sign up with (for example, Participant 4-Interview 2). The participants were informed about the aim and purpose of the study, they were asked to sign the informed consent form if they wished to participate in the research study, and they were informed that they could withdraw from the study at any time without any penalty, thereby further contributing to confidentiality (Bos 2020).

As suggested by Harriss and Atkinson (2013), the following ethical aspects were kept in mind when the participants were asked to participate in this study:

- The aim of the study was clearly communicated to the participants.
- The participants were informed that participation was completely voluntary.

- The participants were informed that they were not obliged in any way to participate in the online individual interview.
- The participants were informed that if they felt uncomfortable at any stage, they had the right to excuse themselves prior to or during the study without penalty.
- The participants were informed exactly what was expected of them if they wanted to participate in the study.
- The participants were informed that feedback would be given electronically once the study had been completed.

The researcher created a consent form on Google Docs to explain the study. After the interested participants had contacted the researcher via email, a link to Google Docs was emailed to them to access, complete, sign and save the consent form if they decided to participate in the study. The consent form also informed the participants that the Gmail address or account created by the researcher would solely be used for the purpose of this study, and that this Gmail address would only be used to communicate with the participants for the duration of this study. The participants were also informed that the Gmail account would be closed once the study was completed and feedback had been emailed to them. The consent form informed the participants not to share any personal information about themselves with others, such as in the case of focus groups. However, as mentioned, only individual interviews were conducted in this study. Furthermore, in order to ensure the safety of the researcher and participants, the researcher adhered to the COVID-19 protocols and restrictions by conducting all interviews online, thereby remaining physically separated from each other. The interview session commenced after each participant signed the informed consent form.

The researcher also aimed to implement and address the four fundamental principles of ethics, namely beneficence, non-maleficence, autonomy and justice (Varkey 2021). As Varkey (2021) states, beneficence refers to keeping the welfare of each research participant in mind by providing benefits to the participant, whereas non-maleficence refers to not harming the participants in any way during their participation in the research. In the informed consent form, the participants were informed about any benefits and risks of the study and were advised to contact the supervisor should any harm or injury occur during their respective interview sessions. Autonomy refers to the worth of an individual in terms of their right to make their own decisions, and includes aspects such as informed consent, truth-telling and confidentiality (which has been discussed previously) (Reis-Dennis 2020). Informed consent was addressed as the participants fully understood the aim of the study, what their involvement entailed, and

they were made aware of any possible risks and benefits associated with participating in the research, thereby giving them the opportunity to decide freely if they wanted to participate (Grant 2021).

Truth-telling refers to remaining truthful towards the participants by disclosing all information about the research study (Varkey 2021), such as disclosing the purpose of the study and any possible risks or benefits. This was addressed in the informed consent form. Furthermore, in terms of the researcher, the researcher aimed to remain truthful when drawing conclusions from the data while ensuring that plagiarism was not committed, as proposed by UNISA's Policy on Research Ethics (UNISA 2016). Gillon (2020) also states that justice is an aspect that should be considered in ethics; thus, the researcher remained impartial and treated each participant fairly and equally in this study. As stipulated in UNISA's Policy on Research Ethics, the rights and interests of all participants were kept in mind during the research study (UNISA 2016).

The researcher also followed other principles of ethics, such as respect, integrity and conflicts of interest. Respect was given by acknowledging that each participant was a unique individual who could make their own decision regarding their participation or withdrawal from the study, and by treating each participant with dignity (Kraft et al. 2020; Varkley 2021). Moreover, the researcher was respectful towards the participants and the surrounding environment while conducting research, as mentioned in the UNISA's Policy on Research Ethics (UNISA 2016). Integrity, in terms of ethics, was also addressed by remaining honest while conducting research, when communicating with the participants, and when the data were analysed and compiled (Taherdoost 2016). The researcher's integrity was also addressed as data collection only commenced after ethical clearance was received, as stipulated in UNISA's Policy on Research Ethics (UNISA 2016). As specified in UNISA's Policy on Research Ethics, the researcher aimed to remain honest during all research activities, such as during the data collection processes, data analysis and in writing-up the findings (UNISA 2016). Furthermore, conflicts of interest generally arise when an individual's personal interests influence their decisions and actions in such a way that benefits them but could negatively affect a second party (Fink 2020). The researcher aimed to address and conform to UNISA's Policy on Research Ethics in order to prevent any conflict of interest.

The researcher portrayed consistency while conducting research and ensured that all promises made to participants were fulfilled. The researcher also strived to restrict any researcher bias while obtaining and analysing data. Moreover, the researcher created a

feedback document on Google Docs, and the link was emailed to the participants to access and read. The study's email account will be closed upon the completion of this study.

4.11 SUMMARY

Following a qualitative methodology, this study was conducted within the constructivist paradigm using a phenomenological, descriptive and exploratory research design. This approach allowed for an exploration into consumers' views and reality of GMFPs through their everyday lived experiences with such food products. Insights were gained from eligible participants residing in the Midlands who met the inclusion criteria and were recruited through non-probability sampling strategies, namely purposive, convenience and snowball sampling via a post on Facebook. The researcher engaged with them in online individual interview discussions and analysed their demographic and interview data obtained via Microsoft Teams through descriptive and qualitative data analysis approaches. These strategies contributed to an improved understanding of the profile of the participants and what constituted their attitudes towards GMFPs. The operationalisation of the study showed which questions were used to address each of the study's objectives, and the feedback from a pilot interview showed that two questions had to be amended in the interview guide. The sampling size was also considered, and data saturation was achieved after 32 individual interviews were conducted. The researcher also stipulated how the data were presented across the chapters that follow.

Throughout this exploration, the researcher strived to remain neutral and unbiased, and refrained from combining any personal feelings or experiences with GMFPs with the responses given by the participants. This allowed the researcher to focus primarily on the data presented by the participants and listen to the detailed discussion of their attitudes towards GMFPs. Trustworthiness and ethical considerations were also kept in mind while conducting the study. In the next chapter, the results and discussions on the demographic data are presented, as well as the data on the participants' salient beliefs about GM crops and food products.

CHAPTER 5
RESULTS, FINDINGS AND DISCUSSION OF THE DEMOGRAPHIC AND BELIEFS DATA OF GENETICALLY MODIFIED CROPS AND FOOD PRODUCTS

To gain insight into the participants' background information and describe the sample of the participants that took part in the study, their demographic profiles are presented in this chapter, as well as the GM context-related information. In this findings and discussion chapter, the five themes regarding participants' salient beliefs about GMFPs that emerged from the data are presented using tables and figures.

5.1 INTRODUCTION

The previous chapter presented the methodology of the study. In this chapter, the participants' demographic profile is discussed as well as the GM context-related information to better understand participants' context in relation to GMFPs before the findings are discussed. The data that links to each research objective are presented in separate chapters. Chapter 5 presents the findings on participants' demographic profile and their beliefs about GM crops and food products (research objective 1.1). Chapter 6 presents the findings regarding the participants' values of GM crops and food products (research objective 1.2). Chapter 7 presents the findings on participants' expectations of GM crops and food products (research objective 1.3). Chapter 8 presents the findings regarding participants' knowledge of GMFPs, sources of GM-related information and their PI regarding such food products (research objectives 2 and 3). Chapter 9 also presents findings in terms of the participants' knowledge of GMFPs and their PI toward these food products (research objectives 2 and 3). Research objective 4 is presented and discussed in the conclusion chapter (Chapter 10), as the objective was to propose a new conceptual framework based on the findings from research objectives 1 to 3.

The beliefs component of the EV Model of Attitudes was used as a lens to explore how GMFPs were evaluated, and which attributes the participants associated with these food products in order to better understand their attitudes towards GMFPs (Ajzen & Fishbein 2000; Osterlie et al. 2018), and aid in the promotion of food security. Thus, in this chapter, the participants' salient beliefs about GMFPs, in terms of the attributes coupled with such food products, are discussed. The proposed influence it could have on their perceived attitudes toward these food products, as it emerged from the data, is also presented. This information offers insight

into the role that the beliefs component of the EV Model of Attitudes played in the participants' attitudes toward GMFPs, which this study aimed to explore. Furthermore, a colour-coded key is used, and each colour represents the volume of quotes produced by the participants on each sub-salient aspect that emerged from the data; this colour-coded key illustrates the prominence of each sub-salient aspect. As mentioned in Chapter 4 (Sections 4.8.2 and 4.8.3), colour coding was only used to represent the sub-salient aspects that emerged from the data, since participants' actual words were used during in vivo coding – which was important – to develop a sub-salient aspect. Therefore, the sub-salient aspects represent participants' actual quotes. Colour coding was not used for the salient aspects as some of these were self-developed through common ideas and words that emerged during the researcher's conversations with the participants. These common words and ideas were grouped together to form a salient aspect, and some of the salient aspects thus did not have any quotes. The salient aspects that emerged from the data are presented in bold to assist with their respective identification in the chapter. The full set of data for this chapter is available in Appendix E. Participants' demographic profile is presented next.

5.2 PARTICIPANTS' DEMOGRAPHIC PROFILES

Participants were recruited from the Midlands, KwaZulu-Natal, SA. The participants who took part in this study were included if they were *male or female*, *above 18 years of age* and *residing in the Midlands*, which is situated in KwaZulu-Natal. The inclusion criteria further stipulated that the participants, in their own opinion, *had heard of GMFPs*, *had been in contact with GMFPs*, *thought they had formed a certain opinion about GMFPs*, *thought they knew something about GMFPs*, or *had some experience with GMFPs*. Six demographic questions were posed to ascertain their gender, age, monthly household income range, highest level of education, marital status, and employment status. However, the current study did not aim to explore the relationship between the participants' demographic information and their attitudes as well as their PI towards GMFPs, nor was it the purpose of this study to find differences between the demographic categories and attitudes and PI towards GMFPs. Therefore, the demographic data were not analysed further to provide such data. The demographic data were only gathered to add context to the participants' responses and gain a better understanding of the profile of participants who took part in this study.

The demographic data were analysed using descriptive statistics, thereby describing the participants' profiles in a meaningful way (Kaur et al. 2018; Fulk 2023). A table (Table 5.1) is used to present the frequency (n) and percentage (%) of each demographic question to allow for a quick and easy interpretation of the demographic data (In & Lee 2017; Fulk 2023). In the

table, the frequency of the number of participants is indicated in the middle column and represented as n. The percentage in the far-right column of the table shows the total number of participants who took part in this study and is represented through a percentage (%). The data presented in the table are based on a total of 32 participants who took part in this study.

Table 5.1: Participants' Demographic Categories

Demographic Criteria	Number of Participants (n)	Percentage (%)
Gender		
Male	12	37
Female	20	63
Age		
18-24 years	2	6
25-30 years	7	22
31-40 years	10	31
41-50 years	5	16
51 years or older	8	25
Monthly Household Income		
R1 000 or less	0	0
R1 001-R1 999	0	0
R2 000-R6 000	1	3
R6 001-R6 999	0	0
R7 000-R15 000	3	9
R15 001-R15 999	2	6
R16 000-R20 000	6	19
R20 000 or more	20	63
Highest Level of Education		
Lower than matric/Grade 12	0	0
Matric/Grade 12	3	9
Grade 12 + a degree/diploma	29	91
Marital Status		
Single	6	19
Married/living with a partner	25	78
Divorced/separated	1	3
Widow(er)	0	0
Status of Employment		
Permanent full-time	18	56
Permanent part-time	1	3
Contract work	2	6
Self-employed	5	16
Unemployed	6	19

A discussion on each demographic category follows.

5.2.1 Gender

The types of food products consumers purchase can be influenced by gender (Muhammad et al. 2017). The participants were asked to indicate their gender by selecting either male or female (see Table 5.1). Table 5.1 reflects that 37% (n=12) of the participants were male and 63% (n=20) were female; thus, the majority of participants were female. Through the recruitment of participants, it was notable that women were more willing to participate in the study, which could have been attributed to the fact that many women do the grocery shopping for their families (Olonade et al. 2021). In SA, a study conducted in 2019 showed that 71% of women had the responsibility to purchase groceries, and that 60% of women were the main shoppers in their households (Food Review 2019; City Press 2022). Since women do the majority of shopping in SA, it could have stimulated their interest in the research topic as it involved food products. However, it was not the intention of the study to recruit a majority of female participants.

5.2.2 Age

The food choices that consumers make vary in terms of their age (Ogundijo et al. 2022). In the demographic questionnaire, the participants could choose from five categories ranging from 18 years to 51 years and older, and were asked to select an age category to represent their current age. Table 5.1 shows that the age groups of the participants varied, with the biggest age group being the 31-40-year-olds, making up 31% of the sample (n=10), followed by some participants between 51 years or older (n=8; 25%), with the least being between 18-24 years (n=2; 6%).

When these age groups are considered together, more than half of the participants were between the ages of 25 and 40 (n=17; 53%). This age range indicates that many participants could be associated with Millennials or Generation Y, including individuals born between 1981 and 1996 (Ahmad & Hardianti 2020). This age group could indicate that the participants were working individuals, were already established in the labour market, and were financially able to purchase their own food products. Millennials grew up with technology (Stanimir 2015; Ahmad & Hardianti 2020), and since more than half of the participants were between 25 and 40 years old, they could have felt more comfortable taking part in this study since the interview sessions took place on an online platform, namely Microsoft Teams.

Furthermore, the Midlands covers a large geographic area, consisting of a host of schools (Midlands Meander 2020; Seeff 2023). This could have accounted for the distribution in age

groups, particularly in terms of the 25-30 and 31-40 years-old age groups. Considering that the participants who took part in the study were between 25 to 40 years old, it could indicate that they had children, as millennials generally delay parenthood and only consider having children at a later stage in their lives (LeBlanc & Gensler 2018). The study recruited participants who met the inclusion criteria and who were willing to participate in the study, and did not aim to recruit participants of a specific age, which could further account for the range in age.

5.2.3 Monthly Household Income

Consumers' household income is an important demographic characteristic as it indicates the choices that consumers have in terms of which products can be purchased (Schiffman & Wisenblit 2019). The participants were asked to select one of eight monthly household income categories, ranging from R1 000 to R20 000 or more, which best represented their monthly household income. Table 5.1 depicts that the majority of participants had a monthly household income range of R20 000 or more (n=20; 63%), while some participants earned a monthly household income of R16 000-R20 000 (n=6; 19%). In SA, a financially stable household is considered to earn more than R236 900 per year (Writer 2021a), which amounts to approximately R20 000 per month, indicating that the participants in this study could have come from a financially stable household. Since financial stability and income are factors that contribute to food security (Yenerall & Jensen 2022), it could suggest that the participants in this study were food secure. The participants were educated, as discussed in Section 5.2.4, which could explain their financial position as higher education equips individuals with specific skills, thereby resulting in better job and career prospects (Ali & Jalal 2018). These statistics further signified that the sample had an already-established household, pointing to the fact that the participants could possibly have other family members to consider in their household for whom they need to provide.

5.2.4 Highest Level of Education

In SA, individuals have the right to basic education and access to further education (Mtwesi 2013; Churr 2015). The participants were asked to select their highest level of education from three categories, as shown in Table 5.1. From Table 5.1, it can be seen that 91% (n=29) of the sample had a Grade 12 and a degree or diploma, while only a few participants had a Matric (n=3; 9%). In SA, only 6% of the adult population have a tertiary education, and only 10% of individuals between the ages of 25 and 34 held a tertiary education in 2020 (Nkosi 2021; Khuluvhe & Ganyaupfu 2022; OECD Indicators 2022). Statistics further showed that in 2021,

5.4% of the SA population had a diploma, while 5.9% held a degree (Khuluvhe & Ganyaupfu 2022). Although these statistics contradict this study's results on participants' highest level of education, the results obtained in the current study could be attributed to the fact that the participants were financially stable and perhaps able to further their studies. In 2020, statistics showed that 17% of women and 13% of men, respectively, between the ages of 25 and 34 were tertiary educated (OECD Indicators 2021). This could explain the participants' highest level of education results, as the majority of participants were female. Since the participants had a Matric certificate and a degree or diploma, it suggested that the study's sample consisted of educated participants.

5.2.5 Marital Status

The participants were asked to select an appropriate marital status category from four possible options. As seen in Table 5.1, the majority of participants were married/living with a partner (n=25; 78%), with a smaller number being single (n=6; 19%), and the least being divorced/separated (n=1; 3%). Statistics indicated that in 2019, a decrease of 1.3% in civil marriages was recorded in SA compared to the year 2018, and the rate further declined by 31.1% in 2020, but between 2020 and 2021, the number of civil marriages recorded in SA increased by 19.2% (Stats SA 2021; Writer 2021b; Stats SA 2022). An explanation for the participants' married or living with a partner status could be attributed to the fact that the majority of the participants were working individuals who had well-established households, as reflected by their financial stability, which was indicated through their monthly household income.

5.2.6 Status of Employment

Adequate employment opportunities in SA are important to enhance the living standards of people and promote the SA economy (SABC Education 2016; City of Johannesburg 2018). In the demographic questionnaire, the participants were asked to choose one of five categories to represent their status of employment. Table 5.1 shows that of the 32 participants who took part in the study, more than half (n=18; 56%) had permanent full-time employment, while 19% (n=6) were unemployed, and 16% (n=5) were self-employed. When the permanent full-time, permanent part-time, contract work and self-employed categories were considered together, it indicated that the majority of participants had some sort of employment (n=26; 81%).

In 2021, approximately 40% of South Africans were employed, which declined slightly to 38.70% in the second quarter of 2022 (Galal 2022; Trading Economics 2022). In 2023, the

unemployment rate in SA decreased to 31.9% (South African Government 2023). Although the unemployment rate in SA remains a concern, the participants' permanent full-time employment status could be explained by their level of education since higher education generally translates into increased job opportunities (Ali & Jalal 2018; Writer 2022). In the context of this study, the categories of employment were not considered as the study did not intend to determine what type of employment the participants had, as the relationship between the type of employment and attitudes and PI toward GMFPs was not explored. The results show that the study's sample had a source of income, as the majority had a form of employment. Their employment status could further suggest that they led busy lifestyles.

5.2.7 Summary of the Participants' Demographic Profile

In terms of the participants' demographics, the majority were female; could be considered as millennials due to their age (25 to 40 years old); had a monthly household income of R20 000 or more; held a Grade 12 and further educational qualifications; were married or living with a partner; and had permanent full-time employment. This demographic information was considered in the interpretation of the data as it is indicative of the type of participants from whom data were collected. A discussion on the GM context-related information acquired from the demographic questionnaire follows.

5.3 GM CONTEXT-RELATED INFORMATION

Data were also gathered from the 32 participants who took part in this study on the context in which they related to GM crops, which contributed to a better understanding of their profile in terms of genetic modification and GMFPs. The participants were asked to select 'yes' or 'no' for each GM context-related question. This data is presented in Table 5.2, with the frequency of the number of participants for each GM context-related question indicated in the middle column, represented as n. The percentage represents the total number of participants, is represented through %, and can be seen in the last column of the table.

Table 5.2: GM Context-Related Questions

GM Context-Related Question	Number of Participants (n)	Percentage (%)
Do you farm with GM Crops?		
Yes	2	6
No	30	94
Do you have family or friends who farm with GM crops?		
Yes	13	41

No	19	59
Do you know someone who farms with GM crops?		
Yes	17	53
No	15	47
Are you aware of GM farming in the vicinity of where you live?		
Yes	16	50
No	16	50

A discussion on each GM context-related question, as seen in Table 5.2, follows.

5.3.1 Farming with GM Crops

From the GM context-related questions, the participants were asked to indicate whether they farm with GM crops. Table 5.2 shows that the majority (n=30; 94%) of the participants did not farm with GM crops, indicating that the study's sample did not consist of participants who personally farmed with GM crops. This suggests that they were actual consumers and not GM crop producers. Since farmers in SA are predominantly male (Ntombela 2021), it could explain why the study's sample did not farm with GM crops, as the participants in this study were mostly female.

5.3.2 Family or Friends who Farm with GM Crops

The participants were further asked to indicate whether they had family or friends who farm with GM crops. From Table 5.2, it can be seen that more than half of the participants (n=19; 59%) did not have family or friends who farmed with GM crops, while 41% (n=13) did have family or friends who farmed with GM crops. These statistics show that more than half of the study's sample did not have any family or friends who farmed with GM crops, suggesting that more than half of the study's sample did not come from a GM farming background and were not acquainted with anyone who farmed with GM crops. Notably, some of the participants did have family or friends who farmed with GM crops, and could therefore have some understanding of GM farming. This understanding could have been acquired through conversations with their family or friends, or observations of such farming practices from visiting family or friends.

In the interview sessions, some participants elaborated on having family or friends who farmed with GM crops by stating that *"my brother-in-law grows huge amount of GM maize – they have a farm in Mooi River"*; *"my father-in-law farms with GM maize"*; and *"I've got friends who farm a lot of genetically modified things in the Midlands"*.

5.3.3 Know Someone who Farms with GM Crops

The participants were asked if they knew someone who farmed with GM crops, as depicted in Table 5.2. Slightly more than half (n=17; 53%) of the participants knew someone who farmed with GM crops, while slightly fewer than half of the participants (n=15; 47%) did not know someone who farmed with GM crops, as illustrated in Table 5.2. Since the Midlands is known for farming (KwaZulu-Natal Top Business 2021), it could account for the participants knowing someone farming with GM crops. Participants could have had contact with a GM farmer and engaged in conversations with such farmers about GM crops and food products. Those participants who did not know someone who farmed with GM crops could be indicative that such participants were unacquainted with GM farmers and have had no conversations with such farmers.

During the interview sessions, some of the participants stated that *"being in a farming area, I have heard of them talking about seed that is more drought resistant"*; *"I know lots of farmers around here who farm with Roundup ready maize"*; *"people have mentioned to me that GM crops like mielies are being produced here in the Midlands"*; *"obviously being in a farming community, I know farmers who use those seeds"*; and *"I know a lot of farmers because of where I live, and I remember one saying that modified crops keep the bugs at bay"*. Thus, living in a farming community, the participants had heard of farmers who farmed with GM crops, which could have contributed to their awareness of GM crop farming in the Midlands area, which is discussed next.

5.3.4 Awareness of GM Farming in the Vicinity

Participants were asked to indicate whether they were aware of GM farming in the vicinity of where they lived. Table 5.2 indicates that the participants were split in terms of their awareness of GM farming in the vicinity; 50% (n=16) answered yes, and 50% (n=16) answered no to the question. The participants resided in the Midlands, which is comprised of a farming community (KwaZulu-Natal Top Business 2021), and this could have accounted for their awareness of GM farming in the Midlands area. Awareness of GM farming in the vicinity of where the participants resided could further have been attributed to the fact that slightly more than half of the participants knew someone who farmed with GM crops, suggesting that possible conversations could have been held with GM farmers, thereby contributing to their awareness. However, a lack of awareness of GM farming in the vicinity could be attributed to more than half of the participants not having family or friends who farmed with GM crops, or it could be

attributed to just under half of the participants not knowing someone who farmed with GM crops. This could indicate that the participants did not interact and have contact with GM crops.

5.3.5 Summary of the Context-Related Questions

The participants did not farm with GM crops, and slightly more than half of the participants did not have family or friends who farmed with GM crops. However, they knew someone who farmed with GM crops and were split in terms of their awareness of GM farming in the area.

The first of the five themes regarding the participants' salient beliefs about GMFPs is presented next, namely their altered state of existence. GM crop production benefits are discussed thereafter, followed by consumer-related benefits of GMFPs, risks and concerns of GM crop production, and consumer-related risks and concerns about GMFPs.

5.4 THEME 1: ALTERED STATE OF EXISTENCE OF GMFPS

From the data, it emerged that the participants believed the term 'genetically modified' was coupled with an altered state of existence. The most salient aspects and sub-salient aspects contributing to the altered state of existence are depicted in Figure 5.1.

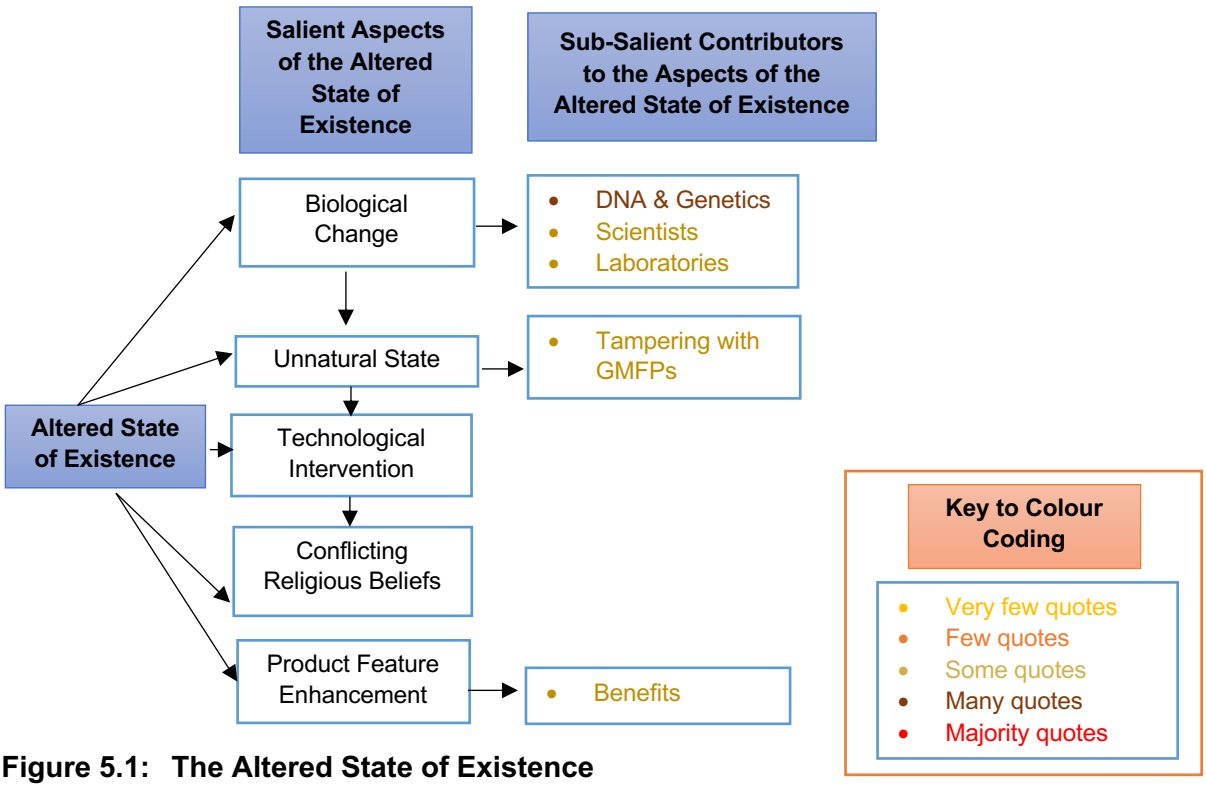

Figure 5.1: The Altered State of Existence

As shown in Figure 5.1, in terms of the altered state of existence that explained the participants' interpretation and belief of the term 'genetically modified', five aspects were identified, namely biological change, unnatural state, technological intervention, conflicting religious beliefs, and product feature enhancements. A discussion of each follows.

5.4.1 Biological Change

The words 'genetically modified' elicited a belief that a change or alteration had occurred in the process of genetically modifying food products. The participants indicated that it is *"something that has been changed"*, that GMFPs are *"products that have been altered"*, and that such *"foods have been altered and changed"*. It was therefore strongly believed that GMFPs had been changed or altered in some way, and **biological change** was a salient aspect that emerged from the data. Similar results were obtained from a study conducted in the USA by Lefebvre et al. (2019), who found that consumers perceived that genetic modification involved altering a food product. Additionally, it has also been found that consumers believed something had been injected into GMFPs, such as steroids or drugs, thereby changing the genetic makeup of food products; consumers consequently often associate the word 'inject' with the process of genetic modification (Deane-Drummond et al. 2001).

Many of the participants believed that this change occurred at a biological level within the DNA and genetics of organisms or plants by suggesting that *"it's foods that have been altered on a genetic level"*, the *"genes have been altered",* and that *"genetically modified would be manipulating the genetics"*. Thus, the biological change of GMFPs was attributed to a sub-salient aspect, namely DNA and genetics. Due to the gene manipulation of GMFPs, discomfort towards GMFPs was demonstrated in that it *"really freaks me out a little bit"*. DNA and genetics were two words that the participants closely related with their beliefs regarding food products' genetic modification. Not only was it believed that the DNA and genetics of GMFPs were changed, but it was also believed that certain genes could be removed or inserted into these foods or organisms from other organisms because it entails *"cutting out genes"* and *"they've got genes from somewhere"*. This view is supported by Ehirim et al. (2020), who state that genes can be removed from an organism, which is referred to as subgenic, or they can be taken from other organisms and placed into a specific organism, plant or crop through a biotechnological technique known as cisgenic.

One participant explained that the change at a molecular or genetic level can occur in different ways:

> *"there are two main different types of genetically modified processes where you take the samples that you do like and make more of those genes, and you introduce that back into the same products, and it becomes a better product. And then there is taking it from a totally different source and introducing a totally different plant gene and giving it to another plant that creates something new"*.

However, there are four ways in which the genetic material of an organism or crop can be altered, namely removing, silencing, inserting, or transferring a gene (Gbashi et al. 2021; Redden 2021; Rathod & Hedaoo 2022). Nevertheless, the participants strongly believed that the process of genetic modification is indicative of gene manipulation. One participant explained this belief by saying that the genes are being *"programmed".* Consumers were thus anxious about GMFPs due to the alteration that had occurred in their genetic material, and due to the insertion of genes into food products (Chen & Chern 2004; Raman 2017; Ghimire et al. 2023).

In this study, one participant believed that genes are complex and organisms' makeup is not fully understood yet:

> *"we don't understand how information is processed in the genome of an organism to an excellent extent yet. The concept of a gene is not quite as clear. And also, we learning about the structure of DNA and how it influences gene expression".*

As a result, the participant believed that scientists need to learn more about the genome or genetic makeup of organisms before gene manipulation can be carried out because:

> *"there is a huge amount that is still being learnt, and so, when we start to manipulate the genetics of an organism, it's not to say that there are not possibly areas where things could go wrong"*.

Thus, it is suggested that, through the process of genetically modifying food products, the manipulation of genes in terms of new gene insertion or the removal of specific genes have consequences, which evoke concern. It has been proposed that the alteration of the genetic material of organisms could have side effects, and it is thus vital to research any possible side effects to ensure the safety of such a process in GMFPs (Sutkovic et al. 2020). In terms of the possible consequences of gene manipulation, a study carried out in London showed that

consumers were particularly concerned about the manipulation of DNA within GMFPs and the possible consequences that it could have (Popek & Halagarda 2017).

Scientists and laboratories were additional sub-salient aspects confirming the belief that a biological change had occurred in GMFPs and was thus closely related to the genetic modification of food products. Some participants believed that the process of DNA or gene manipulation was orchestrated by scientists working in laboratories, which was illustrated by them saying that the DNA of GMFPs are *"altered in a lab"*, *"scientists in a lab"* are altering the genes of GMFPs, and *"the genetic makeup of whatever food has been fiddled with by the scientists"*. According to Deane-Drummond et al. (2001), consumers link laboratories to the genetic modification of food products. In the current study, although scientists and laboratories were coupled with GMFPs, one participant explained that:

> *"scientists are not sitting in their labs trying to genetically modify foods to create monsters that are going to eat people, I mean that is not what scientists do".*

Instead, the participant believed that *"our scientists have gone a long way in terms of dealing with genes"*.

In terms of genetic modification, GMFPs were associated with a biological change that occurred in their DNA and genetics, which scientists working in laboratories were responsible for; all of which could result in apprehension toward such food products. The volume of sub-salient aspects and the prominence of the sub-salient aspect (DNA and genetics) (due to the volume of quotes) reflected that this salient and sub-salient aspect appeared particularly important to the participants and influential in their beliefs in terms of GMFPs' altered state of existence.

5.4.2 Unnatural State

Due to the belief that the process of change within the DNA of organisms or plants was controlled by scientists in laboratories, the participants further believed that such a process contributed to the emergence of an important salient aspect, namely the **unnatural state** of GMFPs. It was thus believed that GMFPs were unnatural because they are *"changing the way the original process should be done"*, *"it's not original",* and therefore *"it's not natural"*. Thus, in terms of GMFPs, it is *"something [that] has been altered from something that is natural"*; as a result, a GMFP is *"a natural product that's been changed"*, which led to the belief that *"genetically modified is not normal"*. Subsequently, GMFPs were believed to be *"a 2.0 version"*

of their traditional counterparts. In terms of the natural state of GMFPs, it was established that Nigerian consumers associated the term 'artificial' with such food products, and USA consumers believed that GMFPs were unnatural (Eneh et al. 2016; Lefebvre et al. 2019). Therefore, the terms 'unnatural' and 'artificial' are two words consumers closely related to GMFPs (Verdurme & Viaene 2003; Chen 2008; Siipi 2015; Dizon et al. 2016; Kotze 2016; Tsatsakis et al. 2017; Hingston & Noseworthy 2018; Dovey & Ntuli 2020; Pakseresht et al. 2021; Siddiqui et al. 2022).

The unnatural state of GMFPs was further attributed to the sub-salient aspect of tampering with GMFPS' production process. In terms of tampering with GMFPs, some participants believed that *"the end products have been tampered with by man"*, that *"it's been assisted, any sort of helping hand"* has been involved in developing GMFPs, and that *"there is a third person that played a role in their creation, or a third element"*. Various authors have also suggested that consumers consider GMFPs to be man-made (Dizon et al. 2016; Hingston & Noseworthy 2018; Pakseresht et al. 2021). Based on the belief that humans are tampering with GMFPs, in this study, participants emphasised that *"humans are involving themselves"* in the development of such food products because *"man loves to fiddle with the genetics"*; however, *"humans should not mess with things at a genetic level"*, as they are doing in the case of GMFPs. Humans' intrusion in the production of food products elicited discomfort as it was stated that it made them feel *"very uncomfortable"*, and therefore *"I don't particularly like the idea"* that *"foods and crops have been tampered with"*, such as GMFPs. Due to humans' involvement in the development of GMFPs, numerous authors have also found that consumers commonly associated the terms 'tampering' and 'tinkering' with genetic modification (Deane-Drummond et al. 2001; Verdurme & Viaene 2003; Phillips 2008a).

Tampering with the development of GMFPs led to the belief that unmarked territory is being entered into by the food industry. Participants expressed *"we are in unchartered waters"* as unknowns could possibly be associated with the production of unnatural food products when *"we don't know the full impact of it"* and *"I wouldn't know the effect of it on me"* in terms of consuming such food products. For that reason, opposition towards the genetic modification of GMFPs was shown: *"I'm not a fan of it"* and *"I am not 100% comfortable with it"*. Likewise, it has been proposed that tampering with the natural process of food production is an aspect that causes hostility towards genetic modification among consumers (Kubisz et al. 2021).

Due to the unknown effects of human interference in food production, one participant believed that caution should be exercised when consuming such food products because *"they are playing with people's lives"*. Further concern was evoked as one participant believed that food

products could possibly be *"over-modified"* and humans could be *"altering too much",* which could result in them *"taking it a step too far"*. Another participant subsequently believed that there is a place for the original and natural variety of respective food products as *"the original genetics that still can be used"* and thus not be displaced by GMFPs. It has been proposed that consumers feel the production of natural food products is important and should therefore not be replaced by GMFPs (Cui & Shoemaker 2018).

The participants believed that the genetic modification process does not follow the natural course of food production since humans tamper with genetics during the production of GMFPs. They consequently associated these food products as being unnatural. Based on the depth of data through the volume of quotes relating to the unnatural state of GMFPs, this salient aspect was important to the participants and had a particular influence on their belief that GMFPs have an altered state of existence.

5.4.3 Technological Intervention

GMFPs' altered state of existence was believed to be coupled with a salient aspect, namely the **technological intervention** that had taken place because the existence of GMFPs *"is a sign of the advance of science"* and *"science does progress and it's part of that progression"*. Therefore, in the genetic modification context, *"it's developing with the times"* and *"it's science, it's development, it is advancing something"*. It was further believed that technology can be used to improve food products by suggesting that *"the role of technology is to make things better"* because *"it's a technology that has been there and developed through science and it's used to modify or change a product for a specific reason or purpose"*. Consequently, *"technology is there to take us forward and to better things, so there's definitely a big role that GM technology can play in global problems that we have at this point"*.

In terms of using technology in food products, findings from a study conducted in Australia showed that consumers felt biotechnology had the potential to improve their lives; therefore, consumers considered biotechnology held the potential to give food products desired and 'interesting' attributes (Bonny 2017; Cormick & Mercer 2017; Sendhil et al. 2022). Contrarily, SA consumers were found not to be in favour of using biotechnology in the agricultural industry (Peter & Karodia 2014; Dovey & Ntuli 2020). Raman (2017) concurs that consumers show opposition towards biotechnology as it is viewed as being 'an imperfect technology'. This could suggest that consumers have mixed views in terms of involving technology in the production of food products.

Although technology's use in the production of food products was believed to be useful, apprehension towards technology was also demonstrated. It was believed that there is *"concern about the science behind it"*, which was attributed to the use of technology in food production still being in its infancy as *"it's still early days"* and:

> *"you are changing the product so much in a short time that there's no adaptation, it's just going straight from A to Z. And the consequences of that is not fully seen yet"*.

Hesitancy towards the use of technology in food production was further driven by the belief that it is a new concept, thereby contributing to the belief that there is an unknown factor involved in GMFPs in terms of possible consequences. For one participant:

> *"it's still got a lot to play out and only then, when more is known, will more comfort and solace be found in the application of technology in GMFPs"*.

In terms of the consumers' opposition towards the use of technology in food production, a study in China found that consumers associated biotechnology with bioterrorism (Cui & Shoemaker 2018). The use of technology in food production, such as in the case of GMFPs, has left consumers feeling anxious toward these products due to the possible risks that could arise from the use of technology (Pakseresht et al. 2021). As a result, the technological interference in food products is a luring factor that contributes to consumer opposition towards such food products (Zhang et al. 2016; Hingston & Noseworthy 2018; Aziz et al. 2022).

Although technology's involvement in the development of GMFPs was believed to improve certain characteristics of food products, there was also a belief that its use could be taken advantage of because:

> *"as much as it is a good technology, I'm scared of how far are we willing to go in terms of manipulating genetics because it's a good technology that was created, but at the same time, I think it's a dangerous way we going"*.

Therefore, one participant posed the question: *"If we are going to say okay to GMO and it's okay to genetically modify plants, then what's next?"* A further question was raised: *"Where do we draw the line? So how far do we genetically modify stuff?"* The participant raised the concern that technology makes it possible for scientists to *"play with genetics"*. Participants believed there was a possibility that the use of technology in food development could be misused. An individual participant summarised that, in terms of using technology to produce

food products, *"it should be pursued, but with caution"* and *"we need to be cautious of the actual technology itself"*. It was thus believed that technology's application in altering the genetics of food products should be done in a responsible manner because *"if it is done responsibly and with a lot of science and education behind it, then it will be great"*; it is important that *"it needs to be done responsibly"*. In terms of the application of technology in developing GMFPs, it has been proposed that biotechnology should be used with caution. However, although consumers showcased a sense of anxiety towards the possible consequences of the application of biotechnology in food products, it was demonstrated that consumers were optimistic in terms of the potential that this technology holds, and should thus not be ignored (Akumo et al. 2013; Van Acker et al. 2017; Dovey & Ntuli 2020).

In this study, technology was linked to genetic modification by the participants as the data showed technology's use in the application of genetic modification could be useful. A discussion on this aspect follows in Section 5.4.5, where beliefs related to product feature enhancements are presented. However, the absence of sub-salient aspects suggests that technological intervention lacked prominence in GMFPs' altered state of existence.

5.4.4 Conflicting Religious Beliefs

Participants believed that there was an unnatural change when genetic modification was applied, and was also believed that there was interference at a technological level that challenged and thus **conflicted with their religious beliefs**. This was a salient aspect that emerged from the data in terms of the altered state of GMFPs' existence. The conflict between the participants' religious beliefs and genetic modification of food products was expressed in statements that *"being a Christian, I don't think you should change things the way God intended them to be"* and *"we are playing God when you are altering the genetics of something"* because *"it's not the way God made it"*. Thus, *"it is a Christian-world view, but I don't think we should be changing something"* such as the genetics of food products. Furthermore, many consumers demonstrated that GMFPs were presenting a conflicting aspect in terms of their religious beliefs (Hossian et al. 2003; Myskja 2006; Phillips 2008a; Lucht 2015; Dizon et al. 2016; Pakseresht et al. 2021; Aziz et al. 2022; Ghimire et al. 2023). It has also been suggested that consumers use the term 'playing God' interchangeably with biotechnology, whereas 'tampering with God's plan' was an additional phrase consumers coupled with the genetic modification of food products (Phillips 2008a; Kotze 2016; Frewer 2017; Pakseresht et al. 2021; Aziz et al. 2022).

To demonstrate the role that consumers' religious beliefs play in terms of GMFPs, a study conducted in Poland indicated that consumers' religion caused opposition towards GMFPs (Rzymski & Krolczyk 2016). Other studies conducted in Germany, Malaysia and Taiwan similarly found that religion caused consumer hesitancy towards biotechnology and genetic modification (Breustedt et al. 2008; Amin et al. 2011; Chiang et al. 2012). It has further been suggested that the transfer of DNA between organisms and the inability to retain a food product in its most natural form were aspects that caused conflict with consumers' religion, and consumers with strong religious beliefs had the opinion that the genetic modification of food products was inappropriate (Glasgow 2015). These results suggest that consumers' religious beliefs are challenged when it comes to the way in which GMFPs are produced.

Even though religious beliefs were highlighted as an aspect in the data, it was indicated that humans had been gifted the skill, together with technology, to research and study the make-up of organisms and plants, thereby gaining more knowledge and insight into organisms and plants at a genetic level. One participant stated that:

> *"it could be a form of a study because there could be thousand different ways you can change something or different methods of changing something".*

Therefore:

> *"God has made us to study science. I mean just to study those things and see what's possible. So I feel like that's something that God has allowed for us to learn about and to study"*.

Nevertheless, it was believed by the respective participant that these learning and research experiences should not be used to change organisms and plants at a biological level as *"it should not be used in the way it has been with actually altering the genes"*. As a result, *"I am sort of torn"* because, although change at a biological level can lead to the enhancement of certain features in a food product, *"you are messing with something that has already been made in a way that is sufficient and efficient"*.

Therefore, in this study, the data demonstrated that the participants struggled with the actual change that was believed to happen in food products at a genetic level through the use of technology. Conflicting religious beliefs were thus linked to the process of genetic modification. However, the absence of sub-salient aspects shows that religious beliefs did not play an influential role in the participants' beliefs regarding GMFPs' altered state of existence.

5.4.5 Product Feature Enhancement

Although the participants recognised the term 'genetically modified' as being indicative that a biological change had taken place, thereby taking food products away from their natural state through the use of technology – which conflicted with their religious belief – it was suggested that the result of this change might lead to the **enhancement of product features**. This was thus an important salient aspect that emerged from the data due to the altered state of GMFPs' existence. The participants believed that genetic change through the use of technology (as seen in Section 5.4.3, where the technological involvement in GMFPs was discussed) could lead to improvements in food products because, in terms of GMFPs, *"it has been improved in some way"* as *"they have taken a product and they have enhanced the qualities within it"*. As a result, the process of genetic modification was believed to be used because *"they are trying to improve on"* particular food product characteristics. Regarding the improvement of food product traits, American consumers felt that biotechnology had the potential to improve food product characteristics, such as in the case of GMFPs (Wunderlich & Gatto 2015). This view was echoed by consumers in China, who were optimistic about such food products as they associated these products with product-enhancing traits (De Steur et al. 2015). It was also found in the USA that consumers would approve of biotechnology if the technology was used for appropriate reasons, such as producing foods with tangible benefits, particularly to the consumer (Hossian et al. 2003). It has thus been proposed that consumers are more accepting of GMFPs if they are modified to retain benefits for themselves (Dovey & Ntuli 2020).

In terms of the benefits of GMFPs, some participants believed there was a purpose for GMFPs because *"food products are genetically modified for specific reasons"* and therefore, *"there are definite benefits"* to GMFPs *"because features can be changed"* within these products. Thus, *"it can play a very big role in everybody's lives"* as the enhancements of GMFP characteristics can be beneficial to both producers and consumers. It was believed that GMFPs can offer benefits to the consumer. Although biological change through technological intervention can result in beneficial attributes in GMFPs, one participant believed that through such a change, *"there has to be some sort of catch towards it in order to modify it from its standard form"*. The participant believed that the consumer was not always kept in mind when food products were GM. Even though the participant admitted that they were *"not totally against it"*, a belief of ambivalence towards GMFPs was elicited as *"mixed feelings"* towards genetically modifying food products were shown by the participant. It was acknowledged that genetic changes in food products could lead to the betterment of certain attributes of GMFPs.

Therefore, the participants believed that changes at a biological level, through the use of technology, can enhance certain features of food products, which can provide them with beneficial traits; in the case of GMFPs, it could create optimism toward these products. The volume of quotes relating to product feature enhancements suggests that the altered state of GMFPs' existence was influenced by participants' belief that product feature enhancements can be attained through genetic modification.

5.4.6 Summary of the Altered State of Existence

A summary of the most salient aspects related to participants' beliefs about genetic modification is illustrated in Table 5.3.

Table 5.3: Theme 1: Salient Belief Aspects of Genetic Modification

Theme	Salient Belief Aspects of GM Crops and GMFPs				
Theme 1: Altered State of Existence	Biological Change	Unnatural State	Technological Intervention	Conflicting Religious Belief	Product Feature Enhancement

As depicted in Table 5.3, the participants believed that genetic modification is an altered state of existence. The altered existence was found at a biological level, leading to an unnatural food product being developed through technological intervention, thereby contributing to the conflict caused in terms of the participants' religious beliefs. Furthermore, a prominent belief emerged in terms of using genetic modification to improve product features. In terms of the salient belief aspects of genetic modification that emerged from the data, tampering with GMFPs through the use of technology to change these food products' DNA, thereby producing an unnatural food product while challenging God's creation, were aspects consumers were concerned about, contributing to their opposition towards these food products (Lucht 2015; Dizon et al. 2016; Hingston & Noseworthy 2018; Pakseresht et al. 2021). However, improvements in food product traits were alluring to consumers, such as in the case of GMFPs (Dovey & Ntuli 2020).

Consumer attitude studies in the GM context have found that the unnaturalness of GMFPs, going against religious beliefs, and playing God were factors that influenced consumers' attitudes towards genetic modification (Bredahl 2001; Verdurme & Viaene 2003; Lopez et al. 2016; Larson 2018; Chagwena et al. 2019). Since this study aimed to explore consumers' attitudes towards GMFPs, it is proposed that the most salient aspects that emerged from the conversations relating to genetic modification, namely biological change, unnatural state, technological intervention, and conflicting religious beliefs, can have an unfavourable

influence on the participants' attitudes towards GMFPs, thereby causing attitudinal conflict and possibly leading to a perceived threatened attitude toward GMFPs. However, it is proposed that GMFPs' product feature enhancements hold merit in terms of the benefits such food products can offer consumers, thereby promoting favourable, more accepting and perceived optimistic attitudes towards GMFPs. In this study, a perceived threatened attitude refers to aspects that were unfavourable to the participants, while a perceived optimistic attitude refers to aspects the participants deemed favourable about GMFPs. It is proposed that the threatened attitude, together with the optimistic attitude, can contribute to a perceived dual attitude towards GMFPs, meaning that more than one attitude can be held towards a product (Ajzen 2001), such as GMFPs. The proposed influence that the most salient and sub-salient aspects could have on the participants' attitudes toward GMFPs is illustrated in Figure 5.2.

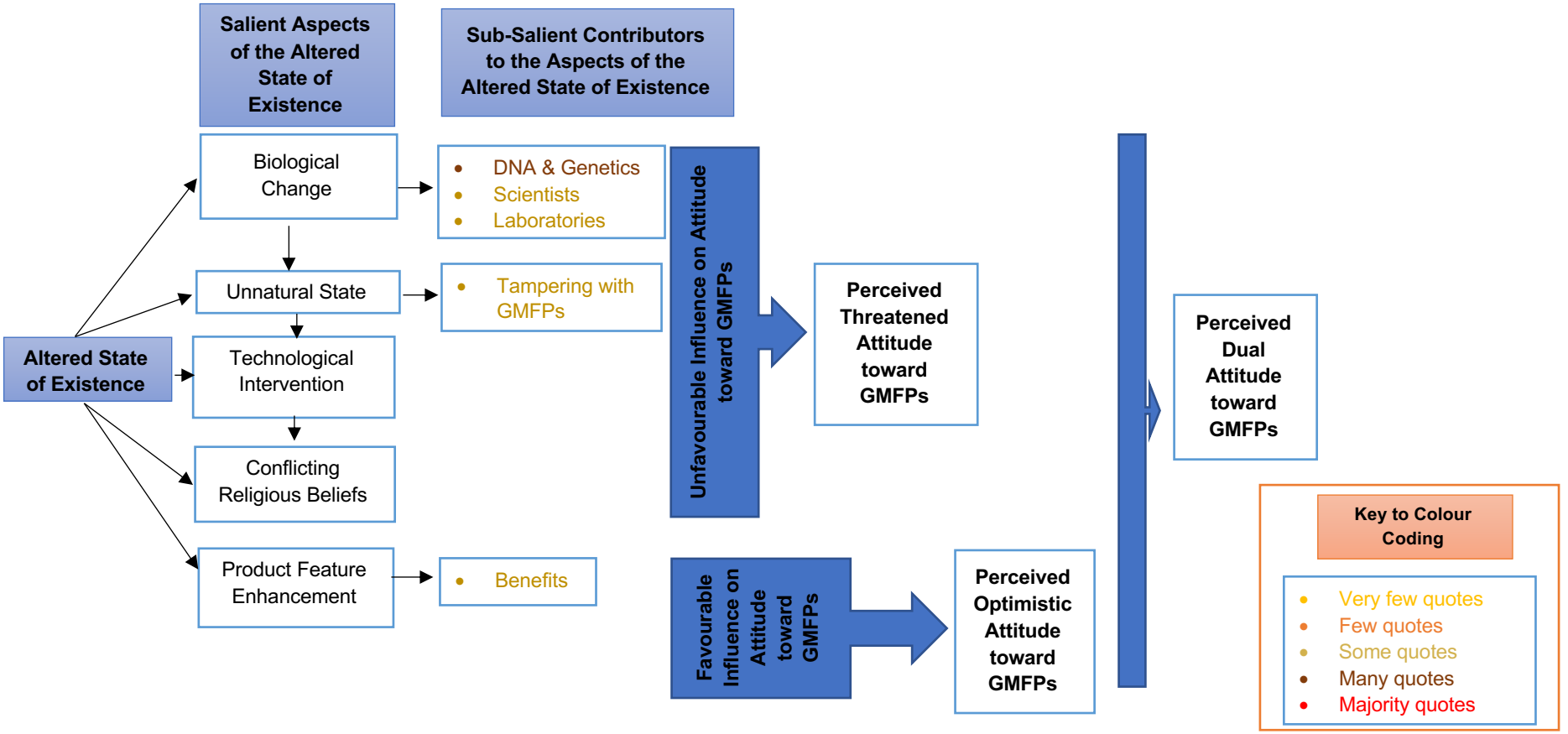

Figure 5.2: The Altered State of Existence and the Proposed Influence on the Perceived Attitude toward GMFPs

From Figure 5.2, it is suggested that the salient aspects relating to an altered state of existence fuelled perceived threatened and optimistic attitudes toward GMFPs among the participants. This outcome could subsequently lead to perceived dual attitudes towards GMFPs, which could promote yet hinder the role that GMFPs could play in enhancing food security in the SA context and attaining SDG 2: Zero Hunger. Based on the depth of data and extent of elaboration (illustrated by the volume of salient aspects), it is proposed that GMFPs' altered state of existence played a pertinent role in shaping the participants' beliefs about GMFPs.

Theme 2, which focuses on the benefits associated with GM crop production, is discussed next.

5.5 THEME 2: GM CROP PRODUCTION BENEFITS

From the previous theme, a belief emerged that food products can be GM for a specific reason to improve certain traits. Holding such a belief incited the participants to believe that there were particular benefits associated with the production of GM crops. Thus, when exploring the participants' salient beliefs about GMFPs, benefits linked to GM crop production emerged from the data. The most salient beneficial aspects and the sub-salient aspects believed to contribute to each of the aspects regarding GM crop production's benefits are depicted in Figure 5.3.

From the analysed data, six aspects believed to be associated with the benefits of GM crop production, as illustrated in Figure 5.3, were identified and are discussed next. These aspects are environmentally friendly; weather resistance; resistant characteristics; increased productivity; increased farmer profitability; and promoting food security.

5.5.1 Environmentally Friendly

A salient beneficial aspect of GM crop production according to the data, was the favourable impact that GM crop production could have on the environment, thereby making the production of GM crops **environmentally friendly**. Hassan et al. (2016) concurred that consumers in Malaysia believed GM crops could have a positive influence on the environment; McFadden (2016) found that American consumers considered GM crop production as being safe for the environment; while Jiang and Zhang (2021) found that Chinese consumers considered GM crops as being environmentally friendly. Another study showed that Flemish consumers approved of the application of genetic modification in crops if there were environmental benefits in doing so (Gheysen et al. 2019).

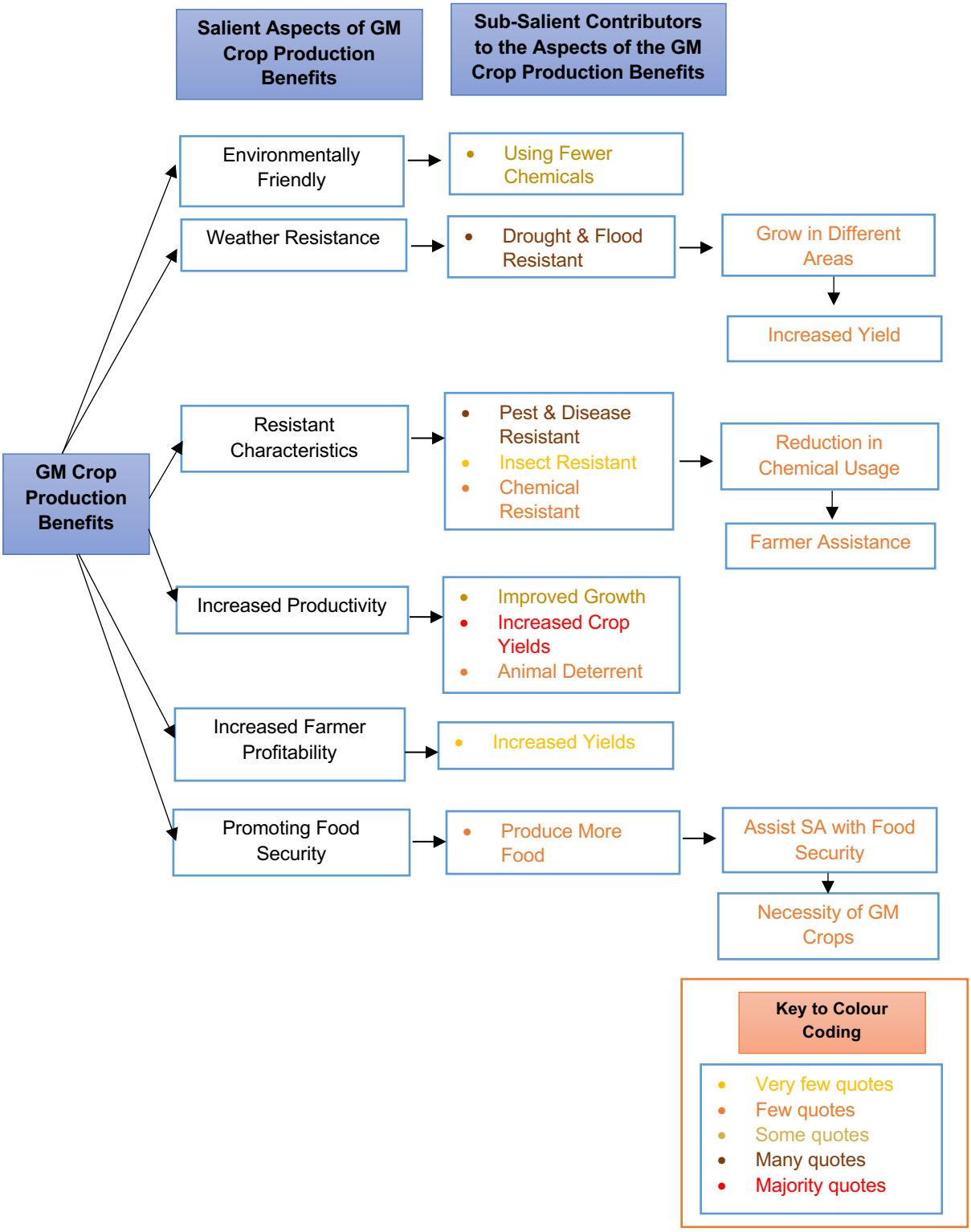

Figure 5.3: GM Crop Production Benefits

These studies suggest that consumers have coupled environmental benefits with the production of GM crops. The environmental benefit in this study was based on the sub-salient belief that the production of GM crops required the use of fewer chemicals, thereby contributing to GM crop production's benefit for the environment. In terms of using fewer

chemicals, it was proposed by some participants that *"farmers don't need to use certain chemicals which could be harmful to the environment"* when growing GM crops; that farmers *"reduce their use of chemical and pesticide"* in GM crop production; and *"they don't need to use quite as many herbicides"* on GM crops. American and Ghanaian consumers also felt that a benefit of GMFPs was that pesticide usage could be reduced (Wunderlich & Gatto 2015; Owusu-Gyan et al. 2023). Various authors concur that the production of GM crops reduces dependence on pesticide usage, resulting in the environment being exposed to fewer chemicals (Pino et al. 2016; Van Acker et al. 2017; Komen et al. 2020; Kovak et al. 2022; Shen et al. 2022; Abdoul et al. 2023). Thus, since GM crops require a reduced amount of pesticide application, such crops could be considered as being environmentally friendly (Pino et al. 2016; Raman 2017; Islam et al. 2020; Sendhil et al. 2022).

In this study, one participant regarded *"tolerance to weeds"* as being an advantage of GM crops and ultimately to the environment because *"a GM crop called Roundup ready seed"* can be sprayed with *"chemicals such as glyphosate"* to control weeds, meaning that *"your crop is unaffected"*, which subsequently *"massively reduces your weed base"*. The Roundup-ready herbicide is commonly used on GM crops to manage weeds, in turn providing environmental benefits as farmers do not need to depend on other harmful chemicals (Brookes & Barfoot 2017; Van Acker et al. 2017; Vicini 2017; Blagoevska et al. 2021; Novotny 2022). Having the opportunity to manage weeds resulted in a belief that the growth and production of such crops could be increased. A participant suggested that GM crops can *"perform better"* while protecting the environment.

Other individual participants believed that GM crops could assist *"against alien invasive plants that may not be native to that country"*, that *"a lot less irrigation is required"* when producing GM crops, and that such crops *"take up less nutrients out of the soil"*, thereby promoting the health of the environment. GM crop production promotes the health of the soil since these crops require less tillage, which, in turn, facilitates carbon sequestration in the soil, thereby assisting in the fight against environmental pollution (Brookes & Barfoot 2017; Schutte et al. 2017; Van Acker et al. 2017; Kubisz et al. 2021; Kovak et al. 2022). Furthermore, another participant believed that *"we don't have to kill more of the environment by using more space to grow crops"* and *"you can even grow them when there's no water or less water"*. These views reflect the possibility that fewer resources are required to grow GM crops, thereby preserving the environment. It has also been suggested there is a reduced need to seek additional land for GM crop production because more crops can be produced quicker in one area of land, thereby further supporting the environment (Ausubel et al. 2013; Raman 2017; Kovak et al. 2022). The production of GM crops can also contribute to a reduction in CO_2

emissions from a reduced use of land and chemicals, thereby reducing their carbon footprint, which contributes to the protection of the environment and is deemed a benefit by consumers (Masehela et al. 2016; Taheri et al. 2017; Van Acker et al. 2017; Kovak et al. 2022; Shen et al. 2022; Mmbando 2023). However, a reduction in CO_2 emissions through the production of GM crops was not mentioned in the current study.

Although GM crop production was linked to environmental benefits in the data, one participant believed GM crop production's effect on the environment is not fully understood yet because *"there is so much conflicting ideas as to whether this is very good for the environment or not"*. This created some difficulty in constructing a firm belief about GM crop production's effects on the environment as *"there is insufficient information to stand firmly on either side of that fence"*. Even though a sense of doubt was emphasised by one participant, it did not take away from the fact that the participants believed growing GM crops could offer environmental benefits. They linked GM crop production to beneficial environmental attributes, particularly due to the use of fewer chemicals. In terms of the benefit that GM crop production could have on the environment, it has been argued that GM crops hold the promise of contributing to a future with "greener" agriculture and food production (Van Acker et al. 2017). In this study, however, the limited quotes and sub-salient aspects suggested that the environmentally friendly benefit of GM crops did not play a prominent role in participants' beliefs about GM crop production's benefits.

5.5.2 Weather Resistance

An important beneficial salient aspect that emerged from the data was the belief that GM crops retain **weather-resistant** features because they are *"more weather resistant"*, and farmers have *"the ability to create or have crops which are able to withstand environmental extremes"*, which was attributed to sub-salient aspects such as being drought and flood resistant. Similar results were found in Malaysia and London, respectively, where consumers believed that GM crops were resistant to extreme weather conditions (Hassan et al. 2016; Popek & Halagarda 2017). Numerous authors also suggested that consumers displayed confidence in GM crops ability to resist droughts and extreme temperatures, thereby making these crops tolerable to harsh weather conditions (Van Acker et al. 2017; Husaini & Sohail 2018; Nazir et al. 2018; Kovak et al. 2022; Siddiqui et al. 2022; Mmbando 2023). In terms of drought and flood resistance, many participants believed that such crops could *"allow a farmer to have a crop that would survive a very dry season in South Africa"* and that *"these crops can be produced in drought-stricken areas such as South Africa", "which is frequented by more droughts"*

because GM crops are *"more resistant against droughts and floods"* and GM *"crops last through droughts or flooding"*.

Due to their weather-resistant traits, a few participants believed that GM crops could grow in different areas because *"they can function better in a different environment"*. Therefore, GM crops *"could possibly grow better in certain areas"* and can be grown in areas where *"certain weather patterns are not suited to that crop"*, emphasising the benefit of producing such crops. These beliefs were supported by authors who suggested that GM crops have the potential to be grown in marginal lands due to their tolerable traits (Van Acker et al. 2017; Olabinjo et al. 2020). Retaining these weather-resistant traits was believed to *"allow it to survive"* and *"last through droughts or through flooding as much as possible"*, which results in *"a greater yield even in dry conditions"* when growing GM crops. Therefore, a few participants believed that *"a decent yield"* and *"a bigger yield"* can be achieved through GM crop production and thus *"the better your outcome of your crop at the end of the season"* will be. Thus, weather-resistant traits contributed to sub-salient aspects such as GM crops' ability to grow in different areas, resulting in an increased yield. Respective participants also believed that the introduction of weather-resistant genes into crops could enable GM crops to be *"more sustainable for itself"* because they are *"more resilient"* and *"more reliable"*, which affords farmers the opportunity to *"ensure crop sales at the end of the day so that they don't lose out due to mother nature"* as *"farmers can be more assured of obtaining a healthy crop"* when growing GM crops.

In terms of climate change, one of the participants believed that climate change is escalating to such an extent that it has already influenced crop production. The participant emphasised climate change is *"a real issue"* because *"the weather is changing constantly, and you are dealing with all sorts of elements that perhaps weren't there 15 or 20 years ago"*, which has led to *"changes in farming practices"*, such as the implementation of GM crop production to cope with the changes in weather patterns. The participant believed that *"they push GMO because of the issues we are going to face with climate change"* – which could be attributed to its ability to be more tolerable to *"floods, droughts and extreme weather"* – because *"if you can't change with climate change, then you are going to end up losing out"*. Although consumers are concerned with the rate at which climate change is evolving, solace is found in GM crops as they have the potential to adapt to climate change, thereby assisting farmers to better cope with weather changes (Van Acker et al. 2017; Nazir et al. 2018; Blagoevska et al. 2021; Kovak et al. 2022; Shen et al. 2022). However, GM crop production's potential in addressing climate change was not elaborated on by the participants in the current study.

In this study, the weather-resistant traits of GM crops were believed to be a benefit of producing such crops. Participants mentioned attributes like their drought and flood-resistant traits, which led to the opportunity to grow such crops in different areas, thereby gaining an increased crop yield. Based on the volume of sub-salient aspects on the belief that GM crops have weather-resistant traits – particularly to droughts and floods (based on the volume of quotes indicating its prominence) – it is suggested that these weather-resistant traits played an influential role in participants' beliefs about the benefits of GM crop production.

5.5.3 Resistant Characteristics

Another important salient aspect that emerged from the data was the **resistant characteristics** of GM crops. In terms of resistant characteristics, resistance to pests, diseases and insects, as well as chemicals were sub-salient aspects that emerged. Many participants believed that GM crops are *"pest and disease resistant"* and *"have resistance to disease"*; while very few participants believed that GM crops are *"more insect resistant"*. A few participants believed that GM crops *"are resistant to certain chemicals"* and that *"they are more resistant to pesticides"*. It was also found that consumers in London considered GM crops to be pest resistant (Popek & Halagarda 2017). Some researchers also suggested that insect, pest and disease resistance are some of the main reasons farmers adopt GM crops into their farming practices, and is considered by many consumers as being an important benefit of such crops (Ghoochani et al. 2017; Raman 2017; Van Acker et al. 2017; Nazir et al. 2018; Ala-Kokko et al. 2021; Blagoevska et al. 2021; Kovak et al. 2022; Shen et al. 2022; Abdoul et al. 2023). It has also been stated that GM crops can be GM to be resistant to chemicals such as herbicides (Redden 2021). Furthermore, in the current study, one participant believed that the breeding of pests could be initiated, thereby encouraging them to migrate due to changes in temperatures, which could lead to the presence of pests that are *"uncontrollable"*. The participant shared that farming with crops that are resistant to pests is essential as *"we need crops that are resistant to pests"*. GM crops' resistant characteristics further led to another participant's belief that crop damage can be reduced because:

> *"they can have a pesticide gene added into the product that makes the bugs' digestive system basically frail, thereby reducing crop damage to insects"*.

Research concurs that crop damage could be minimised due to the insect and pest-resistant traits held by GM crops (Kovak et al. 2022). Resistant traits against pests, diseases, insects and chemicals contributed to the sub-salient belief that the use of chemicals can be reduced. A few participants believed that *"they can require less pesticides"* and that *"less pesticides and*

chemicals [are] used" during the production of GM crops; therefore, farmers are gifted the opportunity to *"reduce herbicide or insecticide use"* when growing GM crops. Drawing an analogy to Section 5.5.1, the use of fewer chemicals was believed to be a contributing aspect to protecting the environment. In terms of GM crops' reduced dependence on chemicals, a study conducted in China also found that consumers coupled the use of fewer pesticides with GM crop production (Jiang & Zhang 2021). It has been proposed that the decreased reliance on herbicides and pesticides was a feature of GM crops that not only attracted and encouraged farmers to produce such crops, but it also imparted benefits to farmers themselves, as their exposure to potentially harmful chemicals decreased (Raman 2017; Van Acker et al. 2017; Ala-Kokko et al. 2021; Kovak et al. 2022; Sendhil et al. 2022). The resistant traits of GM crops were also believed by a few participants to make farming practices easier because *"it helps farmers"* as *"the farming process is easier"*, and thus farming with GM crops *"makes it a lot easier to grow and deal with"* certain factors such as pests. As a result*, "it's easier to grow that kind of crop"* when it comes to GM crops. Therefore, farmer assistance emerged as another sub-salient aspect from the data attributed to GM crops' resistant traits.

Subsequently, various resistant traits were believed to be coupled with the production of GM crops. These included being able to resist and withstand pests, diseases and insect invasion, while also being able to resist chemicals. These attributes could contribute to the use of fewer chemicals, which can further benefit the farmers' farming practices when it comes to GM crops. Based on the volume of sub-salient aspects that emerged from the data, resistant characteristics (particularly pest and disease resistance based on the volume of quotes illustrating its prominence) were of particular importance to the participants and were therefore a pertinent aspect impacting participants' beliefs about the benefits of producing GM crops.

5.5.4 Increased Productivity

In addition to believing that the production of GM crops is environmentally friendly, can resist harsh weather conditions, and has various resistant traits, **increased productivity** also emerged as a beneficial salient aspect from the data. Increased productivity was linked to GM crops, and it was believed that such crops have *"been scientifically engineered to improve productivity and crop growth"*, which was attributed to the sub-salient aspect that GM crops have improved growth. Some participants believed that they *"grow stronger or better"* and are *"crops that grow quicker"* as opposed to other crops. Attaining such growth abilities led the majority of the participants to the sub-salient belief that increased crop yields can be achieved. They stated growing GM crops can *"create more of a bigger yield"* and can also *"create bigger output"*, which *"can yield more crops"*. Subsequently, GM crop production can *"basically [result*

in] having bigger yields", which *"improves production",* and therefore the *"overall productivity will improve"*. Thus, GM crops can *"be more productive"* as opposed to farming with other crops. In terms of increased yields, it was suggested that the GM crops' adoption in farming practices leads to higher crop yields, which is viewed as a promising aspect of GM crops among consumers (Verdurme & Viaene 2003; Brookes & Barfoot 2017; Taheri et al. 2017; Vicini 2017; Amin et al. 2021; Kovak et al. 2022; Shen et al. 2022; Mmbando 2023). The same finding was seen among consumers in Malaysia and Ghana (Hassan et al. 2016; Owusu-Gyan et al. 2023). It has further been suggested that increased yields can be achieved when producing GM crops due to their insect and pest-resistant features, which can be referred to as 'yield protection traits' (Van Acker et al. 2017).

Enhanced crop growth and ultimate output in terms of increased yields resulted in one participant's belief that GM crops can be *"mass produced"*, which leads to a *"quick turn-around"*, thereby making it possible for *"farmers and food producers"* to *"maximise crops"*. Drawing an analogy to Section 5.4.3 (technological intervention), another participant highlighted that *"the reality is that we have the technology which has the potential to produce greater yields in difficult circumstances"* and therefore *"the use of GM technology allows greater food production"*. As a result, *"the idea and concept of GMO's is astonishing and it's revolutionising the world and the agricultural world especially"*, particularly in terms of food production.

Increased productivity linked to GM crops was attributed to another sub-salient aspect, namely animal deterrent. A few participants believed that animals can be prevented from eating and destroying crops because they prefer non-GM crops. It was highlighted that a farmer who farms with GM maize in the Mooi River area experienced first-hand that *"the baboons are just not interested in the GM mealies"*. One participant mentioned that other farmers in the area *"planted GM maize"* which was *"combined with non-GMO maize"*; the farmer was astounded to discover that *"the non-GMO maize was all nailed by bush pig"* and that *"they didn't touch the GMO maize"*. Another participant added that a farmer planted GM maize and heirloom seeds and found that *"the cows only ate the heirloom seed that's not genetically modified"*. An additional participant added that *"buck, rabbits and other wildlife did not touch the GM seed"*, but *"when you plant normal seed, that is eaten by the buck and wildlife"*. This behaviour demonstrated by the animals led to the belief that *"it can assist farmers with animal control"*, thereby contributing to increased crop production and productivity. Although participants were mesmerised by animals' behaviour towards GM maize, it also led to scepticism and concern about such crops, as it was believed that *"maybe there is something more to this"* and that *"I've got this lingering sort of thing in my head saying what is it that makes the animals reject*

it", as there has to be *"a reason"* why the animals refrained from eating the GM maize. The animals' rejection of GM maize contributed to one participant's concern towards genetic modification; the participant stated, *"I was sort of 90% against it and now I'm like 99% against it"*. This suggests that animals' hesitant behaviour towards GM crops could contribute towards a sense of dubiousness regarding these crops.

Evidently, the participants believed that increased productivity is a beneficial aspect that can be attained through the production of GM crops, particularly by improving their growth, enhancing crop yields, and deterring animals from eating such crops. Based on the volume of sub-salient aspects that emerged, it is suggested that increased productivity is an important aspect of GM crop production benefits. Increased crop yields were the most important to the participants based on the prominence of the sub-salient aspect (as reflected by the volume of quotes), and thus an influential attribute impacting their beliefs about the benefits of producing GM crops.

5.5.5 Increased Farmer Profitability

From the data, it emerged that the production of GM crops could *"increase profitability for farmers"*, *"it brings more money for the farmers"*, and thus there is *"an economic benefit to a farmer"*. Therefore, **increased farmer profitability** emerged as another salient aspect in terms of the benefits of producing GM crops. Very few participants attributed this belief to the sub-salient aspect of increased yields (which also emerged as a sub-salient aspect in terms of the increased productivity of GM crops in Section 5.5.4) because *"if they are able to produce larger crop yields, then they will be able to earn more money from that"* and *"if they can produce bigger crops or something that is of higher value, then you can get more profit"*. As a result, farmers *"are actually going to make a profit"* if they implement GM crop production into their farming practices. Consumers in Iran and Malaysia also believed that farmers could benefit financially from producing GM crops as their production costs are lowered, while their crop yield is increased (Ghanian et al. 2016; Hassan et al. 2016). It was further found that Chinese consumers supported GM crop farming due to the increased profits that can be enjoyed (Deng et al. 2019). Various authors have stated that GM crops can benefit farmers, particularly small-scale farmers, in terms of their income, due to insect-resistant traits, reduced labour input, and enhanced crop quality (Brookes & Barfoot 2017; Raman 2017; Taheri et al. 2017; Van Acker et al. 2017; Ala-Kokko et al. 2021; Kubisz et al. 2021; Kovak et al. 2022; Sendhil et al. 2022). Other factors, such as GM crops' resilience and reduced crop losses, were also believed to drive farmer profits even higher, which are aspects that prompted

consumers to be positive about the production of GM crops (Taheri et al. 2017; Van Acker et al. 2017).

One participant believed that, in terms of producing GM crops, *"it is more cost-effective to Third World Countries"* and genetic modification is *"a great business opportunity"* and is therefore encouraged to be incorporated into existing farming practices and production. In addition to the financial benefit that farmers can enjoy through GM crop production, Gastrow et al. (2018) found in their study that SA consumers were optimistic about adopting biotechnology in food production as it could potentially improve the economy. It has been suggested that economic returns for farmers can be increased by incorporating GM crops into their farming practices, which subsequently also benefits the economy as a whole (Ala-Kokko et al. 2021; Kubisz et al. 2021). In addition to the financial gain associated with the production of GM crops, particularly to the farmer, one participant in this study believed that farming with GM crops could encourage commercial farming because *"it's large, [and] commercial"*.

Therefore, farmer profitability was a benefit associated with the production of GM crops, which was ascribed to the increased yields that can be achieved. Nevertheless, the lack of elaboration – as evident in the limited quotes – and the absence of sub-salient aspects suggest that the aspect was not influential in participants' beliefs about GM crop production benefits.

5.5.6 Promoting Food Security

Participants believed that food shortages, coupled with food security, are becoming increasingly threatened, particularly in *"Africa"* and *"Third World"* countries, which is a *"real issue"* because *"you are already dealing with poverty at such an exponential level"*, particularly since *"the population is just really getting to a point where we can't actually provide for the population"*. Therefore, *"the growing population that we have in the world"* is posing a challenge to food security. This led to the belief that *"food is outnumbered by the number of mouths it needs to feed"*, and therefore *"there is an overall need for food"*. It has been found that consumers are growing particularly anxious about the state of food security globally (Frewer 2017).

To address issues that could be compromising food security, a participant believed that the Green Revolution played a role *"in the sense that it did help with ensuring that people got food"*; however*, "in the process of doing so, there was a lot of biodiversity that was lost"*. Nevertheless, this participant shared that "*there was a very big, fast development of the technology"* in terms of biotechnology, which was indicative of the beneficial role that

technology could play in food production. This view was supported by Van Acker et al. (2017), who stated that world hunger led to the Green Revolution, and it has been argued that GM crops could be considered the 'next agricultural production revolution'. From the data in this study, it was evident that the participants were persistent in their belief that the production of GM crops and GMFPs could stand as a possible solution to securing food for the population because *"it can feed the world"* and *"it can stop world starvation*". As a result, *"they have the potential to provide food security for untold millions of people"* by producing GMFPs because *"it will help with hunger and the shortage of food"*. Therefore, *"it's definitely a way of providing food security and to alleviate hunger in many places"*. Participants said the production of GMFPs *"is going to be able to help people that are in need"* when it comes to the availability of food products, and it will also *"help us with poverty"*, thereby promoting food security efforts. Thus, GM crops and food products' contribution to **promoting food security** was a salient aspect emerging from the data. Other studies in Mexico, Botswana and Ghana found that consumers also believed that the production of GMFPs can combat food shortages (Lopez et al. 2016; Hulela et al. 2019; Owusu-Gyan et al. 2023), while consumers in Florida similarly responded favourably to GMFPs due to their ability to address food insecurity issues (Ruth & Rumble 2019). A further study in Nigeria and Ghana also showed that consumers approved of the application of genetic modification in food products if it could aid in addressing food insecurity challenges (Adenle et al. 2012). These studies suggest that, generally, consumers feel GMFPs can provide food to the population. It has further been proposed that governments should place more focus on addressing food production challenges by incorporating modern and new tools and technology into their existing food systems, such as biotechnology, to aid in alleviating hunger (Zhaleh et al. 2023). Other authors concurred that GMFPs are a valuable tool that can be used to keep up with food demands, thereby addressing poverty and food insecurity issues (Prianto et al. 2020; Rodriguez et al. 2022; Abdoul et al. 2023; Zhaleh et al. 2023).

It was further believed by a few participants that *"more food"*, *"more tonnage"* and *"having more product on offer and available"* can be achieved, which can contribute to promoting food security. Therefore, the production of more food emerged from the data as a sub-salient aspect. Individual participants believed that GM crops could be produced *"quicker"*, *"especially in marginal areas such as in the drought-stricken parts of Africa and Asia"* because GM crops *"perform better"* as they are *"stronger"* crops and are *"more controllable"*, thereby aiding *"desperate and vulnerable"* people by *"feeding our growing world"* and enhancing food security. One participant believed that being able to produce GM crops on smaller areas of land is a contributing factor assisting with food security because *"if we had crops the same way we had crops 50 years ago, we probably wouldn't be able to feed everyone, we just don't*

have enough space". This is a sign of how genetic modification has developed over the years, and how GMFPs are already taking a step forward in the quest for food security. In addition, other GM crop traits, such as attaining higher crop yields, improved crop and food quality, adaptability to climate change, resistance to pests, and improved growth, are commonly considered to contribute to alleviating food insecurity (Carzoli et al. 2018; Olabinjo et al. 2020; Ala-Kokko et al. 2021; Gbashi et al. 2021).

5.5.6.1 Food Security in SA

In terms of food security in SA, a participant held the belief that *"food scarcity"* is *"something that is a reality here in South Africa"* and that *"South Africa faces a serious food shortage problem"*. This phenomenon is fuelled by the fact that *"we don't have enough of our own food and therefore we are importing everything"* because *"we have a population that exceeds what we can produce"*. A participant believed that:

> *"we just don't have enough resources in South African and Africa to be able to accommodate everyone, especially with [the] growing population, and hunger and malnutrition"*.

This view was supported by Ala-Kokko et al. (2021), who alluded to the fact that a large proportion of the SA population has a compromised food security status. However, a few participants believed that the production of GM crops and food products could *"definitely"*, *"absolutely"* and *"100%"* assist SA's food security status, especially considering *"an economy like ours"*; *"our unemployment rate"*; and *"our Third-world country status"*. Assisting SA with food security was thus a sub-salient aspect that emerged from the data in terms of the production of more food. Subsequently, it was believed that SA could benefit from the production of GM crops and food products as it can assist in providing *"enough food for our country"*, promoting the country's food security status. Since GMFPs were believed to produce sufficient amounts of food to feed a growing population, a participant believed that *"it's quite difficult for farmers and producers to be able to reach the needs of all the people out there"*, and more focus should also be placed on getting the food to those in need because:

> *"a lot of people in South Africa don't necessarily have the transport or the capital income to purchase foods or even have enough places nearby they can get food from"*.

It was suggested that access to and the distribution of food could pose as hindering factors to feeding the hungry, which could impede food security efforts (Van Acker et al. 2017). It was

also believed among participants that *"management would play a very big role"* in the success of using GMFPs to provide a sufficient amount of food to the SA population since other factors are present that could contribute to hunger. The role that GMFPs play in food security *"is quite a tricky topic"*.

It was believed that GM crops need to be incorporated into crop production and embraced in the agricultural sector in SA, particularly considering its potential to aid in food security. A few participants signified that *"it's necessary"* and that *"genetically modified crops is a necessity"* because in *"the world we live in, and how population is looking, we need to have them, there is no way around it"*; therefore, *"it's definitely got its place when it comes to food scarcity"*. The necessity of GM crops was therefore a sub-salient aspect that emerged from the data in terms of assisting SA with food security. It was further believed by a participant that *"there is a need for improved techniques of food production"*, and that GM technology needs to be considered by farmers to grow GM crops, particularly to address food insecurity. Various authors concurred that GM technology and GM crops should be embraced and incorporated into agricultural practices to produce GMFPs, thereby combatting the ever-increasing demand for food (Hefferon 2016; Chagwena et al. 2019; Ehirim et al. 2020; Ghimire et al. 2023; Mmbando 2023).

The belief that the collaboration between GM crops and food products can be considered as a tool to increase food security contributed to an individual participant stating that it is *"our responsibility" "to look after our population"*, which can be achieved by making use of GM technology to produce GM crops and promote the production of adequate amounts of food to feed the growing population. Another participant added that *"food security will improve"* if GM crops are grown on a large scale, and that:

> *"they are the future and people need to embrace them, because if we don't, we are going to run into serious issues with food shortages and we are going to go hungry"*.

Evidently, *"genetic modification is a no brainer because we can't afford not to"* incorporate the production of GM crops into agricultural practices in SA, particularly considering the threat to individuals' food security status. In terms of integrating GM crop production into farming practices, GM crop production should receive serious attention (Gbashi et al. 2021).

5.5.6.2 Potential Concerns Hindering the Role of GM Crop Production in Promoting Food Security

Although GM crops and food products were believed to act as a link to promoting food security efforts, it was also suggested by one participant that the *"scientific community"* should exercise caution in terms of *"long-term testing of the side effects of GMFPs"* before *"rushing ahead"* to address food insecurity issues. Therefore, *"there needs to be more research in order to make it a viable option"*, particularly in terms of *"knowing enough about how it's modified and how it will affect people"*, especially after consuming such food products. To this effect, it was believed that scientists should be careful in terms of *"trying to sort out one issue, which then lead to creating other issues"*. Such concerns were echoed by Nesser et al. (2021), who exhibited that the possible health and environmental risks associated with GM crop production could hinder individuals' adoption of GM crop production, and sufficient research needs to be conducted to negate the proposed risks consumers have associated with GM crops and food products. A participant also added that *"they could be ticking all the boxes"* in terms of producing more food through genetic modification, but *"people are still starving"*, which was attributed to factors such as *"human wastage"*, *"inequality and other economic and social concerns"*. These aspects could be affecting food security, thereby hindering genetic modification's efforts to maintain food security. Van Acker et al. (2017) concurred that waste is a factor contributing to food insecurity. In this study, respective participants believed that such contributing factors to poverty and hunger, and their subsequent effect on food security, must first be acknowledged and addressed to assist in GMFPs' quest to promote food security because *"GM foods on their own are not going to solve the problem, because it's much broader"*. Nevertheless, participants' belief that GMFPs can offer a lending hand to promoting food security through feeding the population meant *"they have the potential to be a great benefit to humanity"*.

5.5.6.3 Alternative Methods to Addressing Food Security

In addition to the potential concerns that could hinder GM crop production's role in promoting food security, doubt was demonstrated in terms of whether the production of GMFPs is the sole solution to ensuring food security. One participant stated that *"whether it's the best option is debatable"* because *"it is an easy cop-out"* and *"we don't know whether it can feed the world or not because it has not been dictated yet"*. Van Acker et al. (2017) opined that it has not been proven whether GM crops are aiding in poverty, hunger and food insecurity challenges. Although it is believed that GMFPs can play a vital role in aiding with food security, other factors such as *"skills improvement"*, *"employment"*, *"the correct kind of land dispersion"*, and

"training" were emphasised by one participant as important to consider in achieving food security. The participant believed there are *"alternative methods"* to attaining food security that should also be considered, such as *"experts looking into more natural ways of doing it"*, particularly in terms of *"farming experts who need to use our soil better and understand soil sciences better".* Datta (2013) underscored such beliefs by alluding to the fact that conventional farming methods should be supplemented with GM technology to promote a more sustainable production of food and improve food security. Other authors have also suggested that the implementation of educational programmes and strategies to educate farmers on the concept of this technology should be focused on first before food security can be addressed (Adeyeye et al. 2017).

It was further believed by one participant that, in SA:

> *"we live in a country that has definitely got the space and the environment for farming, and if farming was actually a government-supported activity, we could improve the food supply in this country easily when we just have the right things in place"*.

As a result, *"there should be a look at an alternative and not taking the easy way"* in terms of addressing food shortages.

Nevertheless, the data showed that the participants were optimistic that GM crop and food production could contribute to promoting food security by producing more food. They associated the production of GM crops with such a benefit. It was further believed that the production of GM crops can assist with SA's food security status, and it is necessary to grow such crops in the country. Based on the extent of elaboration, the volume of quotes relating to enhancing food security and the volume of sub-salient aspects illustrate that the promotion of food security was of specific importance to the participants where GM crops and food products were concerned. Food security is therefore suggested to be an influential attribute impacting participants' beliefs about GM crop production's benefits.

5.5.7 Summary of GM Crop Production Benefits

To illustrate the most salient aspects of each theme in this chapter and to give a visual description of each theme as it emerged from the data and how each theme builds on the previous theme, a summary of the themes is provided in Table 5.4. The summary further shows the participants' different views and what their beliefs were comprised of to better understand the magnitude of their beliefs about GMFPs. A summary of the salient aspects in

Theme 1 and Theme 2, namely GM crop production benefits that emerged from the data, is depicted in Table 5.4.

Table 5.4: Summary of the Most Salient Beliefs Aspects of Themes 1 and 2

Theme	Salient Belief Aspects of GM Crops and GMFPs					
Theme 1: Altered State of Existence	Biological Change	Unnatural State	Technological Intervention	Conflicting Religious Belief	Product Feature Enhancement	
Theme 2: GM Crop Production Benefits	Environmentally Friendly	Weather Resistance	Resistant Characteristics	Increased Productivity	Increased Farmer Profitability	Promoting Food Security

In addition to the belief that genetic modification involves an altered state of existence, as discussed in Theme 1 of this chapter and illustrated in Table 5.4, GM crop production's benefits also emerged from the data, as seen in Theme 2. GM crop production benefits were believed to be coupled with GMFPs, such as being environmentally friendly, having weather-resistant and various other traits, increased productivity, increased farmer profitability, and promoting food security, as depicted in Table 5.4.

In support of the salient aspects and sub-salient aspects that emerged from the data in this study regarding the benefits of GM crop production, several authors have agreed that there is an array of benefits coupled with producing GM crops (Ala-Kokko et al. 2021; Muzhinji & Ntuli 2021; Smyth et al. 2021; Sendhil et al. 2022; Shen et al. 2022). According to these authors, these benefits include environmental benefits, retaining weather, pest, disease and insect resistance, being able to promote growth and increase yields, having economic and financial benefits, and being able to contribute to attaining food security. In the GM consumer attitude context, environmental benefits in terms of being herbicide and pest-resistant, using fewer chemicals and promoting the health of the soil; as well as economic factors, like increased yields and alleviating hunger, have been considered as determining factors in consumers' attitudes toward GMFPs (Morris & Adley 2000; Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Lopez et al. 2016; Rzymski & Krolczyk 2016; Ghoochani et al. 2017; Jonker 2017; Deng et al. 2019; Amin et al. 2021). It has further been postulated that the benefits considered to be coupled with GMFPs can positively influence consumers' attitudes toward GMFPs (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Ghoochani et al. 2017). In this study, it is suggested that the most salient and sub-salient beliefs about the various benefits of producing GM crops could contribute to the participants' belief that the production of GM crops holds merit. This attitude could propel consumers to adopt a more accepting standpoint toward GMFPs, thereby influencing their attitudes in a

favourable manner, contributing to a perceived optimistic attitude toward GMFPs. The beneficial aspects of GM crop production's proposed influence on participants' perceived attitudes are summarised in Figure 5.4.

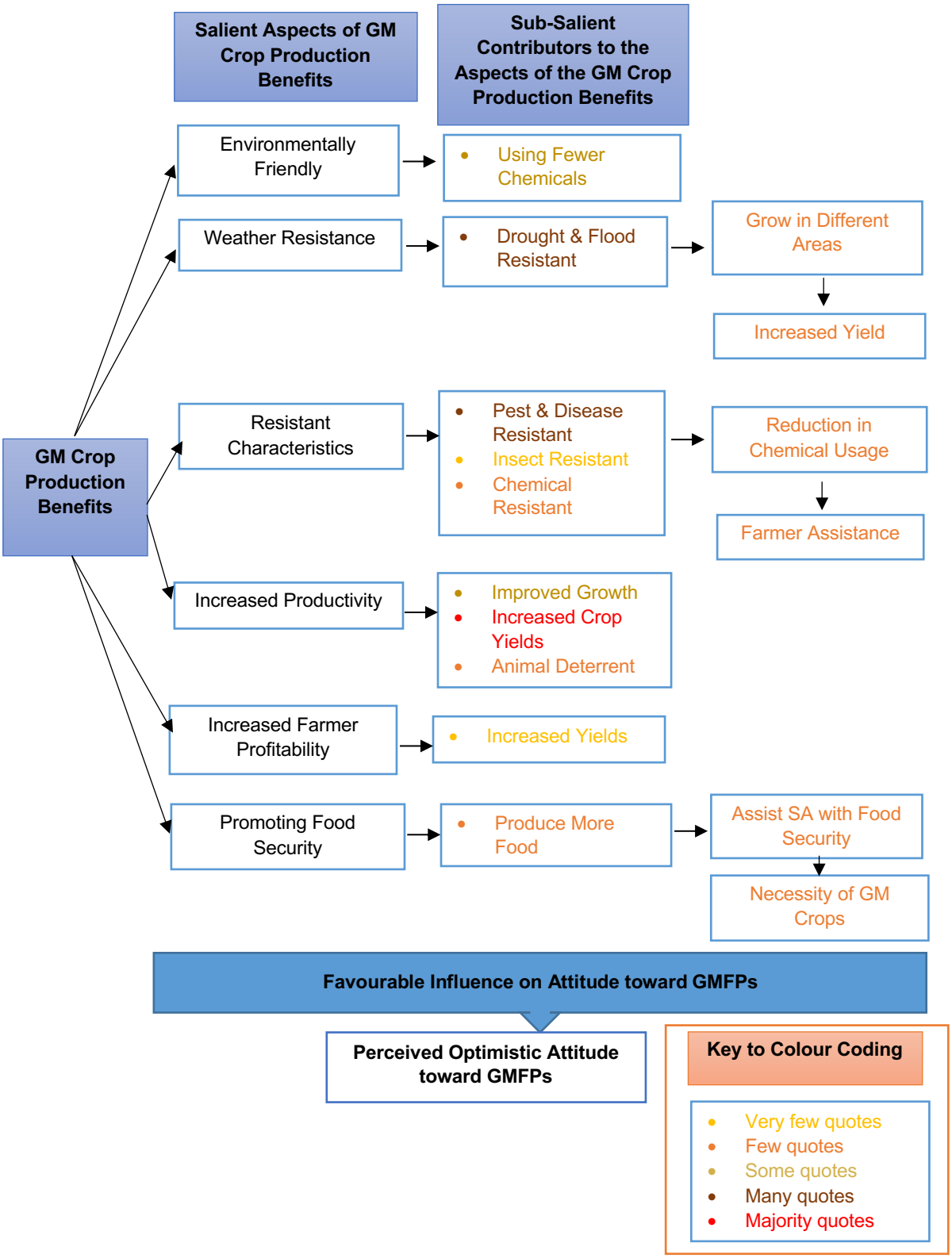

Figure 5.4: GM Crop Production Benefits and the Proposed Influence on the Perceived Attitude toward GMFPs

As shown in Figure 5.4, it is proposed that the beneficial aspects related to GM crop production, according to the participants, could contribute toward a perceived optimistic attitude toward GMFPs, which can be beneficial in attaining food security in SA and reaching SDG 2: Zero Hunger. Based on the depth of data, the extent of elaboration and volume of salient aspects that emerged, it is suggested that GM crop production's benefits played an influential role in the participants' beliefs about GMFPs. This could be promising to the GM food industry as having such a belief could create acceptance toward GM crop production, particularly since participants resided in an agricultural community. Associating GMFPs with GM crops also suggests that, where GMFPs are concerned, the participants' beliefs regarding GMFPs were also formed based on the attributes of the GM crops.

Theme 3 focuses on the consumer-related benefits that participants coupled with GMFPs. A discussion on this theme follows.

5.6 THEME 3: CONSUMER-RELATED BENEFITS OF GMFPS

In addition to GM crop production's benefits that emerged from the data, various GMFP benefits also emerged as being directly beneficial to the participants as consumers. The most salient consumer-related beneficial aspects and the sub-salient aspects contributing to each salient aspect are illustrated in Figure 5.5.

As seen in Figure 5.5, the discussion on the data regarding the five beneficial consumer-related aspects of GMFPs, as it emerged from the data, include increased nutritional value, increased accessibility and availability, lower price, improved aesthetic properties, and improved food processing properties of GMFPs.

5.6.1 Increased Nutritional Value of GMFPs

The **increased nutritional value of GMFPs** was a salient aspect that emerged from the data believed to be a beneficial attribute of GMFPs because such food products *"have an increased nutritional value"* because *"there is a possibility for creating foods with higher nutritional value"*. Thus, *"[GM] foods have higher nutritional value"* than conventional food products, which was attributed to the sub-salient aspect of GMFPs having more nutrients.

In terms of GMFPs having more nutrients, some participants stated that such food products *"give us more nutrients"* because, through the genetic modification process, they are *"adding extra nutritional value to food"* and *"certain nutrients can be introduced into it to make it more*

beneficial for the consumer", "which then [also] means that people are able to obtain more nutritious diets" when consuming GMFPs.

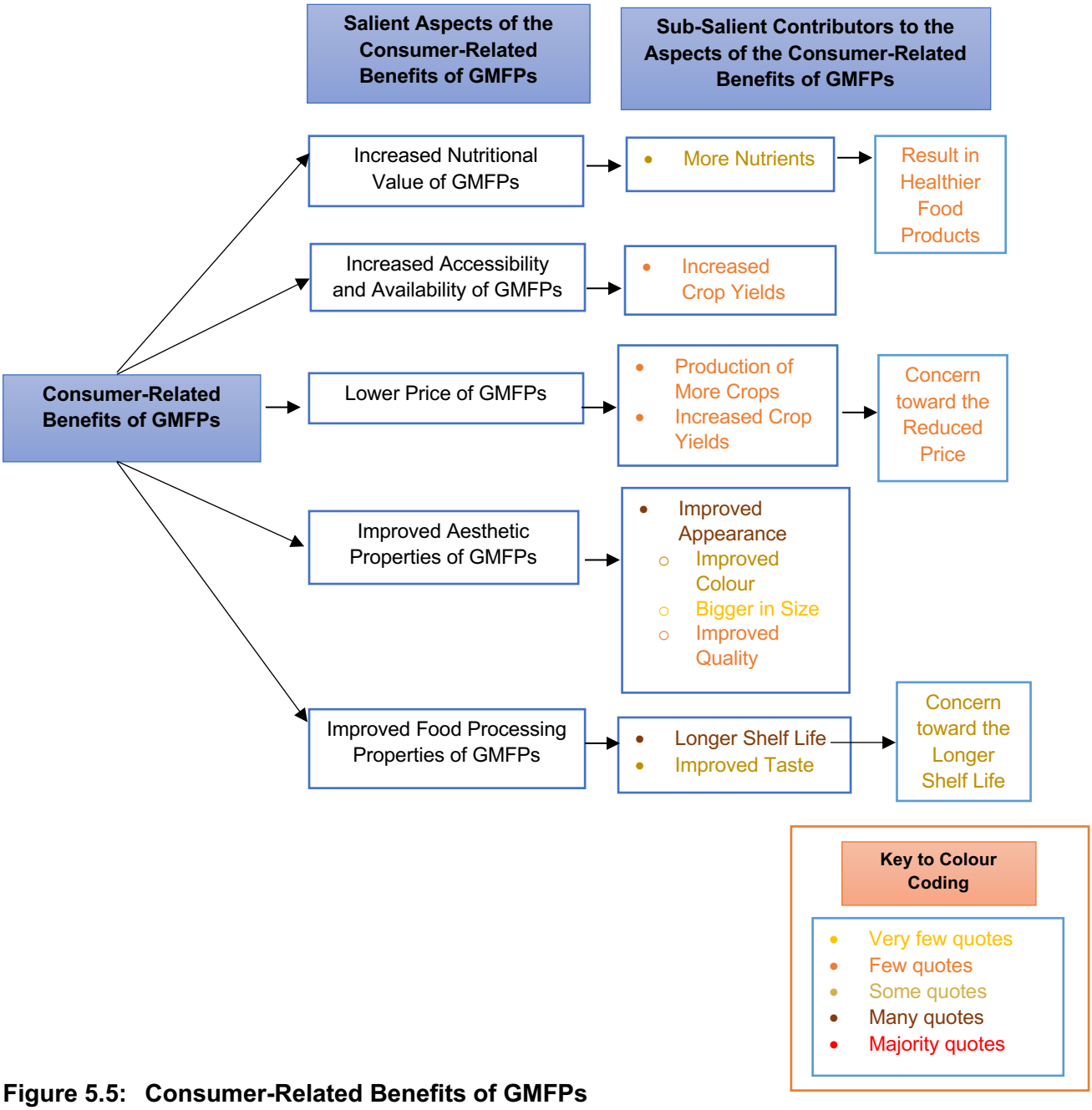

Figure 5.5: Consumer-Related Benefits of GMFPs

A study conducted in SA and the USA, respectively, acquired similar results in that consumers approved of the use of genetic modification if it was used to enhance the nutritional composition of the food (Peter & Karodia 2014; Wunderlich & Gatto 2015). Other studies in Georgia and Nigeria, respectively, also established that consumers associated GMFPs with increased nutritional value (Todua et al. 2015; Eneh et al. 2016). Regarding biotechnology's contribution to food products' nutritional value (Ghimire et al. 2023), Sendhil et al. (2022)

suggested that an appropriate use of biotechnology is to increase the nutritional content of food products, such as with Golden Rice©, thereby directly benefiting the health of consumers. This view was echoed by other authors who expressed that biotechnology can be used to enhance the nutritional value of GMFPs, which is an aspect consumers viewed favourably (Hefferon 2015; Nazir et al. 2018; Blagoevska et al. 2021; Rathod & Hedaoo 2022; Siddiqui et al. 2022; Abdoul et al. 2023). These consumer studies show that, generally, GMFPs were believed to have an increased nutritional content. It was further established that Chinese consumers believed GMFPs contained less fat than other food products (Jiang & Zhang 2021), but this aspect did not emerge from the data in the current study.

The enhanced nutritional traits of GMFPs led to a participant's belief that *"they can have application in just helping the vulnerable and perhaps those who are malnourished or undernourished"* and that consuming GMFPs *"can alleviate malnutrition"*, which is also a beneficial aspect of such food products. One participant made a particular reference to Golden Rice© in China, which was believed to be genetically modified to increase its nutritional value to contribute to alleviating vitamin A deficiency, *"which is a staple food"*, and therefore *"things like Golden Rice could be massively beneficial"* in addressing nutritional deficiencies. In terms of Golden Rice©, this variety of rice was developed through biotechnology to specifically assist in the fight against vitamin A deficiency and address malnutrition, which is a global issue (Van Acker et al. 2017; Muzhinji & Ntuli 2021). Another participant referred to maize, saying that *"they have added additional vitamins into maize"*, thereby aiming to demonstrate how additional nutritional value can be added to food products through genetic modification. However, *Bt* maize in SA has been GM for resistant purposes, not to promote nutritional content (Gbashi et al. 2021).

Due to the increased nutritional value believed to be coupled with GMFPs, a few participants believed GMFPs could be GM to be healthier in terms of consumption purposes. They mentioned that *"it's a more healthier product"*, *"it's healthier"* than its traditional counterparts, and *"some products could become healthier than what they originally are"* once components of food products have been genetically modified. Thus, having healthier food products emerged as a sub-salient aspect from the data, which could be attributed to the increased nutritional value believed to be associated with such food products. In other studies, it was found that Turkish and Malaysian consumers also believed they could benefit from GMFPs due to their belief that GMFPs were healthier (Ozdemir & Duran 2010; Hassan et al. 2016). It was also established that Flemish consumers supported GMFPs if their production could benefit human health (Gheysen et al. 2019). In addition to the role that increased nutrition plays in food products' health status, the reduced use of chemicals was also linked to the

beneficial health aspects of GMFPs. One participant emphasised it is beneficial because *"less herbicides and pesticides are put onto the food that we are eating"* in terms of GMFPs, which points to the reduced intake of harmful chemicals through food consumption. According to Van Acker et al. (2017) and Ala-Kokko et al. (2021), the reduced use of chemicals on GM crops, as well as pest management, decreases the amount of mycotoxins in the food, which, in turn, contributes to making GMFPs healthier.

Although the aspect lacked depth, as seen by the lack of sub-salient aspects, and was thus suggested not to be influential in the consumer-related benefits of GMFPs, the participants believed GMFPs have an increased nutritional value. The increased nutritional value was attributed to such food products having more nutrients, which was further believed to result in the development of healthier food products.

5.6.2 Increased Accessibility and Availability of GMFPs

Participants claimed that consumers have increased access to GMFPs in-store. They stated that *"you will have access to them"* and *"GMFPs are going to be a lot more accessible than farm fresh, holistic or organic items"*. It was believed that GMFPs *"are more readily available"* and *"they are what's usually available"* in the supermarkets because the genetic modification of food products *"allows food to be more readily available than it was before"*. As a result, *"we are finding greater quantities of genetically modified foods as opposed to non-genetically modified foods"*. Thus, **increased accessibility and availability of GMFPs** was a consumer-related beneficial salient aspect that emerged from the data and was attributed to the sub-salient aspect of increased crop yields. A few participants stated that *"higher yields"* or *"bigger yields"* can be achieved by producing GM crops, thereby allowing for *"more production"* of food products. A participant also believed that certain food products would be *"available for longer periods"* in supermarkets as *"they are not dictated by seasons"*. To illustrate this belief, avocados were used as an example by the participant: *"some people would, for instance, want avos in season when it's not avo season traditionally"*; thus, the participant believed that genetic modification could allow certain food products to be available to the consumer outside their respective season, which can be considered as an advantage. Evidently, the participant believed that genetic modification could contribute to and make it possible to have particular foods available throughout the year. In terms of the accessibility and availability of GMFPs, Malaysian consumers also believed that GMFPs could be made more readily available, which they also attributed to higher yields (Hassan et al. 2016). Harmony existed between authors who mirrored beliefs that the production of GM crops can lead to an increased availability of food products (Qaim & Kouser 2013; Dizon et al. 2016).

The data thus showed that increased accessibility and availability of GMFPs was a beneficial consumer-related aspect that participants associated with such food products. The benefit was ascribed to farmers' opportunity to attain higher yields through the production of GM crops. However, the increased accessibility and availability of GMFPs are suggested not to be influential in the consumer-related benefits of GMFPs due to the limited quotes and emergence of sub-salient aspects.

5.6.3 Lower Price of GMFPs

In addition to increased nutritional value, accessibility and availability coupled with GMFPs, the **lower price of GMFPs** was a further important, beneficial and salient aspect linked to GMFPs. Participants stated, *"they are definitely cheaper"* than conventional food products, and therefore *"you can't argue with how cheap it is to purchase foods that are GM foods"*. As a result, it was believed that *"it's more affordable to the public"* to purchase GMFPs as opposed to traditional food products. Three respective studies conducted in the USA, Nigeria and China established that GMFPs were considered cheaper by consumers than traditional food products (Kim & Fang 2020; Emmanuel et al. 2021; Jiang & Zhang 2021). Sendhil et al. (2022) echoed this finding by stating that consumers associated GMFPs with a reduction in price. American and SA consumers also approved of the application of technology in food production systems if they were used to produce lower-costing foods for consumers (Hossian et al. 2003; Peter & Karodia 2014). Various authors were of the opinion that GMFPs are coupled with a reduced price, which is an attractive feature to consumers (Dovey & Ntuli 2020; Prianto et al. 2020; Amin et al. 2021; Siddiqui et al. 2022; Alalwan et al. 2023). It also came to light in the data that, according to one participant, cheaper brands were associated as being GMFPs because *"the cheaper brands are generally the GM brands"*; therefore, *"if it's cheaper, it's immediately assumed that it's GMO-made"*. To this effect, a study established that consumers from Western countries associated food products sold at a lower price as being inferior to food products that are more expensive, such as in the case of GMFPs (Gheysen et al. 2019). Nevertheless, these consumer studies indicate that GMFPs were being sold at a lower cost.

In this study, the reduced price of GMFPs was attributed to sub-salient aspects such as the production of more crops and increased crop yields. In terms of producing more crops, a few participants believed *"more crops can be grown"* in terms of GM crops and *"because more crops are produced, the farmer can sell it at a lower rate"*. As a result, *"genetic modification has allowed for more mass production and therefore can keep cost down"*, which has subsequently resulted in *"reducing farmers costs as much as possible, therefore, they can sell it at a lower price"* when it comes to GMFPs. In terms of achieving increased crop yields, a

few participants believed that *"they are increasing their yield"* of GM crops and *"they are getting a bigger yield from their crops"*, therefore, *"they are getting more product" "which [then] makes it cheaper for consumers to purchase"* GMFPs. These beliefs were supported by Van Acker et al. (2017), who were of the opinion that increased yields and reduced production costs are considered to lead to the production of food products that can be sold at a lower price. Although the participants in this study were adamant that reduced price is a trait affiliated with GMFPs, the reduced price fuelled a sense of concern for a few participants. They stated that *"I'm wary of GMFPs due to their reduced price"* and *"it is always a red light for me when anything is remarkably cheaper than anything else on the shelf of a similar type of product"*; thus, *"there has got to be a reason why there is such a discrepancy in price"* when it comes to GMFPs. Therefore, concern about the reduced price of GMFPs emerged as a sub-salient aspect from the data.

Although a sense of concern was demonstrated about the lower price of GMFPs, the affordability of such food products emerged as an important aspect that consumers could benefit from. It was believed that the production of more crops and enhanced crop yields in the production of GM crops contributed towards reduced prices of GMFPs. Furthermore, based on the volume of quotes relating to the lower price of GMFPs, it is suggested that this aspect was a pertinent attribute and influencer in the consumer-related benefits of such food products.

5.6.4 Improved Aesthetic Properties of GMFPs

The data reflected that GMFPs are believed to be *"products that are more inviting"* and *"more appealing"* to the consumer. Such beliefs were supported by authors stating that the genetic modification of food products can make them more appealing to the consumer (Wunderlich & Gatto 2015; Nazir et al. 2018). As a result, **improved aesthetic properties** emerged as a salient aspect, coupled with the sub-salient aspect of improved appearance. Many participants believed that GMFPs have an *"altered appearance"*; therefore, these food products are *"better looking"* or *"prettier"* because *"they look better"* and are *"more perfect looking"* as opposed to other food products. It was further believed that GMFPs are *"less deformed"*, are *"more standard in look and shape"*, and *"have less blemishes"* than conventional food products. To illustrate this belief, a tomato was used as an example by one participant: *"a pretty tomato looks better than a lob-sided tomato, which is more attractive to people"*. Kubisz et al. (2021) concurred that food products are GM to improve their appearance, thereby making the food product more appetising to the consumer. Furthermore, consumers in Athens were also found to associate GMFPs with having a regular shape (Arvanitoyannis & Krystallis 2005).

In the current study, the improved appearance of GMFPs was further believed to be ascribed to sub-salient aspects, namely improved colour, being bigger in size, and having improved quality. In terms of improved colour, it was also believed by some participants that GMFPs have *"different colours"*, or *"better colours"* or *"look brighter"* than their traditional counterparts. To this effect, it has been suggested that changing the colour or improving the colour of food products is an alluring aspect that attracts consumers to GMFPs (Kubisz et al. 2021). However, one participant in this study believed that caution should be exercised when genetically modifying food products to change or enhance their colour by suggesting that *"it should not be done to the extent where it looks unnatural, artificial or fake"* and that *"it shouldn't look like it's radioactive or glowing"*. Therefore, *"there needs to be a regulating party that regulates what people do"* in terms of genetically modifying components of food products because *"we don't want to one day wake up and we've only got purple crops or that it's gone so far that we can't even recognise the crop anymore"*. The participant added that:

> *"There is a small portion of genetically modified food groups or foods that people are just playing with more than anything else. So, making your carrots purple and making your chillies a certain shape, making your watermelons a certain shape; I think there's a few things that are there just for gimmicks, just to make your product look different to others"*.

This could lead to taking genetic modification *"too far"*. Regarding the bigger size of GMFPs, very few participants believed that *"they are bigger"* or *"maybe larger"* than non-GMFPs; however, American consumers associated the word 'giant' with GMFPs (Lefebvre et al. 2019). With regards to the improved quality coupled with GMFPs, a few participants believed that *"a genetically modified crop is probably better than the original one"*, and GMFPs are of a *"better quality"*, are *"high quality goods"*, and thus deemed these food products as *"luxury items"* and *"good products"*. Various authors agreed that the application of biotechnology could assist in improving the quality of food products, which is an aspect that is enticing to consumers (Nazir et al. 2018; Shetty et al. 2018; Blagoevska et al. 2021; Gbadegesin et al. 2022; Sendhil et al. 2022). One participant believed that fruits and vegetables such as bananas, strawberries, tomatoes, and potatoes have enhanced aesthetic purposes, as these fruits and vegetables have *"changed over the last century"* in terms of their *"shape and appearance"* as *"the shape and appearance of a banana, strawberry and tomato for instance is vastly different to what it used to be"*, and:

> *"potatoes have a lighter skin, they are bigger, more watery, and in today's society, bigger and brighter and somehow better"*.

Although such fruits and vegetables were mentioned as examples to illustrate the improvement in their aesthetic traits, vegetables and fruits have not been GM in SA; only GM maize, cotton and soybean are produced in the country (African Centre for Biodiversity 2015b; Woolworths 2020; Kedisso et al. 2022).

The data thus showed that improved aesthetic properties were coupled with GMFPs as a consumer-related benefit of these food products, which the improved appearance of these food products contributed towards. It was further believed that improved colour and attaining a bigger-sized product with improved quality were linked to the improved appearance of GMFPs. Based on the extent of elaboration and depth of data (evident in the volume of sub-salient aspects), it is proposed that the improved aesthetic properties of GMFPs contributed to consumer-related benefits of these food products. Based on the prominence of improved appearance due to the volume of quotes, the sub-salient aspect specifically emerged as an important attribute to the participants.

5.6.5 Improved Food Processing Properties of GMFPs

In addition to the improved aesthetic features of GMFPs, **improved food processing properties** also emerged as a salient aspect from the data in terms of the consumer-related benefits of GMFPs, attributed to sub-salient aspects such as a longer shelf life and improved taste. In terms of longer shelf life, many participants believed that a longer shelf life was a feature coupled with the genetic modification of food products, because it *"extends the shelf life of food"* and *"improve[s] shelf life"*. Therefore, GMFPs *"last[s] longer"* on the shelf than conventional food products. Similar findings were echoed in a study conducted in London, which established that consumers believed increased shelf life was a benefit of GMFPs (Popek & Halagarda 2017). A study in Ghana also found that longer shelf life was linked to GMFPs (Owusu-Gyan et al. 2023), and American consumers similarly approved of biotechnology if it was used to produce foods that could last longer (Hossian et al. 2003). It has, therefore, been suggested that longer shelf life is an attribute of GMFPs that is particularly appealing to consumers (Nazir et al. 2018; Dovey & Ntuli 2020; Olabinjo et al. 2020; Gbadegesin et al. 2022; Sendhil et al. 2022; Siddiqui et al. 2022; Abdoul et al. 2023). Coupled with longer shelf life, it has also been suggested that the delayed ripening of food products is another attractive attribute of GMFPs that consumers can enjoy (Nazir et al. 2018).

Even though longevity was linked to GMFPs, it did spark some concern among some of the participants as it was stated that:

> *"I'd be wary as a consumer if my vegetables didn't go off. It makes me a little bit nervous when something survives in the fridge for two months – that is unusual"*.

As a result, *"I'm a little bit sceptical because how would that be achieved?"* and *"how is it able to last this long?"* It was believed that food products *"should have an expiry date, [and that] they should go off"*. Due to the longevity coupled with GMFPs, participants believed that such food products could be *"weird, mutant food that never goes off"*. Therefore, after the longevity of GMFPs, concern toward the longer shelf life of these products emerged as a sub-salient aspect from the data. In support, American consumers coupled the word 'mutant' with GMFPs (Lefebvre et al. 2019).

In addition to a longer shelf life being coupled with GMFPs, some participants believed that improved taste was also linked to such food products. They shared that the genetic modification in food production *"enhances [the] taste"* of food products and, as a result, *"they taste better"*. It was also believed that a GMFP is a *"sweeter food product"*. These findings were echoed in Malaysia, Australia and China, where results showed that consumers believed they could benefit from the improved taste and flavour of GMFPs, and this attribute was thus considered an alluring feature to consumers (Hassan et al. 2016; Bray & Ankeny 2017; Dovey & Ntuli 2020; Jiang & Zhang 2021; Sendhil et al. 2022). Another study in SA found that consumers felt an appropriate use of biotechnology was to enhance the taste of food products (Peter & Karodia 2014), which could still be the case, as seen in the findings of the current SA study. Furthermore, to demonstrate the GMFPs' improved taste, one participant referred to a tomato, stating that:

> *"genetic modification makes a tomato's flavour to become enhanced to maybe taste like a bit of a seafood tang to it"*.

The belief that GMFPs had an improved taste led to another participant's belief that they are *"better"* than their traditional counterparts, as *"it gives you the opportunity to have a better taste of a same product, for example, a better tasting tomato"*. In saying that, the individual participant believed that *"not every single genetically modified food product would be better than the generic"* and *"it doesn't necessarily mean if it's genetically modified, then it's better"*. Again, tomatoes were used as an example to illustrate the improved taste of GMFPs. However, although the first food to undergo genetic modification was a tomato, known as the Flavr Savr™ Tomato, tomatoes have not been GM in SA, and no GM vegetables or fruits are available for purchase and consumption purposes in SA (African Centre for Biodiversity

2015b; Woolworths 2020; Blagoevska et al. 2021; Kedisso et al. 2022). Australian consumers were also found to incorrectly identify tomatoes as being GM in their country (Cormick & Mercer 2017).

Even though improved taste emerged as a beneficial characteristic of GMFPs, a participant believed that the taste of original food products should not be *"significantly altered"* to the extent that *"certain qualities are sacrificed to enhance others"*. It has been suggested that consumers were concerned that genetic modification could alter the taste and texture of native foods; an aspect that could cause opposition towards GMFPs (Sendhil et al. 2022). In addition to improved taste, a study in Malaysia found that consumers perceived the aroma of GMFPs was improved (Hassan et al. 2016), but this aspect did not emerge from the data in the current study.

Improved food processing properties were a further beneficial trait associated with GMFPs, in addition to their improved aesthetic properties. Based on the extent of elaboration, as evident in the volume of sub-salient aspects that emerged, improved food processing properties played an important role in the consumer-related benefits of GMFPs. The longer shelf life and improved taste of GMFPs were also linked to the improved food processing properties of these food products; however, concern was shown among the participants in terms of the longevity of GMFPs. Considering the prominence of the sub-salient aspect through the volume of quotes relating to longer shelf life, it is proposed that the longevity of GMFPs was a pertinent attribute of such food products.

5.6.6 Summary of the Consumer-Related Benefits of GMFPs

To add to the most salient aspects that emerged from Themes 1 and 2, the most salient consumer-related beneficial aspects that contributed to Theme 3 are summarised in Table 5.5.

Table 5.5: Summary of the Most Salient Beliefs Aspects of Themes 1 to 3

Theme	Salient Belief Aspects of GM Crops and GMFPs					
Theme 1: Altered State of Existence	Biological Change	Unnatural State	Technological Intervention	Conflicting Religious Belief	Product Feature Enhancement	
Theme 2: GM Crop Production Benefits	Environmentally Friendly	Weather Resistance	Resistant Characteristics	Increased Productivity	Increased Farmer Profitability	Promoting Food Security

Theme	Salient Belief Aspects of GM Crops and GMFPs					
Theme 3: Consumer-Related Benefits of GMFPs	Increased Nutritional Value	Increased Accessibility and Availability	Lower Price	Improved Aesthetic Properties	Improved Food Processing Properties	

As illustrated in Table 5.5, the participants believed that genetic modification encompasses an altered state of existence (Theme 1), but there were benefits to producing GM crops (Theme 2). It was also believed that GMFPs offered consumer-related benefits, such as increased nutritional value, increased accessibility and availability, lower price, and improved aesthetic and food processing properties, as emphasised in Theme 3.

It has been suggested that consumers can enjoy various benefits from purchasing and consuming GMFPs. Among these benefits, the consumption of nutritious and healthy food products at an affordable price, having increased access to food products due to the increased availability of such food products, and being able to enjoy better looking, better tasting and longer lasting food products were mentioned; all of which is suggested to drive consumers towards GMFPs (Qaim & Kouser 2013; Hefferon 2015; Hassan et al. 2016; Shetty et al. 2018; Dovey & Ntuli 2020). Consumer attitude studies toward GMFPs illustrated the lower price of GMFPs, increased nutrition, being healthier than other food products, having an improved quality, increased availability, looking and tasting better are considered determining factors in consumers' attitudes toward such food products (Morris & Adley 2000; Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Lopez et al. 2016; Rzymski & Krolczyk 2016; Ghoochani et al. 2017; Jonker 2017; Deng et al. 2019; Amin et al. 2021). It has also been proposed that the various benefits associated with GMFPs could have a positive influence on consumers' attitudes toward these products (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Ghoochani et al. 2017). This SA study suggests that the most salient and sub-salient consumer-related beneficial aspects of GMFPs that emerged from the data were features meriting GMFPs, favourably influencing attitudes and encouraging an acceptable and optimistic attitude toward GMFPs. A summary of the most salient and sub-salient aspects of consumer-related benefits of GMFPs and its proposed influence on their perceived attitude towards such food products can be seen in Figure 5.6.

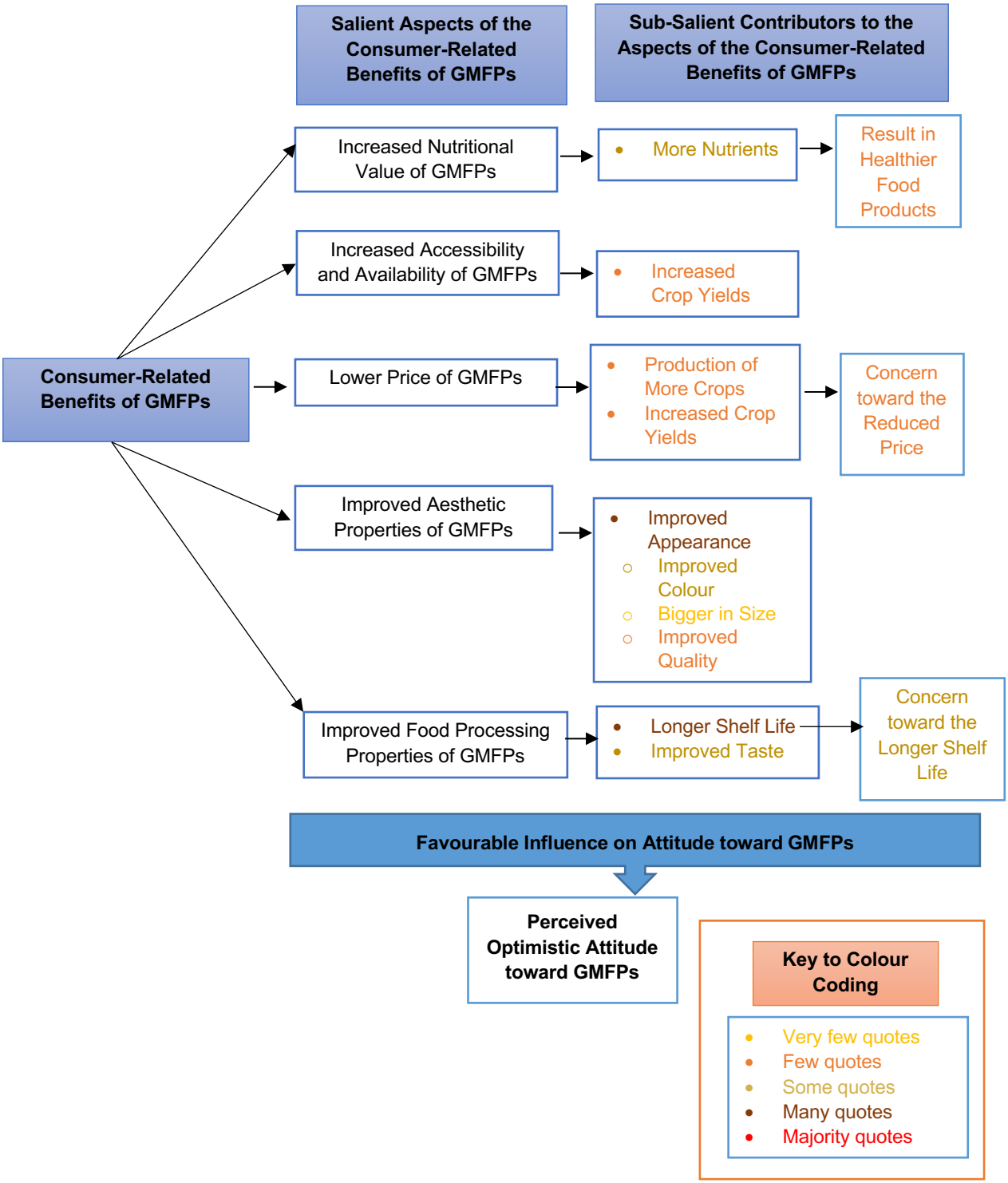

Figure 5.6: Consumer-Related Benefits of GMFPs and its Proposed Influence on the Perceived Attitude toward GMFPs

Figure 5.6 illustrates that, from this theme, the consumer-related beneficial aspects of GMFPs propelled the participants to adopt a perceived optimistic attitude towards such food products. This could be promising for the GM food industry in terms of using GMFPs to enhance the food security status of the SA population and achieve SDG 2: Zero Hunger.

The depth of participants' elaboration, as evident in the volume of quotes and salient and sub-salient aspects that emerged from the data suggest the consumer-related benefits of GMFPs played a pertinent role in the participants' beliefs about such food products. It is further suggested from the depth of data regarding GM crop production's benefits and GMFPs' consumer-related benefits that the beneficial aspects of GMFPs play a pertinent role in influencing participants' beliefs regarding GMFPs.

In the next theme, the risks and concerns of producing GM crops are discussed.

5.7 THEME 4: RISKS AND CONCERNS OF GM CROP PRODUCTION

Although the participants believed that there are both production and consumer-related benefits associated with GM crops and food products, the data reflected that they also believed there are risks and concerns associated with GM crop production. The most salient risks and concerns coupled with GM crop production and the sub-salient contributing aspects to such risks and concerns, which emerged from the data, are illustrated in Figure 5.7.

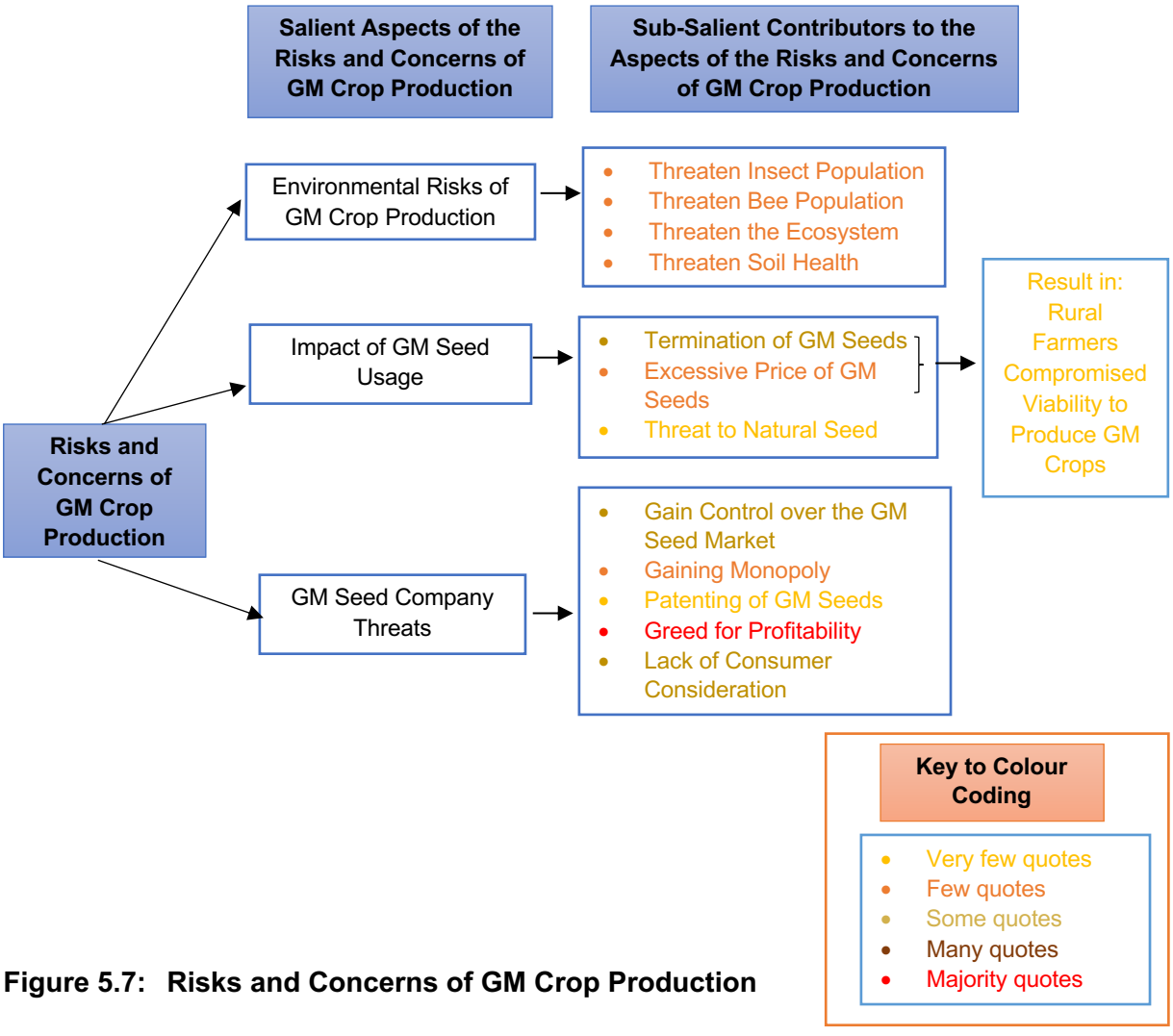

Figure 5.7: Risks and Concerns of GM Crop Production

As depicted in Figure 5.7, three salient aspects of the risks and concerns of GM crop production were identified from the data, namely environmental risks, the impact of GM seed usage, and GM seed company threats. These three salient aspects are subsequently discussed.

5.7.1 Environmental Risks of GM Crop Production

Although participants believed that the production of GM crops is environmentally friendly and could contribute to protecting the environment (see Section 5.5.1), a contrasting belief emerged in terms of the possible environmental risks associated with the production of GM crops. **Environmental risks of GM crop production** emerged as an important salient aspect from the data, which was particularly concerning to the participants because *"we need the environment",* and the environment needs to be protected, otherwise *"there won't be any of the nature left for our grandchildren to see"*. A body of authors complemented the environmental concern demonstrated by the participants in this study; it has been suggested that negative environmental effects and degradation due to GM crop production was an aspect that caused opposition towards such crops among consumers (Siipi 2015; Ghanian et al. 2016; Ruth & Rumble 2019; Prianto et al. 2020; Sendhil et al. 2022; Siddiqui et al. 2022; Abdoul et al. 2023; Alalwan et al. 2023; Ghimire et al. 2023; Zhaleh et al. 2023). Consumers from India, Georgia and Sweden were also of the opinion that GM crop production could potentially be harmful to the environment (Kajale & Becker 2014; Todua et al. 2015; Pakseresht et al. 2021), while another study conducted in Europe concluded that consumers were apprehensive towards the effect that GM crops could have on nature (Aleksejeva 2014). However, numerous organisations have agreed that, based on research, the production of GM crops does not pose environmental risks (Gbashi et al. 2021; Redden 2021). Nevertheless, consumer studies determined that consumers are concerned about the possible harmful effects that the production of GM crops could have on the surrounding environment.

In the current study, environmental risks were ascribed to sub-salient aspects such as threatening the insect population, the bee population, the ecosystem and soil health. In terms of the risk towards the insect population through the production of GM crops, a few participants believed that *"it will have an impact on the insect life around them"*; *"insect population could be affected, which is necessary for pollination in the environment"*; and *"it can discourage certain insects and encourage other insects"*, leading to *"an imbalance in the environment"*, which *"could be detrimental"* to maintaining harmony within the environment. Echoed by a study in Turkey, consumers were dubious of GM crops as they felt the production of such crops could compromise the ecological balance (Sanlier & Sezgin 2020). Consumers in

London highlighted that an additional environmental aspect that concerned them was the creation of species-specific toxins that are believed to have a harmful effect on the environment (Popek & Halagarda 2017).

Regarding the threat towards the bee population, a few participants believed that *"after pollinating GMO plants, some bees have digestion problems, and that kills the bees' population"*; that *"these seeds are filled with chemicals, which kills the bees"*; and that *"the modification of some plants means that it reduces the food available for bees"*. Therefore:

> *"the problem with genetic modification is that you are breeding out things that are important to the environment, like food production for bees"*.

Concerns have been raised about GM crop production's negative influence on bee pollinators, which could be attributed to a decrease in the availability of food for bees (Arpaia et al. 2021). Neglecting to protect the bee population led to the belief that *"a problem in our food supply in terms of actually pollinating things"* could occur *"because if we have no bees, there is no pollination"*, thus:

> *"if there are no bees, we might as well say goodbye to the earth because there will be no pollen production and no natural foodstuffs made because the bees will be gone"*.

Evidently, bees are believed to be "*the worlds' life blood"* because *"they pollinate virtually everything"*. Therefore, *"if there weren't any bees, the world would collapse"*. As a result, it was believed that a threatened bee population could be detrimental to the well-being of the environment because *"bees are essential to the environment"*. This view was supported by Arpaia et al. (2021), who stated that bees are vital to sustaining life. Other studies concurred that the impact of GM crop production on the bee population is concerning to consumers (Dovey & Ntuli 2020). Concern has also been demonstrated towards the harmful effect that the production of GM crops could have on the Monarch butterfly population (Raman 2017; Zennah & Cyrus 2019; Aziz et al. 2022; Ghimire et al. 2023). In terms of GM crop production's harmful effects on the environment, American consumers added that they believed the production of GM crops was risky to all living things; while another study conducted in Turkey found that consumers were of the opinion that biodiversity would be decreased if GM crop production increases (Wunderlich & Gatto 2015; Sanlier & Sezgin 2020). Various authors have thus agreed that consumers are concerned that biodiversity could be threatened by the production of GM crops (Ghanian et al. 2016; Taheri et al. 2017; Van Acker et al. 2017; Russo et al. 2020; Pakseresht et al. 2021; Aziz et al. 2022; Ghimire et al. 2023).

A few participants believed there is a threat towards the ecosystem, since *"the chemicals sprayed on GM crops are harmful to the ecosystem"* because the chemicals sprayed on GM crops *"washes into the rivers when it rains, which can be harmful to the ecosystem"* and *"put ecosystems at huge risk"*. Damage to the ecosystem has been raised as a concern among consumers regarding the production of GM crops (Ghoochani et al. 2017). In the context of threatening soil health, it was believed by a few participants that:

> *"you are sort of production-orientated that the GM crop or the GM seed is allowing you to farm without all the right building blocks in place for the farming operations, so you are neglecting the soil health"*.

It was further stated that, in terms of producing crops, *"it's going to lead to industrial farming on a different level to the current commercial farming where soil health is neglected"* and that:

> *"in the past you would be able to plant a certain crop and then the soil will rest for a year and then you will plant that crop again, whereas now, you are planting a crop and, because it grows so quickly, you are able to take it off and put another crop on and then you are not giving the soil enough time to rest"*.

Thus, participants believed that the soil does not have a sufficient amount of time to recover after growing GM crops, therefore, *"there is, to an extent, environmental issues that come with genetically modified crops"*. Similar beliefs were reported by consumers in China who were sceptical about producing GM crops due to the possible harmful effect their production could have on soil surroundings (Ma 2015).

In this study, one participant believed that *"they've made crops more resistant to pesticides so that they can use more pesticides in order to control the growth of weeds, and they can use it more"*, which *"is harmful to the environment"*. Thus, *"the biggest danger is the weeds and the resistance to weed killers and the strong, harmful chemicals that would then have to be used to kill the weeds"*, believed to contribute to the creation of *"super weeds"*, which was attributed to the *"use of stronger weed killers"*. It has been suggested that the production of GM crops could encourage the creation or emergence of super weeds and resistance to weed chemicals, causing concern among consumers and that resistance to weed chemicals has thus been raised as a concern regarding the production of GM crops (Maghari & Ardekani 2011; Ghanian et al. 2016; Ghoochani et al. 2017; Taheri et al. 2017; Van Acker et al. 2017; Dovey & Ntuli 2020; Sendhil et al. 2022). In addition to the link consumers made between

chemicals and weed resistance, another participant believed that it could lead to possible river contamination because GM crops are:

> *"very harmful to the environment because now you are putting all the chemicals and things in the soil, you spray crops with pesticides, so when it rains, it will be washed into the rivers"*.

It was believed that this then contaminates the water and *"gets into the food chain"*. Another participant claimed *"chemicals are being abused"*, which can *"be damaging to the environment"*. Although resistant traits inserted into the genetic makeup of GM crops were believed to be beneficial attributes, as discussed in Section 5.5.3, one participant shared that the resistance to pests *"could create resistance to other aspects within the environment"*. The creation of resistant pests, through the production of GM crops, has been an environmental concern that various authors have highlighted (Zhang et al. 2016; Van Acker et al. 2017).

An individual participant further believed that GM crop production *"is obviously about monoculture"* being *"an issue"* as *"you are reducing the genetic diversity by promoting monoculture crops"*. Other authors concur this is a potential concern regarding the production of GM crops (Van Acker et al. 2017; Rodriguez et al. 2022). One participant also believed that gene jumping was an issue when growing GM crops:

> *"GMO genetics can jump from one maize to another maize that is not GMO and contaminate that, which can then genetically contaminate the environment. What do we do when we have genes jumping?"*

A participant stated that *"there is a big issue with cross-pollination where genetically modified genes were then being introduced into non-GM crops"*, thereby showcasing their concern towards possible cross-pollination between GM and non-GM crops. Numerous authors have highlighted that the potential gene flow and cross-pollination between crops could be a potential risk when growing GM crops (Ghoochani et al. 2017; Van Acker et al. 2017; Karalis et al. 2020; Pakseresht et al. 2021; Sendhil et al. 2022). An additional environmental aspect consumers in Turkey mentioned was the biological pollution linked to GM crop production (Kaya et al. 2014); however, this did not emerge as a concern in the current study.

The belief that the production of GM crops could have environmental risks led one participant to believe that other farming methods need to be considered because GM crops are *"sort of interfering with nature a lot more on a microscopic level than normal seed development"*.

Alternative methods such as *"agro-ecology"* were suggested by the participants, *"which is more like agriculture plus the ecology and ecosystems"*, and therefore *"having a symbiosis of the two"* can benefit *"our ecology"*. The participant added that additional farming methods need to be considered, such as *"organic"*, *"biodynamic"*, *"principles of permaculture",* and *"urban agriculture",* which refers to *"growing close to the cities"*. A study executed in China found that consumers were similarly concerned about the effect that GM crop production could have on the ecology of the environment (Ma 2015).

The data also showed that threats to the insect population, bee population, the ecosystem and soil health contributed to the environmental risk associated with GM crop production. This suggests that the well-being of the environment was important to the participants, potentially attributed to their residential location where they were surrounded by an agricultural community. Based on the extent of elaboration, as seen in the volume of sub-salient aspects that emerged from the data, it is suggested that environmental risk played an influential role in participants' beliefs about the risks and concerns related to producing GM crops.

5.7.2 Impact of GM Seed Usage

The data reflected the salient aspect that there is an **impact of GM seed usage** among farmers when producing GM crops. This was attributed to the sub-salient aspect of the termination of GM seeds as some participants believed that *"there is concern that local small farmers will not be able to utilise their own seed"*, particularly since *"GM seed is not viable for the next season"*, meaning that the farmer *"grows a whole crop and can't plant that seed again"*. Thus, GM crops are *"a crop that doesn't produce seeds that can then produce a yield again for the farmer"*; as a result, GM seeds are *"terminator seeds"*. Due to the termination of GM seeds, GM technology has been referred to as 'terminator gene technology' (Islam et al. 2020). It has also been suggested that consumers consider the inability to regrow GM seeds as a significant drawback of producing GM crops (Akumo et al. 2013; Wray 2021; Aziz et al. 2022). In this study, opposition was shown towards the termination of GM seeds as *"plants are supposed to be able to reproduce"*, therefore *"the farmer then needs to keep buying seeds from the company"*, which then translates into *"you becoming locked into buying seeds from companies", "such as Monsanto"*. A participant summarised that *"the biggest problem with GM foods actually is that Monsanto has terminated the seed"*. Such beliefs were echoed by Zilberman et al. (2018) as well as Aziz et al. (2022), who stated that producers have to purchase GM seeds from specific, legitimate companies. GM crop producers are further required to sign agreements and pay a royalty fee to GM seed companies, thereby agreeing not to re-plant the GM seeds on a second occasion (Francescon 2006; Farm Aid 2016).

Opposition to the termination of GM seeds was further illustrated by one participant stating that:

> *"There are governments who are trying to tax solar panel, that's ridiculous, because the sun is free from God. How can you sell the sun to people? And there are governments that are trying to tax the rainwater that falls on your roof, it's not their water, it comes from God. So the sun, the rain and seeds are our gift from God, how can you now terminate it and then force people to buy seeds?"*

The termination of GM seeds was thus *"highly opposed"*. Coupled with the termination of GM seeds, another sub-salient aspect that emerged from the data in terms of GM seed usage was the excessive price of GM seeds. A few participants believed that *"it's rather expensive to buy these seeds"*, that *"they are expensive"* to purchase, and that *"farmers are forced always to buy the expensive seed stock"* because of their inability to regrow. Such concerns were complemented by various authors who stated that the excessive price of GM seeds has caused consumer apprehension towards genetic modification and GMFPs (Azadi et al. 2016; Ghanian et al. 2016; Lemarie et al. 2017; Taheri et al. 2017). A few participants said that the termination and excessive cost of GM seeds could have repercussions on *"developing countries"* as *"poorer farmers aren't able to retain seed and grow from them"*, which could potentially not make the production of GM crops a financially viable option for *"rural"* farmers. It was summed up that:

> *"on a continent where we've got a lot of subsistence farmers, I think it's diabolical that some seed is not viable to regrow the next season"*.

Therefore, concern about rural farmers' compromised viability to produce GM crops emerged as a further sub-salient aspect from the data as a result of the termination and excessive price of GM seeds. Bonny (2017) and Van Acker et al. (2017) expressed a similar concern that the price of GM seeds could be unaffordable to small-scale farmers, while Taheri et al. (2017) was of the opinion that the accessibility of GM seeds is an issue for the GM seed market. Such aspects could be seen as threatening the rights of farmers (Pakseresht et al. 2021). Although it was believed that the price of GM seeds was excessive, some consolation was found by one participant in the fact that GM farmers could receive financial backing from the government to grow such crops because:

"sometimes subsidies are given out to people who are doing experimental crops or introducing it, so there could be a benefit from that side for farmers in terms of meeting their budgets".

Subsidies can thus give farmers the opportunity to incorporate GM crop production into their farming practices. Therefore, the Land Bank of SA provided financial support to rural farmers in SA to grow GM crops (Wray 2021).

Another sub-salient aspect that emerged from the data regarding the use of GM seeds was the belief that the conservation of natural seed banks could become threatened, as very few participants believed that *"the biggest problem is that it will have a big impact on a variety of things including the natural seeds"* and *"referring to the natural seed bank, it can have an effect"*. Various authors echoed similar concerns and expressed that the variety of seed sources may become threatened by the production of GM crops, which could result in the reduced production of other crop varieties, which has been raised as an issue among consumers (Bonny 2017; Van Acker et al. 2017; Islam et al. 2020). It was thus suggested by a participant that *"scientists need to ensure that the normal, natural seed source is not lost before it's too late"* and that *"there is something to be said for keeping some natural, non-modified organisms around and making sure that they remain to be cultivated"*.

The impact of GM seed usage was linked to GM crop production since the inability to regrow GM seeds and the excessive price of GM seeds was further believed to compromise rural farmers' ability to incorporate GM crop production into their agricultural systems. This could have been concerning to these participants as they were surrounded by farmers, which could have made them particularly sensitive toward GM seeds' impact on farmers. A concern that natural seed banks could be threatened by producing GM crops was further demonstrated among the participants. These views could be considered as potential drawbacks to growing GM crops. Considering the depth of data (based on the volume of sub-salient aspects), it is suggested that the impact of GM seed usage was an important and influential aspect linked to the risks and concerns of GM crop production.

5.7.3 GM Seed Company Threats

The environmental risks and impact of GM seed usage concerns, coupled with the production of GM crops, were accompanied by another important salient aspect that emerged from the data, namely the potential **threat GM seed companies** pose to the GM seed market. It was believed that GM seed companies seek to gain control over the GM seed market; this sub-

salient aspect emerged from the data. It was believed by some participants that *"GM seed banks could end up being over-run by one or two large companies"* and therefore *"global-domination by certain firms"* could occur, and is thus a concern. This was attributed to the belief that, in terms of GM seeds, *"they are bred and hybridised by companies who then control production and distribution"*, thereby contributing to *"the concern that corporates are taking over and stamping their own, larger footprint and expanding their footprint"* when it comes to GM food production. As a result, there is a *"control mechanism involved"* in the selling of GM seeds. It has been expressed that the sale of seeds is controlled and dominated by a handful of seed companies, which is an aspect consumers feel uneasy about (Dibden et al. 2013; Van Acker et al. 2017). Therefore, these companies are often considered to hold great power (Bonny 2017). In the SA context, Monsanto is one of the biggest companies selling GM seeds (Fischer 2021).

Sub-salient aspects believed to contribute to GM companies' threat over the GM seed market included gaining a monopoly, the patenting of GM seeds, and greed for profitability. In terms of GM companies gaining monopoly, a few participants believed that *"they have monopoly on production of these food types"*, they have *"a complete monopoly"*, and that GM companies can *"get a monopoly on the system"*, particularly referring to the food production system. Gaining such control and monopoly could potentially lead to GM seed companies having the ability *"to manipulate the market"*, which could eliminate *"free-trade"* in the GM seed industry. Authors have agreed that a concern linked with the GM seed market is that monopolies could be created; this market could be manipulated by large companies as competition in the industry is limited (Bonny 2017; Van Acker et al. 2017; Pakseresht et al. 2021; Aziz et al. 2022). In the current study, it was further believed by a participant that GM seed companies have retained great power as *"one of the most powerful things is owning the food because people get desperate without food"*, and therefore people have no choice but to *"support these companies"*, thereby fuelling their power. In support, Bonny (2017) stated that consumers have shown concern that companies who sell GM seeds could gain the power to eventually have complete control of the food chain. Consumers are also concerned that if seed companies dominate the food industry, they could dictate the production of food, which could result in consumers not having the option to choose food products they wish to purchase and consume, such as conventional food products (Dibden et al. 2013). One participant also associated the acquisition of control and power with the fact that *"these companies are trying to hide something"*, thereby making them hesitant towards GMFPs. The fact that GM seeds are owned by only a few companies, such as Corteva, Syngenta, Bayer, Monsanto, Dow and Du Pont has contributed to consumers' apprehension towards GMFPs (Raman 2017; Muzhinji & Ntuli 2021; Redden 2021; Aziz et al. 2022).

Regarding the patenting of GM seeds, it was believed by very few participants that companies could *"patent certain genes that have been used in plants"*, and thus *"there are probably potential evils that could emerge too"* from producing GMFPs. It was further stated that:

> *"if one company has got to develop a certain seed that is engineered with a certain gene, and one of their scientists worked on it and so on, and they patent it to the exclusion of any other company using it, that could be a problem in terms of being true to your intent of securing food for people as a whole – its more an indication of perhaps maybe selfishness"*.

Therefore, patenting could contribute to the acquisition of GM seed companies' control and power. It has been suggested that intellectual property rights over GM seeds were a concern showcased by farmers, while patent infringement also posed an issue for companies selling GM seeds (Van Acker et al. 2017; Pakseresht et al. 2021; Aziz et al. 2022).

In terms of greed for profitability, a majority of the participants believed that *"through patenting, the greed of man comes through"* and that companies *"such as Monsanto"* are greedy in terms of being fixated on making large profits from the selling of GM seeds, because *"they have crossed a line of commercial greed to some extent, they are exploiting GM seed"*. As a result, it was believed that *"large agricultural, international companies"*, such as *"Monsanto"* are money-driven as they are *"controlling"* the selling of GM seeds as well as the cost of seeds, and *"there is a greed behind genetically modifying seed and products"* because "*the push is really on making profits and capitalising that"*, *"maximising production and profits"* and *"to increase money"*. Such beliefs were supported by Bonny (2017), who suggested that large companies are selling GM seeds at excessive prices for their own financial gain. A study in China also determined that consumers opposed the adoption and production of GM crops, particularly due to their concern that businesses are using the industry to line their own pockets (Deng et al. 2019).

The consumer was also linked to the financial gain of GM seed companies as some of the participants believed *"the producers, the people selling the products"* are trying to *"catch"* consumers in order to financially benefit from GMFPs because:

> *"the more they are able to target the customers, and the consumers purchase their goods – no matter if the product is good or bad for them – they will be benefiting in the long run, because they will be able to sell more and more products"*.

Subsequently, it was believed that *"it's not about the consumer for them, it's about the greed aspect, it's about the profitability"*, which:

> *"shows an underlying issue towards not protecting the consumers and not caring about the consumers, and it's more about the producers making money and getting the most that they can at the risk of consumers"*.

Instead of being money-driven:

> *"companies that engage in it should also be aware of their dutiful responsibility to the work that they are doing and modifying plants in order to ensure that there are not potential hazards to consumers"*.

The belief that the control and power of GM seed companies override the well-being of consumers led to one participant's belief that GM seeds have fallen *"in the wrong hands"*, which is a *"big red flag"*, and that *"we cannot trust these companies"*. Evidently, a lack of consumer consideration on behalf of GM seed companies emerged as a sub-salient aspect of the data in terms of producing GM crops.

The data thus showed that there was a threat coupled with GM seed companies, attributed to their ability to gain control over the GM seed market, thereby gaining a monopoly, while being able to patent GM seeds. This illustrates their greed for profitability and lack of consideration for the consumer in the process. The depth of data, through the volume of sub-salient aspects, proposes that GM seed company threats were influential in participants' beliefs about the risks and concerns linked to GM crop production. Based on the prominence of the sub-salient aspect (due to its volume of quotes), it is suggested that GM seed companies' greed for profitability was the most important attribute participants linked to the threat of such companies.

5.7.4 Summary of the Risks and Concerns of GM Crop Production

In Table 5.6, the main salient aspects of Theme 4, namely the risks and concerns of GM crop production, in addition to the salient aspects of Themes 1 to 3, are presented.

Table 5.6: Summary of the Most Salient Beliefs Aspects of Themes 1 to 4

Theme	Salient Belief Aspects of GM Crops and GMFPs					
Theme 1: Altered State of Existence	Biological Change	Unnatural State	Technological Intervention	Conflicting Religious Belief	Product Feature Enhancement	
Theme 2: GM Crop Production Benefits	Environmentally Friendly	Weather Resistance	Resistant Characteristics	Increased Productivity	Increased Farmer Profitability	Promoting Food Security
Theme 3: Consumer-Related Benefits of GMFPs	Increased Nutritional Value	Increased Accessibility and Availability	Lower Price	Improved Aesthetic Properties	Improved Food Processing Properties	
Theme 4: Risks and Concerns of GM Crop Production	Environmental Risks	Impact of GM Seed Usage	GM Seed Company Threats			

Table 5.6 depicts that an altered state of existence was coupled with genetic modification, and there were GM crop production and consumer-related benefits coupled with GMFPs, as illustrated in Themes 1 to 3. However, the data also showed in Theme 4 that the participants coupled risks and concerns with GM crop production, such as environmental risks, the impact of using GM seeds, and the threat posed by GM seed companies.

Regarding these salient aspects that emerged from the data in terms of GM crop production, consumers appear concerned about the possible risk GM crop production could impose on the environment (Ghanian et al. 2016). They also harboured concerns about the acquisition and growing challenges linked to GM seeds as well as the potential domination that GM seed companies could ultimately gain by controlling the GM seed market and selling GM seeds at unaffordable prices (Van Acker et al. 2017; Wray 2021). In consumer attitude studies in the GM context, environmental hazards such as the interference with wild species; harming the ecosystem; resistance to weeds; gene flow to other plants; and the profits made by GM companies were used as factors in previous studies to explore consumers' attitudes towards GMFPs (Morris & Adley 2000; Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Lopez et al. 2016; Rzymski & Krolczyk 2016; Ghoochani et al. 2017; Jonker 2017; Deng et al. 2019; Amin et al. 2021). It has been posited that the potential risks linked to GMFPs could affect consumers' attitudes toward GMFPs in a negative manner (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Ghoochani et al. 2017). In the current study, it is proposed that the most salient and sub-salient aspects of the risks and concerns related to GM crop production could conflict with the participants' attitudes toward GMFPs. The harmful aspects associated with such food products could be influencing their

attitude in an unfavourable way, leading to a perceived threatened attitude toward GMFPs. The most salient risks and concerns associated with the production of GM crops, as well as their contributing sub-salient beliefs, and the proposed influence it could have on the participants' perceived attitude toward GMFPs, can be seen in Figure 5.8.

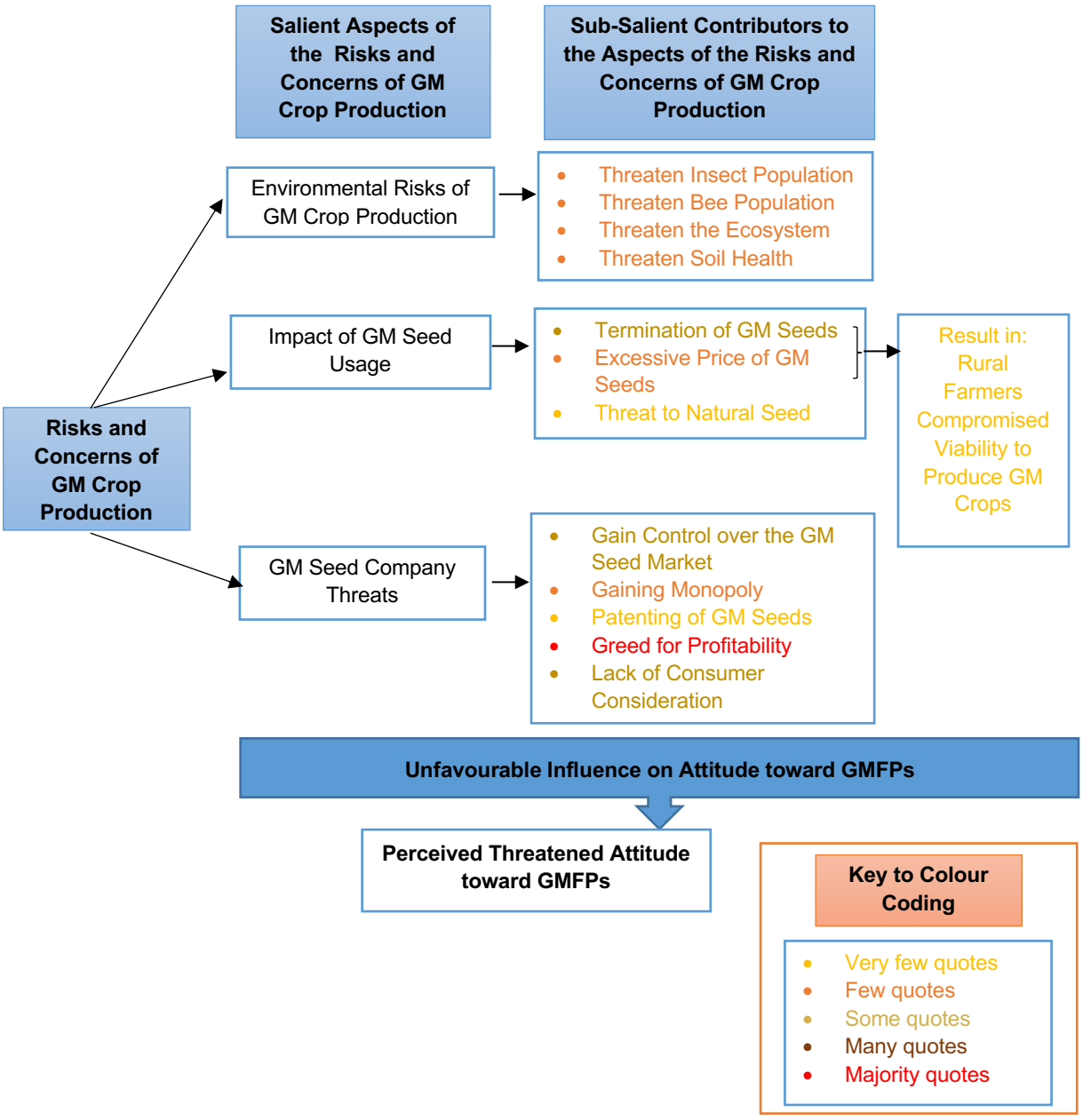

Figure 5.8: Risks and Concerns of GM Crop Production and the Proposed Influence on the Perceived Attitude toward GMFPs

In Theme 4, as illustrated in Figure 5.8, it is proposed that the risks and concerns linked to GM crop production could lead toward a perceived threatened attitude toward GMFPs – holding such an attitude could compromise food security efforts in SA and the achievement of

SDG 2: Zero Hunger. Therefore, these risks and concerns need to be negated so that consumers are not hesitant toward GMFPs. However, based on the extent of elaboration and depth of data reflected in the salient aspects linked to the benefits coupled with GM-crop production and food products in Themes 2 and 3, as well as their altered state of existence in Theme 1, it is proposed that the risks and concerns associated with GM crop production were less influential than their beneficial beliefs and their beliefs about GMFPs' altered state of existence.

A discussion of the final theme, which relates to consumer-related risks and concerns about GMFPs, follows.

5.8 THEME 5: CONSUMER-RELATED RISKS AND CONCERNS OF GMFPS

In addition to the risks and concerns associated with GM crop production, the participants further associated GMFPs with one particular risk and concern, specifically relating to consumers themselves. The most salient and sub-salient contributing aspects to the consumer-related risk and concern about GMFPs, as it emerged from the data, is illustrated in Figure 5.9.

One salient consumer-related risk and concern, as shown in Figure 5.9, was identified from the data analysis, namely long-term health risks and concerns about GMFPs, which are presented next.

5.8.1 Long-Term Health Risks and Concerns about GMFPs

From the data, **long-term health risks and concerns** came forward as an important salient aspect. Participants believed that the consumption of GMFPs could be harmful to human health in the long term because *"the concern is the long-term effects on the build-up in the human body"*. It was added that *"the long term effects of GM food on human health is a little bit sketchy"* as *"the food that is produced from these crops would be harmful to people"*. Therefore, it was believed that GMFPs *"are harmful if we consume them"* because *"they are not healthy for you"*. As a result, *"GM food sounds very good on paper"*, but *"there are potential health effects that it has on human bodies when consuming those foods"*. Aligned with previous research, it was concurred that consumers felt GMFPs carried health risks (Siipi 2015; Pino et al. 2016; Raman 2017; Van Acker et al. 2017; Vicini 2017; Oz et al. 2018; Ruth & Rumble 2019; Prianto et al. 2020; Siddiqui et al. 2022; Abdoul et al. 2023; Zhaleh et al. 2023).

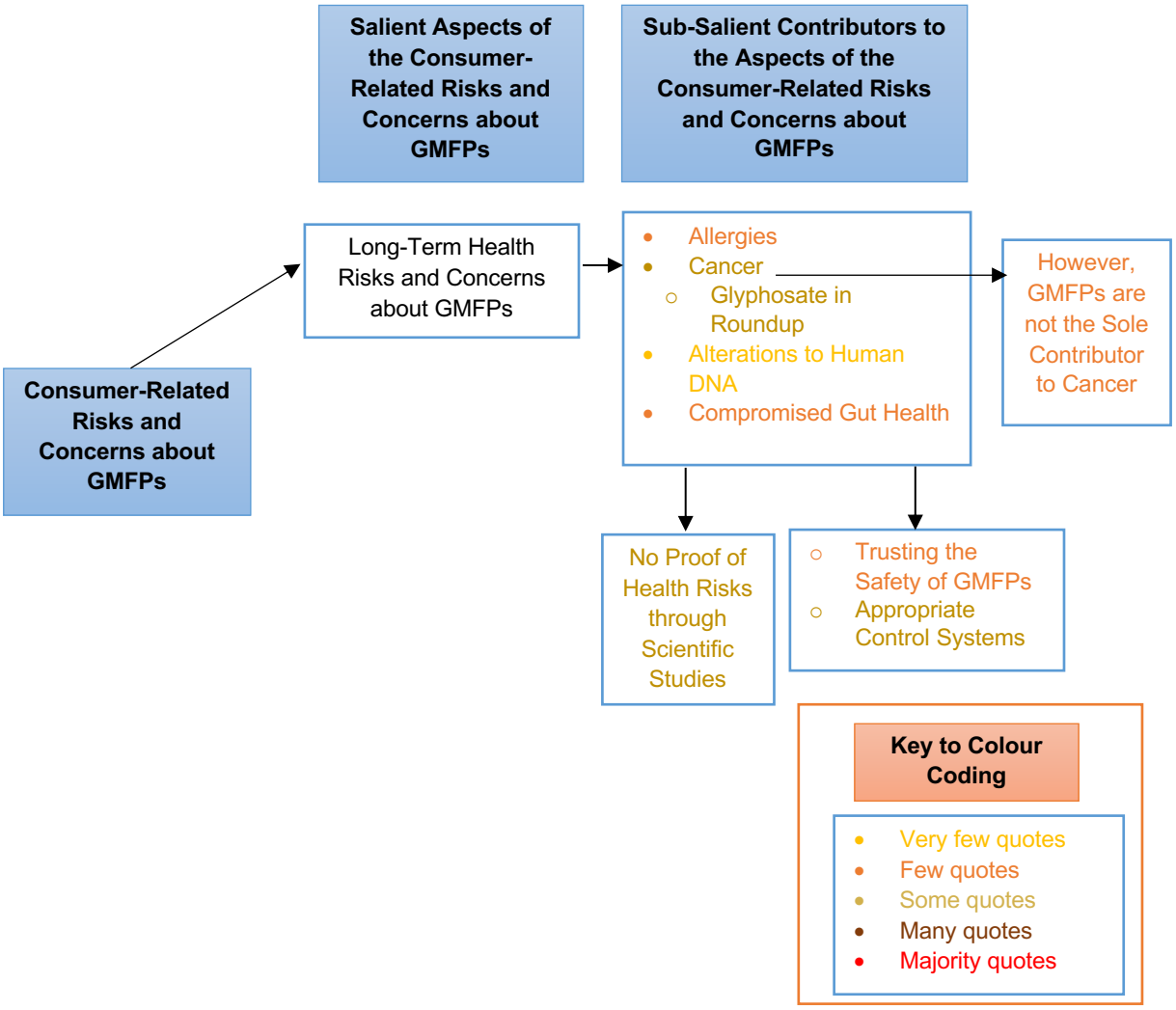

Figure 5.9: Consumer-Related Risks and Concerns about GMFPs

Mirrored responses were found in studies carried out in Uganda, Nigeria, the USA, Turkey, Poland and Sweden, respectively, which reported that consumers were concerned about the dangerous effect that the consumption of GMFPs could have on their health (Kikulwe et al. 2011; Wunderlich & Gatto 2015; Eneh et al. 2016; Sanlier & Sezgin 2020; Kubisz et al. 2021; Pakseresht et al. 2021). Consumers from Georgia were also found to be sceptical and fearful about the health impacts attributed to the consumption of GMFPs (Todua et al. 2015). It has been suggested that the health risks of GM crops and food products are monitored closely (Nesser et al. 2021; Aziz et al. 2022); nevertheless, these studies suggest that health risks remain a common concern among consumers when it comes to GMFPs.

In the current study, two specific health risks and sub-salient aspects were associated with GMFPs, namely allergies and cancer. In terms of allergies, a few participants expressed that *"it increases allergies amongst children and adults"*; therefore, *"people develop more allergies or more severe allergies"* after consuming GMFPs, because:

> *"They take a certain colour of a crab and they take those genetics and they put it in an apple so that when you eat the apple, it's got that same red colour as the crab. So someone who doesn't eat shellfish, is now eating shellfish. And now, there are other repercussions to that - his allergies. So the allergies situation is rising, more people have allergies now even though they eating food that they think is normal food, but they don't know they are eating something which their genetics could react to, so they have an allergic reaction. But they thinking 'but this is normal food'"*.

Similar findings were presented in studies conducted in Poland, London, the USA, Pakistan, Nigeria and Warsaw (Poland), respectively, where it was established that consumers were particularly worried about developing allergic reactions after consuming GMFPs (Rzymski & Krolczyk 2016; Popek & Halagarda 2017; Lefebvre et al. 2019; Amin et al. 2021; Emmanuel et al. 2021; Kubisz et al. 2021). Supported by many authors, it was proposed that consumers coupled allergic reactions with the consumption of GMFPs (Maghari & Ardekani 2011; Raman 2017; Van Acker et al. 2017; Nazir et al. 2018; Pham & Mandel 2019; Blagoevska et al. 2021; Sendhil et al. 2022). This finding indicates consumers are anxious about allergic reactions linked to the consumption of GMFPs, which is also seen in the current study.

Regarding cancer, it was stated that *"if you look back 100 years, the things that people died from were not typically cancer, that we deal with today"*, and *"if I look back at my parents' time, there are a lot more people now that have cancer"* because *"I certainly don't recall when I was youngster that there were people that had as much cancer then as they do now"*. Cancer was believed to be attributed to food consumption, as *"a lot of that has to do with what we eat these days"* as *"food could be a major factor in that"*. Thus, *"food plays a large part into that"* in terms of developing cancer. The consumption of GMFPs was a contributing factor to developing cancer, according to some participants, as *"consuming GM food could potentially lead to cancer"*, particularly because *"they put people at a higher risk for cancer"*; therefore, *"it can cause or increase risk for cancer"* when GMFPs are consumed. Consumers in Turkey, Poland, China, the USA, Florida and Pakistan were also anxious about consuming GMFPs as they opined that such food products could increase their chances of developing cancer (Kaya et al. 2014; Rzymski & Krolczyk 2016; Jiang & Fang 2019; Lefebvre et al. 2019; Ruth & Rumble 2019; Amin et al. 2021). Other authors similarly concurred that consumers are concerned about the possibility of developing cancer if GMFPs are consumed (Ozkok 2015; Aziz et al. 2022; Gbadegesin et al. 2022; Shen et al. 2022). Evidently, these studies suggest that the consumption of GMFPs has been linked to the development of cancer, and is thus a health concern that emerged among international consumers and in this SA study.

Possible cancer development was attributed by some participants to the use of glyphosate in Roundup – *"which is a chemical sprayed on GM crops"* – because *"the glyphosate that is sprayed will definitely have an impact because it's carcinogenic"* and *"any Roundup ready grain"* or *"anything that's been genetically modified to be able to withstand the poison or the action of the chemical"* cannot be healthy to humans. As a result, in terms of glyphosate in Roundup:

> *"GM foods go to causing a lot of illnesses because if you eat food that has chemicals [that are sprayed on them], it is not fit for human consumption, and in the years to come, you will find that our bodies will have cancer"*.

Thus, the intake of glyphosate in Roundup through the consumption of GMFPs *"could lead to negative health consequences like cancer"* because *"it could be that it is dangerous"* for human consumption. Glyphosate in Roundup thus emerged as a further sub-salient aspect from the data, which was believed to contribute to the development of cancer when consuming GMFPs. The association between glyphosate and cancer has been debated among researchers and is therefore an ongoing research topic (Tarazona et al. 2017; Peillex & Pelletier 2020). In terms of the harmful effect that pesticides could have through the consumption of GMFPs, consumers in Uganda believed that such pesticides could harm human health (Kikulwe et al. 2011).

Drawing an analogy to the reduced price believed to be coupled with GMFPs (as discussed in Section 5.6.3 regarding the consumer-related benefits of GMFPs), one participant stated that it is a *"catch-22"* as *"people are in a way forced to purchase GMFPs due to their reduced price"*. However, *"this then has a ripple effect in that you have to spend more money on healthcare"* due to the possible contribution to cancer development. To this effect, the participant added that:

> *"most people who are living on the bread-line or below the bread-line are more concerned about food today than they are about illness tomorrow"*.

According to the participant, although the consumption of GMFPs could contribute to the development of illnesses such as cancer, factors like the cost of food could be considered as being more important than the concern of developing health issues such as cancer.

Even though the consumption of GMFPs was believed to accompany cancer development, it was opined that *"nearly everything is advertised as possibly being carcinogenic"*. A few

participants thus believed that *"there are other influencing factors associated with the onset of cancer",* such as *"stress can be a factor"* and *"cancer also happens with age"*. Although *"GM [food products] might be a contributing factor"* to the onset of cancer, *"it's hand-in-hand with other factors as well*", and therefore it is *"difficult to prove or to link cancer specifically to genetically modified foods"*. Thus, the consumption of GMFPs could not be considered the sole contributor to cancer and was therefore a sub-salient aspect that emerged from the data. According to Chen et al. (2023), many lifestyle factors could cause cancer, such as smoking, alcohol consumption and obesity, thus complementing the participants' beliefs that numerous factors play in role in the onset of cancer.

In addition to possible allergy and cancer development linked to GMFP consumption, other sub-salient health risk-related aspects, such as alterations to human DNA and compromised gut health, further emerged from the data. In terms of the alterations to human DNA, it was believed by very few participants that *"it has an impact on our own DNA"* because *"if you are changing the DNA structures of the things you eat, that can have a ripple effect in essentially degrading our own DNA"*, and therefore *"the liver would have to carry a heavy load of toxins"* after consuming GMFPs. Concern among consumers has been demonstrated regarding the possibility that GMFPs' consumption could change human genes, and that DNA could be transferred from GMFPs to humans (Van Acker et al. 2017; Blagoevska et al. 2021). It was further reported that Polish consumers associated impaired kidney function with the intake of GMFPs (Rzymski & Krolczyk 2016). However, it has been argued that the consumption of GMFPs cannot change human genes (Freedman 2013; The Royal Society 2016). In this study, a few participants also believed that, *"in terms of [compromised] gut health, it would be more difficult for it to process and digest and extract nutrients from something that is genetically modified"*; thus, *"they are not good for the gut lining because they upset the bacterial balance in the gut"* once GMFPs are consumed. Animal studies have shown that the consumption of GMFPs can contribute to stomach inflammation and intestinal adenoma lesions, but this outcome has not been confirmed in humans (Shen et al. 2022).

Other health-related risks were believed to be coupled with the consumption of GMFPs by respective participants. According to one participant, possible infertility was a concern because:

> *"It can affect your offspring, it could be generations down the line, so what will happen to my grandchildren in the future after they have been eating GMO foods? Will my granddaughter still be able to produce children?"*

Although it was not elaborated on in the current study, infertility was a concern highlighted by Turkish, Polish and Pakistani consumers (Kaya et al. 2014; Rzymski & Krolczyk 2016; Amin et al. 2021) linked to GM food consumption; some reported it could possibly have an impact on infertility and pregnancy (Keshani et al. 2020; Blagoevska et al. 2021). It was further believed by an individual participant that *"genetically modified food that we eat could affect our endocrine system, our hormonal system"*, that *"they reduce immunity to certain parasites, viruses and bacteria"*, and that *"GM products could inhibit the use of antibiotics. So if you get a virus or disease, then antibiotics might not work against it"*. Turkish consumers also believed that antibiotic resistance is a concern of GMFPs (Kaya et al. 2014), and this view was supported by other authors who proposed that genetic modification can cause antibiotic resistance (Maghari & Ardekani 2011; Van Acker et al. 2017; Blagoevska et al. 2021; Aziz et al. 2022; Sendhil et al. 2022).

In terms of possible health risks, consumers in London believed that the consumption of GMFPs could negatively influence the functioning of the body (Lefebvre et al. 2019); Ugandan consumers believed that the intake of GMFPs could cause bodily damage; consumers in Turkey linked organ damage and toxicity to GMFPs; Polish consumers attributed immune malfunction to GMFPs; while consumers in Warsaw, Poland attributed internal organ damage to such food products (Deffor 2014; Kaya et al. 2014; Rzymski & Krolczyk 2016; Kubisz et al. 2021). Possible toxicity and food poisoning have also been raised as concerns among consumers in terms of GMFPs' consumption (Maghari & Ardekani 2011; Raman 2017; Gheysen et al. 2019). Although various health-related concerns were associated with GMFPs globally, as suggested by these studies, *"allergies and cancer cells would be the two main risks"* to the consumption of GMFPs participants reported in this study, which could suggest why the participants did not elaborate on other health-related risks and concerns.

Another participant believed that consuming GMFPs was specifically linked to health risks among children in terms of attention deficit hyperactivity disorder (ADHD), concentration problems and hormonal change because:

> *"There is a link between GMO foods and attention deficit disorder. There has got to be a reason why we suddenly have an increase in children that are on medications for ADHD, than what there was 15 years ago. So, there must be a link somewhere there"*.

The participant added that *"more and more children have concentration issues, and I'm open to the fact that GM is part of it"*. In terms of hormonal change, the participant believed that the

consumption of GMFPs is *"changing the hormones of children"* because *"they are maturing faster"* and *"it affects the health of our children"*.

Although health risks were associated with GMFPs, some participants believed that these potential health risks have not been confirmed because *"it hasn't been scientifically proven to be harmful"*, therefore *"it's not to say that it's actually the case"* because:

> *"I haven't read an article or something like concrete where I can really say that 'here is something that GMO has done. I've never heard that, I've never seen that"*.

Subsequently, *"I don't think there is enough research for me to have confidence in the long-term health effects"* as *"most studies I have seen do not show such effects"* pertaining to the consumption of GMFPs. It was believed that concern towards the possible health risks of GMFPs would be confirmed and substantiated *"if reputable, peer-reviewed, rigorous and conclusive studies show that effect"*. It was further believed that:

> *"Most studies seem to conclude that we don't have enough long-term data yet, and certainly not in humans. So, until I see rigorous, reputable, peer-reviewed studies that show conclusively that there are negative health effects on humans, I am not going to panic about GM foods"*.

Subsequently, *"there's no proof"* that the consumption of GMFPs could result in specific health issues and the associated risks could therefore possibly be unfounded and *"GMFPs cannot be blamed specifically for health issues"*. No proof of health risks through scientific studies therefore emerged as a sub-salient aspect in terms of the health risks of GMFPs. Studies that have been conducted on the health risks linked to GMFPs have not yet been able to link any health risks to the consumption of GMFPs (Nicolia et al. 2014; Pham & Mandel 2019; Prianto et al. 2020; Addey 2021; Rodriguez et al. 2022). This view was supported by Russo et al. (2020), who stated that research conducted on GMFPs found that these products are not more harmful than their traditional counterparts. Although participants in this study believed there was no current research suggesting there are proven facts that GMFP consumption is unsafe, particularly in terms of health, respondents in a study conducted in Australia reviewed this aspect from a different point of view, stating science had to prove to the public that the consumption of GMFPs was, in fact, safe before they would consider purchasing such food products (Cormick & Mercer 2017).

Even though health concerns were evident in the data and coupled with GMFPs, these food products were trusted to be safe to consume by a few participants in terms of health because *"I trust that GM food is healthy"* and *"I trust the scientists"*. Trusting the safety of GMFPs therefore emerged as a sub-salient aspect, contributing to the mediation of the health risks of such food products. In addition to trusting the safety of GMFPs, solace was found among some participants that GMFPs follow certain procedures and have to meet specific guidelines before they are made available for human consumption. They mentioned *"there are certain guidelines that the producers need to follow"* when GMFPs are produced; therefore, *"I'd like to think that there's kind of controls in place"*. It was further believed that *"there is a consumers' protection act, so I do believe that the food that is there have gone through the right protocols"*, and *"I also believe that there's some strong legislation"* regarding that of GMFPs. Making particular reference to SA, one participant believed that there are regulatory systems in place for GMFP production because:

> *"I think South Africa has something like a trial period where it goes through testing before the crop is able to be sold on the market"*.

To this effect, the Genetically Modified Organisms (GMO) Act was developed in 1997 to regulate the safety of GM crops (Department of Agriculture South Africa 2004; Wray 2021). Therefore, in terms of GMFPs' regulation, *"it's done properly"* before they are released on the market for purchase and consumption purposes, then *"I don't see it being too much of a problem".* Having appropriate control systems in place during the production of GMFPs also emerged as a sub-salient aspect in terms of mediating GMFPs' health risks. Although some participants placed their trust in control and regulatory systems in terms of introducing food on the market that is safe for consumption, contrasting results were found in studies conducted in Turkey, Nigeria and China, respectively, where it was reported that consumers were adamant in their opinion that GMFPs were unsafe for human consumption (Celik & Dagistan 2016; Eneh et al. 2016; Deng et al. 2019).

In terms of the consumer-related risks and concerns about GMFPs, long-term health risks were linked to these food products, particularly allergies, cancer, alterations to human DNA, and compromising gut health, all of which could create opposition toward these food products. Although cancer was believed to be coupled with the consumption of GMFPs as a result of glyphosate's use in Roundup (which is sprayed on GM crops), it was believed that the consumption of GMFPs was not the only aspect contributing to the development of cancer. While health risks were associated with GMFPs, it was believed that there are no scientific studies proving that GMFPs are responsible for particular health issues. It was further believed

that GMFPs available on the market are trusted to be safe for human consumption because appropriate control systems are in place to regulate their production. Based on the depth of data through the volume of sub-salient aspects that emerged, it is proposed that long-term health risks were an important and influential aspect linked to the consumer-related risks and concerns about GMFPs.

5.8.2 Summary of the Consumer-Related Risks and Concerns about GMFPs

The main salient aspects of Themes 1 to 4 in this chapter are illustrated in Table 5.7, as well as the most salient aspects of Theme 5 to further show the various beliefs among participants regarding GMFPs.

Table 5.7: Summary of the Most Salient Beliefs Aspects of Themes 1 to 5

Theme	Salient Belief Aspects of GM Crops and GMFPs					
Theme 1: Altered State of Existence	Biological Change	Unnatural State	Technological Intervention	Conflicting Religious Belief	Product Feature Enhancement	
Theme 2: GM Crop Production Benefits	Environmentally Friendly	Weather Resistance	Resistant Characteristics	Increased Productivity	Increased Farmer Profitability	Promoting Food Security
Theme 3: Consumer-Related Benefits of GMFPs	Increased Nutritional Value	Increased Accessibility and Availability	Lower Price	Improved Aesthetic Properties	Improved Food Processing Properties	
Theme 4: Risks and Concerns of GM Crop Production	Environmental Risks	Impact of GM Seed Usage	GM Seed Company Threats			
Theme 5: Consumer-Related Risks and Concerns about GMFPs	Long-Term Health Risks and Concerns					

As illustrated in Table 5.7, the data from Themes 1 to 4 show that the participants believed genetic modification was indicative of an altered state of existence, and that there were benefits in doing so, particularly in terms of GM crop production and for the consumer of GMFPs. Even though benefits were linked to GMFPs in the data, risks and concerns were also believed to be associated with these crops' production, and consumer risks and concerns included fears about long-term health risks and concerns, as shown in Theme 5. Thus, the

data from Themes 2 to 5 show that the participants believed there were benefits, risks and concerns associated with GMFPs.

Regarding the salient aspect that emerged from the data in this study regarding the consumer-related risks and concerns believed to be linked to GMFPs, consumers demonstrated concern towards the possible health risks associated with consuming GMFPs, particularly the development of cancer and allergies, which has caused opposition and apprehension towards such food products (Ruth & Rumble 2019; Sendhil et al. 2022; Shen et al. 2022; Zhaleh et al. 2023). In terms of consumer attitude studies that have been conducted, threatened human health has been considered an influencing factor in consumers' attitudes toward GMFPs (Morris & Adley 2000; Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Lopez et al. 2016; Rzymski & Krolczyk 2016; Ghoochani et al. 2017; Jonker 2017; Deng et al. 2019; Amin et al. 2021). In GM-related consumer studies, it has been suggested that the risks linked to GMFPs may negatively affect consumers' attitudes towards GMFPs (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Ghoochani et al. 2017). In this SA context study, it is postulated that the most salient and sub-salient aspects of the consumer-related risks and concerns of GMFPs could be a harmful aspect of such food products causing attitudinal conflict, thus influencing attitudes in an unfavourable manner, thereby contributing to a perceived threatened attitude toward GMFPs. The most salient and sub-salient aspects contributing to the consumer-related risks and concerns linked to GMFPs and the proposed influence it could have on the perceived attitude toward GMFPs are depicted in Figure 5.10.

As shown in Figure 5.10, it is proposed that the consumer-related risks and concerns about GMFPs could steer participants toward a perceived threatened attitude towards such food products. This could pose as a problem to the promotion of food security in the SA context and the realisation of SDG 2: Zero Hunger. However, based on the lack of depth of data, as seen through the emergence of only a single salient aspect (whereas the other themes had numerous salient aspects), it is suggested that the consumer-related risks and concerns about GMFPs were less influential on the participants' beliefs regarding these food products. It is also suggested that, considering the depth of data and extent of elaboration on aspects based on the volume of salient aspects, the participants' beliefs were influenced more by the benefits of GM crops and GMFPs as opposed to its risks and concerns.

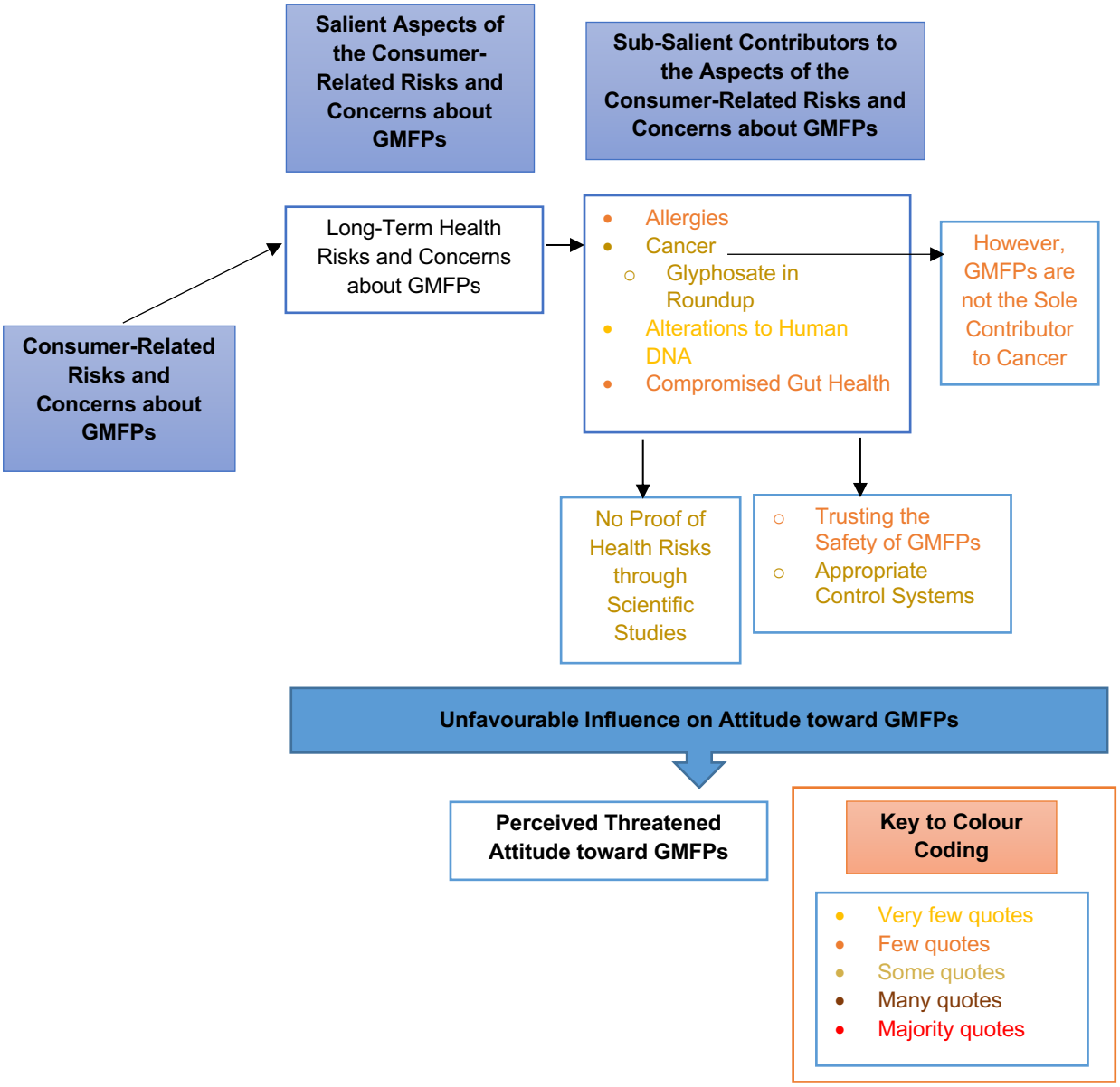

Figure 5.10: Consumer-Related Risks and Concerns of GMFPs and the Proposed Influence on the Perceived Attitude toward GMFPs

5.9 SUMMARY

The sample in the current study was predominantly working, educated female individuals, aged between 25 and 40, financially stable, and married or living with a partner. The study's sample was not GM farmers, did not come from a family who farmed with GM crops, was not acquainted with friends who had adopted GM farming practices, but knew someone who did farm with GM crops and was equally divided regarding the awareness of farming with GM crops in the Midlands area.

In this chapter, it is evident that the participants believed genetic modification involves an altered state of existence, particularly due to a biological change taking place in the DNA and genetics of GMFPs, thereby making them unnatural. The change that occurs through genetic modification was, however, believed to improve products in terms of enhancing some of their beneficial traits. Beneficial aspects were linked to GM crop production in terms of their weather resistance, particularly against droughts and floods; their resistant characteristics against pests and diseases; their increased productivity, specifically in terms of increased crop yields; and promoting food security. GMFPs' benefits were also linked specifically to the consumer, particularly in terms of their lowered price; their improved aesthetic properties – specifically improved appearance – and longer shelf life as a result of improved food processing properties. Risks and concerns were also linked to the production of GM crops in terms of environmental risks; the impact of using GM seeds; and the threat that GM seed companies pose, specifically regarding their greed for profits. Consumer-related risks and concerns were further coupled with GMFPs in terms of long-term health risks.

By linking benefits, risks and concerns to both the production of GM crops and GMFPs – specifically focusing on the consumers themselves – it indicates that the participants' beliefs comprised of benefits as well as risks and concerns. The presence of both benefits and risks and concerns about GMFPs is proposed to influence the participants' attitude in a favourable and unfavourable manner, leading to both a perceived optimistic and threatened attitude, and could thus be indicative of the participants developing perceived dual attitudes towards these food products. This could create a sense of hesitancy among the participants and thus hinder food security efforts in SA and the attainment of SDG 2: Zero Hunger. Nevertheless, reassurance can be found in the possibility of changing threatened attitudes to acceptance of GMFPs in the marketplace, which can be done by focusing on the beneficial aspects linked to these food products.

The volume of data in this chapter demonstrated that a variety of beneficial and concerning attributes were coupled with GM-crop production and GMFPs, leading to some confusion about the participants' actual beliefs about GMFPs. This finding suggests that the participants may have been unsure about their beliefs or their beliefs potentially stemmed from an unfounded foundation, thereby resulting in the identification of numerous beliefs, instead of vocalising a confident belief. However, based on the depth of data, it is proposed that the participants' salient beliefs and, thus the beliefs component of the EV Model of Attitudes is a pertinent influencer of attitude formation towards GMFPs. The beliefs component thus needs to be used to enhance food security where the acceptance of food aid comprising GMFPs may be concerned. This can be achieved by focusing particularly on GM crop production

benefits and consumer-related GMFP benefits as well as remedying their concerns about GMFPs' altered state of existence. The participants' realities, views and images of GMFPs reflected that there are benefits as well as risks and concerns related to GMFPs and GM crops, and that they have an altered state of existence. This is also what they understand about GMFPs. From a phenomenological point of view, participants experienced GMFPs to have benefits, risks and an altered state of existence; this is what these food products mean to them and this is the truth of GMFPs to them. Further interpretations will be made in the conclusion chapter, namely Chapter 10. The data regarding the salient values assigned to GM crops and food products by the participants are discussed in the next chapter.

CHAPTER 6
FINDINGS AND DISCUSSION OF THE VALUES DATA OF GENETICALLY MODIFIED CROPS AND FOOD PRODUCTS

In this findings and discussion chapter, the four themes that emerged from the values data relating to the salient value assigned to the GMFP attributes in the previous chapter (based on participants' beliefs about such food products) are discussed. In this chapter, the ethical aspects relating to genetic modification are also presented.

6.1 INTRODUCTION

The previous chapter presented the participants' demographic profiles and the findings reflecting participants' salient beliefs about GMFPs based on attributes linked to these crops and food products. This chapter discusses the salient value given to the attributes of GM crops and food products. To better understand attitudes (Ajzen & Fishbein 2000) toward GMFPs – and to be able to enhance food security – the role of the values component of the EV Model of Attitudes in the participants' attitudes toward such food products was explored. This exploration reflected what salient values the participants assigned to the attributes they coupled with GMFPs, which GMFP attributes were important to them, and what overall value the participants ascribed to GMFPs as a whole (Mahajan 2020; Goedegebure et al. 2022). To do so, the four categories of task values were explored, namely cost, attainment value, intrinsic value, and utility value (Meyer et al. 2019). Since the attainment, intrinsic and utility task value categories are closely correlated (through statistical analysis) (Dietrich et al. 2019), the data that emerged from these three respective value categories was also found to relate to each other as communicated during the discussions with participants, and have been merged and are discussed together in one section, namely the overall values of GMFPs. In this chapter, the ethical aspects relating to genetic modification are also presented. The perceived influence that the values assigned to GM crops and food products are proposed to have on the cost value and overall values of GMFPs and subsequent attitudes are also presented. As mentioned in Chapter 5, Section 5.1, colour coding was used to reflect the prominence of each sub-salient aspect. The foremost sub-salient aspects that were developed using in vivo coding and focusing on the words spoken by the participants have thus been colour-coded in the discussion of the data. The salient aspects that emerged from the data are presented in bold to assist in their identification. The remaining quotes relating to this chapter can be found in Appendix E.

In this chapter, the four themes that emerged from the data, namely the cost value of GMFPs, the value of GM crop production, the consumer-related value of GMFPs, and the ethical values of genetic modification, are discussed.

6.2 THEME 1: COST VALUE OF GMFPS

The cost category was used to explore what the participants believed they had to give up to obtain GMFPs and the effort that needed to be applied to acquire such food products (Seals 2016; Bostrom & Palm 2020; Schweder & Raufelder 2022; Shang et al. 2023). The most salient and contributing sub-salient aspects of the cost value of GMFPs are illustrated in Figure 6.1.

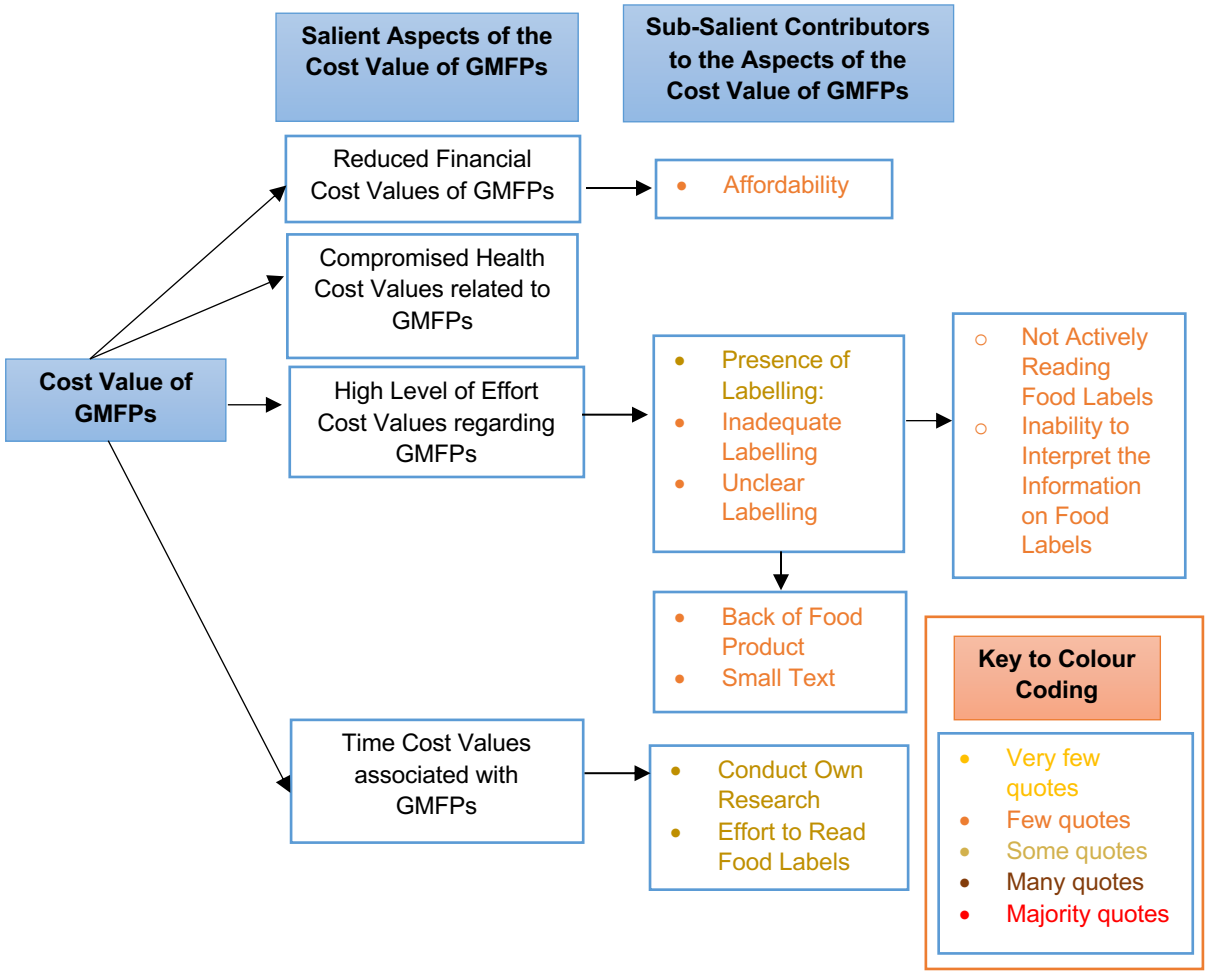

Figure 6.1: Cost Value of GMFPs

As depicted in Figure 6.1, a discussion on the most salient aspects of the cost value of GMFPs, namely the reduced financial cost values of GMFPs, compromised health cost values related

to GMFPs, the high level of effort cost values attributed to GMFPs, and the time cost values associated with GMFPs follow.

6.2.1 Reduced Financial Cost Values of GMFPs

Based on the belief that GMFPs were associated with a reduced price, as seen in Chapter 5, Section 5.6.3, it emerged from the data that the participants believed this attribute would require them to give up less financially to acquire GMFPs. Thus, the **reduced financial cost value of GMFPs** emerged from the data as a salient aspect of the cost values of GMFPs because *"they are cheaper"*, *"they cost less"*, and *"they don't cost as much"* as traditional food products. Therefore, *"GM's lower price will help me financially"* because *"it makes our monthly food budget go further"* so that *"we can buy more of it"*. Various authors concurred that the presence of GMFPs on the market provides consumers with an opportunity to purchase food at lower prices (Dovey & Ntuli 2020; Jiang & Zhang 2021; Sendhil et al. 2022). Additional value was assigned to the reduced cost value of GMFPs in terms of assisting the larger population in acquiring food products. This aspect benefits the financially struggling population, who will be able to pay less for food. A few participants stated that *"it is about what people can afford, which is true for the majority" "specifically for the majority of South Africans who are living below the poverty line"*, *"and for many South Africans, that means that they can eat possibly more and better because GM makes food cheaper"* and because *"GM is within in the budget"*, therefore, *"there is so much good in it in that you can afford more food, you can eat more food as a family"*. Having to use fewer financial resources to acquire GMFPs based on their affordability was a sub-salient aspect that emerged from the data contributing to the financial cost values of GMFPs. This suggests that it is an aspect participants believed added value to such food products.

In this study, it is proposed that the reduced financial cost value of GMFPs, which the affordability of such food products contributed towards, can favourably influence the perceived cost value assigned to GMFPs in terms of the cost involved in acquiring such food products. However, the lack of quotes and sub-salient aspects suggest that the aspect was not influential in assigning a cost value to GMFPs. This shows that, in terms of the cost value of GMFPs, there was no particular effort or willingness demonstrated among the participants to give up their finances to acquire GMFPs. Perhaps the aspect, in the cost value context, was not elaborated on as the participants believed GMFPs cost less, as seen in Chapter 5, Section 5.6.3; therefore, in their own opinion, they did not need to give up their finances to acquire such food products. In addition, when conversing particularly about the acquisition or purchasing of GMFPs, their lower price was perceived as a benefit of purchasing GMFPs (as

discussed in Chapter 9, Section 9.2.3). Thus, coupling a lower price with an effort or willingness to give up their finances to acquire GMFPs was not prominent.

6.2.2 Compromised Health Cost Values related to GMFPs

Although a reduced financial cost value was coupled with the acquisition of GMFPs, **compromised health cost values** emerged as a salient aspect from the data. Participants reflected on possibly giving up on or compromising their health to acquire GMFPs because *"there is a chance that they are unhealthy"* and *"it's not for the benefit of my health"*. Thus, even though the use of fewer financial resources *"is an attractive part of it, I don't know if it would outweigh the possible health risks"*. This view is supported by various authors who stated that the possible health risks associated with GMFPs caused consumer opposition towards such food products (Raman 2017; Van Acker et al. 2017; Ruth & Rumble 2019; Prianto et al. 2020; Zhaleh et al. 2023). However, one participant stated that the current economy could override such health costs because *"in the current economic climate people are cutting costs"*, and *"with COVID, everyone had to cut down"*; therefore:

> *"price would be a huge factor in driving people to set aside their fears or to perhaps turn a blind eye so that they can still purchase food"*.

In terms of the cost involved in obtaining GMFPs, it is suggested in this study that the compromised health related to GMFPs' acquisition could have an unfavourable influence on the perceived cost value of GMFPs. Although health risks emerged as an important aspect in Chapter 5, Section 5.8.1, influencing participants' beliefs about the consumer-related risks and concerns of GMFPs, it did not emerge as a prominent aspect in this chapter regarding GMFPs' cost value. This could indicate that health risks were more influential on beliefs, but less so on the value assigned to GMFPs. This was further evident in the limited quotes and absence of sub-salient aspects, showing that the participants did not elaborate on having to give up on their health or possibly compromise it to obtain GMFPs, and this aspect was therefore not influential on the cost value of GMFPs. The finding could suggest that a prominent belief about GMFPs does not mean it will emerge as a prominent attribute when assigning value to such food products.

6.2.3 High Level of Effort Cost Values regarding GMFPs

In addition to the reduced financial cost and compromised health cost values related to GMFPs, it emerged from the data that there was a high level of effort involved in acquiring

such food products due to the difficulty in determining whether a food product had been GM or not, and distinguishing between GM and non-GMFPs. Therefore, **the high level of effort cost value regarding GMFPs** emerged as a salient aspect because *"it takes quite an effort"* and *"you would have to put in a fair amount of effort"* to determine whether a food product contains GM ingredients and decide whether to purchase it. Therefore, *"it does take effort on your part as a consumer"* and *"there's a huge effort"* involved in acquiring GMFPs. As a result, *"you have to make a guess"* in terms of whether the food product contains GM ingredients or not. The high level of effort was directly linked to the sub-salient aspect, namely the presence of labelling on GMFPs. According to some participants, *"the effort is simply determined by whether or not it is actually written on the product or not"* because *"if it's not labelled, then how do you know, it would be a virtually impossible mission"* to identify between a GM and non-GMFPs. It was added that *"it would be quite an effort, unless it was well packed and labelled"*; therefore, *"the effort is either very easy if they have it labelled on them"* or *"it can be distinctly difficult if it's not"* labelled on the food products that there are GM components present in the product. In terms of labelling GMFPs, it has been argued that GM labelling is insufficient, resulting in consumers' inability to confidently differentiate between a GM and non-GMFP (Sebastian-Ponce et al. 2014; Wunderlich & Gatto 2015; Macall et al. 2021), signifying the effort involved in establishing whether a food product contains any GM components. Subsequently, a study in Iran established that consumers wanted to distinguish between GM and non-GMFPs, which they felt could be achieved through labelling (Ghanian et al. 2016).

In terms of the presence of labels, the inadequate and unclear labelling of GMFPs emerged as sub-salient aspects that elevated the level of effort involved in acquiring GMFPs. Regarding the inadequate labelling of GMFPs, a few participants believed that *"it is not being labelled that well"*; *"it's poorly labelled"*; and *"it's not particularly advertised on the product"* in terms of whether the food product contains any GM ingredients. They also stated:

> *"it is not blatant on any packaging, it is not openly stated on a label that this product is genetically modified"*.

It has been suggested that GM labels need to be made more noticeable to consumers to assist them when purchasing food products (Oh & Ezezika 2014).

A few participants mentioned the unclear labelling of GMFPs and explained, *"the labelling is not as clear as it should be"*, *"it's not labelled very clearly"*, and *"in terms of labelling they have not cleared it out properly and demarcated it properly"*. These views were confirmed by additional sub-salient aspects where a few participants stated that *"it is at the back"* of the food

product and *"it is in small text"*, therefore, *"it's not just going to come and stand out at you"*. The high effort required on behalf of the consumer in recognising and thus procuring a GMFP *"would be a bit easier if they have it in front of the product – the face of the product"* to show *"that it's got these GM ingredients"* and in *"larger writing than it currently is"*, *"then you would know straight away"* if the food product contains GM components. Therefore:

> *"the best thing is to make the labelling simple and clear so that people are aware of what they actually putting into their bodies"*.

One participant stated that labelling would be able to assist them in recognising a GMFP because:

> *"when you walk into a grocery store and you looking at shelves and rows and rows of things, if it's clearly labelled it might be easier to pick those things out"*.

It has been opined that GM labels need to be placed on the front of food packages while using an appropriate size for the letters (Delgado-Zegarra et al. 2022). A study conducted in Vermont found that consumers were more likely to read labels on the front of a product (Kolodinsky et al. 2019). In this study, another participant stated that *"it would be lovely as a consumer if that information was readily available"*, which would not *"require as much legwork on my part"* to determine whether a food product contains GM ingredients. The usefulness of communicating the presence of ingredients in a food product to consumers was emphasised in two respective studies in the USA and China, which found that GMFP labelling was important to consumers (Wunderlich & Gatto 2015; Zheng & Wang 2021).

Although inadequate and unclear labelling emerged from the data as contributing to the high level of effort cost values involved in acquiring GMFPs, additional sub-salient aspects further emerged from the data in terms of labelling, namely not actively reading food labels and the inability to interpret information on food labels. With regards to not actively reading food labels, it was stated by a few participants that *"I can't say that I look at the labels to figure out whether or not it's genetically modified"*, and *"I don't look at the product and seeing if it's a GM product" "because I believe the products that are there are for the benefit of the consumer"*. It was added that "*there might be 10% of people or even less that might read those labels"* on food products. Other authors have opined that food labels are not frequently read by consumers (Jonker 2017; Popek & Halagarda 2017; Macall et al. 2021), as seen in a study conducted in Vermont, which found many consumers did not read the ingredients on labels (Kolodinsky et al. 2019).

In addition to inadequate and unclear labelling, a point was made by one participant: *"I wonder if the supermarket staff know whether or not they are genetically modified"*, thereby suggesting that there is a possibility that respective supermarket staff would not be able to point out GMFPs to consumers. This could further contribute to the effort required of consumers in the acquisition of food products containing GM components.

In the context of not being able to interpret information on food labels, it was stated by a few participants that *"even if it's on the box, they would probably not even know what it really means"* because *"they would not understand anything about it"* in terms of genetic modification. Thus:

> *"as a normal consumer, if you read the label, you are not going to necessarily know – unless you've studied it –what a lot of the names and ingredients mean"*.

A study in Brazil echoed that it was difficult for consumers to interpret and understand what the GM symbol meant on food products (Hakim et al. 2020). Consequently, it has been proposed that consumers do not know how to interpret GM labels (Popek & Halagarda 2017).

It emerged from the data that a high level of effort was involved in acquiring GMFPs, particularly due to the presence of inadequate and unclear labelling of GMFPs, which is located at the back of the food product in small writing. Although the participants did not actively read the labels on food products and believed they could not interpret information on food labels, this study proposed that the high level of effort linked to GMFPs' acquisition could influence the perceived cost value of GMFPs unfavourably. Based on the volume of sub-salient aspects, it is suggested that the high level of effort assigned to GMFPs by the participants was the most important and influential aspect in the cost value of GMFPs.

6.2.4 Time Cost Values Associated with GMFPs

Time cost values associated with GMFPs emerged as a salient aspect from the data. The cost value related to obtaining such food products was attributed to the sub-salient aspect that own research needs to be conducted to establish if a food product contains GM ingredients or not. The need to conduct research contributed to the time that some participants believed was required to distinguish between GM and non-GMFPs because *"you might have to go and search on the Internet to find out"* and *"it takes quite a bit of homework before hand and looking into it"*. As a result, *"I would have to look quite hard"* and *"it's going to be a search"* to establish whether a food product contains GM components, all of which *"would be time-consuming and*

it would be difficult" and *"be a bit of a chore"*. Thus, *"checking and then background checking"* to establish whether a food product contains GM components would be necessary, and GMFPs' acquisition takes *"more effort than it should"*. A study conducted in Vermont suggested that if adequate information is included on the labelling of GMFPs, it would reduce the time needed to search for additional information (Kolodinsky et al. 2019).

However, even if GMFPs were adequately and clearly labelled, some participants claimed it would still require an effort in terms of time on their part to establish whether a food product contains GM ingredients and acquire such food products as *"it's an effort to read labels on every single product"* because *"you'd have to pick up every product and try and read through everything to see if it's genetically modified, which is an effort"*. Subsequently, *"I'd have to read the label and it takes a bit of time"*, which means that *"your shopping trip might not just be a 10 minute pop into the shops"* because *"it would take looking at the food labels"* which *"takes time and is tedious"*. The effort to read food labels was an additional sub-salient aspect that confirmed the salient aspect.

This study proposes that the time costs associated with procuring GMFPs, in terms of consumers conducting their own research and having to read food labels, could contribute to an unfavourable perceived cost value being given to such food products. However, the limited sub-salient aspects suggest that the aspect did not influence participants' views of the cost value of GMFPs.

6.2.5 Summary of the Cost Value of GMFPs

Table 6.1 shows the most salient aspects of Theme 1 in this chapter, namely the cost value of GMFPs, which emerged from the data.

Table 6.1: Salient Aspects of the Cost Value of GMFPs

Theme	Salient Value Aspects of GM Crops and GMFPs			
Theme 1: Cost Value of GMFPs	Reduced Financial Cost Values	Compromised Health Cost Values	High Level of Effort Cost Values	Time Cost Values

As demonstrated in Table 6.1, regarding the cost value of GMFPs, reduced financial cost values, compromised health cost values, high level of effort cost values and time cost values emerged as the most salient aspects in Theme 1.

In terms of these salient aspects, authors have suggested that GMFPs cost less than their traditional counterparts; however, the health risks consumers have coupled with GMFPs have

made them dubious about these products (Raman 2017; Dovey & Ntuli 2020). It has further been argued that the lack of GMFP labelling contributes to consumers' struggle in identifying a GMFP; however, consumers also do not read food labels frequently and find it difficult to interpret food labels (Popek & Halagarda 2017; Islam et al. 2020). Still, it has been proposed that the supply of adequate information on food labels could assist consumers and reduce the time needed to seek additional information about the food product (Kolodinsky et al. 2019). Consumer attitude studies suggested that the positive and negative aspects coupled with GMFPs can positively and negatively influence consumers' attitudes towards GMFPs (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Ghoochani et al. 2017).

This study proposes that the most salient and sub-salient aspects of the cost value of acquiring GMFPs, in terms of the reduced financial cost, could favourably influence the cost value of such food products. However, the most salient and sub-salient aspects of the cost value of acquiring GMFPs, in terms of compromised health, high level of effort and time could have an unfavourable influence on the cost value assigned to GMFPs. Thus, it is proposed that the most salient and sub-salient aspects that emerged from the data can favourably or unfavourably influence the cost value assigned to GMFPs. A perceived optimistic or threatened cost value could consequently influence consumers' attitudes, leading to both a perceived optimistic or threatened attitude toward GMFPs, resulting in a proposed dual attitude. The most salient and contributing sub-salient aspects that emerged from the data, in terms of the cost related to GMFPs' acquisition and the proposed influence on the perceived cost value and attitude towards GMFPs, are presented in Figure 6.2.

As seen in Figure 6.2, it is proposed that the salient cost value aspects of GMFPs resulted in a perceived optimistic and threatened cost value, leading to a perceived optimistic and threatened attitude towards GMFPs. The consequence is a perceived dual attitude towards GMFPs, benefiting but also possibly hindering the influence that GMFPs could have on promoting food security in SA and attaining SDG 2: Zero Hunger. However, based on the lack of depth of data and elaboration (as seen through the lack of quotes and sub-salient aspects that emerged in the majority of the salient aspects), it is suggested that the cost task value category was not a prominent influencer on the participants' ascribed values to GMFPs. The lack of elaboration on the cost task value category may further suggest that, in terms of GMFPs, the participants have not formed any meaningful link to the cost value of GMFPs and the acquisition of these food products.

The two themes that emerged by combining the attainment, intrinsic and utility value data of GM crops and food products are discussed next.

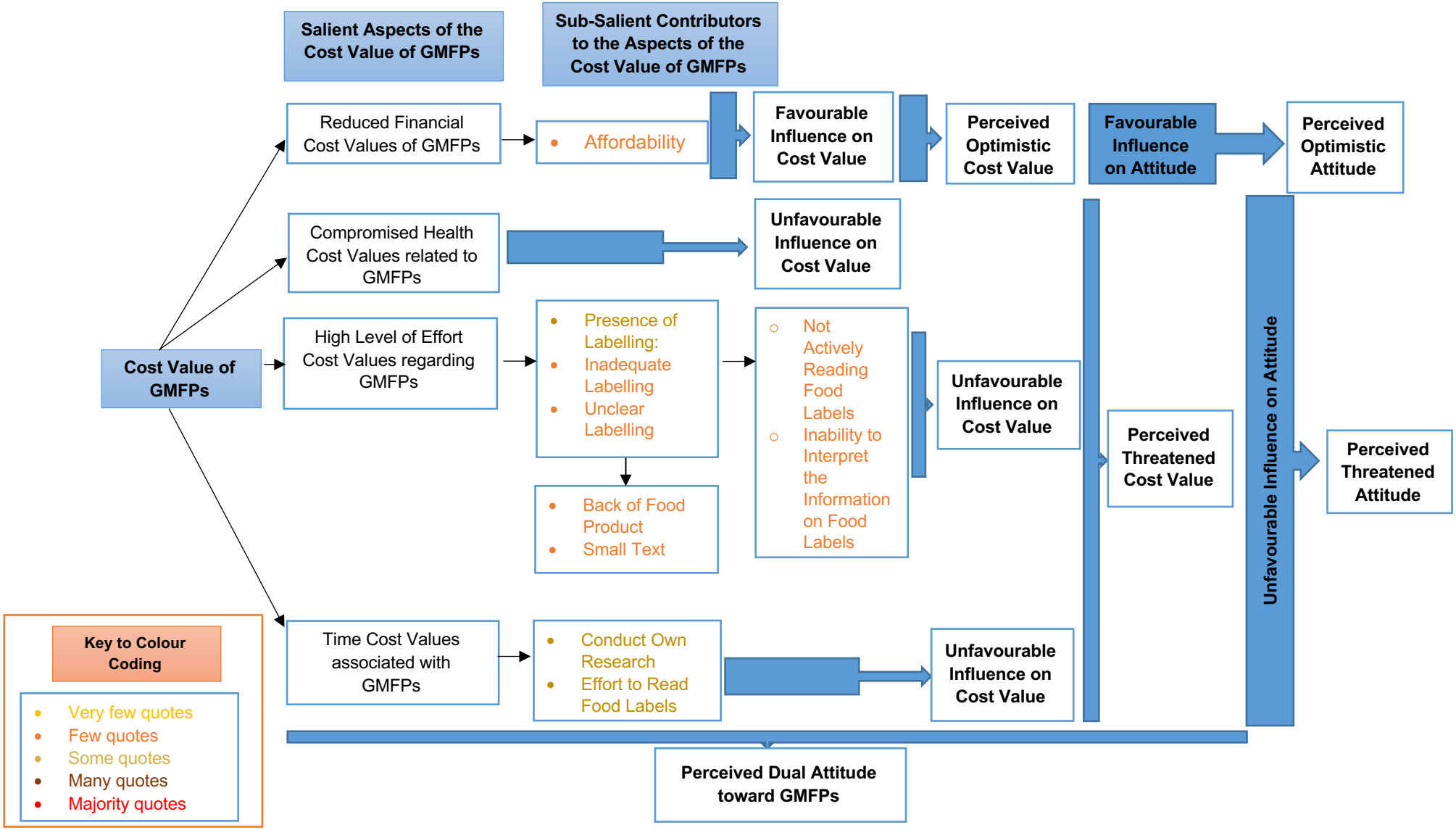

Figure 6.2: The Cost Value of GMFPs and the Proposed Influence on the Perceived Cost Value and Attitude towards GMFPs

6.3 OVERALL VALUES OF GMFPS

From the categories of task values, the attainment value was explored to determine the relevancy of GMFPs to the participants' personal values, thereby gaining insight into which GMFP attributes were important and valuable to them on a personal level, thereby complementing their core values and encouraging the participants to acquire such food products (Yurt 2015; Dietrich et al. 2019; Tang et al. 2022). The intrinsic value category was explored to see which GMFP attributes the participants could get a reward from and thus enjoy, whereas the utility values were explored to see what functional use and usefulness the participants assigned to GMFPs (Biedenbach & Jacobsson 2016; Loh 2019; Bostrom & Palm 2020; Shang et al. 2023). The acquisition of such data led to an improved understanding of the overall value the participants credited to GMFPs. The data that emerged from these three task values have been combined and are presented together.

From the data, two themes emerged, namely the overall value of GM crop production and the overall consumer-related value of GMFPs, as discussed next.

6.3.1 Theme 2: Overall Value of GM Crop Production

The data reflected that the participants believed particular attributes of GM crop production were valuable. The most salient aspects of the overall value of GM crop production and their contributing sub-salient aspects are illustrated in Figure 6.3.

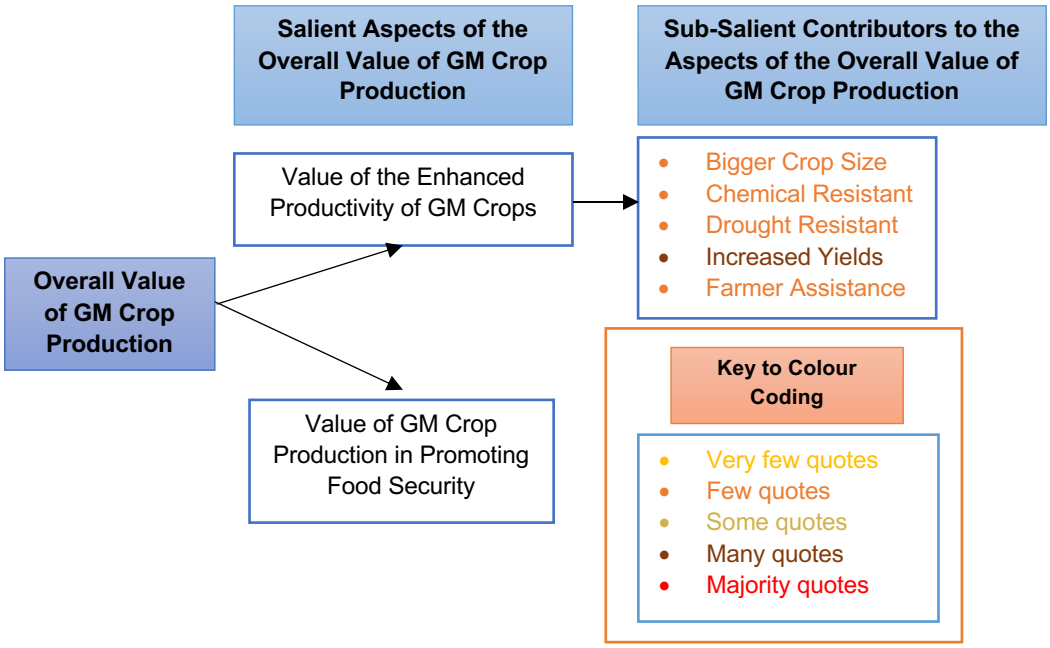

Figure 6.3: Overall Value of GM Crop Production

From the data analysis (see Figure 6.3), two salient aspects emerged, namely the value of the enhanced productivity of GM crops and the value of GM crop production in promoting food security. These are discussed next.

6.3.1.1 Value of the Enhanced Productivity of GM Crops

The **enhanced productivity of GM crops** emerged as an important salient aspect from the data that the participants considered valuable. It was ascribed to sub-salient aspects such as attaining a bigger crop size, being chemical resistant, drought resistant, and achieving increased yields. According to a few participants, in terms of attaining a bigger crop size, *"they do give you a bigger crop"*, *"bigger crops"* can be grown and *"they grow quicker and bigger"*, thereby illustrating GM crops' value in terms of their production. According to an individual participant, growing GM crops *"can produce crops that can make do with a lot less water, meaning you don't have to extract as much water from dams"* and *"you could produce a lot of food on a smaller piece of land, that means that you need less land"*, indicating that fewer resources can potentially be used in GM crop production. It has been argued that GM crops abate water usage, which contributes to the use of less water resources, and GM crops can be grown on smaller areas of land (Conrow 2020; Islam et al. 2020).

In terms of being chemical resistant, a few participants highlighted that GM crops are *"resistant to herbicides"*, that *"they work well in terms of resisting pesticides"*, and that such crops are *"tolerant to certain pesticides"*. In terms of drought resistance, it was proposed by a few participants that the purpose of GM crops was *"to be drought resistant"* and *"to be able to plant seeds in areas that were generally not planted in before, like in drought-stricken areas"*. As a result, GM crops are grown *"to give crops the ability to survive through increased drought resistance",* which *"is going to help with climate instability"* because:

> *"you have got people who are able to grow the crops that they are growing now in a climate that is changing – that is huge"*.

Further value was assigned to GM crops by one participant who expressed that GM crops are *"more resistant"* as *"they are pest resistant"*. A study conducted in Australia found that consumers assigned value to GM crops when they were made to retain drought and pest-resistant traits (Cormick & Mercer 2017). In terms of using biotechnology to develop drought-resistant crops, an example can be seen in Argentina and Brazil, where a variety of wheat has been GM to retain drought-resistant traits (Reuters 2020; Bioceres Crop Solutions 2023). Drought-tolerable soybeans have also been developed through the use of biotechnology

(Bioceres Crop Solutions 2022), illustrating that GM crops' resistant traits are considered valuable among consumers and producers.

In terms of increased yields, many participants believed GM crops could function in a way that increases yields because *"they were designed to increase the yield",* thereby attaining *"bigger yields"*. As a result, GM crops can be *"produced on a mass scale"* and can *"produce more tons of hectare"*; therefore, *"higher crop outcomes or higher crop yields at the end of the season"* as well as *"more volume"* of GM crops can be achieved. Authors have alluded to the fact that the production of GM crops is expected to increase crop yields, thereby allowing the production of more food (Conrow 2020; Islam et al. 2020; Sendhil et al. 2022), further illustrating the value of producing and growing such crops. Various authors have further agreed that attaining a bigger sized crop, promoting the growth of crops, having to use less irrigation and land, retaining specific resistant traits, and achieving bigger crop yields are reasons why GM crops have been GM; therefore, such functions are specifically rewarding to the food production industry (Van Acker et al. 2017; Ala-Kokko et al. 2021; Blagoevska et al. 2021; Kovak et al. 2022).

Additional value was assigned to the production of GM crops by a few participants since these crops could be a useful reward to the farmer because *"it would help the farmer"* as *"they are easier to grow"*, thereby *"benefiting a farmer from season to season"*, and contributing to an *"increase of profit"*. Islam et al. (2020) highlighted additional valuable aspects of GM crops in that these crops are GM to be better suited to environmental factors such as frost, salinity and soil pH. Islam et al. (2020) add that these are particularly valuable traits to farmers who produce GM crops since fewer resources and labour are required. In this study, providing assistance to the farmer was an additional sub-salient aspect that emerged from the data, which was important and is proposed to favourably relate to the participants' personal values.

The participants found value in GM crop production. The attainment of a bigger crop size, chemical and drought resistance, increased yields and assistance for the farmer contributed towards this value, illustrating that these were important aspects linked to the participants' personal values. These were also rewardable aspects that contribute to the function, purpose and usefulness of producing GM crops – all of which are suggested to encourage GM crop production. It is proposed in this study that these valuable GM crop traits could favourably influence the overall value that is assigned to the production of such crops. However, Chapter 5, Sections 5.5.1 to 5.5.5, illustrate that the participants coupled many benefits to the production of GM crops, which were omitted in the values discussion. To illustrate, the participants did not mention environmental benefits as a value of producing GM crops and did

not elaborate on their weather resistance, resistant traits and their ability to increase farmer profitability when valuing GM crops for their production benefits. In relation to Chapter 5, a lack of data emerged when valuing GM production as, evident in the lack of quotes. This suggests that, although GM crops' enhanced productivity was influential on the value the participants ascribed to GM crop production (based on the volume of sub-salient aspects), particularly increased yields (based on the prominence of the sub-salient aspect) – the value of GM crop production was not elaborated on by the participants. This could indicate a struggle in assigning value to GM crop production or not knowing what values entailed. This also further shows that when a belief is prominent, it does not mean it will always carry through to the value assigned to GMFPs.

6.3.1.2 Value of GM Crop Production in Promoting Food Security

Promoting food security was a salient aspect that emerged from the data in terms of the overall value of GM crops' production because *"they can definitely help food security"* as *"they have the potential for feeding those who are vulnerable"*; thus, *"there would be a reward because you could feed more people"*. As a result, *"the biggest value [of producing GM crops] is to curb starvation"*, and thereby *"help with SDGs"*. According to the participants, the main function of GM crops was to enhance food security because GM crops were designed *"to enhance food security"*; therefore, in terms of producing GM crops, *"a specific purpose is to help people in the sense of hunger"*. As a result, the main purpose of GM crop production is *"to cater for those bigger global issues"* such as *"helping and providing food to solve food insecurity"*. Subsequently, *"GM products are filling tummies"*, which can assist *"to resolve the food hunger crisis"*. It was added that *"the whole reason why this started taking place is to alleviate hunger and starvation"* by *"feeding our population"*; therefore, *"they were designed as a stop-gap to food shortage and to fill a stomach"*.

According to individual participants, aspects such as *"drought resistant"*, being able *"to survive in different environments"*, and *"to have a more reliable crop"* contributed to GM crops' value in providing sufficient food to the population, thereby assisting in the promotion of food security efforts. A consensus has been researched among authors and consumers across the globe that producing GM crops and GMFPs is a valuable contribution that the GM food industry can make in providing food to the population, addressing food insecurity and aiding food security, which is made possible particularly due to their resistant traits and higher production yields (Carzoli et al. 2018; Hulela et al. 2019; Ruth & Rumble 2019; Olabinjo et al. 2020; Prianto et al. 2020; Ala-Kokko et al. 2021; Gbashi et al. 2021; Rodriguez et al. 2022; Abdoul et al. 2023).

In this study, it is proposed that increasing food security is an aspect of GM crop production that the participants valued and held dear to their own identity. The population could be rewarded if food security can be promoted, thereby contributing to the functional use, purpose and usefulness of producing GM crops. From the data, it is suggested that being able to promote food security was an attribute the participants deemed valuable of GM crop production, thereby proposing that this aspect can contribute to favourably influencing the overall value of GM crops and food products. Notably, no sub-salient aspects emerged from the data in terms of GM crop production's value in promoting food security. In Chapter 5, Section 5.5.6, the participants elaborated on the role that GM crops and food products can play in promoting food security when their beliefs were explored. However, the participants did not elaborate on GM crops and food products to the same extent when their value was explored in promoting food security efforts. In terms of the value of GM crop production and enhanced food security, a lack of data emerged, which suggests that it was not a prominent aspect in assigning value to GMFPs.

6.3.1.3 Summary of the Overall Value of GM Crop Production

In Table 6.2, a summary of the most salient aspects of Themes 1 and 2 of this chapter are presented to demonstrate how each theme builds on the next, thereby giving a visual depiction of what participants value about GM crops and food products.

Table 6.2: Summary of the Most Salient Overall Value Aspects of Themes 1 and 2

Theme	Salient Value Aspects of GM Crops and GMFPs			
Theme 1: Cost Value of GMFPs	Reduced Financial Cost Values	Compromised Health Cost Values	High Level of Effort Cost Values	Time Cost Values
Theme 2: Overall Value of GM Crop Production	Value of the Enhanced Productivity of GM Crops	Value of GM Crop Production in Promoting Food Security		

In addition to the cost value assigned to GMFPs, it also emerged from the data that the participants valued the production of GM crops, particularly in terms of enhancing productivity and promoting food security, as seen in Table 6.2. In terms of the salient aspects in this theme, numerous authors have exhibited that there are valuable factors to producing GM crops, such as the pest, disease and insect-resistant traits that such crops can be GM to have; preserving resources; attaining increased crop yields and producing more food, contributing to the opportunity to feed more people, thereby aiding in the effort to enhance food security (Van Acker et al. 2017; Ruth & Rumble 2019; Ala-Kokko et al. 2021; Blagoevska et al. 2021; Kovak

et al. 2022). Numerous authors have also suggested that the benefits consumers link to GMFPs can affect their attitudes towards such food products in a positive way (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Ghoochani et al. 2017). This can include resistant traits, increased yields, and assistance with food security, which are also beneficial aspects used in consumer studies to explore attitudes (Morris & Adley 2000; Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Lopez et al. 2016; Rzymski & Krolczyk 2016; Ghoochani et al. 2017; Jonker 2017; Deng et al. 2019; Amin et al. 2021).

This study postulates that the salient and sub-salient aspects that emerged from this theme can favourably influence the overall value of GMFPs and lead to a perceived optimistic overall value, favourably influencing attitudes and thus contributing to a perceived optimistic attitude toward GMFPs. The most salient aspects that emerged in terms of the overall value of GM crop production, their respective sub-salient aspects, and the influence it is proposed to have on the participants' perceived overall value and perceived attitudes, are shown in Figure 6.4.

As seen in Figure 6.4, the overall value of producing GM crops is suggested to prompt participants to ascribe a perceived optimistic overall value to GMFPs. Thus, a subsequent perceived optimistic attitude toward GM crop production is suggested, which could be beneficial to the role that GMFPs can play in promoting food security in SA and achieving SDG 2. It is, however, suggested that based on the lack of depth of data in comparison to the beliefs data, GM crop production did not play a prominent role and lacked influence in assigning value to GMFPs.

A discussion on the third theme, namely the overall consumer-related value of GMFPs that emerged from the data, follows.

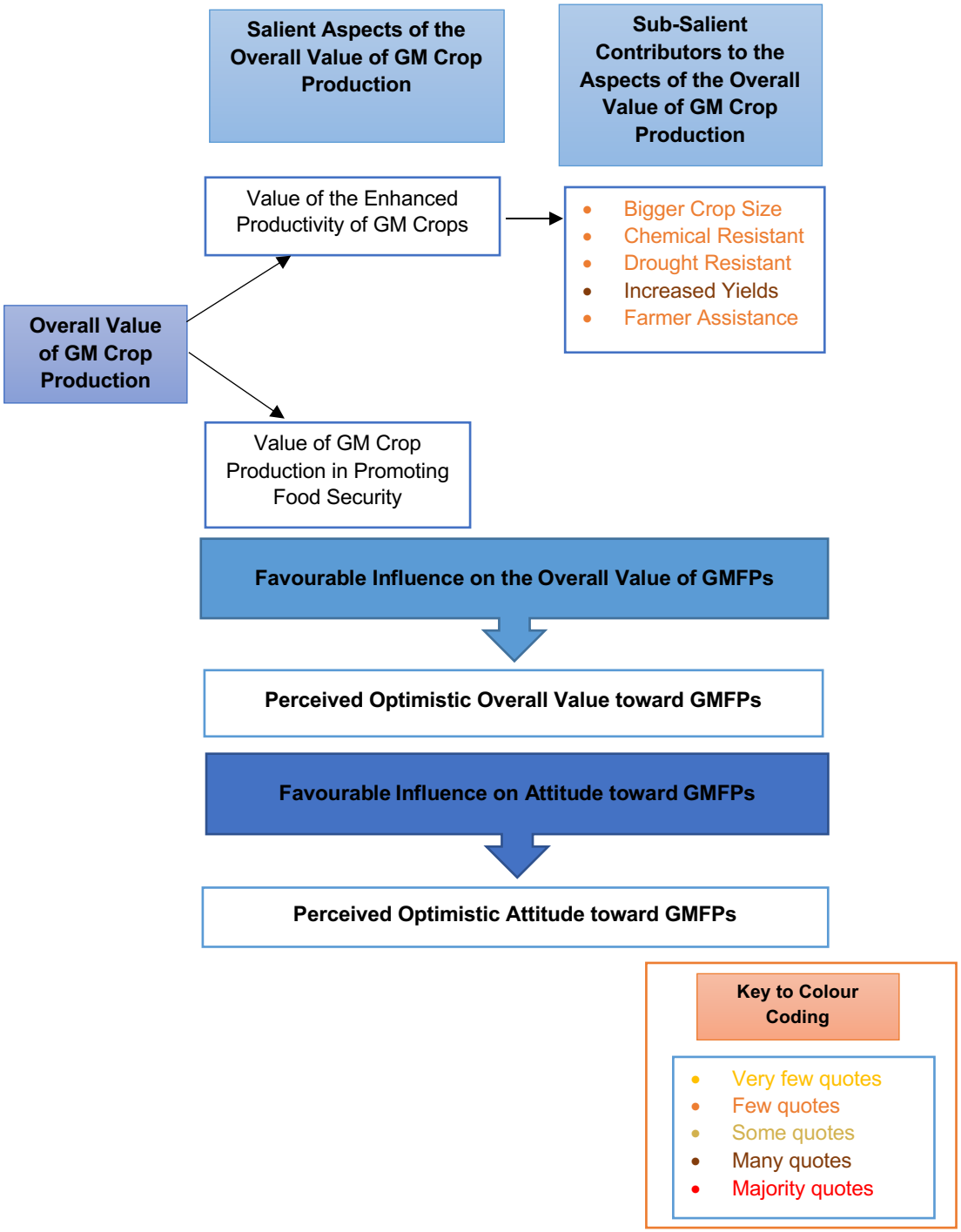

Figure 6.4: Overall Value of GM Crop Production and the Proposed Influence on the Perceived Overall Value and Attitude toward GMFPs

6.3.2 Theme 3: Overall Consumer-Related Value of GMFPs

In addition to the overall value of GM crop production, it emerged from the data that the participants also coupled various consumer-related values to GMFPs. The most salient aspects and their contributing sub-salient aspects relating to the overall consumer-related values of GMFPs are shown in Figure 6.5.

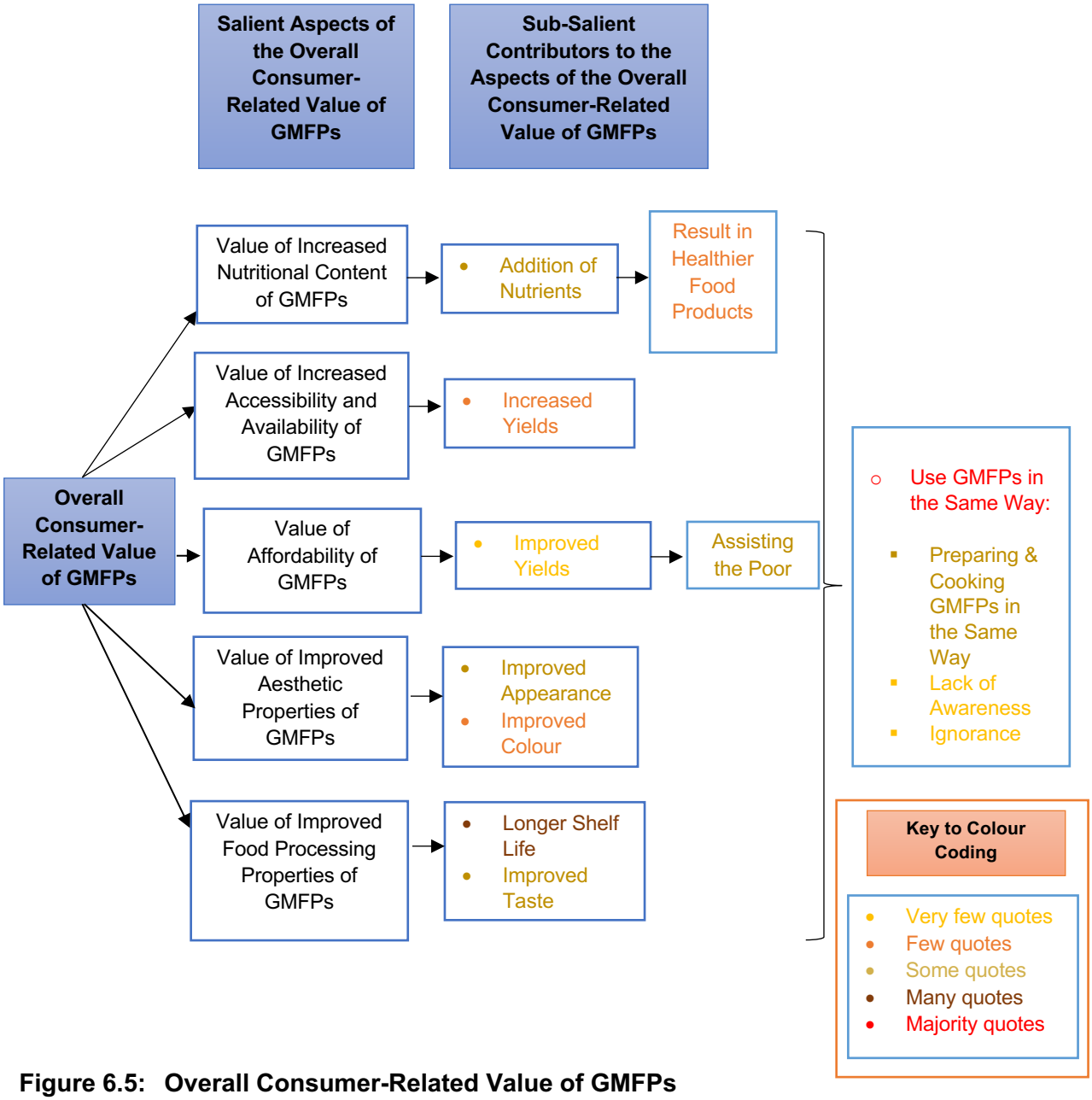

Figure 6.5: Overall Consumer-Related Value of GMFPs

A discussion on the five salient aspects that were identified from the data regarding the overall consumer-related values of GMFPs, as seen in Figure 6.5, follows. These include the value of increased nutritional content of GMFPs; the value of increased accessibility and availability of GMFPs; the value of affordability of GMFPs; the value of improved aesthetic properties of GMFPs; and the value of improved food processing properties of GMFPs.

6.3.2.1 Value of Increased Nutritional Content of GMFPs

The increased nutritional content of GMFPs was a salient aspect that emerged from the data in terms of the overall consumer-related value assigned to such food products because GMFPs have *"improved nutritional content"*. It was stated that a function of GMFPs is *"to increase nutrition to provide a population with a higher vitamin or nutrient base"* and *"to enhance the nutritional value of food"*. Therefore, a function of such food products is *"to fulfil more nutritional benefits"*, *"to provide affordable nutrition to the majority of people within a population"* and *"to help you to just buy one product, but with better nutrients for you to be a healthier person with less food"*. The increased nutritional content of GMFPs was considered valuable by the participants. Golden Rice© can be used to illustrate the functional use of GMFPs. Golden Rice© was GM to produce beta carotene, which is converted into vitamin A when consumed, thereby making the food product more nutritional (Dubock 2017; Muzhinji & Ntuli 2021; Nosowitz 2021). Authors from across the globe have suggested that consumers consider food products to be GM to provide a product with added nutritional value, thereby contributing to a nutritionally balanced diet (Datta 2013; Todua et al. 2015; Wunderlich & Gatto 2015; Jiang & Zhang 2021; Gbadegesin et al. 2022; Abdoul et al. 2023).

The increased nutritional content was ascribed to the sub-salient aspect of the addition of nutrients to GMFPs because, according to some participants, *"they are trying to add nutrition"*, to *"introduce nutrients or different nutritional factors into the products"*, thereby *"adding nutritional value"*. Thus, GMFPs are *"more nutritious than it previously was"* because GMFPs have *"additional nutritional value"*, thereby "*giving us more nutritious products that can help people who are really suffering"*. Evidently, the increased nutritional value of GMFPs was a valuable aspect. Participants believed they could gain a nutritional reward from GMFPs' consumption because the *"biggest value [of GMFPs] is the increased nutritional content"*. By doing so, the additional value was accredited to GMFPs because:

> *"GM foods are there for health issues, like for people who don't get enough food and are suffering from other illnesses"*.

This is because:

> *"GM food make sure that even if they just get the one product that they can actually benefit from that is a health situation too"*.

Therefore, the intent of developing GMFPs was *"to modify foods and different things together in order to get something that's even better and healthier than what the original two products were"*, thereby contributing to the usefulness of genetically modifying food products. Thus, due to GMFPs' increased nutritional value, access to healthier food products was a further sub-salient aspect that emerged from the data, which a few participants believed was a valuable characteristic of GMFPs. Various authors have stated that genetic modification can be particularly useful because healthy food products can be created for people to consume (Van Acker et al. 2017; Ala-Kokko et al. 2021; Amin et al. 2021; Aziz et al. 2022). Islam et al. (2020) added that there is significant value in GMFPs as they can increase the nutrients in food products, such as vitamins and minerals, which can promote the population's health. It has also been found that consumers view food products as being more valuable when they provide benefits to human health (Dovey & Ntuli 2020), such as GMFPs. This phenomenon was seen in Australia, where consumers valued GMFPs more if they were developed to make food products healthier (Cormick & Mercer 2017). To illustrate the usefulness of GMFPs' value in promoting human health, the GM purple tomato was GM to increase its nutritional content in terms of producing more antioxidants (John Innes Centre 2022). The genes of potatoes have also been gene-edited through the use of CRISPR-Cas9 to reduce sugar formation, thereby producing a healthier potato for the consumer (Yasmeen et al. 2022).

In the current study, a useful function of GMFPs was coupled with allergies by one participant as *"people are allergic to certain products"* but *"can now consume something that's similar to the product that they are allergic to"* due to the process of genetically modifying food. It was considered to be a reward that can be enjoyed by individuals with health issues, such as allergies. To illustrate, Chakravorty (2021) explained that scientists are seeking to produce varieties of wheat and peanuts that individuals with such allergies can consume without having any adverse allergic reactions. Scientists have also discovered that GM soybeans can produce casein, thereby making it possible for lactose-intolerant consumers to consume food products, such as cheese (Innovature 2021). Evidently, genetic modification can allow consumers to consume food products they are allergic to, thereby demonstrating the functional use of GMFPs and the enjoyment consumers can receive from consuming them.

GMFPs' increased nutritional content was considered by the participants as a valuable attribute of GMFPs, which was also an aspect that emerged from the data on participants' beliefs about these food products, as seen in Chapter 5, Section 5.6.1. This study suggests that increased nutritional content concurred with the participants' personal values in terms of GMFPs' function, purpose and usefulness in providing food products with enhanced nutritional value to the population. The data reflected that the increased nutritional content of GMFPs

was a valuable trait of such food products, which the addition of nutrients contributed towards, thereby creating a healthier food product. It is suggested this aspect can favourably influence the overall consumer-related value of GMFPs. Based on the depth of data and the volume of sub-salient aspects, it is suggested that this salient aspect shared the same prominence in the value assigned to GMFPs as the participants' beliefs of such food products. However, due to the limited sub-salient aspects, this salient aspect lacked influence in terms of the consumer-related values of GMFPs.

6.3.2.2 Value of Increased Accessibility and Availability of GMFPs

In addition to the value coupled with GMFPs due to their improved nutritional content, another salient aspect of GMFPs emerged from the data related to the overall consumer-related values of GMFPs, namely **increased accessibility and availability of these food products** because GM "*food is more accessible";* the production of GMFPs means *"they are more easily accessible"*. As a result, the purpose of producing GMFPs is to *"make food more readily available and accessible to people"*, particularly since *"there is more food around and available"*, and because there is a *"greater availability of a product*". Therefore, *"one of the main reasons for genetically modifying food products is to make them more accessible to consumers"*. Numerous authors agreed that the production of GMFPs can make food products more readily available and accessible to consumers (Qaim & Kouser 2013; Dizon et al. 2016), illustrating the value that GMFPs have on the food production industry. To this effect, it was announced that components of strawberries will be gene-edited to grow for longer seasons – among other traits – thereby making this fruit available to consumers for a longer period during the year (Ridler 2021). This recent event in biotechnology illustrates its usefulness in altering traits of crops and food products for consumers' convenience.

A few participants attributed the increased accessibility and availability of GMFPs to *"increased yields"*, *"better yields"* and *"improved yields",* which can be attained through GM crop production. This sub-salient aspect thus emerged from the data, confirming the salient aspect. Hassan et al. (2016) found that Malaysian consumers agreed high crop yields can promote the production of more food, thereby making more food available to the population. This finding was also evident among Ghanaian consumers (Owusu-Gyan et al. 2023). By increasing the accessibility and availability of GMFPs, one participant believed that *"more food is accessible specifically in the rural communities"*, thereby *"providing food for the poor"*, which is a further value GMFPs can bring to the consumer. Another participant added that the increased accessibility and availability of GMFPs are *"convenient"* to consumers. Consumers are rewarded by convenience, further illustrating the usefulness of GMFPs.

This study proposes that the value of the increased accessibility and availability of GMFPs complemented the participants' personal values. GMFPs' function, purpose and usefulness in making food products more accessible and available to the population reward consumers. Thus, in addition to the value assigned to GMFPs in terms of having an increased nutritional content, the participants further considered increased availability and accessibility as a valuable attribute of GMFPs (which was also an aspect participants discussed related to their beliefs in Chapter 5, Section 5.6.2 regarding the consumer-related benefits of GMFPs), credited to the attainment of increased yields during the production of such food products. It is suggested in the current study that the value of increased accessibility and availability of GMFPs favourably influences the overall value of these food products. The aspect shared a similar prominence as in the beliefs data based on the extent of elaboration and volume of sub-salient aspects. However, the lack of elaboration and limited sub-salient aspects suggests the aspect lacked prominence in contributing to the value of consumer-related benefits of GMFPs.

6.3.2.3 Value of Affordability of GMFPs

The **affordability of GMFPs** emerged from the data as a salient aspect that contributed to the overall consumer-related values participants assigned to GMFPs because *"GM has better prices"* than their traditional counterparts, *"they are more affordable"* and *"they are cheaper"*. Subsequently, *"they are cheap and affordable"*. In terms of the value of GMFPs due to their affordability, *"GM crops do have value because they save you money"* and it is *"a savings gain"*, therefore *"cost wise and value wise, you definitely going to get more"*. The participants further stated that providing the population with affordable food products was the intent behind developing GMFPs in that *"the intention was to create a cheaper product"* and that *"GMFPs are being grown for the purpose of lowering prices"* of food products. Due to the reduced price of GMFPs, *"people are paying less for what they are eating"*, thereby *"ensuring that food is affordable for every single person"*. As a result, *"they are made to make them cheaper"* for consumers and *"they were created"* to be sold *"at a cheaper price"*, and to produce *"cheaper products, so things are better priced"*. The data reflected that creating and selling food at lower prices contributed to the usefulness of GMFPs. Authors have opined that GMFPs are more affordable (Zhu et al. 2018; Dovey & Ntuli 2020; Jiang & Zhang 2021; Sendhil et al. 2022; Alalwan et al. 2023), thereby demonstrating their usefulness to consumers.

Very few participants attributed affordability to improved yields, which was a sub-salient aspect that emerged from the data, confirming the salient aspect because *"more yields"* and the *"enhanced yields farmers get can be passed onto consumers"*. Participants explained:

"you can drastically improve your yields using GM technology that can enhance the production and so it filters through to the price".

Authors have stated that GMFPs can be sold at a lower price by achieving higher crop yields (Van Acker et al. 2017). The affordability of GMFPs was thus a reward for the participants, which they could enjoy as *"price would be the biggest reward"*.

Further value was assigned to GMFPs, based on their reduced price, since some participants believed that these food products were developed to assist the poor: *"there are people who don't have a lot of money to spend on food, so it will definitely impact them"*. Thus, *"the value for me would purely be that people in our country could afford food",* and *"the biggest value is the decreased price for a nation that has such a low income rate and such a high level of poverty"*. The affordability of GMFPs can *"help a poorer person to be able to buy a food product"* because they are *"cheaper for the poorer masses to get hold* of". GMFPs are thus valuable because *"it is cheaper for the poor"* to purchase such food products. Assisting the poor therefore emerged as a valuable sub-salient aspect. Additional value was given to the affordability of GMFPs by one participant, stating that *"soup kitchens and charity organisations where people need food"* and *"Gift of the Giver's"* can *"buy a whole stack of food"* due to their reduced prices, further illustrating the usefulness of GMFPs' affordability.

The data thus showed that affordability was a valuable and useful trait of GMFPs, which is subsequently proposed to supplement participants' personal values. GMFPs' purpose and function to make food products more affordable to the population – through the achievement of higher yields – results in the poor gaining the financial opportunity to purchase these food products. This is also a rewardable aspect consumers can enjoy, compelling them towards GMFPs. Based on the volume of quotes, the lowered price of GMFPs was thus coupled with such food products, which was also seen in the beliefs data in Chapter 5, Section 5.6.3, suggesting that the aspect shared a similar prominence with the beliefs data. This could indicate that a prominent belief about GMFPs could emerge as a valuable attribute when assigning value to such food products. Even though there was a lack of sub-salient aspects, the volume of quotes relating to the affordability of GMFPs suggests that affordability did play a pertinent role in assigning a consumer-related value to GMFPs. It is further proposed that the affordability of GMFPs can favourably influence the overall value assigned to such food products.

6.3.2.4 Value of Improved Aesthetic Properties of GMFPs

In addition to GMFPs' value based on their increased nutritional content, increased accessibility and availability, and affordability, the **improved aesthetic value of GMFPs** was a further salient aspect that emerged from the data, reflecting overall consumer-related values linked to GMFPs. It was believed that food products were being GM in such a way that *"they are trying to target the consumer as much as possible",* and thus *"the whole push behind genetic modification"* is to produce food products for aesthetic purposes. The salient aspect was attributed to two sub-salient aspects, namely improved appearance and improved colour. In terms of the improved appearance of GMFPs, some participants stated that they could enjoy GMFPs because they have an *"improved appearance"*, they are more *"appealing"*, they *"look better"*, and have *"less blemishes"* compared to traditional food products. In terms of the purpose of developing GMFPs, it was stated that *"the intention is to make it look more appealing"* and that *"they were designed to look desirable"*. Thus, *"genetically modified go into making them look better"*, *"to look nicer"*, and *"to look aesthetically better"*, thereby *"getting the most sought after products"*. According to a few participants, the intent behind improving the colour of GMFPs is that *"they can take the favourable genes to recreate something that looks good"* or *"to change their colour"* or to *"make the colour better".* Colour was deemed a valuable attribute of GMFPs as *"people eat with their eyes", "so if you have a thing on the shelf that looks tastier or is a brighter red colour, they are attracted to those certain aspects"*. Thus, the improved aesthetic properties of GMFPs *"gives you an even better product"*. Authors echoed these findings in that genetic modification is used to make food more appealing to the consumer and change the colour of food (Kubisz et al. 2021). To illustrate, components of the PinkGlow™ pineapple were altered to change the fruit's colour from yellow to pink (CropLife International 2021). The GM purple tomato was GM to change its colour from red to purple; and research has been conducted in Halle (Germany) to genetically modify a component of tomatoes to give them a deep purple colour (Seed World 2021; John Innes Centre 2022). These findings illustrate the enjoyment that consumers can retain by having food products in different colours, which is made possible through biotechnology, where genes can either be GM or gene-edited.

It was further proposed by one participant that the aesthetic properties of food products are GM for *"sale purposes"* to increase profits by selling food products that are better looking and more colourful, thus they *"sell better"* because consumers have *"less chance of being disappointed"* with the appearance of such food products. Another participant depicted this by illustrating that:

"for example, carrots or apples or tomatoes – typically the genetically modified ones are perfect looking and so a consumer would be drawn to them, rather than something that's got funny bumps or isn't the perfect shape or is not as brightly coloured".

From the data, it emerged that participants considered improved appearance and colour useful, rewardable, and thus valuable traits of the aesthetic properties of GMFPs. This was the purpose of producing such food products that consumers could specifically enjoy, thereby driving them towards GMFPs. The enhanced aesthetic properties of GMFPs emerged as an important salient aspect when the participants' beliefs were explored regarding the consumer-related benefits of GMFPs in Chapter 5, Section 5.6.4. Based on the depth of data and the volume of sub-salient aspects, it is suggested that the improved aesthetic properties of GMFPs were less influential in the values data, but more influential on the participants' beliefs about GMFPs. It is, however, suggested that the valuable aspects in terms of the improved aesthetic properties of GMFPs can favourably influence the overall value given to GMFPs.

6.3.2.5 Value of Improved Food Processing Properties of GMFPs

In addition to GMFPs' value related to their improved aesthetic properties, the **improved food processing properties of GMFPs** was another salient aspect that emerged from the data on overall consumer-related values being assigned to GMFPs by the participants. One of the sub-salient aspects that emerged from the data, contributing to the improved food processing properties of GMFPs, was their increased shelf life. This was linked to gaining a reward from GMFPs, creating value due to their ability to last longer. This value was exhibited through various statements by many participants, such as *"it would last longer"*, they are *"less likely to go off quickly"*, and therefore *"you are getting a product that has a longer shelf life"*. Due to the longevity of GMFPs, they *"stay longer in your fridge without going off"* and *"they stay fresh for longer"*. The value of GMFPs, in terms of the reward and enjoyment that can be experienced from having a product with increased shelf life, was indicated by participants. They explained these food products *"will give you more value"* because *"you are saving on the product"* as *"it's going to last you longer"*, and therefore *"you are going to get way more out of that product"*. Subsequently, *"it is convenient to my life and my lifestyle",* and *"it's going to make people's lives easier"* because *"I can keep GM food on the shelf longer"*. Tomatoes were used as an example by one participant to illustrate the value of GMFPs' longer shelf life, saying that:

"so when we buy a packet of tomatoes, in a weeks' time it's gone off, but GM tomatoes will last in your fridge for a month. So you don't have to throw away a tomato every week".

Although tomatoes were used as an example to depict the longevity of GMFPs, no GM vegetables or fruits are available on the market in SA (Woolworths 2020). Evidently, the participants not only believed that a reward and enjoyable experience can be attained from the longevity of GMFPs, but that if food products showed such attributes, they must be GM. In terms of the main functions of GMFPs, it was stated that these food products were developed *"to have a longer shelf life"* as *"one of the main drives towards it is longer shelf life"* and *"to prevent early decay or going off soon"*; therefore, *"they were designed to have a long shelf life"*. Thus, *"they are used [by consumers] because they preserve better"*. Additional value was coupled to the longevity of GMFPs by one participant stating *"it will reduce waste"*, so *"that's another functional use"* of GMFPs, further illustrating that increased shelf life was a valuable trait of such food products to the participants. Numerous authors have agreed that the longevity of GMFPs is a useful trait of these products that can allow consumers to keep food on the shelves for longer (Nazir et al. 2018; Dovey & Ntuli 2020; Olabinjo et al. 2020; Siddiqui et al. 2022; Abdoul et al. 2023). To illustrate, the Flavr Savr™ Tomato was GM to have a longer shelf life (Islam et al. 2020; Wray 2021). The White Russet potato and the Arctic® Apple were also GM to prevent them bruising and turning brown, thereby making these products last longer, while the CONICET potato variety was gene-edited to silence its browning trait – but is not yet available on the market (Maxmen 2017; Goldberg 2018; Kubisz et al. 2021; ISAAA Inc. 2023). Bananas in the Philippines have also been gene-edited to reduce browning (Tropic 2023). Although not available in SA (Maxmen 2017; Woolworths 2020; Kubisz et al. 2021), these three respective GM and gene-edited food products show the usefulness of longer shelf life, allowing consumers to enjoy these food products that have undergone genetic modification or gene-editing.

In the current study, value was further assigned to the longevity of GMFPs by an individual participant reflecting on the prevalence of poverty in Africa and SA. The participant opined the increased shelf life of GMFPs would be particularly useful and valuable to people who *"live in poverty-stricken or remote areas where they don't have electricity or fridges"*, as they would have the opportunity to purchase food products that *"can live on the shelf and not the fridge for longer"*. Subsequent to this, people can *"buy in bulk"* without having to be concerned about the food *"spoiling"* because *"some people just can't have something lasting for one day, they may need that to last a couple of days"*. Since many people are confronted with these challenges, *"this is where genetically modified foods can step in and halt people's expenditure"* because their food can last longer, thus less food is potentially thrown away. This view further demonstrates the usefulness of being able to purchase a food product that lasts longer, such as in the case of GMFPs.

In addition to the increased shelf life of GMFPs, improved taste was another sub-salient aspect confirming the salient aspect because, according to some participants, *"genetically modifying things go into them tasting better"*, *"they can make it taste better"*, and *"it increases taste"*, and therefore GMFPs *"better taste"*. It was further stated that GMFPs were designed to produce tastier food as *"the intention was to create a better tasting product"*; therefore, *"they intended to make it taste better"* than conventional food products. The purpose of genetically modifying components of food products is thus to create products that are *"better tasting"*, thereby contributing to their usefulness to the consumer. Various studies confirmed that the improved taste of GMFPs is a trait that appeals to consumers (Verdurme & Viaene 2003; Hassan et al. 2016; Bray & Ankeny 2017; Dovey & Ntuli 2020; Sendhil et al. 2022). Therefore, gene-edited strawberries with increased shelf life and improved taste will be available for American consumers to enjoy in the near future (Ridler 2021).

The data reflected that GMFPs were valued for their improved food processing properties, specifically attributed to their longer shelf life and improved taste. It is suggested in this study that the purpose of genetic modification is to provide and develop food products with longer shelf life and improved taste, thereby propelling the participants toward GMFPs due to the enjoyment they could obtain from being rewarded with a longer lasting and better-tasting food product, further adding to the functionality and usefulness of such food products. Based on the prominence of the sub-salient aspect, GMFPs' longevity emerged as an important, valuable aspect to the participants relating to the overall consumer-related values of such food products. It was also important to the participants when discussing their beliefs about GMFPs in terms of the consumer-related benefits of such food products, as seen in Chapter 5, Section 5.6.5. Based on the volume of quotes that emerged on the longer shelf life of GMFPs, it is suggested that the aspect shared the same prominence in the beliefs and values data. It is thus proposed that this aspect (longer shelf life) was influential in the beliefs and values data, which could suggest a link between beliefs and values is made in terms of the consumer-related benefits and values of GMFPs. It is proposed that the improved food processing properties of GMFPs, reflected in their longevity, can favourably influence the overall value assigned to such food products.

6.3.2.5.1 The Use of GMFPs

Although the participants valued various traits of GMFPs, the data indicated that, according to the majority of participants, *"I use the [GM] products exactly the same way"* as a conventional food product and *"I won't treat it any different or use it any different"* to other food products. As a result, *"I can't see how it's going to affect how I use it"* because *"I would use it exactly the same as I would use the non-GM food product"* as *"there is no reason to think they should be*

used differently". Therefore, using GMFPs in the same way emerged as a sub-salient aspect, ascribed to further sub-salient aspects such as preparing and cooking GMFPs in the same way, as well as a lack of awareness and ignorance regarding such food products. In terms of preparing and cooking GMFPs in the same way, some participants stated that *"I'm not going to all of a sudden cook the GM food product differently or treat it any different"* and *"I don't think I would cook them differently"* because *"you are going to cook GM food the same as an organic food"*. Therefore, *"the preparation and cooking [for GMFPs] would be the same"* as for non-GMFPs, as *"the cooking method will still stay the same"*. As a result, *"I cook it the same way, prepare it the same way"*. In terms of a lack of awareness and ignorance, very few participants stated that GMFPs could be used in the same manner as other non-GMFPs *"probably just because of lack of awareness"* as *"most of the time I am not aware"* if they are GMFPs or not *"because I don't really know what's GM and what isn't"*, which *"just points to my ignorance of what is genetically modified and what isn't"*. Evidently, GMFPs have been valued for their various attributes, and these attributes did not influence the way in which many participants used these food products, demonstrating a sense of comfort when using (preparing and cooking) GMFPs as they were not treated differently. However, it shows that GMFP attributes do not contribute to the usefulness of these food products when they are actually used (prepared and cooked). Based on the prominence of the sub-salient aspect, it is suggested that using GMFPs in the same way was a prominent and influential sub-salient aspect when assigning value to such food products.

6.3.2.6 Summary of the Overall Consumer-Related Value of GMFPs

To build on the value of GMFPs and crops, as shown in Themes 1 and 2, the most salient aspects of the overall consumer-related value assigned to GMFPs (Theme 3) are presented in Table 6.3.

Table 6.3: Summary of the Most Salient Overall Value Aspects of Themes 1 to 3

Theme	Salient Value Aspects of GM Crops and GMFPs				
Theme 1: Cost Value of GMFPs	Reduced Financial Cost Values	Compromised Health Cost Values	High Level of Effort Cost Values	Time Cost Values	
Theme 2: Overall Value of GM Crop Production	Value of the Enhanced Productivity of GM Crops	Value of GM Crop Production in Promoting Food Security			
Theme 3: Overall Consumer-Related Value of GMFPs	Value of Increased Nutritional Content	Value of Increased Accessibility and Availability	Value of Affordability	Value of Improved Aesthetic Properties	Value of Improved Food Processing Properties

As shown in Table 6.3, the cost value of GMFPs emerged from the data. Overall value was also assigned to GM crop production, which was supplemented with overall value for consumers regarding GMFPs' increased nutritional content, increased accessibility and availability, affordability, improved aesthetic properties and improved food processing properties, as evident in Theme 3 of this chapter.

In terms of the aspects that emerged from the data in this theme, authors have illustrated that the reduction in price, improved nutritional content, being readily available, improved appearance and taste, and the longer shelf life of GMFPs are determining aspects of consumers' attitudes when it comes to GMFPs (Morris & Adley 2000; Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Lopez et al. 2016; Rzymski & Krolczyk 2016; Ghoochani et al. 2017; Jonker 2017; Deng et al. 2019; Amin et al. 2021). In consumer attitude studies, it has been posited that the benefits consumers associate with GMFPs – such as those previously mentioned – could affect their attitude in a positive way (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Ghoochani et al. 2017). In this study, it was postulated that the salient and sub-salient aspects that emerged from the data in this theme could favourably influence the overall value of GMFPs, thus contributing to a perceived optimistic overall value of GMFPs, which is suggested to influence attitudes in a favourable manner, thereby leading to a perceived optimistic attitude toward GMFPs. The most salient and contributing sub-salient aspects that emerged on the overall consumer-related values of GMFPs and the suggested influence it could have on the participants' perceived overall value and perceived attitudes towards GMFPs are illustrated in Figure 6.6.

Figure 6.6 shows that from this theme, it is postulated that the overall consumer-related salient aspects contribute to the perceived optimistic overall value of GMFPs, resulting in a perceived optimistic attitude towards such food products. This could promote the role that GMFPs can play in promoting the food security status of the SA population and accomplishing SDG 2. Considering the depth of data in relation to the previous themes in this chapter (based on the volume of salient aspects that emerged), it is proposed that the consumer-related value of GMFPs was a prominent influencer on participants' value of such food products. It is further suggested, based on the extent of elaboration on the consumer-related value of GMFPs and volume of salient aspects (and also sharing a similar prominence as the beliefs data), that combining the attainment, intrinsic and utility task value categories was useful in the exploration of the value assigned to GMFPs.

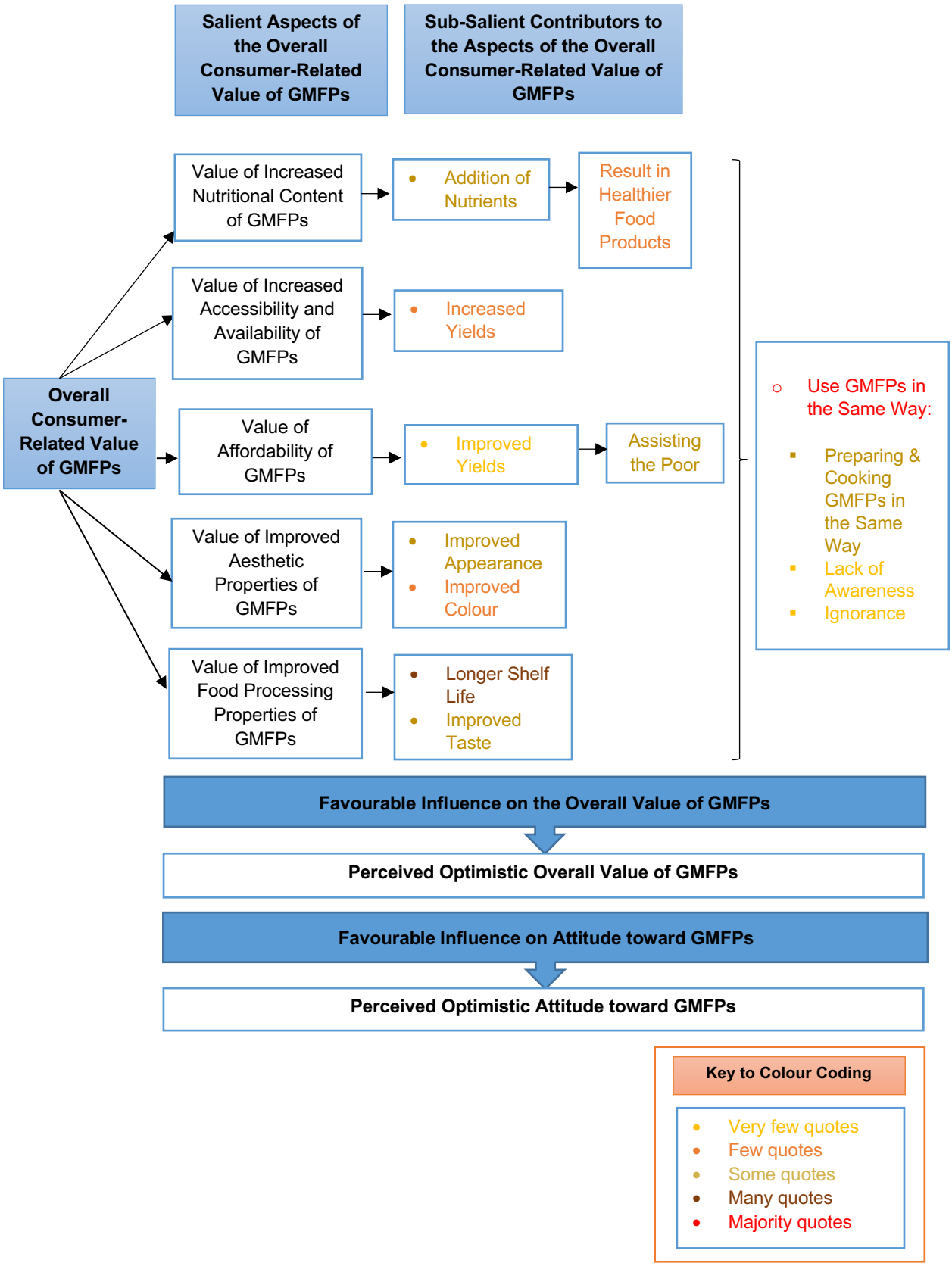

Figure 6.6: Overall Consumer-Related Value of GMFPs and the Proposed Influence on the Perceived Overall Value and Attitude toward GMFPs

In the next theme, the ethical values of genetic modification are presented.

6.4 THEME 4: ETHICAL VALUES OF GENETIC MODIFICATION

Although cost values were assigned to GMFPs while also ascribing value to GM crop production and GMFPs, ethical aspects emerged from the data that challenged the participants' personal values. Thus, the ethical values of genetic modification emerged from the data – within the attainment value category of the four categories of task values – as an important main theme. The most salient and contributing sub-salient aspects of the ethical values of genetic modification are presented in Figure 6.7.

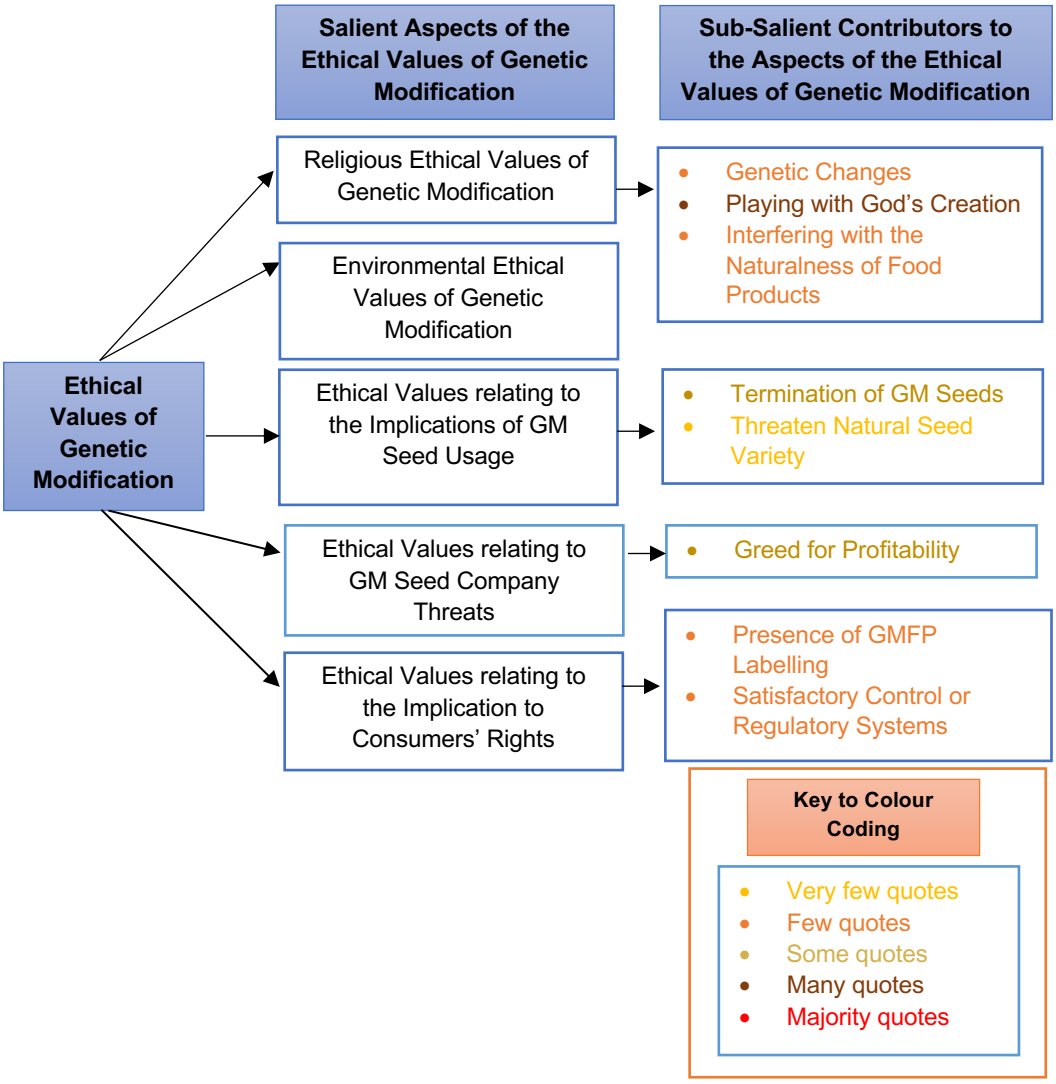

Figure 6.7: Ethical Values of Genetic Modification

As seen in Figure 6.7, five salient aspects of the ethical values of genetic modification conflict with participants' personal values, namely religious ethical values; environmental ethical values; ethical values relating to the implications of GM seed usage; and ethical values relating

to GM seed company threats. These salient aspects also emerged as risks and concerns in the beliefs data. An ethical value relating to the implications of consumers' rights emerged as another salient aspect. These five salient aspects of the ethical values of genetic modification are subsequently discussed.

6.4.1 Religious Ethical Values of Genetic Modification

An important salient aspect that conflicted with the participants' personal values was **religious ethical values** because *"as a Christian, I just don't feel that it is morally and legally and ethically right"*, and *"from a Christian perspective", "it's ethically wrong to change a food substance"*, such as in the case of GMFPs. Numerous authors have argued that the process involved in developing GMFPs challenge consumers' religion, thereby causing resistance towards such food products (Chen 2008; Lucht 2015; Dizon et al. 2016; Pakseresht et al. 2021; Ghimire et al. 2023). The religious ethical values were confirmed by various sub-salient aspects, such as the genetic changes of GMFPs; playing with God's creation; and interference with the naturalness of food products. According to a few participants, in terms of changing the genetics of food products, it was stated that *"it's wrong to take a gene from a completely different organism and then insert it into something that is going to be consumed"*; and that:

> *"I think to a large extent when it's genetically modified in terms of in a laboratory and there's actual modifications on a genetic level through like unnatural processes – that to me is where it becomes a bit of an ethical question"*.

Thus, *"from my Christian belief, you shouldn't modify stuff because you shouldn't mess with genetics"*. It has been established that the transfer of or manipulation of DNA was seen by consumers as an immoral process (Phillips 2008a; Gatew & Mengistu 2019).

In terms of playing with God's creation, there was an ethical issue with genetic modification for many of the participants because producers are *"messing with something that was designed to work in a certain way"*; therefore, *"from a Christian perspective, it's difficult for me to think that messing with something that was designed to be perfect is helpful"*. Subsequently, *"I suppose it's coming back to that sort of thing of playing God; how much are you interfering with nature"*, and:

> *"I think we [are] playing God [through producing GMFPs]. I mean God has created a perfect world and now we intervening to try and change that perfect world, and I'm*

> *really opposed to that. I think we become God and we start playing God and I think it's wrong"*.

The participant continued that *"God didn't create them like that and now people are toying with what God has created"*. Various authors concur that there are ethical concerns around genetic modification, which has led consumers to believe that the production of such food products entails "playing God" and messing with the integrity of what God has created (Verdurme & Viaene 2003; Phillips 2008a; Kotze 2016; Gatew & Mengistu 2019; Aziz et al. 2022). It has further been opined that consumers object to GMFPs due to their personal, ethical and religious views (Islam et al. 2020; Aziz et al. 2022; Ghimire et al. 2023). This was evident in an SA study that reported consumers felt the production of GMFPs was ethically wrong (Gastrow et al. 2018), which is still the case, as seen in the findings of this study.

In terms of interfering with the naturalness of food products, a few participants became cynical about GMFPs because:

> *"looking at it more in a religious way, I will be a bit sceptical and not with total ease with the idea because you do tamper with the natural way of the plant"*.

Therefore, *"it's not purely natural because you work against the natural processes that's been put out there"*, thereby deeming GMFPs as *"recreated"* food products. Phillips (2008a) stated that many consumers are of the opinion that it is immoral to disrupt nature and the natural process of producing food. Other authors similarly concurred that the unnaturalness of GMFPs has been raised as an ethical concern (Weale 2010; Russo et al. 2020; Siddiqui et al. 2022). Considering the emergence of these aspects, from a religious point of view, it was stated that *"it doesn't sit well, it does make me question whether I should take a stand against something like that"*; *"it just really goes against my moral fibre"* because *"the very thought of it is frightening actually"*. Therefore, *"I sort of have a bit of a struggle understanding and coming to terms with that"* because *"I always worry that there will be retribution in some way"* in terms of interfering with the natural process of producing food products, such as GMFPs. Because *"the ethics around GM is a bit shaky"*, the question raised by one participant was: *"as a Christian, should we be supporting that?"*.

Although ethical opposition was showcased towards GMFPs in terms of the participants' religion, according to one participant, *"we've got to adapt to provide for all the millions of us"*. Thus, religion was viewed from a different angle in that *"God has given people the ability, through science, to be able to create better products through technology to be able to provide*

for humans and human needs". Therefore, *"there's two ways to look at this from a religious side and point of view"* because *"by the same token, if we didn't have modern science, where would we be?"* To illustrate, the participant stated that:

> *"it's a tough one because ethically we should change what is natural, but, ethically too, we have the means and the tools to support an expanding population and we are not going to see children starving from starvation, what's more ethical? Maybe it's more ethical to use GM foods to grow better crops and to feed the world than to have people not receiving food"*.

It is ultimately *"not black and white"*, but instead *"it's a grey area"* when it comes to the genetic modification of food products. Thus:

> *"GM foods is not a net-ethical concern, because if they are meeting the needs of a lot of people across the world who are starving, then that is also important to consider"*.

It was added that, although GMFPs are genetically altered through the use of technology, *"it is our ethical responsibility to use [the] technology God has given us"*.

Based on the volume of sub-salient aspects, genetic modification challenged the participants' religion, which is considered an influential aspect of the ethical values of genetic modification. Based on the prominence of the sub-salient aspect, participants' religious challenge was particularly related to the idea of playing with what God created, which could create hesitancy toward GMFPs. Religious ethical values towards GMFPs were also attributed to changing the genetics of GMFPs and interfering with the natural process of producing food products. These were important aspects that the participants elaborated on in-depth when their beliefs about the altered state of existence due to genetic modification were discussed, as seen in Theme 1 of Chapter 5, Section 5.4. Although the religious ethical values of genetic modification were influentially linked to the ethical values of genetic modification, the genetic modification of food products was more prominent in the beliefs data in Section 5.4.1 (particularly when participants discussed the biological change in the DNA and genetics of food products) and the unnaturalness of GMFPs in Section 5.4.2. It is suggested to be a less prominent aspect of religious ethical values of genetic modification based on the lack of quotes on the genetic changes and interference with the naturalness of food products in this section. However, the current study proposes that the religious ethical values coupled with genetic modification conflicted with the participants' personal values and moral standing relating to GMFPs, thereby unfavourably influencing the attainment value and overall value given to GMFPs.

6.4.2 Environmental Ethical Values of Genetic Modification

In terms of the participants' ethical values linked to genetic modification, the **environment** emerged as a salient aspect of the data as it was stated that *"it's ethically wrong because of the [negative] impacts that they have on the environment"*. Therefore, producing GMFPs goes against *"the security of the environment"*, which was attributed to the fact that *"GM crops is wiping out biodiversity on a big scale, and that is completely wrong"*. According to individual participants, the production of GM crops *"will affect ecosystems"*, and what *"if we genetically modified everything and you no longer had food source for insects"*? As a result, *"we would actually have a problem because we would put the whole environment out of whack"* and *"we could end up damaging the environment more than we are actually helping it"*, thereby suggesting genetic modification could potentially be damaging the environment, and this aspect did not sit well with the participants' personal values. These findings were echoed by other authors who stated that potential harm to the environment could be caused through the production of GM crops, which has been raised as an ethical concern among consumers (Weale 2010; Todua et al. 2015; Ghanian et al. 2016; Prianto et al. 2020; Sendhil et al. 2022). It has further been highlighted that harming or threatening the ecological balance is a factor that has challenged consumers in terms of producing GM crops and food products; as a result, it has been opined that environmental ethics in terms of genetic modification in food production is a concern (Gatew & Mengistu 2019; Russo et al. 2020; Sanlier & Sezgin 2020).

In this study, it was added that, instead of damaging the environment:

> *"technically according to some Christians and the Bible, man is supposed to act as custodian of nature, which implies that he should simply be taking care of it and not actually altering it"*.

The participant continued that *"God gave us this earth to look after for Him, not to kill it and mutilate it"* through the genetic modification of food products. Therefore, *"we should be doing the best that we can to keep everybody and the earth safe"*. One participant added that:

> *"some form of sense in the scientific community must debate this far enough and get some more understanding on it to ensure that we don't have damage beyond repair*".

Therefore, *"sufficient scientific review must be done"* on the genetic modification of GMFPs.

Although harmful effects on the environment did emerge as an aspect when considering the ethical values of genetic modification, the data indicates that the aspect was elaborated on more deeply when the participants conversed about their beliefs about GMFPs in terms of the risks and concerns coupled with GM crop production in Chapter 5, Section 5.7.1. This is evident by the absence of sub-salient aspects in this section. It could indicate that the participants' beliefs about the harmful impact or risk to the environment through GM crops' production were perhaps more influential on their beliefs than their ethical value of genetic modification, suggesting that they lacked confidence in terms of assigning value to GMFPs. However, the data showed that the environment was a conflicting ethical aspect to the participants' personal values and morals, and could lead to a perceived unfavourable influence on the attainment value and overall value given to GMFPs. The absence of sub-salient aspects suggests that the aspect did not carry particular prominence.

6.4.3 Ethical Values relating to the Implications of GM Seed Usage

The data reflected that **ethical values relating to the implications of GM seed usage** was a salient aspect of the ethical values of genetic modification. It was attributed to the sub-salient aspect of the termination of GM seeds as some participants stated that *"you are beholden to buy your seed every year even though you look after your seed, [because] after you've harvested it won't grow next year"*, therefore *"you can't grow it again next season, you can't just look after this season's crop and plant it that seed again next season"*. Subsequently, *"seed from genetically modified food can't be reused year after year"*. Therefore, *"you've got some seed company in the middle that you've always got to buy from next season"*, which is *"is not morally correct"*, and is *"an ethical negative"*. It was added that it is:

> *"definitely a no-no to terminate seeds so that you have to keep buying it from a company; that's totally immoral"*.

In terms of the termination of GM seeds, concern has been raised that it is not ethically correct for a handful of companies to have control over GM seeds, and GM seeds do not have the ability to be regrown (Weale 2010; Akumo et al. 2013; Wray 2021; Aziz et al. 2022; Idris et al. 2022). Ethical opposition towards GM crops threatening the natural variety of seeds also emerged as an additional sub-salient aspect relating to the implications of using GM seeds. According to very few participants, *"all the other smaller varieties of seeds just get ignored"*; thus, *"instead of having like a few hundred different varieties, we now only end up with only one or two varieties"*, and *"that is not ethically correct"*. An individual participant added that *"it's very important to keep your 'virgin seeds' to have that assurance if things do go wrong"*

that natural seed varieties are still available to be produced. Bonny (2017) concurred that consumers want natural seed varieties to remain in production.

It is suggested that the implications of GM seed usage – which the termination of GM seeds and threats to natural seed varieties contributed towards – could lead to an ethical dilemma and resistance toward genetic modification. These aspects were considered unethical by the participants, subsequently challenging their personal values and contributing to a perceived unfavourable influence on the attainment value and overall value of GMFPs. In Chapter 5, Section 5.7.2, the participants elaborated on GM seed usage more deeply when discussing their beliefs about the risks and concerns related to GM crop production. Therefore, due to the lack of quotes in this section, it is suggested that GM seed usage was less influential on the ethical values of genetic modification than the participants' beliefs about these food products and was thus not a prominent aspect.

6.4.4 Ethical Values relating to GM Seed Company Threats

In addition to the ethical values relating to the implications of GM seeds, the **threat of GM seed companies** emerged as a salient aspect in this theme, which the sub-salient aspect, namely the *"greed factor"* in terms of profitability, contributed towards. Regarding the greed for profitability, some participants expressed that *"terminating seeds is an immoral way of getting an absurd profit"*. Therefore, in terms of the GM seed market, *"it's about greed and profitability, and that is an ethical issue"*. GM seed companies *"have crossed a line of commercial greed to some extent"* because *"the commercial exploitation of GM seed on the one hand has overstepped an ethical boundary"*. Drawing from Section 6.4.3, where the termination of seeds was highlighted as an ethical implication when using GM seeds, it is *"an immoral way of getting an absurd profit"*, and *"it goes against man's greed"* because *"big companies will terminate the seed just to make insane profit"* and *"I'm highly opposed to that"* because it goes *"against my general moral structure"*. Russo et al. (2020) highlighted that making money by producing GMFPs has been an ethical debate around such food products for years.

In the beliefs data (Chapter 5, Section 5.7.3), GM seed company threats were highlighted by the participants as an important aspect to them in terms of the risks and concerns associated with producing GM crops. However, the participants did not elaborate on this aspect in as much detail when vocalising their ethical values towards genetic modification. This suggests that GM seed company threats was a more prominent aspect of the participants' beliefs about GMFPs and less prominent and influential in terms of the ethical value they assigned to the

genetic modification of food products, evidenced by the lack of sub-salient aspects that emerged from the data. Nevertheless, this study proposes that GM seed company threats (attributed to the greed for profitability) conflicted with the participants' personal values, which could result in ethical opposition toward GMFPs, unfavourably influencing the attainment value and overall value of such food products.

6.4.5 Ethical Values relating to the Implication to Consumers' Rights

In addition to the religious, environmental, GM seed usage and GM seed company threats as ethical issues of genetic modification, an additional salient aspect, namely the **ethical values relating to the implication of consumers' rights**, also emerged from the data. It was stated that, in terms of food products, *"ethically, consumers should know and we have a right to know where it come from"*; and *"we should know what we are consuming"* regarding the ingredients in food products. In terms of consumers' rights regarding genetic modification, it is *"just the ethical and moral side of it, it goes against not being honest to the consumers"* because *"producers of these products are not driven by making sure that the consumers of those products are fully aware of what they are consuming"*. Therefore, *"it's just lack of honesty and care for the wider consumer population"* because *"it is just the [lack of] openness to the consumer"* in terms of the food products they are consuming. Subsequently, *"it goes against human rights, like the privacy of my body and it goes against my life"* if there is a lack of communication on whether a food product contains GM ingredients.

"The [presence of] labelling is one [salient] aspect" that contributed to the ethical values relating to the implication of consumers' rights in terms of GMFPs. Participants emphasised, *"we should know if we wanted to pick up a box and read the label, we should be able to distinguish between a GM product and a non-GM product upfront"*, and *"we should at least know it is GM or not".* Therefore, for:

> *"someone who holds integrity quite highly or has a moral grounding, you will want to know what it is that you are consuming"*.

It was further stated that the presence of labelling on GMFPs *"is a bit deceptive because the customer should have full disclosure about what they are buying, and if a company doesn't disclose that, I think there's a large ethical concern around that"* because *"I should really have the right to decide what I am putting into my body or not"*. The presence of GMFP labelling was thus considered by a few participants as being important to consumers' rights when it comes to such food products, and therefore a sub-salient aspect that emerged from the data.

Various authors were united in their opinion that consumers have a right to know what ingredients are in the food they are consuming, and such information should be communicated by labelling GMFPs (Phillips 2008a; Huffman & McCluskey 2014; Oh & Ezezika 2014; African Centre for Biodiversity 2015b; Gostin 2016; Lefebvre et al. 2019; Rodriguez et al. 2022). This finding was also reported in a study conducted in Malaysia, where it was established that consumers felt they had the right to know what ingredients were used in GMFPs and what GMFPs consist of so that they know what they are consuming (Tanius & Seng 2015). Considering consumers' religious beliefs regarding what they can and cannot consume, it has been opined that labelling is important, and it therefore needs to be stipulated when a food product contains GM ingredients so that consumers are aware of what they are ingesting (Glasgow 2015). This view further demonstrates the need to protect consumers' rights when sharing information about the ingredients in food products.

Having satisfactory control or regulatory systems in place to ensure that *"it doesn't have any negative effects"* was another sub-salient aspect that emerged from the data because *"it must exist within a regulatory framework and there has to be satisfactory quality controls"* in terms of producing GMFPs. As a result, *"it would probably need to be moderated or perhaps have a board or a higher authority that it be need to be vetted through"* and *"it needs to be regulated to moderate it and people who know what they are doing need to control what everyone else is doing"* in terms of genetically modifying components of food products. By having such measures in place, the production of GMFPs *"can be monitored carefully"*, thus it would *"not be abused"* and would *"be done responsibly"* to prevent food products from being *"genetically modified so hectically that it cannot be propagated outside of a lab"*, because *"at the moment the ethics around GM are a little bit fast and loose"*. Evidently, a few participants believed that, ethically, satisfactory regulatory systems must be in place to ensure that consumers' rights are protected in terms of the food products they purchase and consume.

The implications for consumers' rights were also linked to the ethical values of genetic modification. To promote consumers' right to know what they are consuming, labelling on GMFPs was important, as well as implementing satisfactory control or regulatory systems to protect consumers' rights when consuming GMFPs. Although the limited sub-salient aspects suggest that the aspect was not prominent, it is proposed that these consumer rights-related ethical value aspects could lead to a perceived unfavourable influence on the attainment value and overall value that GMFPs hold. The presence of labelling, as well as the inadequate and unclear labelling of GMFPs, was elaborated on in Section 6.2.3, where the participants' high level of effort regarding GMFPs were discussed. The re-emergence of labelling in this section

could suggest that GMFPs' labelling could have played a role when assigning value to such food products.

6.4.6 Summary of the Ethical Values of Genetic Modification

A summary of the most salient aspects of Theme 4, namely the ethical values of genetic modification, is depicted in Table 6.4 in addition to Themes 1 to 3.

Table 6.4: Summary of the Most Salient Values Aspects of Themes 1 to 4

Theme	Salient Value Aspects of GM Crops and GMFPs				
Theme 1: Cost Value of GMFPs	Reduced Financial Cost Values	Compromised Health Cost Values	High Level of Effort Cost Values	Time Cost Values	
Theme 2: Overall Value of GM Crop Production	Value of the Enhanced Productivity of GM Crops	Value of GM Crop Production in Promoting Food Security			
Theme 3: Overall Consumer-Related Value of GMFPs	Value of Increased Nutritional Content	Value of Increased Accessibility and Availability	Value of Affordability	Value of Improved Aesthetic Properties	Value of Improved Food Processing Properties
Theme 4: Ethical Values of Genetic Modification	Religious Ethical Values	Environmental Ethical Values	Implications of GM Seed Usage	GM Seed Company Threats	Consumers' Rights

As presented in Table 6.4, although value was assigned to GMFPs in terms of cost value, GM crop production and consumer-related values, the data also reflected that ethical values related to genetic modification were assigned to GMFPs, particularly in terms of religion, the environment, implications of GM seed usage, GM seed company threats, and consumers' rights.

GMFPs have been criticised for creating conflict with consumers' personal religious beliefs, particularly due to the process involved in developing such food products (Lucht 2015; Dizon et al. 2016). These food products have further been judged for their possibly negative impact on the environment, the termination of GM seeds and the control and profits GM seed companies could gain and acquire within the GM seed market (Todua et al. 2015; Russo et al. 2020; Wray 2021). Consumers' rights, in terms of being fully informed about what food products are being purchased and consumed, were also raised as a concern among consumers regarding GMFPs (Gostin 2016; Lefebvre et al. 2019; Rodriguez et al. 2022). In terms of consumer attitude studies toward GMFPs, the unethicalness of GMFPs has been

used in previous studies to determine consumers' attitudes toward such food products, particularly in terms of intruding with what God has created (Verdurme & Viaene 2003; Lanzillotti 2007; Costa-Font & Gil 2011; Ghoochani et al. 2017; Chagwena et al. 2019). Various authors have further opined that the unfavourable aspects coupled with GMFPs can negatively influence consumers' attitudes towards GMFPs (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Ghoochani et al. 2017; Oz et al. 2018). In this study, it is postulated that the main ethical values related to genetic modification that emerged in this theme could have an unfavourable influence on the attainment value and the overall value of GMFPs, contributing to perceived threatened attainment and overall value. This could unfavourably influence the participants' attitudes toward GMFPs, thereby causing attitudinal conflict, resulting in a perceived threatened attitude. The most salient and their sub-salient contributing aspects that emerged under this theme, and the proposed influence on the perceived attainment and overall value of GMFPs and participants' perceived attitudes towards GMFPs, are summarised in Figure 6.8.

As depicted in Figure 6.8, the study proposes that ethical values can unfavourably influence the attainment value and therefore the overall value assigned to GMFPs, further leading to a perceived threatened attainment, overall value and attitude towards GMFPs. The study suggests that the perceived threatened attitude demonstrated toward GMFPs could hinder the promotion of food security in SA and its role in achieving SDG 2: Zero Hunger. Although the aspects were more prominent in the beliefs data, it is suggested that ethics played an important role in the value participants ascribed to GMFPs. This is based on the depth of data and volume of salient aspects that emerged. It is also proposed that ethics played an important role in the attainment task value category based on the volume of salient aspects that emerged from the data.

6.5 SUMMARY

The data revealed that, in terms of the cost value involved in acquiring GMFPs, the high effort attributed to labelling was particularly important. It is suggested that the aspects in the cost value task category could lead to a perceived optimistic and threatened cost value of GMFPs and therefore a perceived optimistic and threatened attitude, contributing to dual attitudes toward such food products; however, the cost task value category lacked depth. The production of GM crops was deemed valuable in terms of their enhanced productivity, particularly due to their increased yields; however, the aspects appeared less prominent than in the beliefs data. GMFPs were further found to be valuable in terms of consumer-related aspects, specifically due to their affordability and longer shelf life due to improved food

processing properties. These were also important to the participants when expressing their beliefs about such food products, indicating that the values data were linked to the beliefs data.

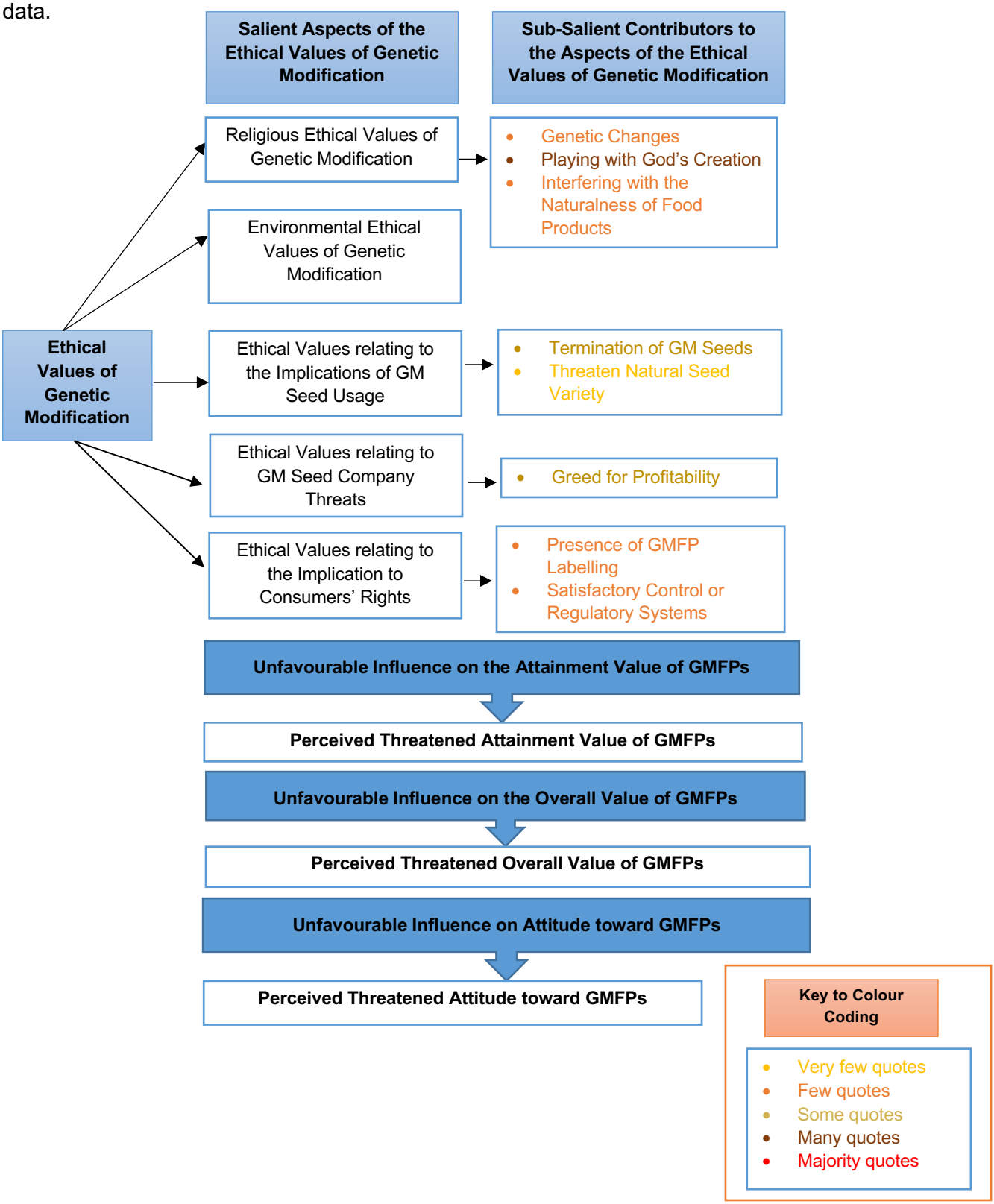

Figure 6.8: Ethical Values of Genetic Modification and the Proposed Influence on the Perceived Attainment Value and Perceived Overall Value and Attitude toward GMFPs

However, GMFPs were used in the same way as other food products. It is proposed that such aspects could lead to a perceived optimistic overall value and attitude towards such food products. Moreover, the value of GMFPs could be compromised by the ethical aspects related to these food products, such as religion, which is challenged by playing with the food that God has created. The ethical aspects were, however, more influential in the beliefs data. It is suggested that these ethical aspects could lead to a perceived threatened attainment, overall value and thus attitude.

The lack of discussion on some of these aspects could indicate that the participants struggled to assign value to GMFPs or lacked confidence in what they valued regarding GMFPs, which could be ascribed to the unconfident foundation from which their beliefs were built. It also showed that the relationship between beliefs and values is not always prominent, and the beliefs component does not always fuel the values component, potentially because not all beliefs carry the same prominence (Sheth & Tuncalp 1974). As a result, it is proposed that the values component is less influential in attitude formation compared to the beliefs component of the EV Model of Attitudes. Nevertheless, based on the variety of data obtained, the values component was useful in the exploration of consumers' attitudes toward GMFPs and therefore needs to be considered in the quest to achieve SDG 2: Zero Hunger. Particular focus needs to be placed on the consumer-related beneficial values of GMFPs, while also remedying the ethical values linked to genetic modification so that consumers are accepting of GMFPs on the market.

The themes that emerged in the values data are further proposed to result in a dual attitude toward GMFPs due to the perceived optimistic and threatened attitudes, which could promote and hinder food security efforts, the realisation of SDG 2: Zero Hunger, and the acceptance of GM food aid. Further interpretations of the findings are made in the conclusion chapter, namely Chapter 10. A discussion of the findings of the data in terms of the participants' salient expectations of GM crops and food products follows in the next chapter.

CHAPTER 7
FINDINGS AND DISCUSSION OF THE EXPECTATIONS DATA OF GENETICALLY MODIFIED CROPS AND FOOD PRODUCTS

The four themes that emerged from the data in terms of the participants' salient expectations of GM crops and food products are presented in this findings and discussion chapter.

7.1 INTRODUCTION

The previous chapter presented the data regarding the salient value the participants assigned to GM crops and food products. This chapter presents the participants' salient expectations of GM crops and food products. The expectations component of the EV Model of Attitudes was used to explore which attributes GMFPs were expected to have or offer and what the expected outcome or consequence of those attributes was in order to gain an improved insight into consumers' attitudes (Ajzen & Fishbein 2000; Cohen et al. 2014; Suvittawat 2022) toward GMFPs. The findings describe the role of the expectations component in the participants' attitudes toward such food products. This information can assist in enhancing food security. Colour coding was used to represent the prominence of each sub-salient aspect, the salient aspects that emerged from the data are presented in bold, and the remaining quotes can be seen in Appendix E.

A discussion on the first theme from the expectations data is presented, namely the expected beneficial outcomes of GM crop production. Three additional themes follow, namely the expected beneficial consumer-related outcomes of GMFPs; the expected concerning outcomes of GM crop production; and the expected concerning consumer-related outcomes of GMFPs. The perceived influence that expectations of GMFPs are proposed to have on consumers' attitudes towards such food products is also presented.

7.2 THEME 1: EXPECTED BENEFICIAL OUTCOMES OF GM CROP PRODUCTION

The data reflected that the participants expected certain beneficial outcomes or consequences from the production of GM crops. The most salient and sub-salient aspects contributing to the expected beneficial outcomes of GM crop production are depicted in Figure 7.1.

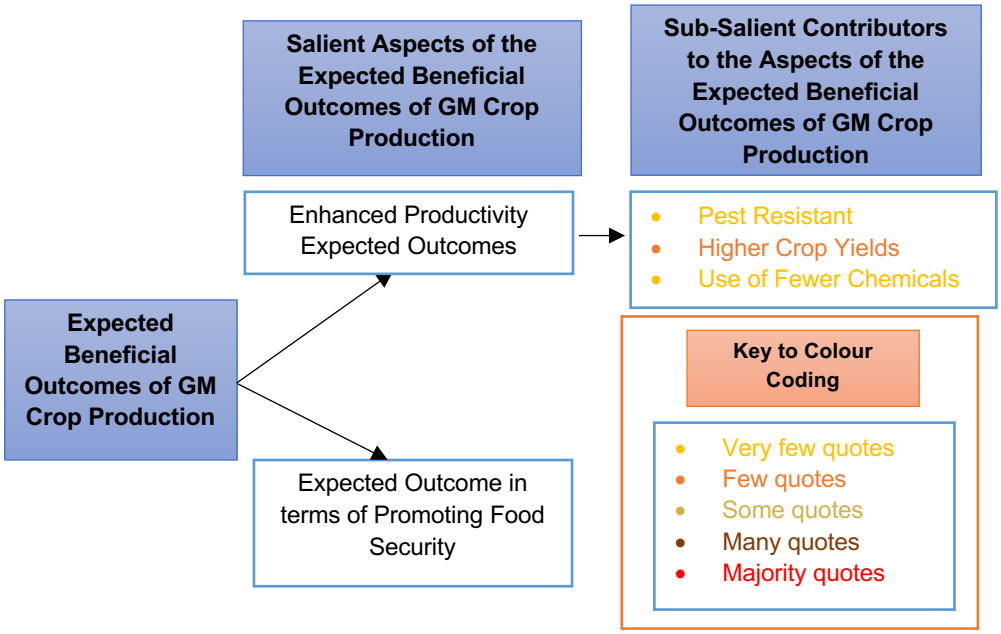

Figure 7.1: Expected Beneficial Outcomes of GM Crop Production

As seen in Figure 7.1, the two salient aspects of the expected beneficial outcomes of GM crop production were enhanced productivity outcomes and promoted food security. A discussion of each follows.

7.2.1 Enhanced Productivity Expected Outcomes of GM Crop Production

The data showed that **enhanced productivity outcomes** were a salient aspect of the participants' expectations of GM crop production. Very few participants had the expectation that *"they would be less prone to be eaten by pests"*; therefore, *"I would expect them to keep away certain pests"*. According to a few participants, *"increased harvest [would be expected] because there are more cobs on a plant";* thus *"good yields would be expected"*, resulting in expectations of *"higher yields"*. Expecting GM crops to be pest-resistant and attaining higher crop yields were thus sub-salient aspects, confirming the salient aspect. In terms of increased yields, many farmers produce GM crops due to the enhanced yields that can be achieved (Ala-Kokko et al. 2021; Blagoevska et al. 2021; Sendhil et al. 2022). In this study, the attainment of higher crop yields led one participant to expect that *"having it on a bigger scale"* could translate into *"the possibility of mass production"*. Respective individual participants further expected GM crops *"to be bigger"*, *"to resist herbicides"*, and *"I would expect it to be drought resistant"*. Various authors have stated that GM crops can grow bigger and be pest, herbicide and drought-resistant (Van Acker et al. 2017; Ala-Kokko et al. 2021; Kovak et al. 2022; Abdoul

et al. 2023). Due to the expectation that GM crops should be drought-resistant, one participant expected that *"these crops will use less water"*.

Very few participants expected that there would be a *"possible reduction of inappropriate use of chemicals"* and that *"less pesticides [would be] used"* when producing GM crops, and consequently, *"they would have a reduced environmental impact in comparison to normal crops"*. Regarding the participants' expectations of producing GM crops, the use of fewer chemicals emerged as a sub-salient aspect from the data, thereby contributing to the expected outcome of enhanced productivity from GM crops. Advocates of GM crops have claimed that many farmers have been able to reduce their pesticide usage, which has contributed to the protection of the environment, thereby deeming GM crops environmentally friendly (Morris & Adley 2000; Conrow 2020; Islam et al. 2020; Abdoul et al. 2023). One participant expected that *"you will have fewer intensive farming techniques that have to be implemented"*, thereby directly supporting farmers. Authors have determined that the production of GM crops requires fewer resources, which contributes to agriculture (Islam et al. 2020).

The participants expected that, by growing GM crops, an enhanced production outcome was anticipated, which pest resistance, higher crop yields and the use of fewer chemicals contributed towards. Thus, based on the volume of sub-salient aspects, an enhanced production outcome was influential in terms of the beneficial outcomes of producing GM crops. However, as mentioned in Chapter 4, Section 4.8.3, the lack of depth within the expectations data is reflected in the lack of quotes that emerged on participants' expectations for enhanced productivity with GM crop production, suggesting that the participants did not elaborate on this aspect when expressing their expectations of GMFPs. Although the discussion on the value of enhanced GM crop productivity (Chapter 6, Section 6.3.1.1) was elaborated on to a lesser extent than the beliefs discussion on the benefits of GM crop production (Chapter 5, Sections 5.5.1 to 5.5.5), this aspect is suggested to be more influential in the values data than the expectations data. This suggests that the enhanced productivity of GM crop production was the most prominent aspect in the beliefs data, followed by the values data, and the least prominent in the expectations data.

7.2.2 Expected Outcomes in terms of Promoting Food Security

Through the production of GM crops, it was stated that they are expected *"to feed more people"* and *"to fill people up"*; therefore, *"they do end up helping with food security"*. Thus, an expected outcome of producing GM crops and food products would be *"to sustain the current and perhaps future human populations"*. It was further expected that GM crops and food

products should *"play a role in improving food security"*, especially *"in the countries or in the towns that have no access to food"*, and *"it should help with food security in more of a social sense of it"*. Conversely, the:

> *"biggest expectation of GMFPs would be to provide greater food security in poverty-stricken communities, particularly in countries that are very marginal in their growing conditions, countries with large areas of desert or saline soils, perhaps countries that have waterlogged soils, places where crops previously could not be grown, but now could be grown because of GM technology"*.

Therefore, the data reflected that a beneficial expected outcome of GM crop production was to **promote food security**, which was a salient aspect. It was suggested that the use of GM technology in the production of GM crops and food products could combat food insecurity, particularly in struggling countries such as Africa, as more food can be produced. There is an anticipation that such crops can act as a fundamental tool in addressing food insecurity in developing countries (Islam et al. 2020; Szenkovics et al. 2020; Maina 2021). Other authors have also agreed that the production of GM crops and, subsequently, food products, can promote food security efforts (Hulela et al. 2019; Ruth & Rumble 2019; Prianto et al. 2020; Rodriguez et al. 2022; Abdoul et al. 2023).

From the data, it emerged that an expected beneficial outcome of GM crop production was the promotion of food security. Although the promotion of food security through GM crop production emerged as a prominent salient aspect in the participants' beliefs data (when the benefits of GM crop production were discussed – as seen in Chapter 5, Section 5.5.6), it did not emerge as an influential aspect when the participants spoke about their expectations about GM crops, which is indicated by the absence of sub-salient aspects. As seen in this salient aspect, a lack of data could have been attributed to participants not understanding what expectations entailed or not being aware or confident about what they expected from GM crop production. Drawing on the values data where GM crop production's value in promoting food security was discussed (Chapter 6, Section 6.3.1.2), it also emerged as a less prominent aspect compared to the beliefs data, suggesting that the aspect was the most influential in the beliefs data, but it was less influential when the participants conversed about their values and expectations of GMFPs. This could suggest that the participants were more confident in their beliefs about GM crop production than in the value that GM crop production can offer and what they expect from GM crops. The participants did not expect environmental benefits, weather resistance, and the ability to increase farmer profitability from GM crops' production. Neither did they mention expecting particular resistant traits from GM crop production, all of which

were elaborated on in the beliefs data (Chapter 5, Section 5.5) but were omitted in the expectations discussions. Based on the lack of elaboration, as evidenced by the lack of quotes, promoting food security did not feature prominently in the expected beneficial outcomes of GM crop production.

7.2.3 Summary of the Expected Beneficial Outcomes of GM Crop Production

Table 7.1 summarises the most salient aspects of Theme 1 in this chapter, namely the expected beneficial outcomes of GM crop production.

Table 7.1: Theme 1: Salient Aspects of the Expected Beneficial Outcomes of GM Crop Production

Theme	Salient Expected Outcome Aspects of GM Crops and GMFPs	
Theme 1: Expected Beneficial Outcomes of GM Crop Production	Enhanced Productivity Expected Outcomes	Expected Outcomes in terms of Promoting Food Security

As depicted in Table 7.1, the enhanced productivity expected outcomes and promotion of food security were the most salient aspects that emerged from the data for Theme 1, encompassing the expected beneficial outcomes of GM crop production.

Consumer attitude studies have postulated that the benefits of GMFPs can positively affect consumers' attitudes toward these food products (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Ghoochani et al. 2017). Benefits can include aspects such as GM crops using a reduced amount of water and chemicals; having various resistant characteristics; attaining bigger-sized crops and increased yields; as well as addressing food insecurity while aiding in food security efforts (Van Acker et al. 2017; Islam et al. 2020; Ala-Kokko et al. 2021; Kovak et al. 2022; Rodriguez et al. 2022). Such aspects were used to explore consumers' attitudes towards GMFPs (Morris & Adley 2000; Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Lopez et al. 2016; Rzymski & Krolczyk 2016; Ghoochani et al. 2017; Jonker 2017; Deng et al. 2019; Amin et al. 2021). In the current study, it is proposed that the most salient and contributing sub-salient aspects under this theme can contribute to participants gaining a more accepting viewpoint of GMFPs in terms of their attitude, thereby influencing their attitudes in a favourable manner, leading to a perceived optimistic attitude toward such food products. The most salient and sub-salient contributing aspects that emerged from the data regarding the participants' beneficial expectations of GM crop production and the proposed influence it could have on their perceived attitude towards GMFPs are illustrated below in Figure 7.2.

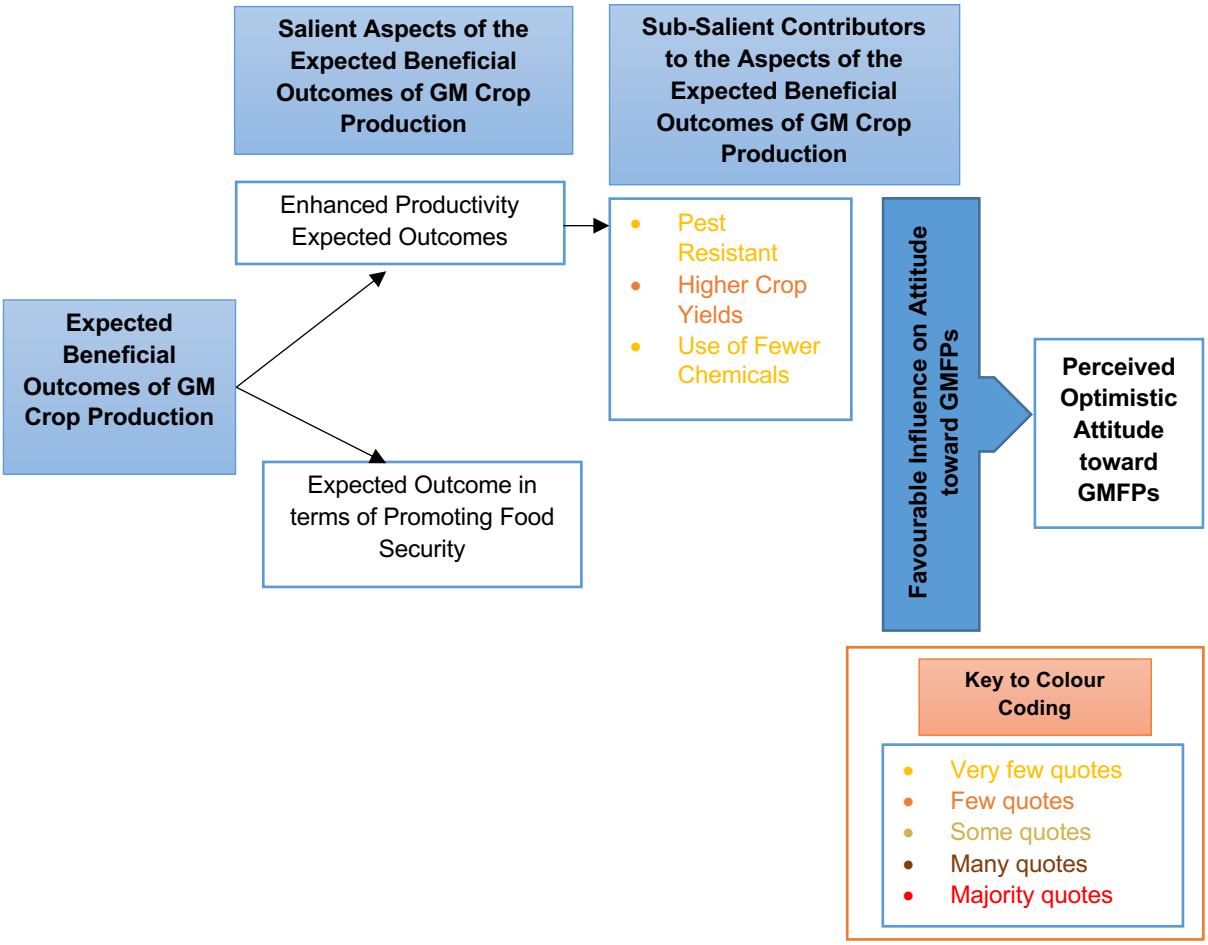

Figure 7.2: Expected Beneficial Outcomes of GM Crop Production and the Proposed Influence on Perceived Attitude of GMFPs

As depicted in Figure 7.2, it is proposed that the salient aspects relating to the expected beneficial outcomes of producing GM crops could result in a perceived optimistic attitude towards such food products. This could contribute to consumer acceptance of GMFPs, thereby enhancing food security and aiding in the attainment of SDG 2: Zero Hunger. However, due to the lack of depth in the data and lack of elaboration (as evidenced by the limited volume of salient and sub-salient aspects), it is suggested that the expected beneficial outcomes of GM crop production were not influential in the participants' expectations of GMFPs.

The second theme from the data, namely the expected beneficial consumer-related outcomes of GMFPs, is discussed next.

7.3 THEME 2: EXPECTED BENEFICIAL CONSUMER-RELATED OUTCOMES OF GMFPS

In addition to the expected beneficial outcomes of GM crop production, expected beneficial consumer-related outcomes of GMFPs emerged from the data. The most salient and sub-salient contributing aspects are illustrated in Figure 7.3.

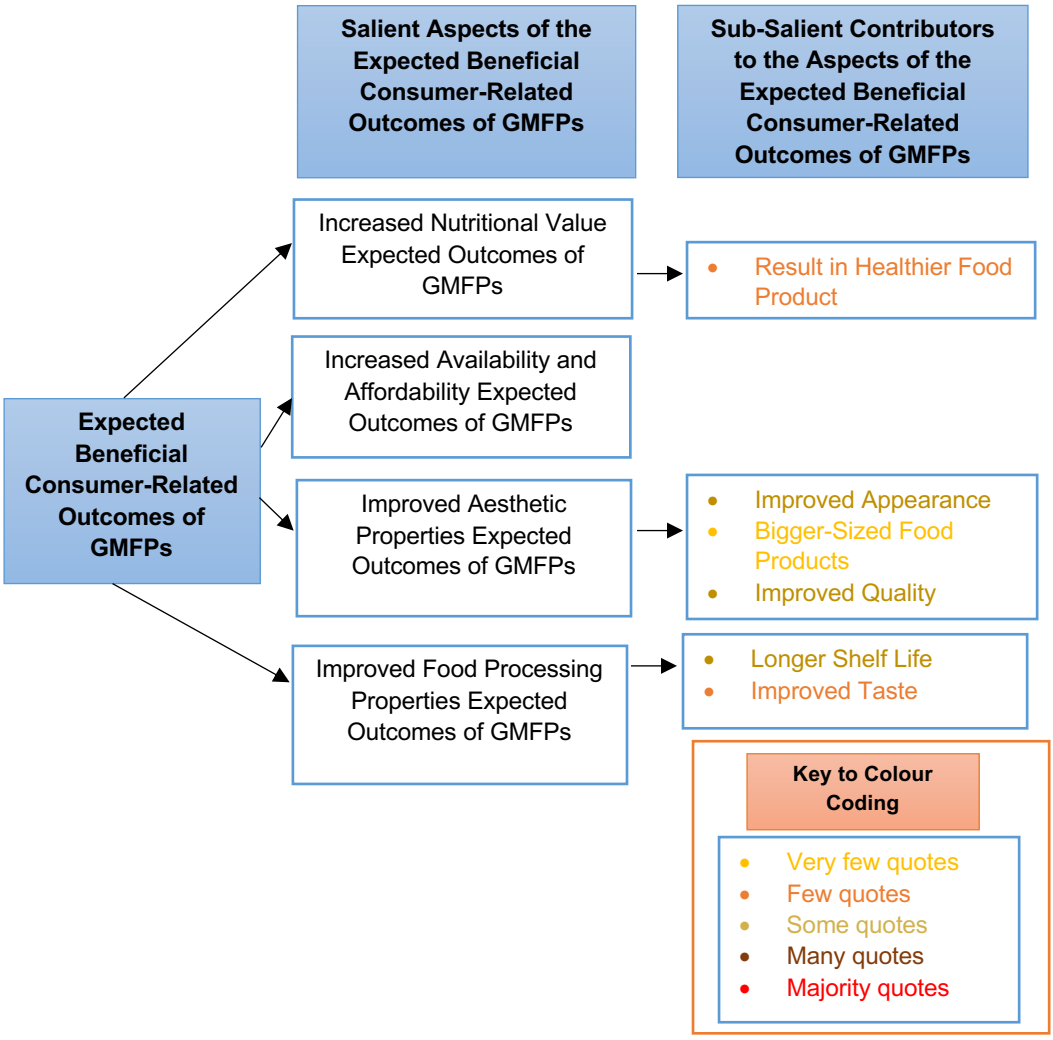

Figure 7.3: Expected Beneficial Consumer-Related Outcomes of GMFPs

In Figure 7.3, four salient expected beneficial consumer-related outcomes of GMFPs were identified through data analysis. These aspects included the increased nutritional value of GMFPs; increased availability and affordability of GMFPs; improved aesthetic properties of GMFPs; and improved food processing properties of GMFPs. These aspects are subsequently discussed.

7.3.1 Increased Nutritional Value Expected Outcomes of GMFPs

A salient aspect that emerged from the data was the expectation that GMFPs should have an **increased nutritional content**. Participants explained, *"I would expect it to be nutritionally sound"* and *"I would expect them to have a correct nutritional content"*; subsequently, *"they should have a higher nutritional value"* and thus *"they should be more nutritious"* so that *"what I buy is going to feed my family and not be empty calories"*. Several authors agreed that the nutritional composition of food products could be enhanced through genetic modification; therefore, GMFPs are considered to be nutritious (Todua et al. 2015; Wunderlich & Gatto 2015; Jiang & Zhang 2021; Siddiqui et al. 2022; Abdoul et al. 2023; Ghimire et al. 2023).

Due to the increased nutritional content expected of GMFPs, one participant expected that the consumption of such food products could *"reduce nutritional deficiencies"*. It has been opined by several authors that genetic modification can be used to address nutritional deficiencies, which can be seen in a food product known as Golden Rice© that has been GM specifically to address vitamin A deficiency, whereas the GM purple tomato produces an increased amount of antioxidants, thereby enhancing its nutritional content (Dubock 2017; Smyth 2020; Muzhinji & Ntuli 2021; Nosowitz 2021; Gbadegesin et al. 2022; John Innes Centre 2022).

According to a few participants, due to the expected increased nutritional value of GMFPs, *"I expect them to be healthy"* and *"I expect a GM food product is going to help the consumer in the long run, for their health"*. In terms of GMFPs, *"health benefits are most definitely"* expected; therefore, *"I would expect them to do no harm"*. A single participant summed up:

> *"I would expect them to help and benefit the consumer in the sense of health by giving us more like the nutrients or giving us more than just the natural product. It needs to enhance and give you more"*.

In terms of increased nutritional value, having healthier food products emerged as a sub-salient aspect from the data. Smyth (2020) explains that the macronutrients and micronutrients in GMFPs can be increased, thereby contributing to individuals' health when consumed. Genetic modification can also be used to enhance particular vitamins in food products, which can promote the health of individuals, and healthier food products can thus be developed through the use of modern biotechnology (Van Acker et al. 2017; Hirschi 2020; Ala-Kokko et al. 2021).

Regarding the expected beneficial consumer-related outcomes of GMFPs, participants expected that GMFPs should have an increased nutritional value and healthier food products should thus be developed. Although the increased nutritional value of GMFPs was elaborated on in the beliefs data (Chapter 5, Section 5.6.1), where the participants conversed about the consumer-related benefits of GMFPs, and in the values data (Chapter 6, Section 6.3.2.1), where the overall consumer-related value of such food products was communicated, it appeared to be a less influential aspect in the expectations data. This is evident in the lack of sub-salient aspects, further indicating that the participants did not elaborate on their expectations that GMFPs would have increased nutritional value. Therefore, the aspect lacked prominence.

7.3.2 Increased Availability and Affordability Expected Outcomes of GMFPs

Increased availability and affordability were additional beneficial salient aspects of the data. Participants expected that GMFPs should be *"more available"* than non-GMFPs, leading to the expectation that *"more of this kind of food will be available to the population"*. Such expectations were confirmed by authors who suggested that GM crop production can increase food production, making more food products available, thereby promoting the population's access to food (Qaim & Kouser 2013; Dizon et al. 2016). In terms of GMFPs' affordability, it was stated that *"I expect them to be more affordable"* and *"I expect a GM product to be cheaper"*. On the cost of GMFPs, it has been argued that the production of GM crops could lead to GMFPs being sold at a lower price, and lower prices have thus been linked to such food products (Chen 2008; Dovey & Ntuli 2020; Jiang & Zhang 2021; Sendhil et al. 2022; Siddiqui et al. 2022; Alalwan et al. 2023).

Regarding the expected beneficial consumer-related outcomes of GMFPs, it was expected that GMFPs should be more readily available at a lower cost. No sub-salient aspects emerged from these two salient aspects, indicating that the participants did not elaborate on them when discussing their expectations of GMFPs. The lack of depth in these salient aspects is further indicated by the minimal quotes that emerged from the data pertaining to availability and affordability. Therefore, increased accessibility and availability, as well as the affordability (lower price) of GMFPs, emerged as more prominent aspects in the beliefs data (Chapter 5, Sections 5.6.2 and 5.6.3 – consumer-related benefits of GMFPs) and values data (Chapter 6, Sections 6.3.2.2 and 6.3.2.3 – overall consumer-related value of GMFPs), but less prominent in the expectations data. The lack of elaboration could, once again, point to the participants' hesitancy in terms of voicing their expectations of GMFPs.

7.3.3 Improved Aesthetic Properties Expected Outcomes of GMFPs

In addition to participants' expectations about the increased nutritional value of GMFPs and their increased availability and affordability, they further expected these food products to have **improved aesthetic properties**. This was an important salient aspect that emerged from the data on the expected beneficial consumer-related outcomes of GMFPs. Sub-salient aspects, such as the expectation of improved appearance, being bigger in size, and having an improved quality contributed to the expected improved aesthetic properties of GMFPs. In terms of improved appearance, some participants expected *"that they would look appealing"*, thus, *"I expect GMFPs to look good"* and *"I would expect them to look better"* than conventional food products. In addition, *"I would expect the GM food product to not show as many blemishes as a normal or natural product"* and *"I would expect it to look standard without any bumps or defects"*. Other authors concur that the appearance of food products can be altered through genetic modification, thereby making the food product more inviting to consumers (Wunderlich & Gatto 2015; Nazir et al. 2018).

Regarding the bigger size of GMFPs, very few participants stated that *"I would expect it to be bigger in size"* compared to traditional food products and that *"I expect them to be a good size"*. In terms of the improved quality of GMFPs, some participants said, *"I expect the product has better quality than a naturally produced product without assistance, just because of why it has been modified",* and *"I would expect the genetically modified one to be of better quality because it has been created in a certain way"*. As a result, *"I would expect it to be possibly better"*; *"my expectation is that the quality has been improved"* regarding GMFPs. Thus, *"good quality is the expectation I would hold from a GM food product"*. It has been reported that the quality of food products can be enhanced through genetic modification (Nazir et al. 2018; Shetty et al. 2018; Blagoevska et al. 2021; Sendhil et al. 2022).

The participants therefore anticipated that GMFPs should have improved aesthetic properties that the expected attributes, such as improved appearance, bigger size and improved quality contributed towards. This expectation could result in disappointment if it is not met when coming across such food products. Although the participants did elaborate on improved aesthetic properties when discussing their beliefs about the consumer-related benefits of GMFPs (Chapter 5, Section 5.6.4), this was done to a lesser extent in their overall consumer-related values of GMFPs (Chapter 6, Section 6.3.2.4). However, based on the volume of sub-salient aspects, the salient aspect was influential in terms of the participants' expectations of consumer-related benefits of GMFPs. Thus, based on the depth of data and volume of the sub-salient aspects, it is suggested that GMFPs' improved aesthetic properties were the most

important in the beliefs data, followed by the expectations data, while being the least influential in the values data.

7.3.4 Improved Food Processing Properties Expected Outcomes of GMFPs

The participants expected GMFPs to have improved food processing properties and aesthetic properties. Therefore, **improved food processing properties** emerged from the data as a beneficial salient aspect ascribed to longer shelf life and improved taste. In terms of longer shelf life, some participants stated that *"I would expect GMFPs to last a bit longer"*, *"I would expect it to be long lasting",* and *"I would expect that it has a longer shelf life"* as opposed to conventional food products. Conversely, *"I would expect them to be more resilient against shelf life"*, and *"that it's going to stay okay for long"*. It has been stated that food products can be GM to retain a longer shelf life, an inviting attribute to consumers (Nazir et al. 2018; Dovey & Ntuli 2020; Olabinjo et al. 2020; Sendhil et al. 2022; Siddiqui et al. 2022; Abdoul et al. 2023). Regarding improved taste, some participants stated that *"a food product is genetically modified for a reason to help the consumer, for the taste"*; therefore, *"I expect them to taste good"*, *"I expect them to taste great",* and *"expect something that tastes good"*. Thus, *"I would expect them to taste better"* than traditional food products. It has been found that enhancing the taste of food products through genetic modification is particularly alluring to consumers (Hassan et al. 2016; Bray & Ankeny 2017; Dovey & Ntuli 2020; Sendhil et al. 2022).

Improved food processing properties were thus expected of GMFPs in terms of the expected beneficial consumer-related outcomes of such food products, which their expected longevity and improved taste contributed towards. Based on the depth of data and volume of sub-salient aspects, the participants did not elaborate on improved food processing properties in terms of their expectations of GMFPs to the same extent they did when expressing their beliefs (Chapter 5, Section 5.6.5 – consumer-related benefits of GMFPs) and values (Chapter 6, Section 6.3.2.5 – overall consumer-related value of GMFPs), indicating that the aspect was the least prominent in the expectations data. Therefore, it is suggested that the improved food processing properties of GMFPs were the most influential in beliefs and values, but not prominent in expectations.

7.3.5 Summary of the Expected Beneficial Consumer-Related Outcomes of GMFPs

The most salient aspects of Theme 1 are presented in Table 7.2, as well as the most salient aspects of Theme 2, namely increased nutritional value, increased availability and affordability, improved aesthetic properties, and improved food processing properties of

GMFPs that were expected beneficial consumer-related outcomes of such food products. An illustration of each theme is given as it emerged in this chapter to visually show how each theme develops and builds on the previous one, thereby contributing to an improved understanding of what the participants expected of GMFPs.

Table 7.2: Summary of the Most Salient Expected Beneficial Outcome Aspects of Themes 1 and 2

Theme	Salient Expected Outcome Aspects of GM Crops and GMFPs			
Theme 1: Expected Beneficial Outcomes of GM Crop Production	Enhanced Productivity Expected Outcomes	Expected Outcomes in terms of Promoting Food Security		
Theme 2: Expected Beneficial Consumer-Related Outcomes of GMFPs	Increased Nutritional Value	Increased Availability & Affordability	Improved Aesthetic Properties	Improved Food Processing Properties

Table 7.2 shows that, in addition to expecting beneficial outcomes from GM crop production, beneficial consumer-related outcomes were also expected of GMFPs, which included salient aspects such as increased nutritional value, increased availability and affordability, improved aesthetic properties, and improved food processing properties.

It has been proposed that beneficial aspects of GMFPs, such as increased nutritional value; having healthier food products; having increased availability to food products; affordability; as well as products with improved appearance, taste and longer shelf life propel consumers towards such food products (Todua et al. 2015; Dizon et al. 2016; Van Acker et al. 2017; Nazir et al. 2018; Dovey & Ntuli 2020). Consumer attitude studies have established these aspects could be determining factors when exploring consumers' attitudes toward GMFPs (Morris & Adley 2000; Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Lopez et al. 2016; Rzymski & Krolczyk 2016; Ghoochani et al. 2017; Jonker 2017; Deng et al. 2019; Amin et al. 2021). As a result, consumer attitude studies about GMFPs suggested that such beneficial aspects can influence consumers' attitudes in a positive way (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Ghoochani et al. 2017). It is proposed in this study that the most salient and sub-salient aspects that emerged under this theme regarding the participants' beneficial expectations of GMFPs in the consumer context can result in a more accepting attitude toward such food products. This outcome is attributed to the merit GMFPs are expected to hold in terms of their beneficial aspects, thereby influencing attitudes in a favourable way, thus contributing to a perceived optimistic attitude. A summary of the most salient aspects that emerged from the data regarding participants'

expected beneficial consumer-related outcomes of GMFPs, as well as the sub-salient contributing aspects and the suggested influence it could have on their attitudes towards GMFPs, can be seen in Figure 7.4.

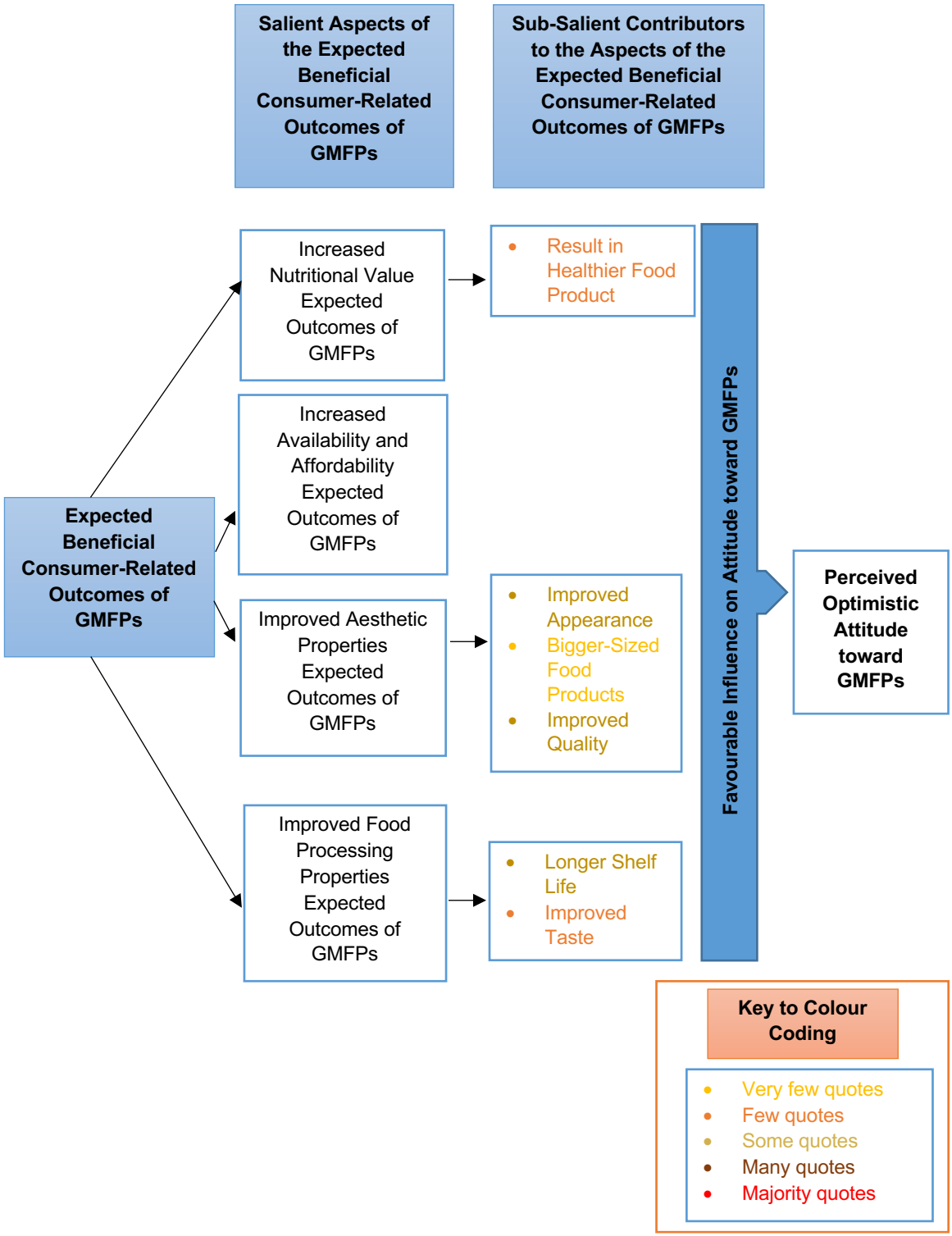

Figure 7.4: Expected Beneficial Consumer-Related Outcomes of GMFPs and the Proposed Influence on the Perceived Attitude towards GMFPs

Figure 7.4 illustrates that the expected beneficial outcomes of GMFPs relating to the consumer are suggested to result in a perceived optimistic attitude towards GMFPs. This could be promising in enhancing food security efforts in SA and achieving SDG 2. Based on the depth of data compared to the extent of elaboration (as evidenced by the volume of salient and sub-salient aspects) in the other themes in this chapter, it is suggested that consumer-related beneficial expected outcomes were the most influential on the participants' expectations of GMFPs. Considering that the theme was also influential on participants' beliefs and values of GMFPs, it is proposed that the consumer-related benefits of GMFPs are of particular importance and require particular attention in promoting food security efforts.

A discussion on the third theme, namely the expected concerning outcomes of GM crop production, follows.

7.4 THEME 3: EXPECTED CONCERNING OUTCOMES OF GM CROP PRODUCTION

Although the participants had expectations about the benefits of GM crop production and for themselves as consumers of GMFPs – as presented in the first two themes of this chapter – some adverse expectations of GM crop production also emerged from the data. The most salient and sub-salient aspects contributing to the expected concerning outcomes of GM crop production are illustrated in Figure 7.5.

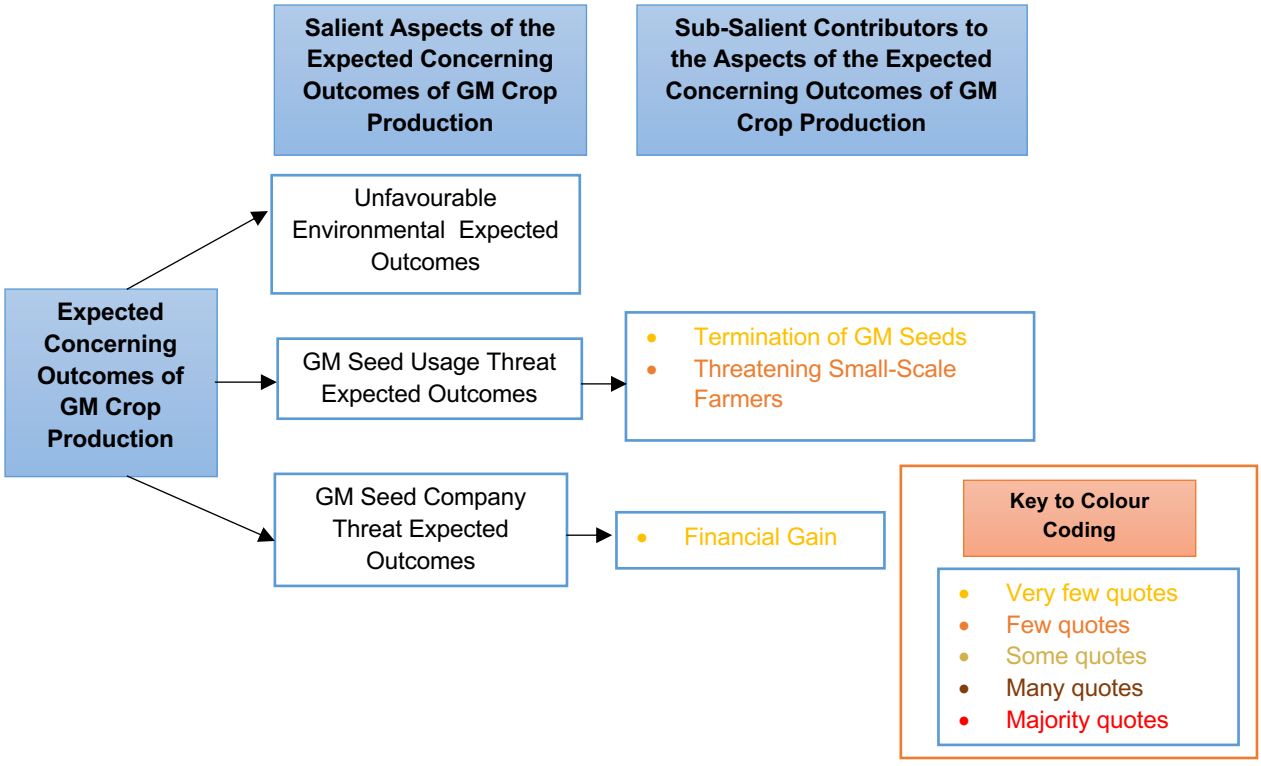

Figure 7.5: Expected Concerning Outcomes of GM Crop Production

The most salient aspects identified from the data regarding the concerning expectations of GM crop production, as seen in Figure 7.5, included the unfavourable environmental expected outcomes; GM seed usage threat expected outcomes; and GM seed company threat expected outcomes. These aspects are presented next.

7.4.1 Unfavourable Environmental Expected Outcomes

Through the production of GM crops, it was expected that *"those things are affecting the environment"*, therefore *"there are environmental consequences"*. **Unfavourable environmental outcomes** thus emerged as a salient aspect linked to the concerning expected outcomes of GM crop production. It has been established that consumers have demonstrated apprehension toward GM crops due to the possible negative impact that their production could have on the environment (Ruth & Rumble 2019; Prianto et al. 2020; Pakseresht et al. 2021; Abdoul et al. 2023; Ghimire et al. 2023). One participant attributed the unfavourable environmental outcomes to the expectation that *"insect populations and a reduction in a species like bees will be affected"* and that:

> *"there's less pollination which means that their species' population becomes restricted and then that might have an effect on other species and the environment because now they are not being as sufficiently pollinated"*.

Concern about the negative impact on living creatures, the Monarch butterfly population and the bee population have been reported among consumers (Wunderlich & Gatto 2015; Raman 2017; Dovey & Ntuli 2020; Aziz et al. 2022; Ghimire et al. 2023). It has also been argued that the ecological balance could be compromised through the production of GM crops (Sanlier & Sezgin 2020).

Although unfavourable environmental outcomes were expected by the participants linked to GM crop production, they did not elaborate on this aspect when vocalising their expectations of GMFPs. Even though environmental risks emerged as a prominent aspect in the beliefs data (Chapter 5, Section 5.7.1 – risks and concerns of GM crop production), but not as prominent in the values data (Chapter 6, Section 6.4.2 – ethical values of genetic modification), this salient aspect was less prominent in the expectations data. This suggestion is supported by the lack of quotes that emerged from conversations with the participants and the absence of sub-salient aspects.

7.4.2 GM Seed Usage Threat Expected Outcomes

From the data, **GM seed usage threat** emerged as a salient aspect in terms of the concerning outcomes participants expected from GM crop production. The salient aspect was attributed to the sub-salient aspect, namely the termination of GM seeds, as very few participants expected that *"you don't get continuity in the seed of a GMO product"* because *"if you get a GMO seed GMO, you won't be able to take that seed and replant it"*, which *"could be stopping the general population from easily growing its own food"*. It has been argued that limited access to GM seeds could occur; therefore, the termination of GM seeds is particularly concerning (Chen 2008; Akumo et al. 2013; Islam et al. 2020; Wray 2021; Aziz et al. 2022).

It was further expected by a few participants that smaller farmers could suffer adverse consequences due to the termination of seeds because *"there is definitely a bigger risk as smaller farming communities can't actually get into this kind of production"*, thus:

> *"it can be a threat to small-scale farmers because they not financially in a position to be able to introduce that kind of farming and to try it out and see whether it's something that they can do"*.

It was added that, in terms of growing GM crops, *"it's a big change for a small farmer to have to go that route because they are not all financially in the position to be able to do that"*. Therefore:

> *"it gives them a disadvantage because it's not an option always, it's not like they don't want to do it, but they can't financially get to that point where they can also make use of it"*.

Threatening small-scale farmers was thus a sub-salient aspect contributing to the threat expected from producing GM crops linked to GM seed usage. It has been argued that the termination of GM seeds makes it particularly difficult for small-scale farmers to repurchase these seeds every season, thereby hindering them from fully adopting the production of GM crops into their farming practices (Zennah & Cyrus 2019; Fischer 2021).

Therefore, the threat of using GM seeds was a concerning attribute and outcome that participants expected from producing GM crops, attributed to the termination of GM seeds and their threat to small-scale farmers. However, as seen through the lack of quotes, the participants did not discuss this aspect in depth, contributing to the lack of data regarding this

salient aspect. In Chapter 5, Section 5.7.2 (risks and concerns of GM crop production), the impact of GM seed usage was discussed in more depth relating to participants' beliefs as opposed to Chapter 6, Section 6.4.3, where the ethical values of genetic modification were discussed. This suggests that the use of GM seeds is an influential aspect in the beliefs data, but less influential in the values data, and the least influential in the expectations data. This could indicate that the threat of GM seed usage was not an influential aspect when the participants described their expectations of GM crop production.

7.4.3 GM Seed Company Threat Expected Outcomes

In addition to the threat of using GM seeds, **GM seed company threats** emerged as a salient concerning expected outcome of GM crop production, attributed to the sub-salient aspect of GM seed companies gaining financially from GM crop production. Very few participants had the expectation that *"corporate places are taking over this kind of technology and gaining in a different way from it*" *"in a financial way"*; and therefore *"those problems can exist and can happen and can come from this"*. Concern has been shown towards genetically modifying crops and food products since companies could gain monopoly control of the GM seed market and could gain financial profits in the process (Bonny 2017; Islam et al. 2020). As a result, it has been argued that access to GM seeds can eventually be controlled by a few seed companies (Dibden et al. 2013; Van Acker et al. 2017; Aziz et al. 2022).

In this study, according to one participant, *"one of the biggest consequences [of purchasing GMFPs] is that we are actually funding something, we are funding that market, we promoting it"*; therefore, *"if you are funding it by buying those products, you are promoting it"*. As a result:

> *"the consequence is that your farms who farm organically, actually cannot put food on their own tables, and their products just become more and more expensive because in order for them to make a living, they have to put their prices up"*.

Even though GM seed companies posed a threat and were an expected concerning outcome from producing GM crops – which was attributed to financial gain – there was a lack of quotes on this aspect. Thus, limited data emerged on this aspect, and it was a considerably more prominent aspect in the beliefs data (Chapter 5, Section 5.7.3 – risks and concerns of GM crop production). Although the threat that GM seed companies posed emerged as a less influential aspect – as opposed to in the beliefs data – when the participants discussed their ethical values of genetic modification (Chapter 6, Section 6.4.4), the aspect appeared to be the least influential when the participants vocalised their expectations of GM crop production.

Evidently, the participants were not vocal about the threat they expected from GM seed companies, which can be seen in the lack of sub-salient aspects and quotes, resulting in a lack of depth in the data regarding this salient aspect.

7.4.4 Summary of the Expected Concerning Outcomes of GM Crop Production

To contribute to the most salient aspects that emerged from Themes 1 and 2 in this chapter, the most salient aspects of the expected concerning outcomes of GM crop production – which Theme 3 encompasses – can be seen in Table 7.3. It further demonstrates participants' expectations regarding GMFPs.

Table 7.3: Summary of the Most Salient Expected Outcome Aspects of Themes 1 to 3

Theme	Salient Expected Outcome Aspects of GM Crops and GMFPs			
Theme 1: Expected Beneficial Outcomes of GM Crop Production	Enhanced Productivity Expected Outcomes	Expected Outcomes in terms of Promoting Food Security		
Theme 2: Expected Beneficial Consumer-Related Outcomes of GMFPs	Increased Nutritional Value	Increased Availability & Affordability	Improved Aesthetic Properties	Improved Food Processing Properties
Theme 3: Expected Concerning Outcomes of GM Crop Production	Unfavourable Environmental Expected Outcomes	GM Seed Usage Threat	GM Seed Company Threat	

Although the participants expected beneficial outcomes from producing GM crops and beneficial consumer-related outcomes from GMFPs, the data reflected that concerning outcomes were also expected of GM crop production among participants. These included unfavourable environmental expected outcomes, GM seed usage threat and GM seed company threat, which were salient aspects contributing to Theme 3, namely expected concerning outcomes of GM crop production, as seen in Table 7.3.

Opposition among consumers has been shown specifically in terms of the environmental consequences that could arise due to GM crop production, the termination of GM seeds, and the profitability that could be attained by companies selling GM seeds (Bonny 2017; Dovey & Ntuli 2020; Islam et al. 2020; Wray 2021). Numerous consumer attitude studies have found that these aspects could be determining factors when exploring consumers' attitudes toward GMFPs (Morris & Adley 2000; Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Lopez et al. 2016; Rzymski & Krolczyk 2016; Ghoochani et al. 2017; Jonker

2017; Deng et al. 2019; Amin et al. 2021). It has been posited that such factors could influence attitudes in a negative way (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Ghoochani et al. 2017). The current study postulates that the most salient and sub-salient aspects that emerged from the data regarding the concerning expectations of GM crop production could elicit a harmful connotation to GMFPs and cause attitudinal conflict and an unfavourable influence on attitudes, resulting in a perceived threatened attitude toward such food products. The most salient and sub-salient contributing aspects that emerged from the data regarding the participants' concerning expectations of GM crop production, and the proposed influence it could have on the participants' attitudes towards GMFPs, are summarised in Figure 7.6.

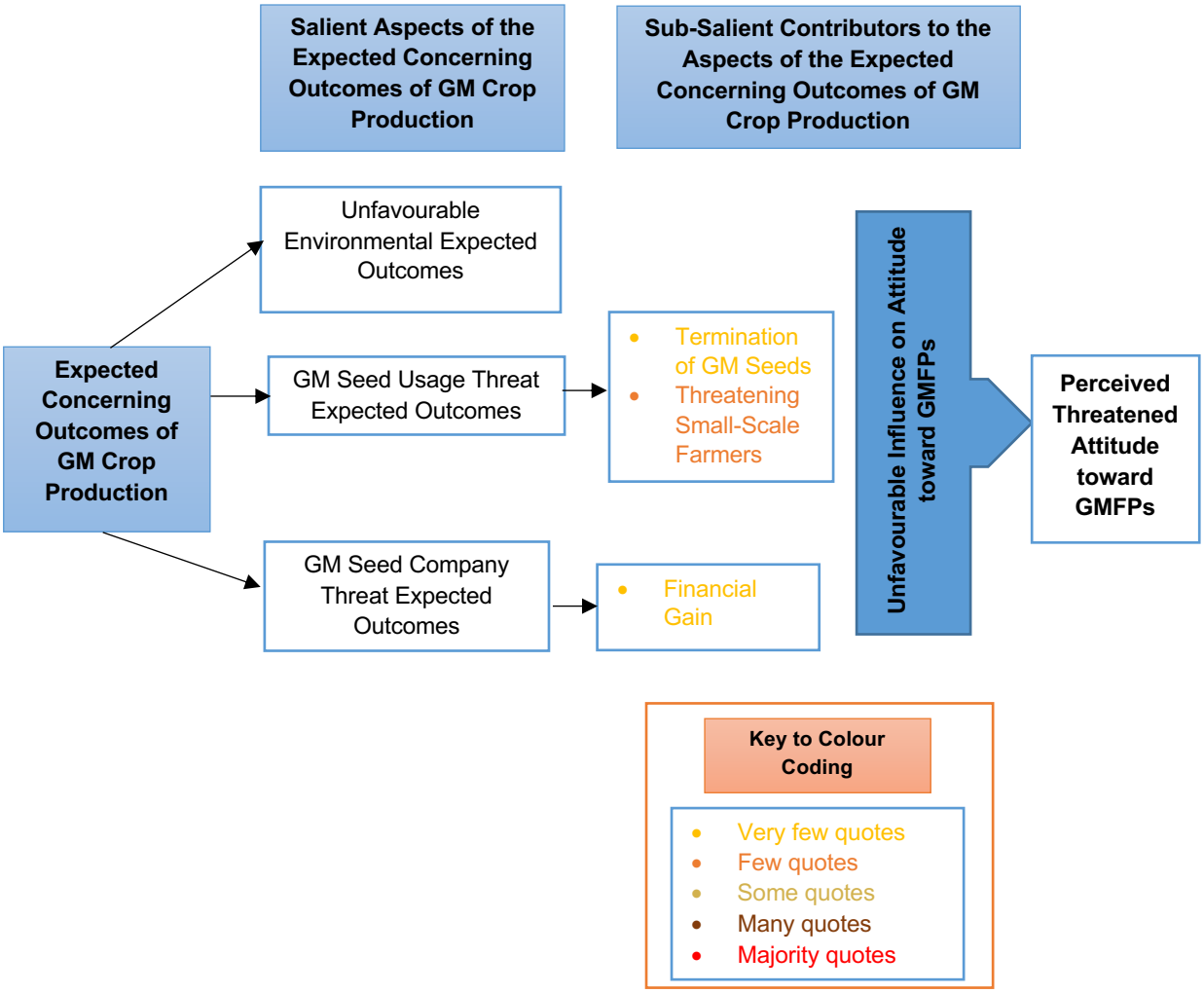

Figure 7.6: Expected Concerning Outcomes of GM Crop Production and the Proposed Influence on the Perceived Attitude towards GMFPs

The most salient expected concerning outcomes of GM crop production that emerged from the data are proposed to contribute to a perceived threatened attitude, as presented in Figure 7.6. It is suggested that the perceived threatened attitude could impede efforts to enhance the food security status of the SA population and the realisation of attaining SDG 2. Due to the lack of depth of data and lack of elaboration and volume of sub-salient aspects (compared to the beliefs and value data – particularly the beliefs data), it is suggested that the concerning outcomes of GM crop production were not a prominent influencer in the participants' expectations of GMFPs.

The expected concerning consumer-related outcomes of GMFPs, which was the fourth theme that emerged from the data, are discussed next.

7.5 THEME 4: EXPECTED CONCERNING CONSUMER-RELATED OUTCOMES OF GMFPS

From the data, one expected concerning consumer-related outcome of GMFPs emerged, namely expected unfavourable long-term health outcomes. The salient and sub-salient aspects of the expected concerning consumer-related outcomes of GMFPs are presented in Figure 7.7, and a discussion follows.

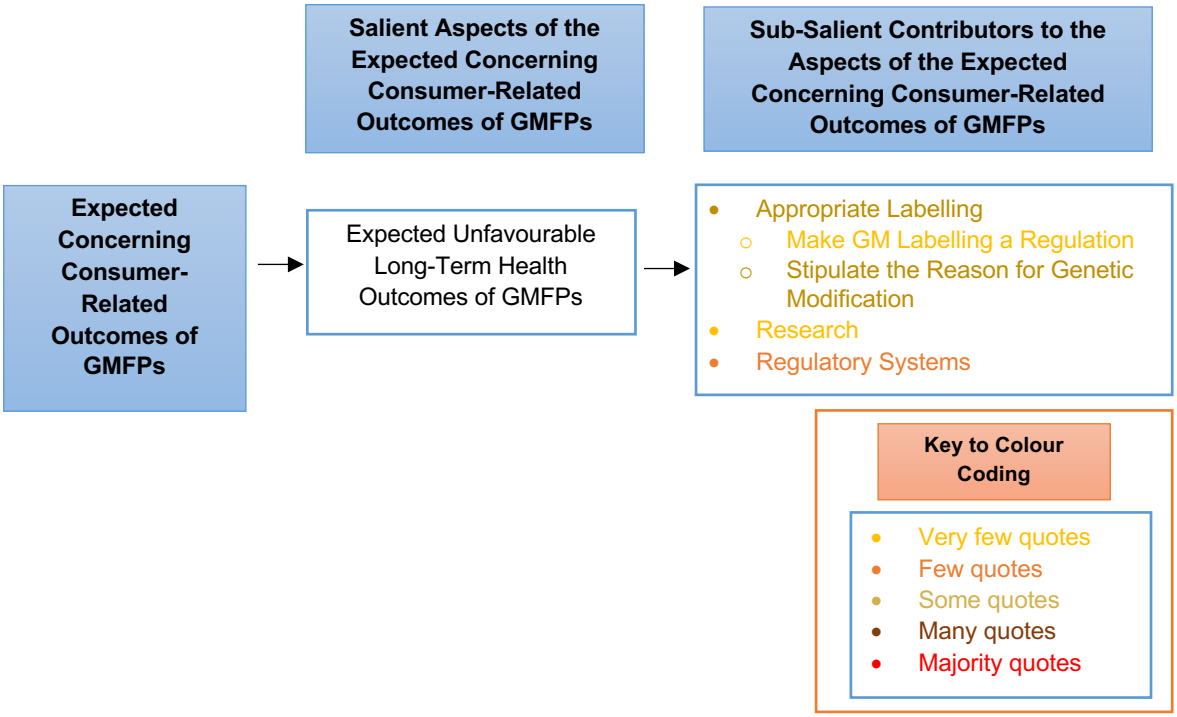

Figure 7.7: Expected Concerning Consumer-Related Outcomes of GMFPs

7.5.1 Expected Unfavourable Long-Term Health Outcomes of GMFPs

A salient aspect relating to the expected concerning consumer-related outcomes of GMFPs emerged from the data, namely the **expected unfavourable long-term health outcomes** of such food products. This was illustrated by participants saying that *"I would expect it to have a negative impact on my health"* and, therefore, *"there would definitely be long term health consequences"* from consuming GMFPs. In terms of consuming GMFPs, *"I expect it does have a long term effect on the consumer in terms of their health"* and *"I expect there's long-term health risks to constantly eating that"* which could develop *"over long periods of time"*, but:

> *"it might not be something that you would notice imminently, but there would definitely be long term health consequences"*.

It was added that the *"actual [health] consequences it has on people are quite serious"*. In terms of the unfavourable long-term health outcomes of GMFPs, a participant expected it *"to be less easily digestible"* and that:

> *"there could be some sort of consequence where you get a virus or you get some sort of bacteria from the goods, and it is immune to antibiotics, and that is something that is a negative consequence"*.

Regarding the consumption of GMFPs, *"a risk factor of possible allergies"* could be expected, and *"there are people who are claiming that they got sick from cancer from chemicals that have landed up on the plant", "which is a negative consequence".* It has also been alleged that resistance to antibiotics can be developed through the process of genetic modification, and it has been argued that GMFPs could lead to allergic reactions, creating anxiety among consumers (Van Acker et al. 2017; Lefebvre et al. 2019; Islam et al. 2020; Blagoevska et al. 2021; Emmanuel et al. 2021; Kubisz et al. 2021; Sendhil et al. 2022; Ghimire et al. 2023). The possible development of cancer from consuming GMFPs has also created consumer concern (Ozkok 2015; Shen et al. 2022). In the current study, the occurrence of such illnesses was attributed by one participant to changing food products and using technology to do so, as *"they are altered and tampered with"* and because:

> *"if things are being inserted into the products that we eat that were not originally there, then it's going to have some kind of effect on your body"*.

As a result, *"there's always a risk factor connected to any sort of new foodstuff or scientific advancements"*, such as in the case of GMFPs. It has been found that consumers fear GMFPs could cause adverse health consequences as GM technology is considered to be a new technology, and there could be potential health risks that consumers feel remain unknown (Raman 2017; Van Acker et al. 2017; Pham & Mandel 2019; Ruth & Rumble 2019; Prianto et al. 2020; Abdoul et al. 2023; Ghimire et al. 2023).

Based on the discussions about the long-term health risks expected to occur from consuming GMFPs, it appeared some participants expected GMFPs to be labelled as *"it is expected of them to be ethically considered"* and *"to label it"*. In terms of labelling GMFPs, it was expected that *"it should be labelled that it's GM-made"*, that *"it should be properly labelled"*, that *"it should at least indicate on the food products whether they are modified"*, and that *"the actual packaging should be there and indicate that"* it contains GM ingredients. Therefore, *"GM foods must be labelled honestly and openly"* so that *"we would have more understanding"*. From the data, appropriate labelling was a sub-salient aspect related to GMFPs due to the possible health risks expected from consuming such food products. Labelling was another sub-salient aspect pertaining to the cost value of GMFPs in terms of the effort involved in acquiring these products and the ethical values of GMFPs in terms of consumers' rights, as seen in Chapter 6, Section 6.2.3 and 6.4.5, respectively. This could indicate that GMFP labelling was important to the participants. It has been suggested that labelling should be present on GMFPs to assist consumers in identifying these products, and consumers are thus increasingly reporting a desire for GM labelling (Gheysen et al. 2019; Islam et al. 2020; Sanlier & Sezgin 2020).

In terms of appropriate labelling, one participant stated that it *"should be a lot clearer"*, while another participant expected that:

> *"it should be on the front or there should be an emblem or a sign that it's genetically modified, so all foods across the board have to have that label or that emblem that gives an indication to you just so that you know"*.

It was further expected that, in terms of GM labels, *"it should say in big font on the front of anything that contains it, that it does"*. As a result, *"it is an area that should be seen to more"*. It has been suggested that GM labels should contain simple words, icons or symbols to make GMFPs easily recognisable (Yeh et al. 2019; Zhang et al. 2021). For example, the USDA approved two symbols for the packaging of GMFPs in the USA, while a yellow triangle with a T (transgenic) inside has been approved in Brazil (Jaffe 2017; Shreeves 2018).

Due to the health risks participants linked to the consumption of GMFPs, it was further expected by very few participants that *"I think it should be law that it should be labelled"*, and therefore *"it should be a legal requirement"*; however, one participant stated that *"I don't think it's law"* in SA. Making GM labelling a regulation emerged as a sub-salient aspect contributing to the expectation that GMFPs should be labelled appropriately. Currently, GM labelling laws have been implemented in SA (Biosafety South Africa 2015).

Another sub-salient aspect that emerged from the data was that the reason for genetic modification should be stipulated on the GM food label, because, according to some of the participants, *"I think there should be a little thing there that says actually what has been modified and why it has been modified"*; and that *"it should be more clear on the labelling what the modification was actually for"*. Therefore, *"the specific modification that is done should be made available to the consumer"*. It was added that *"I'd love to be able to pick up a product and see oh this is genetically modified for x, y, z reasons"*; for example, *"to reduce herbicide use"*; *"reduced use of insecticides or pesticides"*; or *"if they have added vitamins and minerals"*; or if *"it's been genetically modified for drought resistance"*; or *"to have a more sustainable crops"*; or *"some sort of health benefit"*; or if *"it's bug resistant"*; or *"so that the plant grows faster"*. It was thus expected that *"they need to say why it was produced"* and *"maybe how they went about it in a little story just to make the consumer feel more at ease"* in order *"to tell the customer what the desired outcome was meant to be when they were doing that modification"*, *"where the food comes from"* and *"why it's been grown in a certain way"*. Authors have pointed out that consumers want to know how food products are made, the process involved, and the country of origin where the food product was produced, and it has therefore been suggested that the production stages of GMFPs should be stipulated on the labels (Sanlier & Sezgin 2020; Macall et al. 2021; Delgado-Zegarra et al. 2022).

In addition to the expectation that GMFPs should be labelled appropriately, *"it would be expected that there has been as much background research that has gone into that modification as what would be reasonable to expect",* and *"the biggest expectation is that they have done their research"*, which very few participants expected. Consumer advocates have argued that additional research needs to be conducted to ensure the safety of GMFPs, thereby preventing any negative outcomes, particularly in terms of health consequences (Islam et al. 2020). As a result, a few participants expected that GMFPs *"needs to be controlled"* and *"I just expect the things to be regulated as well"*. Therefore, it was expected that *"there needs to be a regulatory party that regulates what people do"* when producing GMFPs and that:

"these things just need to be regulated to say 'well, as long as the positives always outweigh the negatives, go for it'".

Participants added that "*there is a lot of unknowns that we still need to unpack"* when it comes to GMFPs because *"we are not always aware of what all the consequences are"*, particularly in terms of *"health risks"* pertaining to the consumption of GMFPs. Having satisfactory control or regulatory systems in place was also important to the participants when discussing the long-term health risks and concerns linked to GMFPs in Chapter 5, Section 5.8.1, and the ethical values of genetic modification in terms of consumers' rights in Chapter 6, Section 6.4.5. Thus, research and regulatory systems emerged as sub-salient aspects of the salient aspect concerning long-term health outcomes that were expected of GMFPs. In terms of regulatory systems, it has been argued that GM crops need to be tested and properly regulated to ensure their safety for human consumption (Pham & Mandel 2019), as seen among Australian consumers who believed that appropriate regulatory systems need to be in place (Cormick & Mercer 2017). In the SA context, the Genetically Modified Organisms (GMO) Act was developed to regulate risk assessments of GM crop production (Department of Agriculture South Africa 2004; Wray 2021).

Unfavourable long-term health outcomes of GMFPs were ultimately expected by participants in terms of the concerning consumer-related outcomes of such food products. This was an important aspect to the participants and could pose an issue in promoting food security as it could lead to consumers' reluctance towards GMFPs. Due to the expected long-term health outcomes from consuming GMFPs, it was further expected that appropriate labelling – in terms of making GM labels a regulation while stipulating the reason for genetically modifying the food product – research and regulatory systems should be in place. The health risks of GMFPs emerged as a prominent aspect when the participants expressed their beliefs about such food products in Chapter 5, Section 5.8.1 (consumer-related risks and concerns of GMFPs); but was considerably less prominent when the participants explained their compromised health cost values of GMFPs in Chapter 6, Section 6.2.2. Therefore, based on the extent of elaboration and depth of data, the participants were found to elaborate more on health risks or concerns regarding GMFPs during their discussions about their beliefs as opposed to their values and expectations of GMFPs. However, health risks were discussed more in-depth when the participants vocalised their expectations of GMFPs as opposed to their values of such food products. Notably, there was an absence of sub-salient aspects in terms of which health risks could be expected, which can suggest that the participants were unsure of whether specific health risks could, in fact, be experienced by or expected from consuming GMFPs. Nevertheless, the volume of sub-salient aspects that emerged in terms of labelling indicates

that the anticipated unfavourable long-term health outcomes influenced the theme: expected concerning consumer-related outcomes of GMFPs. Although this was the case, the lack of elaboration suggests that the aspect was less influential in the expectations data than the beliefs data, yet more prominent than in the values data.

7.5.2 Summary of the Expected Concerning Consumer-Related Outcomes of GMFPs

The salient aspect of Theme 4, namely the expected concerning consumer-related outcomes of GMFPs, is depicted in Table 7.4, in addition to the most salient aspects of Themes 1 to 3.

Table 7.4: Summary of the Most Salient Expected Outcome Aspects of Themes 1 to 4

Theme	Salient Expected Outcome Aspects of GM Crops and GMFPs			
Theme 1: Expected Beneficial Outcomes of GM Crop Production	Expected Enhanced Productivity Outcomes	Expected Outcomes in terms of Promoting Food Security		
Theme 2: Expected Beneficial Consumer-Related Outcomes of GMFPs	Increased Nutritional Value	Increased Availability & Affordability	Improved Aesthetic Properties	Improved Food Processing Properties
Theme 3: Expected Concerning Outcomes of GM Crop Production	Unfavourable Environmental Expected Outcomes	GM Seed Usage Threat	GM Seed Company Threat	
Theme 4: Expected Concerning Consumer-Related Outcomes of GMFPs	Expected unfavourable long-term health outcomes			

In Themes 1 and 2, the data showed that expected beneficial outcomes were from producing GM crops and benefits were expected for the consumer specifically. The data in Theme 3, however, showed that concerning outcomes were also expected from GM crop production, which was supplemented with the salient aspects that emerged in Theme 4. Theme 4 demonstrated that a concerning consumer-related outcome of GMFPs was also expected by the participants, as depicted in Table 7.4. The data throughout Themes 1 to 4 showed beneficial and concerning aspects were expected of GMFPs among the participants.

In terms of the salient aspect that emerged in this theme, potential health consequences have resulted in consumers experiencing opposition towards GMFPs (Van Acker et al. 2017). Such concerns have contributed to the demand for adequate labelling of GMFPs and the implementation of appropriate regulatory systems to monitor all the processes involved in genetic modification (Wray 2021; Zhang et al. 2021). Authors have established that health

concerns could be a determining factor in the exploration of consumers' attitudes toward GMFPs (Morris & Adley 2000; Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Lopez et al. 2016; Rzymski & Krolczyk 2016; Ghoochani et al. 2017; Jonker 2017; Deng et al. 2019; Amin et al. 2021). In the GM consumer attitude context, it has been postulated that adverse factors associated with GMFPs could negatively influence consumers' attitudes towards GMFPs (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Ghoochani et al. 2017). This study proposed that the one salient aspect in this theme, together with its respective sub-salient aspects, could result in a harmful association toward GMFPs, causing conflict with the participants' attitudes and influencing their attitudes in an unfavourable manner. The outcome would be a perceived threatened attitude toward such food products. The most salient and sub-salient aspects relating to the expected concerning consumer-related outcomes of GMFPs, and the suggested influence that they could have on the participants' perceived attitudes toward GMFPs are presented below in Figure 7.8.

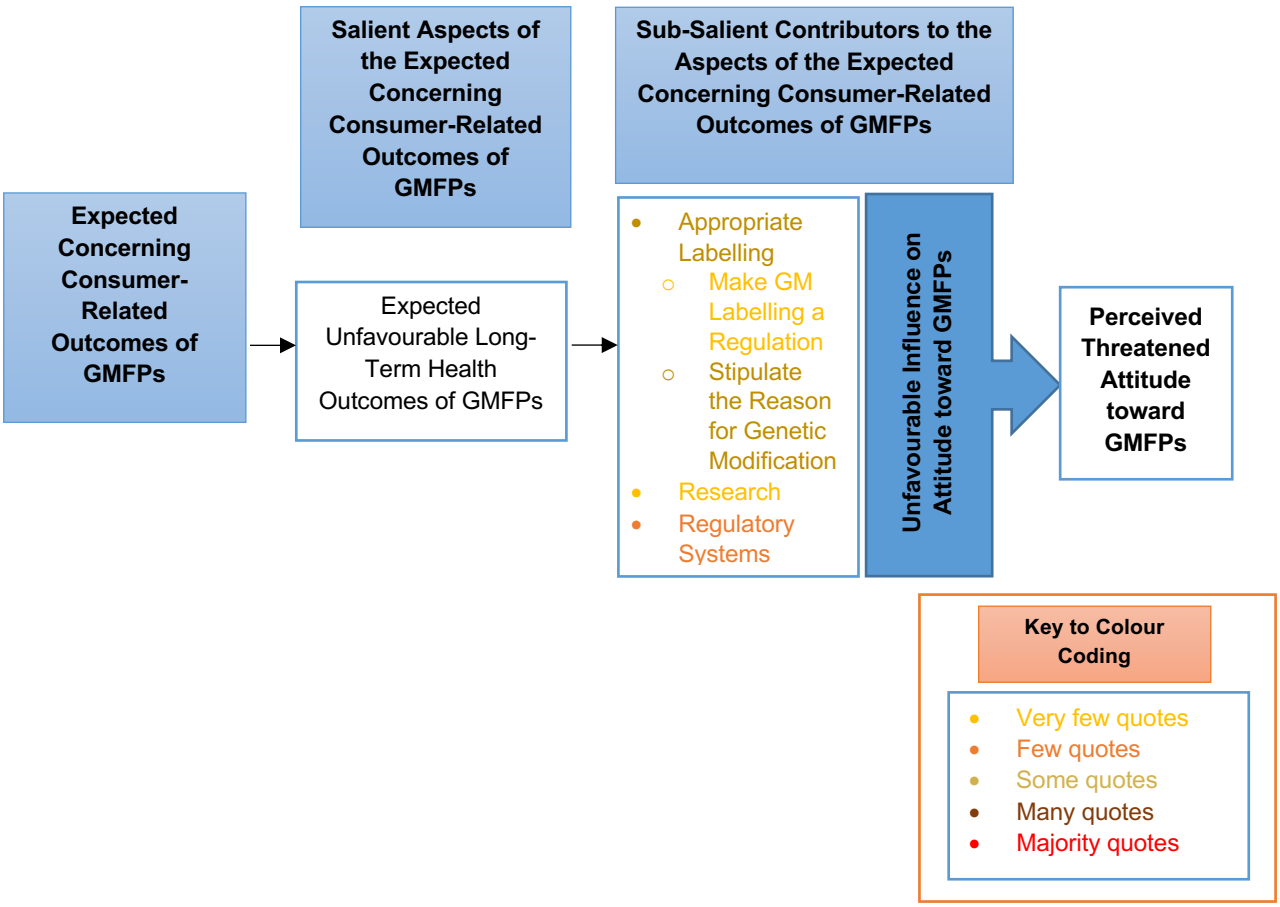

Figure 7.8: Expected Concerning Consumer-Related Outcomes of GMFPs and the Proposed Influence on the Perceived Attitude towards GMFPs

As shown in Figure 7.8, it is proposed that the salient aspect relating to the participants' expected concerning outcomes of GMFPs contributes toward a perceived threatened attitude towards these products, which could pose an issue for securing food for the SA population and achieving SDG 2: Zero Hunger. However, based on the lack of depth of data compared to the beliefs data and lack of salient aspects, it is suggested that the concerning consumer-related outcomes of GMFPs were not influential in the participants' expectations of these food products.

7.6 SUMMARY

In this chapter, participants demonstrated beneficial and concerning expectations of GM crop production and GMFPs. Of particular importance in terms of GM crop production was the expected enhanced productivity outcomes, but these aspects appeared to be less prominent than in the beliefs and values data. In terms of the expected beneficial consumer-related outcomes of GMFPs, improved aesthetic properties were an aspect that was particularly important. However, the beneficial consumer-related aspects were less prominent in terms of the participants' expectations of GMFPs compared to their beliefs and values, with the exception of improved aesthetic properties. Regarding the expected concerning outcomes of GM crop production, these aspects were lacking and more influential in the beliefs and values data – particularly the beliefs data. In terms of the expected concerning consumer-related outcomes, unfavourable long-term health outcomes were expected and influential in the participants' expectations. However, the aspect lacked depth in terms of specific expected health risks and was considerably less prominent than in the beliefs data but more prominent than in the values data. This indicates that although an attribute could influence participants' beliefs and values, it did not follow through to their expectations. It is therefore suggested that beliefs and values do not result in a prominent expectation regarding GMFPs, and beliefs, values and expectations do not work together to form an attitude toward these food products.

The lack of discussion and depth of data in this chapter could suggest that the participants did not understand what their expectations of GMFPs were, that they possibly were unable to articulate their expectations of GMFPs, that they were unsure if their expectations were feasible, and that they were not confident in their GMFP expectations. These views may be ascribed to the uncertainty with which their beliefs were formed, which filtered through to their expectations in terms of whether it was, in fact, viable to expect certain attributes from GMFPs. It could also suggest that the participants did not have sufficient experience with GMFPs to develop a confident expectation of GMFP attributes. Their uncertainty also suggests that the participants did not have particular expectations of GMFPs, but were more vocal in their beliefs

and values of such food products – thereby leaving a gap in understanding in terms of what attributes are expected of GMFPs. Therefore, it is suggested that the expectations component of the EV Model of Attitudes was the least influential in the formation of participants' attitudes toward GMFPs, indicating that the component is not of particular use in attaining SDG 2: Zero Hunger. In contrast, three respective quantitative studies found that expectations contributed more toward attitude formation than the values component with regard to product brands, hair shampoo, and persuasive messages used in advertising (Sheth & Talarzyk 1972; Sheth & Tuncalp 1974; Ahn et al. 2019). Another study in the USA found that values had a more positive influence on attitude formation compared to expectations in relation to the attitudes of boycotters and non-boycotters of consumer products (Belch & Belch 1987).

Although limited quotes emerged in the expectations data, it is proposed that the beneficial and concerning expectations of GM crop production and GMFPs could lead to an optimistic and threatened attitude toward such food products. As a result, dual attitudes toward GMFPs could exist, which could contribute to yet compromise the quest to promote food security in SA, attain SDG 2, and accept GMFP food aid. A further interpretation of these findings is provided in the conclusion chapter, namely Chapter 10. The following chapter presents the first part of the data regarding the participants' knowledge, sources of GM-related information, and PI towards GMFPs.

CHAPTER 8
FIRST PART OF THE FINDINGS AND DISCUSSION OF THE KNOWLEDGE, SOURCES OF GENETICALLY MODIFIED-RELATED INFORMATION AND PURCHASE INTENTION DATA ON GENETICALLY MODIFIED FOOD PRODUCTS

Nine themes emerged from the data pertaining to participants' knowledge, sources of GM-related information and PI of GMFPs. The first four themes are discussed in this findings and discussion chapter, and the remaining five themes relating to participants' knowledge and PI of GMFPs are presented in Chapter 9.

8.1 INTRODUCTION

The previous chapter discussed the data on participants' salient expectations of GM crops and food products. This chapter presents data on participants' knowledge of GMFPs; the GM-related information sources that would be consulted; and their PI of GMFPs. The participants' knowledge of GMFPs was explored to see what influence knowledge has on their beliefs about such food products. Moreover, the sources from which the participants gained information about GMFPs were explored and considered an influential aspect of their knowledge of such food products. In terms of the GM-related information sources, the study aimed to see whether the participants looked for information about GMFPs and which sources they consulted that influenced their knowledge, thereby gaining insight into their state of knowledge. The TPB framework's elements of attitudes, subjective norms and PBC were used to explore the participants' PI, which was done through an exploration of behavioural, control and normative beliefs (Ajzen 1985) regarding GMFPs to assist in improving food security.

The findings that emerged regarding participants' knowledge, sources of GM-related information and PI (in terms of the TPB framework) of GMFPs are discussed together in this chapter, as some of the same questions were used in the interview guide to particularly explore the participants' knowledge and PI of GMFPs. The proposed influence that knowledge could have on beliefs and the proposed influence that PBC could have on consumers' PI of GMFPs are also presented. In this chapter, colour coding was used to represent the prominence of each sub-salient aspect that emerged from the data, and each salient aspect has been presented in bold to assist with their identification within the discussion. The remaining quotes relating to the aspects in this chapter can be found in Appendix E.

The first theme, namely the participants' lack of knowledge about GMFPs, is presented first. Thereafter, the sources of GM-related information that would be consulted are discussed, followed by the food products purchased regularly assumed to contain GM ingredients and participants' interactions with GMFPs on the market. Thus, the first three themes that emerged from the data regarding the participants' knowledge about GMFPs are presented, and the fourth theme about their knowledge and PI of such food products is later described in the chapter. The remaining five themes are presented in Chapter 9.

8.2 THEME 1: LACK OF KNOWLEDGE ABOUT GMFPS

This study aimed to explore how knowledge could influence the participants' beliefs about GMFPs. This required an exploration of their knowledge about GMFPs. From the data, it emerged that the participants demonstrated a lack of knowledge about GMFPs. The most salient and sub-salient contributing aspects that emerged from the data in terms of the participants' lack of knowledge about GMFPs are depicted in Figure 8.1.

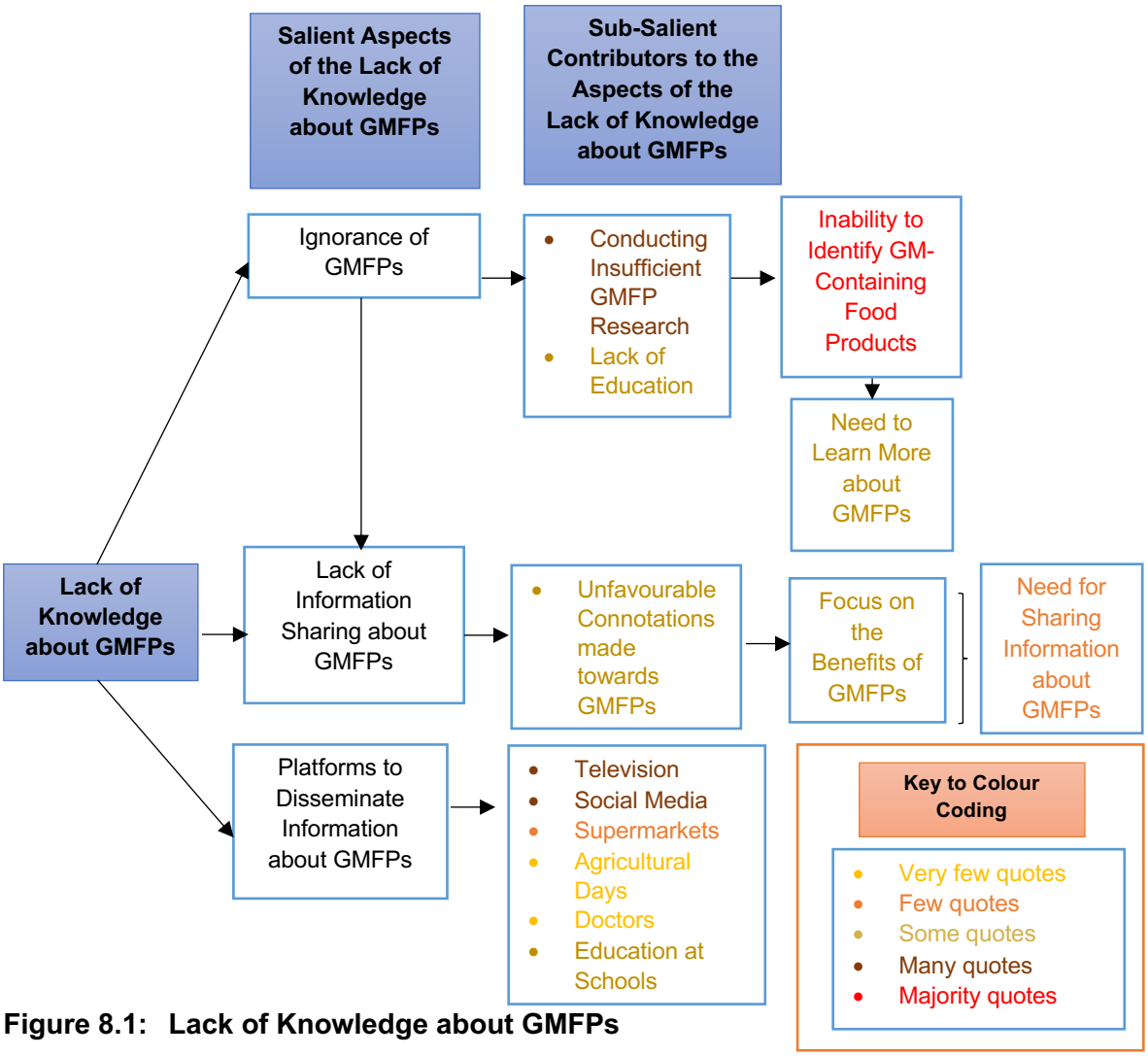

Figure 8.1: Lack of Knowledge about GMFPs

As illustrated in Figure 8.1, three salient aspects linked to participants' lack of knowledge about GMFPs were reflected in the data analysis, namely ignorance of GMFPs, lack of information sharing about GMFPs, and platforms to disseminate information about GMFPs. A discussion of these aspects follows.

8.2.1 Ignorance of GMFPs

The data reflected that the participants lacked knowledge about GMFPs. They explained: *"I unfortunately don't know enough about it"* and *"I have very limited knowledge of them"*, thereby recognising that *"I have realised gaps in my understanding"*, which may point to the fact that *"I don't have a perfect understanding"* of GMFPs. It was thought that *"the majority of people don't know*" the difference between a GM and non-GMFP as *"people probably don't know that it's got GMO or not"*. As a result, it was thought that *"a large proportion of the population"* would say that *"I'm not sure"*, or *"I would say more than half of people would say 'GM, what's that?', like they've never heard of it"*. In addition, it was stated that *"I don't know all the details behind it"* in terms of genetic modification because *"I have a very concentrated understanding of what the whole process entails"*. Therefore, *"I think there needs to be an understanding of the process of where it comes from, how it got there"* because *"people don't understand the science behind it"*. Although the participants knew someone who farmed with GM crops, they did not farm with GM crops themselves, did not have friends or family who farmed with GM crops and did not demonstrate a particular awareness of GM farming in the vicinity of where they lived – as seen in the GM context-related information section (Section 5.3) in Chapter 5 – which could have contributed to their lack of GMFP knowledge. **Ignorance of GMFPs** thus emerged as an important salient aspect of the data, which was ascribed to sub-salient aspects such as conducting insufficient GMFP research and a lack of education about such food products.

In terms of consumers' GMFP knowledge, various authors agreed that consumers do not understand what the concept of genetic modification involves (Wunderlich & Gatto 2015; Celik & Dagistan 2016; Cui & Shoemaker 2018; Shtulman et al. 2020). This was evident in a study conducted in the Chris Hani District Municipality in SA in 2014, where the results showed that consumers did not understand what the term 'genetic modification' meant (Peter & Karodia 2014), which the participants in this SA study also admitted. Additional results showed that in Switzerland and SA, consumers had limited knowledge, lacked understanding, and were uninformed about GMFPs (Lucht 2015; Jonker 2017). According to Marx (2017), such results could be attributed to SA consumers not generally having a sound knowledge of GMFPs. A study in Nigeria also ascertained that consumers had limited knowledge of the term 'genetic

modification', and this lack of knowledge among consumers was particularly evident in developing countries (Dirisu et al. 2020). Cui and Shoemaker (2018) were also of the opinion that consumers are not knowledgeable about GMFPs, which was seen in a study conducted by Deffor (2014), where it was determined that consumers in Ghana had not heard of GMFPs. However, a study in Sri Lanka found that consumers had heard about GMFPs (Jayasuriya & Rathnayaka 2016). These studies show that consumers generally have limited knowledge of GMFPs, as seen in this SA study in the GM context.

In terms of conducting insufficient research, many participants' ignorance of GMFPs was ascribed to the fact that *"I haven't done any research"* into GMFPs and *"I haven't done enough research in it myself"*, and as a result, *"I haven't ever really looked into it deeply"*; therefore *"I haven't investigated enough"*. It was added that insufficient GMFP research was conducted because *"I just haven't taken the time or the desire to know much more"*, *"I wouldn't say that it is something that I am extremely passionate about"*, and *"I've just been very preoccupied with other stuff"* because *"my priorities are just elsewhere"*. The lack of research into GMFPs could be attributed to the participants' employment status, which could indicative that they led busy lifestyles. It has also been suggested that consumers' limited knowledge of GMFPs could be attributed to their lack of interest in researching these food products (Bonah et al. 2017). Regarding the absence of not conducting research into GMFPs, it was further stated that *"I think the food that I buy off the shelves are good for me"* and the food products in the supermarkets have been *"regulated"* and appropriate *"testing"* has been done to ensure these products are *"safe"* for human consumption. Therefore, *"there is no reason for me to go online and search these products"*. To regulate the safety of GMFPs in SA, the GMO Act was developed in 1997, which enables risk assessments to be conducted on GM crop field trials, thereby regulating any risks to ensure the safety of such food products for the environment and human consumption (Wray 2021).

Regarding the lack of education about GMFPs, it further emerged from the data that some participants' ignorance of GMFPs was attributed to their lack of education. Participants stated, *"I don't know enough because I haven't learnt enough about it"*; therefore, *"I don't have an understanding"* of GMFPs because *"I'm not very well educated"*. It was added that *"people lack understanding because they haven't been informed correctly about what it is"* and *"I don't think many South Africans are actually educated in this regard, I would guess the majority are not"*. Education was thought to be important because:

"it allows people to understand concepts better and it also helps them deal with concerns that might be irrational – it might rationalise them, and then they can understand it a little bit better".

This could also be the case for GMFPs. Since consumers do not have sound scientific knowledge about GMFPs, it was suggested that consumers need to be educated about the science behind genetic modification to enhance their knowledge about what the concept entails (Ezezika et al. 2012; Emede & Fasina 2020). In the SA context, it has similarly been suggested that consumers need to be educated about GMFPs (Marx 2017); however, a lack of knowledge prevails, as reflected in the findings of this study.

Due to their ignorance of GMFPs, the majority of participants explained, *"I don't know specifically off hand"* which food products have been genetically modified; *"I don't know of all of the food that has been modified"*; *"I actually really have no idea what's GM or not"*; and *"I don't know to be honest"* which food products "*that I'm buying that are modified"*. The inability to identify GM-containing food products was a sub-salient aspect that emerged from the data. This finding was ascribed to the participants not conducting sufficient research into GMFPs and their lack of education, resulting in their ignorance of these food products. These findings were consistent with other studies, such as a study conducted in SA that established consumers were unsure which GMFPs were available to purchase in SA (Peter & Karodia 2014). Two respective studies found that SA consumers were not knowledgeable regarding which food products contained GM ingredients, and they did not know which GMFPs they were consuming (Jonker 2017; Marx 2017; Van Zuydam et al. 2023); this was also seen in the current study. International studies in the USA and Nigeria also found that consumers did not know which GMFPs were available for purchase and consumption purposes (Wunderlich & Gatto 2015; Dirisu et al. 2020). Glasgow (2015) similarly concurred that many consumers are unaware of the GMFPs available in supermarkets, which the findings of this study also suggest.

In the current study, the participants' ignorance of GMFPs led some of them to think that *"I probably should be reading up more about them"* and *"I probably should know more about GM food than I do"* because *"there is a lot to learn"*; and *"I suppose, as a consumer, it's always good to read up on these things and to equip ourselves with the correct knowledge and know what it is that we are consuming"*. As a result, *"I need to pay more attention in general and educate myself more in terms of what we get in our supermarket, what things are typically genetically modified and what are not"*; and therefore *"I should have a broader awareness of the products that actually are or do contain the various GM foods"*. Thus, the need to learn

more about GMFPs emerged as a sub-salient aspect from the data, which could be ascribed to the participants' profiles in this study as they were educated individuals. This could suggest that they understood there could be a need to further their understanding of an aspect such as GMFPs.

Considering the volume of quotes relating to participants' ignorance of GMFPs and the volume of sub-salient aspects that emerged from the data, it is proposed that their ignorance was an influential and important aspect in relation to their lack of GMFP knowledge. Their ignorance about GMFPs was attributed to participants not conducting enough research into GMFPs and a lack of education (leading to the inability to identify them); a need to learn more about these products was ultimately identified. Based on the volume of quotes, conducting insufficient research on GMFPs and not being able to identify food products containing GM ingredients were particularly important to the participants that potentially underpinned their lack of GMFP knowledge.

8.2.2 Lack of Information Sharing about GMFPs

It emerged from the data that *"there is a lack of communication"*; that *"there is a lack of information"*; and that *"there is no direct information"* about GMFPs. Therefore, when it comes to information about GMFPs, *"it's a little vague"*. The lack of information about GMFPs contributed to the fact that *"I don't know enough", "I just don't know"*; and *"I don't have an understanding"* of such food products. Therefore, a **lack of information sharing about GMFPs** emerged as a salient aspect, which was thought to contribute to the lack of GMFP knowledge. It has been opined that there is not enough information being communicated to the public regarding GMFPs, and more GM information needs to be provided to address consumers' lack of knowledge about GMFPs (Bonah et al. 2017; Kim & Choi 2018; Abdoul et al. 2023). The lack of information sharing about GMFPs led participants to think that *"it comes across as a thing that's done behind closed doors"*; *"I think it just happens in the background without us knowing"*; and *"the fact that they don't"* share information or that it *"doesn't pop up in places to make you think about it"*, *"indicates to me that they know there are issues and they'd rather that people didn't think about it and didn't know enough"*; because *"if it was such a good thing and there is nothing to be scared of or to be wary of, then I think they would advertise it more easily"* and *"it would be plastered all over the place"*. As a result, *"that makes me suspicious"*. According to Frewer (2017), consumers have become wary of governments as they do not share sufficient information regarding genetic modification, which may result in suspicion and opposition toward such food products.

The lack of disseminating GM-related information was attributed by one participant to the limited focus placed specifically on the consumer because *"I think GM technology started out mainly focused on agriculture and the farmer, that was the starting point"*, but *"things have now moved and advanced so much that the focus should actually be shifted to the consumer"*. However:

> "*I don't think, at this point, the consumer has sort of been put in the picture of what is GM and why it's there and why it's good for the consumer and what we, as consumers, can actually get out of it*".

Thus, *"I don't think the knowledge and the shift in focus has been done enough and effectively at this point"* and:

> *"I don't think they've done enough to actually involve the consumer in all the advancements and also in giving us enough information to make good choices and to make use of what science has actually done for us so far in the food industry"*.

According to this participant, a lack of consumer focus could be contributing to their lack of GMFP knowledge. Evidently, in terms of GMFPs, *"it's not being spoken about",* and *"they are not getting the right information and message to the consumers",* and *"they don't actually filter through information"*; therefore, *"they should do and make a bigger effort to get that knowledge out to the consumer"* because *"they know that the consumer is important because the consumer is such an important part of what they are trying to achieve"*. In terms of the role that consumers play in the context of GMFPs, it has been argued that consumers are largely influential in the success of GMFPs in the marketplace (Muzhinji & Ntuli 2021; Owusu-Gyan et al. 2023). Thus, the study's findings suggest a need for sufficient information to be shared about GMFPs.

According to some participants, *"I think a lot of people have very negative ideas about it"*, *"people have an opinion about it", "but it is an uneducated opinion"*; and *"it's probably got quite a negative connotation"*; and therefore *"GMFPs may not seem normal to the uneducated"*. Due to the perceived negative connotations made to GMFPs, *"their immediate impression of genetically modified food is them being 'Frakenfoods'"* because *"bad things are being injected in our food"*. Therefore, the idea around GMFPs is that *"they must be making it wrong"* because *"it's against God"*; and that is *"why people fear it"* because *"they don't know exactly what it is"*. Due to being ignorant and *"not having the information"* about GMFPs, *"I think the general opinion is that genetically modified food is bad"*. Such findings were substantiated by Marx

(2017), who suggested that even if consumers think they know something about GMFPs, their knowledge may not be based on factual information. It has also been stated that the ethical-related concerns about GMFPs could be founded upon a lack of knowledge regarding genetics (Kubisz et al. 2021). It thus emerged from the data in this study that the unfavourable connotations made towards GMFPs were a sub-salient aspect and a potential reason why the dissemination of information about such food products is not actively pursued.

Relating to the unfavourable connotations made about GMFPs, it has further been argued that miscommunication from governments and consumers' lack of knowledge has contributed to their misconceptions about GMFPs; thus, consumers are sceptical about GMFPs and view them as being 'Frakenfoods' (Zennah & Cyrus 2019; Dovey & Ntuli 2020; Hunt & Wald 2020). Authors have further agreed that sharing reliable and factual information – on a level that is understandable – can address any misconceptions, particularly since consumers have associated GMFPs as being harmful to their health (Ghanian et al. 2016; Hassan et al. 2016; Cormick & Mercer 2017; Marx 2017; Emede & Fasina 2020; Sanlier & Sezgin 2020; Amin et al. 2021; Van Stekelenburg et al. 2021). Consumers' misconceptions about GMFPs could ultimately be fuelled by their ignorance of such food products. This study's findings also allude to this phenomenon.

The unfavourable connotations about GMFPs meant *"there has to be a counter argument given to us as to why this is important"* to *"both us as humans and also to the environment"*. To achieve this, some of the participants suggested that they need to make *"people aware of why food is modified, for what purpose"*; for example, *"they can advertise and say that they have genetically modified the product to get these benefits"*. It was added that *"they need to advertise it as a great thing"* and *"that there are benefits"* to genetically modifying food products, such as *"helping the world"*, *"helping food shortages"*, and *"helping add nutrition to your meal"*, which can be particularly important in SA to promote the food security status of the population. Getting the message out to the consumer *"that it is beneficial"* through *"sufficient and accurate information"* can negate any unfavourable connotations about GMFPs and bring solace to consumers. It can *"enlighten the consumer",* thereby making *"the consumer more informed"*, and *"more keen and comfortable to purchase the products"*. A need to focus on the benefits of GMFPs emerged as a sub-salient aspect to remedy the unfavourable connotations linked to these food products. Such suggestions were echoed by authors who were of the opinion that GM messages should include the benefits of GMFPs, particularly regarding human health and the environment, as such information could create a sense of comfort, dispel scepticism, and reduce the moral opposition towards such food products, thereby increasing consumers' acceptance of these food products (Olabinjo et al.

2020; Heng et al. 2021; Hwang & Nam 2021; Jiang & Zhang 2021; Aziz et al. 2022; Rodriguez et al. 2022). Such findings were evident in a study conducted by Sendhil et al. (2022), who found that Indian consumers supported GMFPs more freely when they were exposed to information about these products' benefits. In this study, a few participants further suggested that GMFPs need to be *"spoken about more"*, "*they need to advertise it"*, *"we need to be given more information about it"*, and *"they need to do more advertising"* because *"it needs to be clarified"*. Doing so is essential because *"if the information was obtainable and readily available, there's nothing to be like suspicious or concerned about [regarding GMFPs] because the facts are in front of you"*. Therefore, a need for sharing information about GMFPs emerged as a sub-salient aspect of the data. The study's findings thus point to the importance of sharing beneficial information about GMFPs to create a favourable position toward such food products and change a possibly unfavourable attitude to a more favourable one.

The extent of elaboration, as seen through the volume of sub-salient aspects, indicates that the lack of information sharing about GMFPs was of importance to the participants in terms of their lack of GMFP knowledge. It was also identified that there is a need to disseminate GMFP information, specifically relating to their benefits, to address the unfavourable connotations linked to them.

8.2.3 Platforms to Disseminate Information about GMFPs

From the data, it emerged that there are **platforms which could be utilised to disseminate information about GMFPs**, thereby addressing the lack of GMFP knowledge. This was an important salient aspect that emerged from the data. In this study, platforms such as television, social media, supermarkets, agricultural days, doctors and education at schools were suggested to share GM-related information, which were sub-salient aspects. In terms of using the television as a platform, many participants thought that *"maybe advertisements on TV"*, *"commercials on TV"*, or a *"TV program"* would be useful to share information about GMFPs because *"a lot of people watch TV"*. In terms of using the television for information sharing about GMFPs, it was found that consumers in Australia and Botswana watched TV programmes about GMFPs because they trusted this source of information (Cormick & Mercer 2017; Hulela et al. 2019). Moreover, many participants suggested that social media could be used to share information about GMFPs because *"we live in a digital age"*, therefore *"these days"*, information can be shared on *"social media"*, such as *"pop-up adds on social media"* on *"Instagram or Snapchat or TickTock"*, and on *"Facebook"* because *"most people do Facebook"*. The suggested use of social media platforms could be ascribed to the age of the participants, since more than half of the participants who took part in this study were

millennials (between the ages of 25 to 40 years old), suggesting that they were acquainted with and made use of technological devices and platforms (Ahmad & Hardianti 2020).

According to Hulela et al. (2019), Asian countries have reported that mass media is an effective platform for sharing genetic modification information with the public, which was further concurred by Dirisu et al. (2020). However, Italian consumers did not think social media was a reliable source of information (Russo et al. 2020), and South Korean consumers did not trust the information in the media about GMFPs (Kim & Choi 2018). These findings can be attributed to the unsubstantiated information that could be construed on social media (Hwang & Nam 2021). The lack of trust could hinder social media's usefulness in sharing GM-related information with the public.

It was further suggested by a few participants that supermarkets could be a useful platform to disseminate GM-related information to the consumer as "*shops could have a thing up saying 'these are the different ways foods can be modified, this is what we are doing and why, and it's safe'"*. It was suggested that they could *"put it in shops as boards"*, *"they can have some sort of informational thing that people can read while they are there"*, or *"they could put up signs in stores saying 'these tomatoes are GM, they have a longer shelf life', so that customers start thinking about that"*. However, at this stage, *"supermarkets don't promote it"*. It has also been suggested that in-store samples of food products containing GMFPs would be a useful way to create awareness of such food products among consumers (Macall et al. 2021).

Other respective participants suggested that information can be shared and GMFPs can be advertised to consumers *"via smses"*; *"they can make use of more media"*; and that *"documentaries"* can be utilised. However, according to one participant, *"if you are looking at our country where so many people are illiterate, it would have to be a verbal type of sharing"* through *"visuals and audio"* such as *"pictures, posters and radio"*, and they can do *"pamphlets or sign boards"*. Therefore, the *"type of market you are attracting"* is important to consider when advertising because *"you've got to find your market, you've got to reach the people that it would impact"*. However, in terms of using audio-related platforms, Italian consumers questioned the reliability of information disseminated on the radio about GMFPs (Russo et al. 2020). Cui and Shoemaker (2018) suggested that the use of written materials and presentations would be beneficial in educating consumers about GMFPs. Furthermore, a *"YouTube channel or website"* which is *"linked to some sort of evaluative organisation"* and *"online newspapers"* where they could have *"a subsidiary column where they evaluate products"* was also suggested by one participant. However, it was added that "*I don't know where the funding would come from"*. Another participant recommended *"clinics and hospitals"*

can serve as information dissemination sources through which *"they could put something like a poster up where it could be read in different languages"* as *"people often go and sit at public clinics for ages, so if they could read something there it would be really nice"*.

According to another participant, *"having campaigns where you have people showing the difference between plants that are genetically modified and those that aren't, in a real-life situation"* could be held to share information about GMFPs. The participant suggested that these campaigns should focus on *"having people"* who *"eat them in front of you"* because this *"would help a lot to convince people that you are not out there just to make money, you are actually trying to help people"*, which *"would make a lot of difference to many people who don't get to see trials or experiments"* conducted on GM plants or crops. Additionally, agricultural days were suggested by very few participants to be a useful information dissemination platform. They explained *"having agricultural awareness days where people can go and see these genetically modified things"* and *"day visits at shows and like agricultural shows and those sort of things"* where *"people can actually interact and touch and see and be part of that experience"*. Such campaigns and agricultural awareness days *"are quite important"* because it is *"difficult to try and change people's opinions when they lack understanding"*, and people need to be informed about GMFPs. As a result, using various platforms to disseminate information and advertise GMFPs to *"create awareness"* and *"inform them"* about *"what they can do for us and what is out there"* could educate consumers and increase their knowledge about these food products. However, it was added that the *"information must be based on facts"*.

In terms of GM-related information-sharing platforms, it has been suggested that information from consumer organisations, environmental groups and scientists need to be used to educate consumers about GMFPs due to their credibility (Deng & Hu 2019). This was seen in South Korea, where consumers trusted environmental groups about GMFPs (Kim & Choi 2018), whereas Australian consumers trusted the information from organisations such as the Department of Agriculture (Cormick & Mercer 2017). It has further been suggested that governments need to support educational programmes to create a better understanding of genetic modification; however, consumers are not particularly trusting of the information disseminated to the public by the government regarding GMFPs (Cui & Shoemaker 2018; Hunt & Wald 2020; Science for Sustainable Agriculture 2022). Hosting agricultural days and using environmental groups and the Department of Agriculture to share information about GMFPs could be particularly useful to the participants in this study as they resided in the Midlands. Thus, they were surrounded by an agricultural community, suggesting that they could feel comfortable with such groups and confident in the information shared with them.

Regarding the use of doctors to share information about GMFPs, very few participants suggested that *"possibly also health practitioners"* and *"doctors who can advise moms"* would be useful for sharing information with mothers. However, it was asked whether *"an average doctor really have a clue on those things?"* Nevertheless, a study conducted in India concluded that consumers trusted the information given by physicians about GMFPs (Russo et al. 2020). Encouraging doctors to speak to patients about GMFPs could be valuable in addressing participants' lack of GMFP knowledge, as their profile suggested that they could be mothers.
In terms of education at schools, some participants further suggested that *"dissemination of information and education should not only be at one level, it can be at all levels"*, and therefore *"schools is one"*. Thus, genetic modification *"could be introduced in schools"* because children need to be educated *"about what GM is and how it could be beneficial"*. As a result, the concept of genetic modification *"could definitely be incorporated into the syllabus"* such as *"Natural Sciences"* or *"Biology"* at the school level, and the topic of GMFPs *"could definitely be something to consider"* teaching at the school level. Therefore, genetic modification should *"definitely"* be incorporated into the syllabus at the school level as it would be *"beneficial"*. A participant shared:

> *"I think anything in terms of education needs to start at school level because that's where most of your education years really start, and they form your adult views and opinions eventually"*.

The findings of this study were consistent with Dirisu et al.'s (2020) views that concepts around genetic modification should be included in school curriculums. One participant believed that educating children about GMFPs was important so that they are equipped with the knowledge to assist them in making informed decisions in the future because *"one day when the children are consumers and buying their own food, it's important that they already have the knowledge"* about these food products so that *"the consumers' of the future are well-informed and can make informed choices"*. Thus, *"it would be awesome if it was part of the curriculum"*; *"I think it would be fantastic for them to learn about this"*; and *"I think it would be good and beneficial"* to educate children about GMFPs. Therefore, sharing information about GMFPs with children at schools could contribute to addressing the ignorance demonstrated among consumers in the GM context by educating future consumers about such food products. Education – through sharing information – about GMFPs at the school level could have been particularly important to the participants in this study as their profiles indicated they were educated individuals, suggesting that they understood the importance of education. The profile of the study's participants further suggested that they were married or living with a partner, and they might

have been parents, which could also have contributed to their views on the importance of educating children about GMFPs.

Based on the volume of sub-salient aspects that emerged from the data, platforms to disseminate information about GMFPs, specifically through the use of television and social media (due to the prominence of the sub-salient aspects as indicated through the volume of quotes), was an important aspect to the participants to attain knowledge about such food products. Other platforms included supermarkets, holding agricultural days, doctors and education at a school level.

8.2.4 Summary of the Lack of Knowledge about GMFPs

A summary of the most salient aspects regarding the participants' lack of knowledge about GMFPs that emerged from the data is shown in Table 8.1.

Table 8.1: Theme 1: Salient Aspects of the Participants' Lack of Knowledge about GMFPs

Theme	Salient Knowledge, Sources of GM-Related Information and PI Aspects of GMFPs		
Theme 1: Lack of Knowledge about GMFPs	Ignorance of GMFPs	Lack of Information Sharing	Platforms to Disseminate Information

As seen in Table 8.1, the participants' lack of knowledge of GMFPs was attributed to their ignorance and lack of information sharing about GMFPs. Platforms to disseminate GMFP information were suggested to remedy their lack of knowledge. Numerous authors have agreed that consumers lack knowledge of GMFPs, as confirmed by various studies conducted across the globe; this phenomenon has been ascribed to the limited dissemination of information about such food products (Ezezika et al. 2012; Lucht 2015; Bonah et al. 2017; Jonker 2017; Marx 2017; Cui & Shoemaker 2018; Kim & Choi 2018; Dirisu et al. 2020). To remedy consumers' limited knowledge of GMFPs, it has been suggested that various platforms should be used to share information about these food products (Lucht 2015; Wunderlich & Gatto 2015; Jonker 2017; Cui & Shoemaker 2018).

Since this study aimed to explore the influence that knowledge has on beliefs about GMFPs, it is proposed that the first two most salient and sub-salient contributing aspects that emerged in this theme regarding the participants' lack of knowledge of GMFPs (ignorance of GMFPs and lack of information sharing about GMFPs) could influence their beliefs (as presented in

Chapter 5) in an unfavourable manner, thereby contributing to factually unfounded beliefs of such food products. The study further proposes that the suggestion of various platforms to disseminate information about GMFPs and their sub-salient contributors could address the participants' lack of knowledge, favourably influencing consumers' knowledge (and the foundation on which their beliefs of GMFPs are built), which could lead to factually founded beliefs. The proposed influence of the participants' knowledge about GMFPs on their perceived beliefs about such food products is suggested in Figure 8.2.

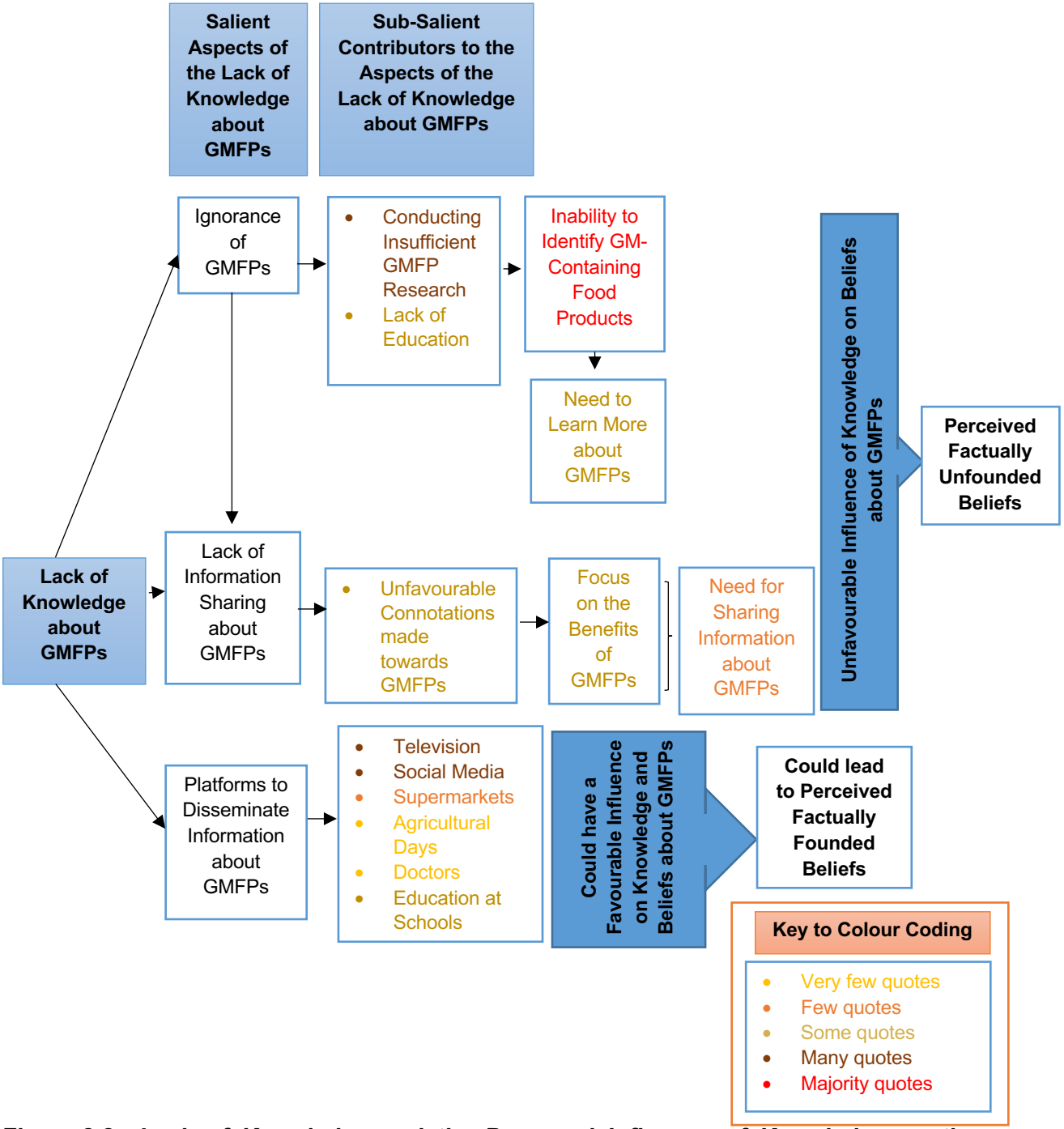

Figure 8.2: Lack of Knowledge and the Proposed Influence of Knowledge on the Beliefs about GMFPs

As shown in Figure 8.2, it is suggested that the participants were ignorant of GMFPs, which the lack of information sharing about such food products contributed toward, thereby leading to perceived factually unfounded beliefs. The participants' self-admitted lack of GMFP knowledge indicates an inability to objectively evaluate their beliefs regarding GMFPs. This suggests that their beliefs in Chapter 5 lacked credibility and did not stem from a solid knowledge foundation. The participants' lack of GMFP knowledge poses a challenge to the role that such food products could play in enhancing the food security status among the SA population and attaining SDG 2: Zero Hunger. It is, however, suggested that platforms to disseminate information about GMFPs could lead to perceived factually founded beliefs. Furthermore, the extent of elaboration and depth of data in terms of the volume of sub-salient aspects that emerged from the data suggests that all three salient aspects were important in the participants' lack of GMFP knowledge.

The second theme that emerged from the data, namely the sources of GM-related information that would be consulted, is discussed next.

8.3 THEME 2: SOURCES OF GM-RELATED INFORMATION THAT WOULD BE CONSULTED

The previous theme reflected that the participants lacked knowledge about GMFPs. In addition to exploring their state of knowledge, sources of GM-related information that could be consulted were explored. The sources where GM-related information was acquired that could influence participants' state of knowledge about GMFPs were explored in this study as the study aimed to explore the influence that knowledge has on consumers' beliefs about GMFPs. Reflecting on Section 8.2.1 of this chapter, where the participants conversed about not conducting sufficient research about GMFPs, they mentioned that they did not seek information about GMFPs, which their busy lifestyles (through their employment) could have contributed towards. Instead, the participants shared which sources they would consult to attain GM-related information should they need additional information, but they currently did not consult any of these sources. The salient and sub-salient aspects regarding the sources of GM-related information which would be consulted, as it emerged from the data, are illustrated in Figure 8.3.

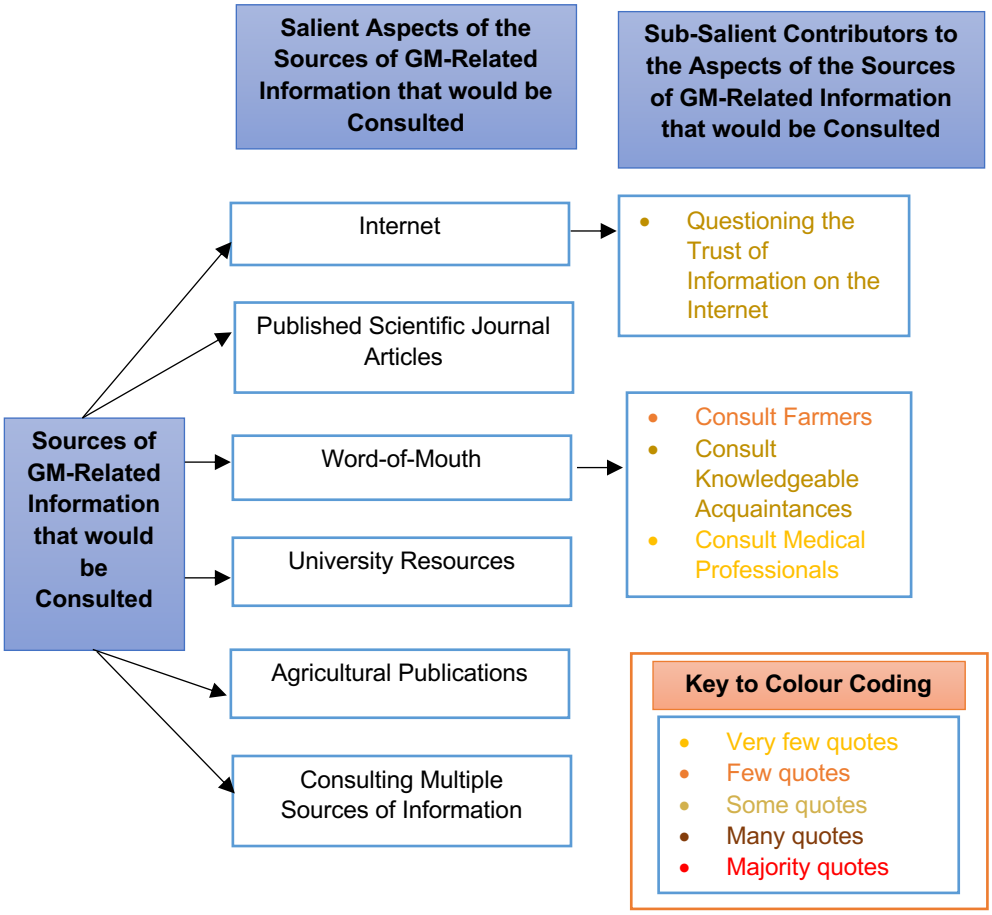

Figure 8.3: Sources of GM-Related Information that would be Consulted

The data analysis identified the most salient aspects in terms of the sources of GM-related information that would be consulted if additional information needed to be obtained about GMFPs. As depicted in Figure 8.3, these aspects included the internet, published scientific journal articles, word-of-mouth, university resources, agricultural publications and consulting multiple sources of information, which are subsequently discussed.

8.3.1 Internet

From the data, it emerged that, due to living in *"the 21st century"*, the internet is the most predominant source that the participants would consult to gain more information about GMFPs as *"Google would be my first start"* and *"I would probably consult the Internet"* because *"there's an endless spit of information"*. The **internet** was thus an important salient aspect that emerged from the data regarding the sources that would be consulted to gain GM-related information. Participants were millennials, suggesting their familiarity with technology (Ahmad & Hardianti 2020), which could explain why they would seek GM-related information on an online platform such as the internet. The findings of this study were congruent with other

studies that ascertained Latvian, Australian, SA, Chinese and Pakistani consumers consulted the internet for GM-related information (Wunderlich & Gatto 2015; Cormick & Mercer 2017; Jonker 2017; Cui & Shoemaker 2018; Amin et al. 2021).

Although the internet was the *"go-to place"* for GM-related information, according to some of the participants, *"the question is whether or not it's reliable information"* because *"it's all a bit of a guessing game when it comes to the Internet"* as *"there is a lot of rubbish on the Internet"*. Thus, *"obviously with the Internet, you've got to be aware of where the information is coming from"* because it could *"come from the organisations that might be against it"*. As a result, *"one has to be critical in your acceptance of whatever information is presented to you, you need to be quite critical of it"*. Caution was further demonstrated because *"on the Internet, there's an algorithm"*, meaning *"if you are for or against something, it tends to pick it up and then you always get that same information over and over again"*. Subsequently, *"as with every Internet, you kind of have to do a bit of a deep dive and look for site to site until you can find something that is fairly authentic or legitimate"*, and *"you have to do background checks on websites"* because *"there are so many websites that put up a front"* as *"they are well-sponsored by something that has their own interests and something to gain from it"*. As a result, one cannot *"just accept anything that you read"* on the internet, and it was suggested that one has to *"take what you read on the Internet with a pinch of salt"*. Therefore, questioning the trust of information on the internet emerged as a sub-salient aspect of the data in terms of using the internet to obtain GM-related information. Australian and Italian consumers were also found to question the reliability of the information on websites (Cormick & Mercer 2017; Russo et al. 2020), and this view was echoed by Cui and Shoemaker (2018), who stated that information on the internet could be deemed untrustworthy.

Regarding the extent of elaboration on the aspect, as reflected by the volume of quotes, the internet was an important source of information that would be consulted in terms of GMFPs, although the trustworthiness of the source was questioned.

8.3.2 Published Scientific Journal Articles

Participants' views on the sources of GM-related information that would be consulted reflected, *"I will probably go and do some research on articles that have been published, something that has some sort of recognition",* such as *"scientific articles"* with *"scientific data"* because *"I would definitely trust something that has been scientifically done"* and if *"it's something that has not been endorsed by a different company to push a certain agenda"*. Consumers have been found to trust the information presented by researchers and academic scientists about

GMFPs and the science involved in developing such food products (Russo et al. 2020; Science for Sustainable Agriculture 2022). It was added that, although published scientific journal articles would be consulted, *"I will look at something that has good credibility"* such as *"something that has been published"*; thus, *"studies"* in *"scientific journals"* and *"high quality journals"* where *"something has been peer-reviewed"* and has been *"accredited"* would be consulted because *"the data has been proven"*; *"rather than just somebody who is writing for the sake of writing in a popular magazine"*. Therefore, *"you would want to look at more scientific studies, rather than what people say about it"*. **Published scientific journal articles** were thus a salient aspect that emerged from the data as a source that would be consulted by the participants for information about GMFPs. The educated status of the study's participants could explain why published scientific journal articles would be a source used to obtain information about GMFPs, as they could be familiar with the credibility of such sources. Contrary to the findings of this study, Latvian consumers did not consider scientific papers as a popular GM-related information source (Wunderlich & Gatto 2015).

However, due to the absence of sub-salient aspects, it is suggested that published scientific journal articles were not an important source of GM-related information that would be consulted.

8.3.3 Word-of-Mouth

From the data, *"**word-of-mouth**"* emerged as a salient aspect regarding a source of GM-related that would be considered. It was linked to sub-salient aspects such as consulting farmers, knowledgeable acquaintances and medical professionals. In terms of consulting farmers, due to *"living in a farming district"*, a few participants stated that *"I would chat to farmers"*; *"I could speak to farmers or people who are in different fields"*, and they would speak *"to farm managers and local farmers"* about GMFPs. Living in the Midlands could explain why the participants in this study knew someone who farmed with GM crops and would seek to speak to farmers if they wanted information about GMFPs. However, it has been opined that farmers lack knowledge about genetic modification (Adenle et al. 2012; Ezezika et al. 2012; Quaye et al. 2012).

In terms of consulting knowledgeable acquaintances, some of the participants would speak to *"friends who has good knowledge of genetic modification"*; or *"perhaps chat with a friend who's involved in genetics"*; and *"I'd chat to my sister who is a Food Scientist"*; or *"I'd speak to husband who is a Biology teacher"*. It was added that *"I would try speak to somebody in the food industry line"*; *"speak to someone who I know has knowledge of it"*; or *"I'd probably have*

to try and track down somebody who was involved in it". Consulting knowledgeable acquaintances about GMFPs emerged as a possible source participants would consult about GM-related information as their educated status suggests they would want to consult educated acquaintances when it came to GMFPs. It was also established that Latvian consumers spoke to knowledgeable acquaintances to gain information about GMFPs (Wunderlich & Gatto 2015). However, a study in Australia found that friends and family were the least consulted sources of GM-related information (Cormick & Mercer 2017). It has also been found that family and friends were not popular sources of information SA and Chinese consumers consulted to gain information about GMFPs; this could be explained by a study that established Italian consumers did not trust that their family and friends would provide credible information about GMFPs (Jonker 2017; Cui & Shoemaker 2018; Russo et al. 2020). Medical professionals would also be consulted by very few participants as *"I'd probably chat to the doctor"* or *"maybe I would chat to a nutritionist or dietician about it who would hopefully have more information"* about GMFPs, which could be attributed to the suggestion that the participants might have been mothers.

Considering the volume of sub-salient aspects, it is suggested that word-of-mouth – including speaking to farmers, knowledgeable acquaintances and medical professionals – was an important source that would be used for information about GMFPs.

8.3.4 University Resources

University resources were a further source participants highlighted they would consult if they wanted more information about GMFPs, and it was thus a salient aspect that emerged from the data. Participants said, *"I would try get information from universities in the area"*, and "*studies from reputable sources such as Universities"* would be consulted. It was added that *"information from Cape Town University"* would be consulted *"where they look into GM"*, which is *"actual research, it's not marketing strategies, they tell you the real stuff"*. In terms of using university sources to obtain information about GMFPs, *"I would rely on university textbooks"*; *"I could use university's library"* where *"I have access to scientific databases",* and *"research papers"*. Therefore, *"I can read up various journals",* which *"I would rather trust than some blogger"* as they are *"reliable sources"* which *"would be useful"*. The participants' educational status could have contributed to their use of university resources should they need more information about GMFPs. Results from a study in Botswana showed that consumers consulted school or college platforms to obtain information about genetic modification (Hulela et al. 2019), while another study determined that SA consumers did not frequent universities for information about GMFPs (Jonker 2017). This is still the case in this SA study, as the

participants did not seek information from universities, but would do so should they want more GM-related information.

However, based on the lack of depth of data in terms of the absence of sub-salient aspects, university sources were not a prominent aspect in the sources of GM-related information that would be consulted.

8.3.5 Agricultural Publications

Regarding the sources that would be consulted to gain additional information about GMFPs, *"**agricultural publications***" emerged as a salient aspect. This included *"farmer's sites"* and *"farmers' journals"*. However, it was added that *"I will assess it for credibility"*:

> *"so if it's written by someone whose got a Doctorate in Agronomy for example, then I would read it, even if they put out views which are contrary to mine, I would definitely consider them because I would think that that person should know"*.

The participants' educational status could explain the need for information to be accredited. According to one participant, they would consult information booklets as *"I would read the booklets of the seed producers and what they say about these plants"* and *"see what the variety of crop does"* because *"those companies that sell the seed are obviously regulated in the sense of what they are putting out in the market"*. Another participant added that agricultural magazines could be consulted as:

> *"they often have articles about GMO products because it affects our local farmers, so there is always a comparative pro's and con's in those kinds of magazines or journals"*.

Other studies found that information shared by agricultural groups was trusted by consumers, as well as environmental groups (Cormick & Mercer 2017; Kim & Choi 2018; Deng & Hu 2019). In this study, the interest in agricultural publications could be attributed to the location where the participants resided, as the study was conducted in the KwaZulu-Natal Midlands, which is in the countryside and surrounded by an agricultural community (Midlands Meander 2020).

Based on the limited quotes and lack of sub-salient aspects, it is suggested that agricultural publications were not an important aspect or source of information regarding GMFPs.

8.3.6 Consult Multiple Sources of Information

In terms of trusting information, *"in this day and age"*, *"I wouldn't just trust one source"* because *"there's so much misinformation and disinformation and plain lies all over"* and *"there's so much false information out there"*, therefore *"you don't know what's true or not"*. Thus, two questions were posed: *"can you believe everything you read?"* and *"which source is absolutely 100% trustworthy?"* In the GM context, Australian consumers were also particularly concerned about the misinformation that could be disseminated to the public (Cormick & Mercer 2017). Due to the perceived misinformation, it was stated that *"I would read multiple sources"* because *"I'm one of those people who does more than one search"*. Therefore, *"I would look at at least 3 sources and then do a background check on those sources"*. Subsequently, *"I would consult a variety of sources"* to *"check if it's true or not"*.

Consulting multiple sources of information about GMFPs emerged from the data as a salient aspect. The importance of consulting multiple sources of information about GMFPs could be ascribed to the participants' educational status, suggesting that they could understand the importance of using various sources to prove the credibility of information, such as in the case of GMFPs. In terms of using a variety of sources to gain information about GMFPs, a study conducted in Botswana similarly found that consumers consulted various media-listed sources for GM-related information (Hulela et al. 2019).

Considering the lack of elaboration and absence of sub-salient aspects that emerged, it is suggested that consulting multiple sources of information was not an influential aspect linked to sources of GM-related information that would be visited.

8.3.7 Summary of the Sources of GM-Related Information that would be Consulted

In Table 8.2, a visual illustration of the summary of the salient aspects of Themes 1 and 2 is provided to show how each one builds on the other. The most salient aspects of Theme 2, namely the internet, published scientific journal articles, word-of-mouth, university resources, agricultural publications and the use of multiple sources of information which would be consulted should the participants seek to acquire more information about GMFPs, are shown in Table 8.2.

Table 8.2: Summary of the Most Salient Aspects of Themes 1 and 2

Theme	Salient Knowledge, Sources of GM-Related Information and PI Aspects of GMFPs					
Theme 1: Lack of Knowledge about GMFPs	Ignorance of GMFPs	Lack of Information Sharing	Platforms to Disseminate Information			
Table 2: Sources of GM-Related Information that would be Consulted	Internet	Published Scientific Journal Articles	Word-of-Mouth	University Resources	Agricultural Publications	Consulting Multiple Sources

Table 8.2 illustrates that in addition to lacking knowledge of GMFPs, the data reflected that the participants did not presently consult GM-related information sources, which this study proposes played an influential role in their lack of GMFP knowledge. However, the participants would consult GM-related information sources such as the internet, published scientific journal articles, word-of-mouth, university resources, agricultural publications and use multiple sources of information to attain additional GM-related information should the need arise. In terms of consumers' knowledge of GMFPs, it has been argued that education and scientific literacy aid in increasing consumers' knowledge (Vecchione et al. 2015; Marx 2017). As a result, the sources consumers consult to gain information about GMFPs have been explored in studies in collaboration with determining their knowledge about such food products (Wunderlich & Gatto 2015; Cormick & Mercer 2017; Cui & Shoemaker 2018; Kim & Choi 2018). However, as mentioned, although sources of GM-related information emerged from the data, these sources were not currently consulted. Instead, these sources would merely be consulted when the participants wanted to seek more information about such food products, which explains why they had limited knowledge about GMFPs.

This study aimed to explore from which sources participants acquired their information about GMFPs, as it was considered an influential aspect of their state of knowledge of such food products. The current study postulates that – although various sources of GM-related information were highlighted by the participants – the self-admitted absence of acquiring information about GMFPs from these sources could unfavourably influence their state of knowledge, leading to a perceived lack of GMFP knowledge. The perceived lack of GMFP knowledge could unfavourably influence their beliefs and lead to perceived factually unfounded beliefs about GMFPs. The most salient and sub-salient aspects are summarised in Figure 8.4, which also depicts the proposed influence that the absence of these information sources could have on the participants' perceived knowledge and subsequently perceived beliefs of such food products.

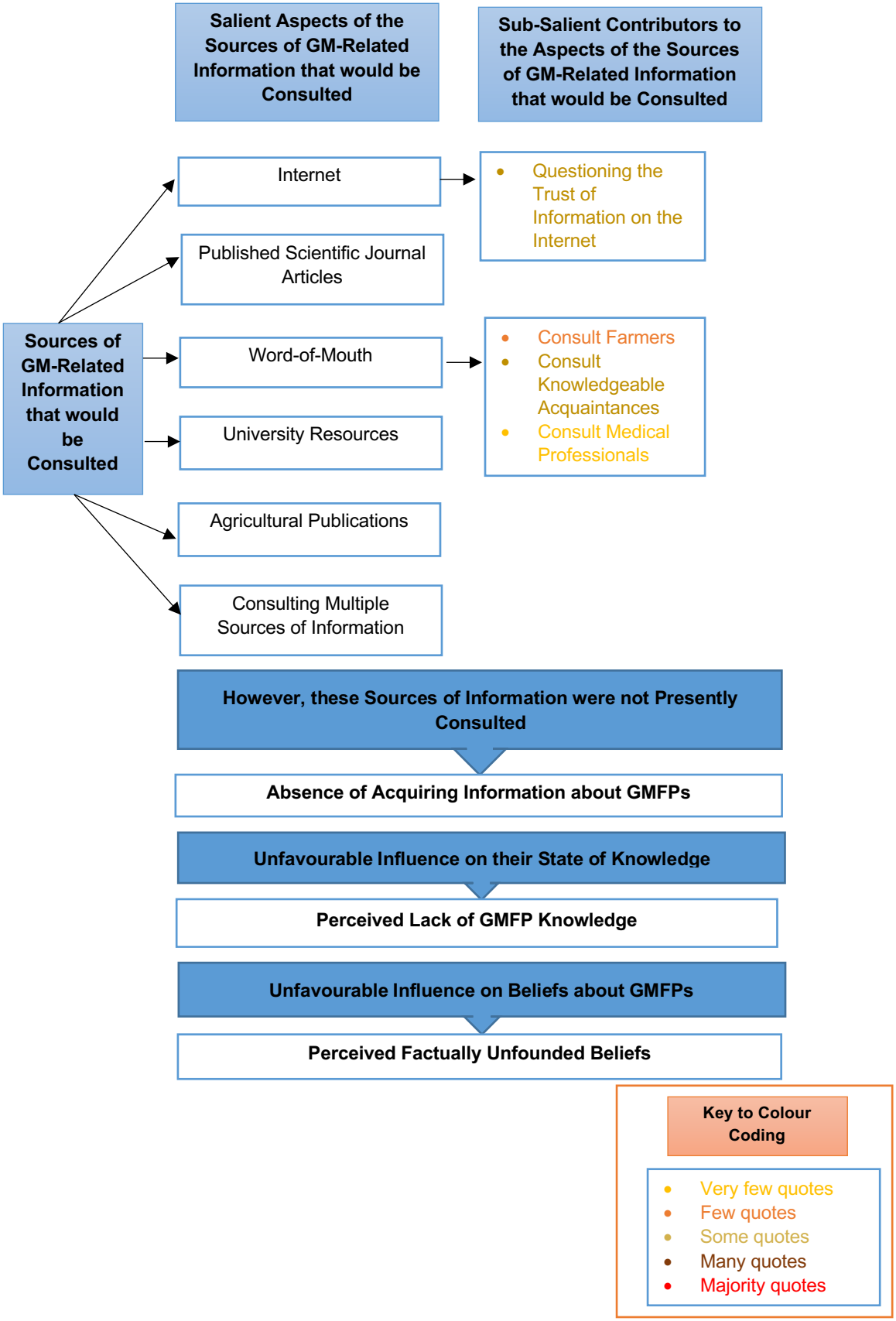

Figure 8.4: The Sources of GM-Related Information that would be Consulted, and the Proposed Influence of the Absence of the Consultation of Sources of GM-Related Information on the Perceived State of Knowledge and Perceived Beliefs about GMFPs

Figure 8.4 reflects that, although various sources of information were suggested to gain additional information about GMFPs, the participants did not consult such sources, and it is therefore proposed that the absence of seeking GM-related information could lead to a perceived lack of GMFP knowledge – as seen in Theme 1 of this chapter (lack of knowledge about GMFPs) – leading to perceived factually unfounded beliefs of such food products. This indicates that sources of information influence knowledge, and knowledge, in turn, influences the foundation from which beliefs about GMFPs are built. It is suggested that the beliefs component of the EV Model of Attitudes did not originate from a solid knowledge structure through factual, academic information, which could have led to the participants' uncertainty in terms of their beliefs, thereby resulting in their elaboration on many beliefs instead of vocalising a confident belief. This could further illustrate that their beliefs were developed from hearsay about GMFPs or from what they have constructed in their own thoughts about these products. In terms of the values and expectations components of the EV Model of Attitudes, the unknowledgeable foundation from which the beliefs component was constructed suggests why the values and particularly the expectations components were left vulnerable in their functionality, as seen through their lack of depth of data (particularly the expectations data). Participants suggested uncertainty could result in an uncertain attitude toward GMFPs.

Participants' perceived lack of knowledge and factually unfounded beliefs might be concerning to the GM food industry as it could hinder the efforts of attaining food security in SA and SDG 2 through the production of GMFPs as they are not fully equipped about GMFPs and what they can offer.

A discussion on the food products purchased regularly assumed to contain GM ingredients, which was the third theme that emerged from the data, follows.

8.4 THEME 3: FOOD PRODUCTS PURCHASED REGULARLY ASSUMED TO CONTAIN GM INGREDIENTS

Theme 1 of this chapter illustrated that the participants lacked GMFP knowledge, and Theme 2 emphasised that they did not consult GM-related information sources – which could have contributed to their lack of knowledge about GMFPs. It also emerged from the data that when their knowledge of GMFPs was explored to see what influence knowledge had on the participants' beliefs regarding GMFPs, they thought they were purchasing food products on a regular basis that were assumed to contain GM ingredients. When the participants' knowledge of GMFPs was explored, they expressed that they did not know which food products contained GM ingredients. This was illustrated by the volume of quotes that emerged in terms of the sub-

salient aspect (not being able to identify GM-containing food products) in Theme 1, Section 8.2.1. Therefore, the participants lacked confidence in their ability to identify GMFPs, and the food products that emerged in this theme were assumed by the participants to contain GM ingredients, which they perceived to be purchasing frequently in-store. It is suggested that these identified GM-containing food products could have emanated from the GM crops perceived to be cultivated in SA (as seen through the use of a bracket leading from the GM crops cultivated in SA to the remaining salient aspects in Figure 8.5). The most salient and sub-salient contributing aspects of their assumption that they were purchasing GMFPs regularly are shown in Figure 8.5.

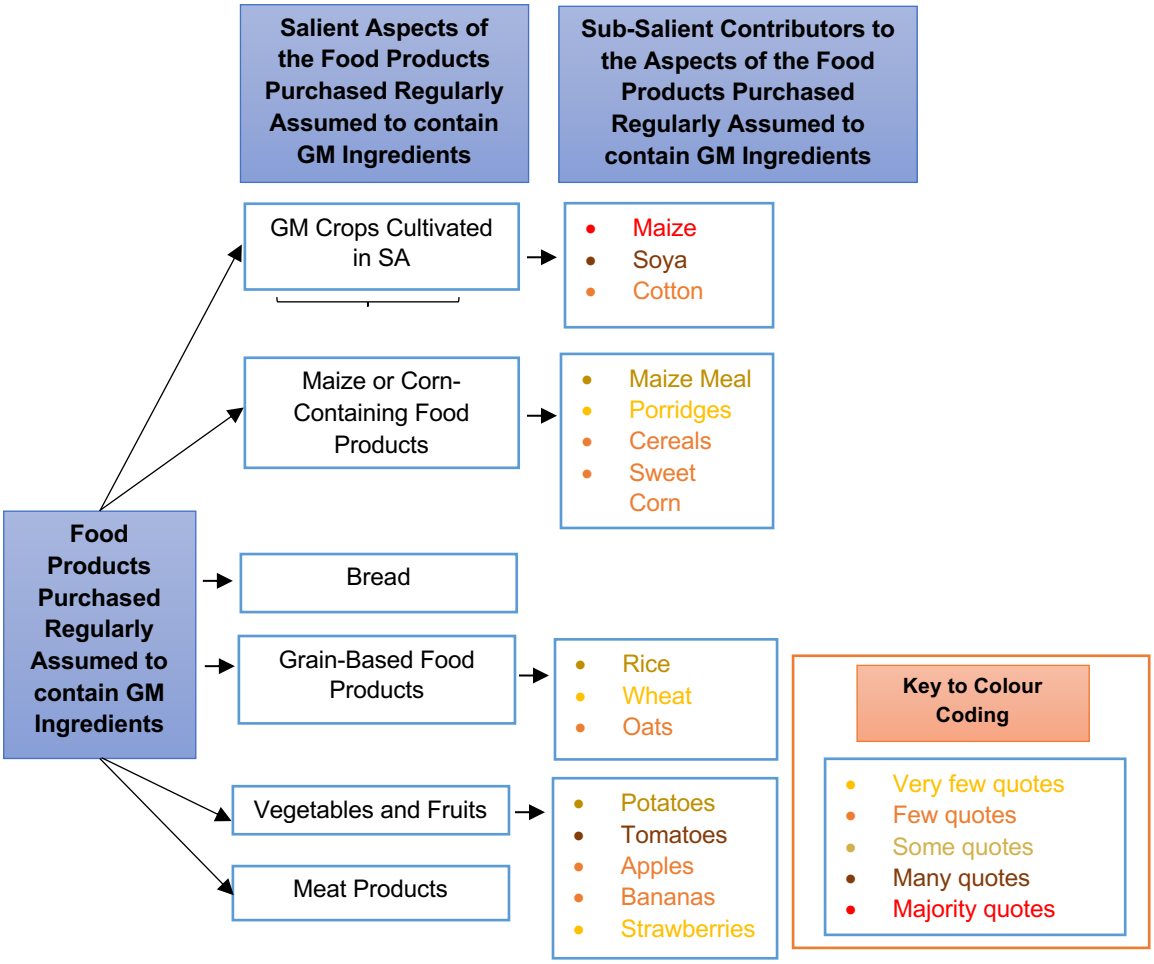

Figure 8.5: Food Products Purchased Regularly Assumed to contain GM Ingredients

As depicted in Figure 8.5, five aspects were considered as food products assumed to contain GM ingredients regularly purchased by the participants. These included maize or corn-containing food products, bread, grain-based food products, vegetables and fruits, and meat products. These aspects are presented next.

8.4.1 GM Crops Cultivated in SA

The data indicated that **GM crops** were **cultivated in SA** and were thus a salient aspect of the food products regularly purchased and assumed to contain GM ingredients. Three primary GM crops were identified by the participants, which were assumed to be cultivated in SA, namely maize, soya and cotton, and were thus sub-salient aspects. In terms of maize, the majority of participants assumed that maize, *"which is a staple food product in South Africa",* was cultivated in SA, while many participants assumed that soya was cultivated in the country, but only a few participants assumed that cotton was produced in SA. These views could have ensued from them knowing someone who farmed with GM crops.

Regarding the three crops identified and assumed to be cultivated in SA, it was stated that *"I know maize is one of the biggest ones"*; *"maize and soya"* are *"two of the main crops"* that are GM and grown in SA; and that *"cotton is highly GM in South Africa"*. Thus, *"cotton, maize and soya are the only ones that are currently in South Africa"* in terms of GM crops that are produced in the country. These three crops were correctly assumed by the participants as being GM because SA currently only grows these three commercial GM crops (Gbashi et al. 2021). In terms of the production of GM maize, soybeans and cotton, other countries such as the USA found that consumers knew that soybeans had been GM (Wunderlich & Gatto 2015), while Malaysian consumers knew that maize had been GM (Tanius & Seng 2015). Although the participants in this study identified maize, soya and cotton as the three primary GM crops grown in SA, participants shared, *"I don't actually know to what extent South Africa uses genetically modified crops"*, and *"I am not really very aware of what scale South Africa does that on in terms of their agriculture"*.

Due to the volume of quotes and prominence of the sub-salient aspects, it is suggested that the cultivation of GM crops in SA, particularly maize and soya (but also cotton), was an important and influential aspect in the food products participants purchased frequently, which were assumed to be GM.

8.4.2 Maize or Corn-Containing Food Products

The data showed that maize or *"mostly corn-based products"* were assumed to contain GM ingredients because *"in this country, probably a lot of maize products"* have been GM. Due to *"other maize products [that] incorporate GM maize"* and because *"maize is in everything", "maize can be a by-product of so many things that we have in our supermarkets"*. Thus, in terms of the GM-containing food products that were assumed to be purchased frequently,

maize or corn-containing food products emerged as a salient aspect, linked to sub-salient aspects such as maize meal, porridges and cereals. According to some participants, *"maize meal"*, for example, *"Five Star maize"* contained GM ingredients. In SA, mielie meal food products such as Premier's Impala Maize Meal, Premier's Nyala Super Maize Meal, Premier's Iwisa, Woolworths Super Maize Meal, Premier's Ace Super Maize Meal, Premier's White Star Super Maize Meal, and Premier course braai pap all contain various levels of GM ingredients (Jaffer 2014; African Centre for Biodiversity 2015a). It was also assumed by very few participants that porridges contained GM ingredients as *"I think that the instant porridges have been modified"*, and *"mealie meal porridge is probably GM"*. In SA, maize porridges such as Ace Instant porridge contain GM maize (African Centre for Biodiversity 2013).

In terms of cereals, it was assumed by a few participants that *"mostly your cereals"* contain GM ingredients and that *"a lot of breakfast cereals have got tons of GM maize in"*. Therefore, *"I am sure a lot of the cereals are GM"*, such as *"Weetbix"*; *"cornflakes"*; "*Allbran Flakes"*; and *"Rice Krispies"*. It has been confirmed that breakfast cereals could contain GM ingredients such as GM maize or soya (African Centre for Biodiversity 2015a). In support, according to the FDA (2022), GM ingredients are used in cereals in the USA. In the SA context, breakfast cereals like Wheat Free Pronutro, Cerelac Honey Infant cereal, Jungle B'fast energy cereal, Jungle Ultra Energy cereal, Nestle Cheerios, and Pioneer's Bokomo Oatees contain GM maize or corn, whereas Pioneer's Pronutro Toddlers Apple and Banana contain GM maize and soya (African Centre for Biodiversity 2015a). Rice Krispies also contain GM ingredients (EWG 2022), as illustrated in Figure 8.6.

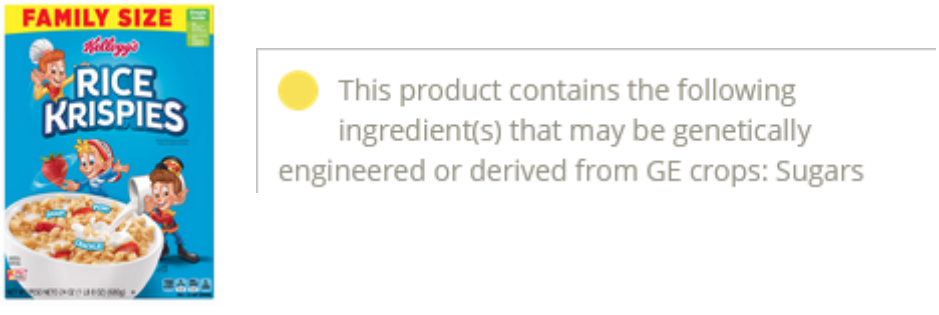

Figure 8.6: Label Indicating the Presence of GM Ingredients in Rice Krispies (EWG 2022)

In addition to Rice Krispies, Bokomo Corn Flakes also contain GM maize (Bokomo 2022), as indicated on the ingredients list as seen in Figure 8.7.

Ingredients:

Maize [genetically modified] (92%), sugar, barley malt extract (gluten), salt,emulsifier, vitamins (A, B1, B2, B3, B5, B6, B7, B9 & B12) and minerals (electrolytic iron, zinc oxide and sodium selenite).

Figure 8.7: Ingredients List indicating the Presence of GM Maize in Bokomo Corn Flakes (Bokomo 2022)

Kellogg's Corn Flakes is another cereal sold in SA supermarkets that contains GM corn (Kellogg's 2022), as seen in the ingredients list in Figure 8.8.

Ingredients

Corn*(89.4%), sugar, barley malt extract (gluten), salt, anti-oxidant (mixed tocopherols), vitamins (vitamin A, B1, B2, niacin, B6, folic acid, B12, pantothenic acid, D) minerals (iron and zinc oxide). *Contains Genetically Modified Ingredients

Figure 8.8: Ingredient List Indicating the Presence of GM Corn in Kellogg's Corn Flakes (Kellogg's 2022)

Various breakfast cereals are available in SA supermarkets (African Centre for Biodiversity 2015a; Bokomo 2022; EWG 2022; Kellogg's 2022). Therefore, maize-containing food products such as maize meal, porridges and cereals were correctly assumed and identified as GM-containing food products that were regularly purchased by the participants.

Furthermore, a few participants assumed that *"sweetcorn"* was a GMFP purchased frequently and thus a sub-salient aspect that emerged from the data. However, GM sweet corn is only available on the market in Canada and the USA (CBAN 2023). Although the participants assumed that food products containing corn were GM – which could be the case as GM maize/corn is cultivated in SA (Gbashi et al. 2021) – sweet corn was incorrectly identified and assumed as a GM-containing food product.

Based on the volume of sub-salient aspects, it is suggested that maize or corn-containing food products – including maize meal, porridges, cereals and sweetcorn – were assumed to be an important aspect in terms of GM-containing food products that were purchased regularly by the participants.

8.4.3 Bread

"**Bread**" emerged from the data as a salient aspect of food products assumed to contain GM components that were frequently purchased. A participant indicated, *"I presume that Albany white bread is made with flour that's probably from a GM source"* and:

> *"I am sure that most of the breads for example that we buy in the supermarket would incorporate some sort of GM maize meal"*.

Various breads sold in SA contain varying levels of GM soya flour (not maize as identified by the participants in this study), namely Checkers white bread, Woolworths white bread, Spar white bread, Blue Ribbon white bread, Pick 'n Pay white bread, Albany superior white bread, and Sunbake white bread; however, only Woolworths white bread indicated the presence of GM ingredients on their label (Gosling 2014; Faithful to Nature 2022). Consumers in Athens also thought that bread contained GM ingredients (Arvanitoyannis & Krystallis 2005). Evidently, it was correctly assumed that bread sold in SA supermarkets contained GM components, although it was incorrectly assumed that bread contained GM maize. Nevertheless, bread lacked prominence as a GM-containing food product that was purchased frequently, as evident through the limited quotes.

8.4.4 Grain-Based Food Products

Grains were also assumed to be GM because *"I think most of our grains have been modified"*; therefore, *"I categorise a lot of grains as GM"* as well as *"grain-based products"*. According to some participants, *"starches like your rice"* has been GM; thus, *"any form of rice that you are eating has been genetically modified"*. According to CBAN (2022a), there is currently no GM rice available on the international markets; however, GM rice, known as Golden Rice©, has been approved for commercial production in the Philippines, which is hoped to reach the Philippine market by 2024 (Muzhinji & Ntuli 2021; Gonzales 2022). Very few participants also assumed that grains such as *"wheat"* have been *"genetically modified in this country"* because *"I've heard of seeds that have been genetically modified like wheat"*. Although Argentina, Brazil and Paraguay have approved the cultivation of HB4® wheat – which has been approved to be used in food products such as flour, bread, pasta and biscuits in Australia – GM wheat is not grown in SA (Reuters 2020; Jones 2022; AgNews 2023b; Bioceres Crop Solutions 2023; Nhlaysia Power Supply 2023). Respective individual participants also stated that *"I associate it mostly with things like grains"*, such as *"sorghums"* as well as *"barley"*. However, sorghum and barley have not been GM either and remain in their natural state (Bean 2019; Chandra

2019). A few participants further assumed that *"oats"* were GM; however, no GMO oats are available on the market (Badore 2018). Moreover, although *"popcorn seeds"* were assumed to be GM, according to Dessinger (2013), there are no GMO popcorn varieties available on the market.

Grain-based food products emerged as a salient aspect from the data, attributed to sub-salient aspects such as rice, wheat, and oats, yet these food products were incorrectly identified as GMFPs participants were purchasing on a regular basis, possibly pointing to their ignorance of such food products. Considering the volume of sub-salient aspects, it is suggested that grains had prominence in terms of the food products that contained GM ingredients that were purchased regularly.

8.4.5 Vegetables and Fruits

In this study, participants assumed that *"many, many fruit and vegetables are definitely GM"* and are being purchased regularly in supermarkets, but *"possibly more fruit than vegetables"* because they are *"insect resistant or weather enhanced and survival ability"*. Therefore, **vegetables and fruit** emerged as a salient aspect of the data in terms of GMFPs that were assumed to be purchased frequently. Similar findings were found in another SA study where consumers thought that vegetables and fruits had been GM and were available in SA (Jonker 2017), which studies in Australia and Pakistan also reported (Cormick & Mercer 2017; Amin et al. 2021). However, in the SA context, no GM vegetables or fruits are available for purchase and consumption purposes (African Centre for Biodiversity 2015b; Woolworths 2020).

8.4.5.1 GM Vegetables

In the current study, the data indicated that some of the participants said, *"I think genetic modification happens a lot to potatoes",* especially the potatoes from Woolworths because:

> *"if you go to Woolworths Food, the potatoes are in an immaculate condition, like somehow they have never been scratched in their life"*.

Therefore, potatoes emerged as a sub-salient aspect of GM vegetables that were assumed to be purchased. Consumers in Athens were also found to associate potatoes with genetic modification (Arvanitoyannis & Krystallis 2005). Although GM potatoes are grown for consumption purposes in the USA, such as the White Russet potato, no GM vegetables are available on the SA market (Goldberg 2018; Woolworths 2020; FDA 2022). Another participant

assumed that the *"sweet potato, the orange one"* was genetically modified. Although sweet potatoes are viewed as being 'naturally genetically modified' since they contain *Agrobacterium* DNA, which is seen as being 'foreign DNA', the orange-fleshed sweet potato was bio-fortified and produced through the use of cross-breeding (Adenle et al. 2012; Kyndt et al. 2015), and thus not GM. It was assumed by another participant that *"the little peppers"* such as *"green peppers*", *"red peppers",* and *"orange peppers"* – *"the ones that are so bright"* are GM because *"they are different, smaller and in different colours"*. Other vegetables were further assumed to be GM by respective individual participants, such as *"peas"*; *"onions"*; *"a lot of beans"*; *"broccoli"*; and *"carrots [because they] have been changed and modified for a long time"*. In terms of beans and peas, soybeans are the only bean variety that has been GM and produced in the USA (Miller 2021). In this study, it was further assumed that *"a little baby spinach have probably been genetically modified"*; that *"I think of our salad stuff that we buy, I would assume that most of it is genetically modified"* such as *"lettuce and cucumber"*; as well as *"all your courgettes"*. In the USA, GM vegetables such as summer squash are available in supermarkets, as well as sugar beets (FDA 2022).

8.4.5.2 GM Fruits

In terms of GM fruit, many participants assumed that *"many tomatoes"* have been GM *"to look better and taste more watery"*, and that *"long life tomatoes"* are GM because *"your old-fashioned tomatoes have got 2 or 3 day shelf life, and your modern tomato have got about a 2 week shelf life"*. Thus, tomatoes emerged as a sub-salient aspect of GM fruits. Athenian consumers were also of the opinion that tomatoes had been GM (Arvanitoyannis & Krystallis 2005). However, in SA, tomatoes have not been GM (Kedisso et al. 2022). Although tomatoes were the first GM crop to be approved by the FDA (Islam et al. 2020), tomatoes are not among the GM crop list given by the FDA (2022). However, in Japan, a gene-edited tomato fruit is available for purchase and consumption, whereas seeds of the GM purple tomato are expected to be available for purchase in the USA in 2023 (John Innes Centre 2022; Nagamine & Ezura 2022).

Regarding other GM fruits, a few participants assumed that *"apples"* were GM. In particular, one participant assumed that pink apples were GM as:

> *"they did cross-pollination for those pink apples a while ago that were very popular for a while. And I guess that's kind of genetic modification"*.

Although slices of the GM Arctic® Apple are available in USA and Canadian supermarkets, GM apples are not available on the SA market (Maxmen 2017; Richael 2020; Woolworths 2020). A few participants also assumed that *"bananas"* are GM because they *"aren't supposed to look the way they look"*, and that *"there's no doubt"* that *"bananas"* have been GM because they *"survive out of the fridge for four to five days"*, and *"because you know that fruit is going to last"*. Although not currently available in international markets, GM bananas are in the approval process for human consumption in Australia (Lu 2023). Very few participants assumed that *"strawberries"*, and particularly *"strawberries at Woolworths"* were GM. Although no GM fruits are being commercially produced in SA, gene-edited strawberries with improved taste, longer-lasting shelf life and a longer growing season are anticipated to enter the US market in the next few years (African Centre for Biodiversity 2015b; Woolworths 2020; Ridler 2021). Evidently, apples, bananas and strawberries emerged as additional sub-salient aspects of GM fruits that were assumed to be purchased frequently.

Furthermore, according to one participant, *"the things that are produced in mass",* such as *"peaches"* and *"pineapples"* were assumed to be GM. In terms of pineapples, the PinkGlow™ pineapple – of which the DNA has been altered – is available for consumers to purchase in the USA and Canada (PinkGlow Pineapple 2020; CropLife International 2021). In addition, *"seedless grapes"* have been assumed to be *"genetically modified to not produce seeds"*, while it was also assumed by the participant that *"watermelon is genetically modified so it doesn't have pips"*. However, another participant stated that:

> *"There are certain foods that people probably automatically think are genetically modified when they are actually not. For instance, seedless grapes, seedless watermelons are actually not modified, they are from plants where it's actually naturally occurred, and then those plants have been selected for. So, people can also quickly draw the conclusion that certain things just seem to be modified, and so they think they eating something that is, but it's not always the case"*.

Kiwifruit was also assumed to be a GM fruit because:

> *"if you look at our kiwifruit, how specialised each kiwifruit is and how they are pollinated in a special way, like in a controlled way in the tunnels they grow in"*.

It was further assumed that *"avocados"* are GM because *"they ripen at the right time"*. Although it was not mentioned in this study, GM papaya is cultivated in the USA for consumption purposes and is also sold in Hawaii (Sekeli et al. 2018; FDA 2022).

The data thus showed that the participants assumed various vegetables and fruits had been GM – specifically potatoes, tomatoes, apples, bananas and strawberries – which they purchased in the supermarkets. However, considering that none of the vegetables and fruits produced in SA are GM (African Centre for Biodiversity 2015b; Woolworths 2020), the participants' assumption was incorrect, signifying their lack of knowledge of such food products. It is, however, suggested that their belief that GMFPs have improved aesthetic and food processing properties – as discussed in Chapter 5, Sections 5.6.4 and 5.6.5 – could have led them to assume that vegetables and fruits that look appealing, have different colours, are different in size, last longer and taste better have been GM with such qualities. It further indicates that the participants linked fresh produce with GM-containing food products.

Considering the extent of elaboration (evident through the volume of sub-salient aspects), GM vegetables and fruits – such as potatoes, tomatoes, apples, bananas and strawberries – were deemed important aspects of GMFPs regularly purchased by the participants. The volume of quotes relating to the sub-salient aspect, namely tomatoes, suggests that tomatoes were of particular importance regarding GM fruits and thus GMFPs, which were purchased regularly.

8.4.6 Meat Products

"**Meat**" **products** emerged as a salient aspect in terms of GM-containing food products that were purchased regularly. Participants assumed that *"all the meat products"* are GM because *"animals" "have been fed with genetically modified ingredients"* such as *"corn and maize"*. In terms of animal feed, GM corn, canola and soybeans are used in animal feeds, as well as GM alfalfa, which is used primarily in cattle feed. However, the GM ingredients consumed are broken down and converted into fats and proteins, thereby eliminating genetic substances, and thus – in addition to meat products – dairy products are also non-GMO (Kalds et al. 2019; FDA 2022; Hallerman et al. 2022; Idaho Milk Products 2023). It was further assumed that *"any of our meat"* has been GM because *"they've been given growth hormones to be bigger and fatter"*, but *"I don't know if that counts as GM"*. However, growth hormones refer to biological stimulants that are either synthetically made or occur naturally in animals; thus, growth hormones are used to promote the growth of animals (Dibbisa & Duguma 2021). In terms of GM animals, it was assumed that *"chickens"* and *"cattle" "have been modified to have larger bodies and shorter legs and smaller heads"*. Thus, *"the meat we eat"* is GM. Results from a study conducted in SA also showed that consumers thought chickens in SA were GM and eggs were consequently also GM (Jonker 2017). Consumers in Athens also thought that meat products sold in the country were GM (Arvanitoyannis & Krystallis 2005). However, the only GM animal sold on the market for human consumption purposes is the AquAdvantage

Salmon© which is only available in the USA, Canada, Argentina, Brazil and India; whereas gene-edited pork sausages are available in the USA and gene-edited fish such as the "Madai" Red Sea Bream and Tiger puffer fish are available on the market in Japan (Loew 2022; Waiblinger et al. 2023; Zaske 2023).

Therefore, the data indicated that meat products were assumed to be GM and purchased regularly. However, the assumption that animals such as chickens and cows have been GM and that GM meat is being purchased in supermarkets highlights the lack of knowledge participants had in terms of GMFPs, since the meat of such animals is not available on the market and is only GM for research purposes (Kalds et al. 2019; Hallerman et al. 2022). Nevertheless, based on the absence of sub-salient aspects, meat products were an aspect that lacked depth and were thus suggested not to be influential in the food products purchased regularly assumed to contain GM components.

8.4.7 Summary of the Food Products Purchased Regularly Assumed to Contain GM Ingredients

The most salient aspects of Themes 1 and 2 and Theme 3, which are the food products assumed to contain GM ingredients and purchased regularly, are shown in Table 8.3.

Table 8.3: Summary of the Most Salient Aspects of Themes 1 to 3

Theme	Salient Knowledge, Sources of GM-Related Information and PI Aspects of GMFPs					
Theme 1: Lack of Knowledge about GMFPs	Ignorance of GMFPs	Lack of Information Sharing	Platforms to Disseminate Information			
Table 2: Sources of GM-Related Information that would be Consulted	Internet	Published Scientific Journal Articles	Word-of-Mouth	University Resources	Agricultural Publications	Consulting Multiple Sources
Theme 3: Food Products Purchased Regularly Assumed to contain GM Ingredients	GM Crops Cultivated in SA	Maize or Corn-Containing Food Products	Bread	Grain-Based Food Products	Vegetables & Fruits	Meat Products

As seen in Table 8.3, the participants showed a lack of GMFP knowledge and did not seek information about GMFPs, but did convey which sources they would consult to acquire GM-related information. To add to the salient aspects of Themes 1 and 2, it was further illustrated

that the participants assumed various GMFPs were purchased on a regular basis. In this study, it is suggested that the identification of GM crops cultivated in SA, such as maize, soya and cotton, influenced participants' assumptions about GM-containing food products they purchased regularly. Such food products included maize or corn-containing food products, bread, grain-based food products, vegetables and fruits, and meat products.

Components of various food products have been GM and are predominantly available in American supermarkets, such as corn or maize, soybean, cotton, potato, papaya, summer squash, canola, apple, and sugar beet, while other GMFPs such as the pink-fleshed pineapple are also available for human purchase and consumption purposes (Thomas et al. 2020; FDA 2022). Due to many food products being made from GM maize, soybean, cotton, sugar beets and canola, a variety of food products contain GM ingredients and are available in international supermarkets for consumers to purchase (Thomas et al. 2020). In SA, food products could contain GM ingredients due to the presence of GM maize, soya and cotton, the three primary GM crops grown in the country; however, there are no GM vegetables or fruits available on the SA market (African Centre for Biodiversity 2015b; Woolworths 2020; Gbashi et al. 2021). Although there are a variety of GMFPs available on the international market, many food products remain in their natural state such as popcorn, oats, sorghum, barley, rice – with the exception of Golden Rice© in the Philippines – meat products (except the GM Atlantic Salmon), and dairy products (Dessinger 2013; Badore 2018; Bean 2019; Chandra 2019; Kalds et al. 2019; Muzhinji & Ntuli 2021; CBAN 2022a; Idaho Milk Products 2023).

In this study, this theme showed that the participants assumed certain food products they were purchasing regularly contained GM ingredients, which points to their lack of confidence in terms of identifying GMFPs. As seen in Section 8.2.1, where the participants' ignorance of GMFPs was discussed, the participants admitted that they did not know and were unable to identify which food products contained GM ingredients, which further became evident in this theme where participants identified the GMFPs they assumed to be purchased frequently. Studies in the USA, SA and Nigeria also found that consumers were unsure which food products contained GM ingredients (Wunderlich & Gatto 2015; Marx 2017; Dirisu et al. 2020). In this study, it is suggested that the assumption of which GMFPs were purchased frequently – stemming from participants' inability to confidently identify GMFPs – indicates that the participants had a perceived lack of GMFP knowledge. This study proposes this lack of knowledge could unfavourably influence beliefs about such food products, and lead to perceived factually unfounded beliefs. The most salient and sub-salient aspects of the food products assumed to contain GM ingredients and purchased regularly are illustrated in Figure

8.9, as well as participants' perceived state of knowledge and the proposed influence of knowledge on the participants' perceived beliefs about GMFPs.

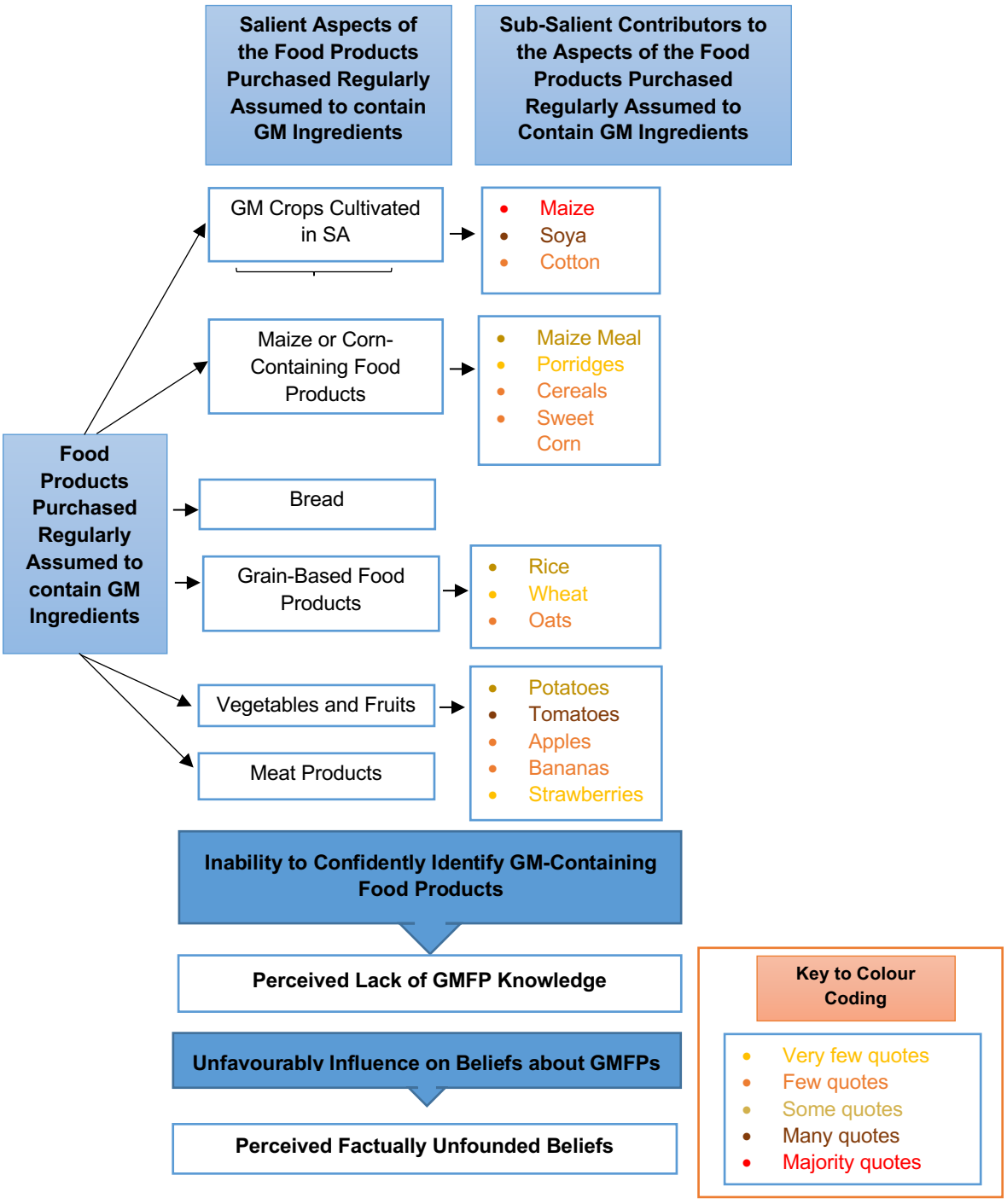

Figure 8.9: Food Products Purchased Regularly Assumed to Contain GM Ingredients, the Perceived State of Knowledge and the Proposed Influence of Knowledge on the Beliefs about GMFPs

In Theme 3, as illustrated in Figure 8.9, assumptions about food products containing GM components (due to a lack of confidence) led to many aspects/food products being incorrectly

identified as GMFPs. This suggests that the participants lacked GMFP knowledge, leading to perceived factually unfounded beliefs about GMFPs, hampering the attainment of food security and SDG 2: Zero Hunger. Drawing from the data in Theme 2 (sources of GM-related information that would be consulted) of the current chapter, the assumption about GM-containing food products could be fuelled by the participants' not consulting sources to gain more insight and understanding into GMFPs. These sources could have increased their confidence in terms of identifying GMFPs. Drawing an analogy to the components of the EV Model of Attitudes, assumptions about GM-containing food products further show the uncertainty from which the participants' beliefs were constructed around GMFPs, contributing to the lack of depth of data in the values and, specifically, the expectations data. The assumption of which food products contain GM ingredients could also be indicative of the participants not having experience with these food products. Furthermore, based on the variety of data obtained in terms of the assumption of which food products contained GM ingredients, it is proposed that this theme played an influential role in showcasing the participants' lack of GMFP knowledge.

A discussion of the possible influence that the identification of numerous GMFPs – which were assumed to be purchased regularly – could have on the participants' PBC and PI is presented in the following theme in Section 8.5.1, as it also relates to the data that emerged in the first salient aspect of Theme 4 (predominance of GMFPs). The fourth theme is discussed next, namely interactions with GMFPs on the market.

8.5 THEME 4: INTERACTIONS WITH GMFPS ON THE MARKET

PBC refers to the degree to which a behaviour can be engaged in and consumers' control over the behaviour; it is thus indicative of the level of difficulty or ease associated with performing a behaviour (Ajzen 1985; Boguszewicz-Kreft et al. 2020). The PBC, within the TPB framework, was explored to see the extent of control the participants perceived to have over purchasing GMFPs. Their PBC was explored based on the participants' control beliefs – as the study aimed to explore the influence of control beliefs on PBC – meaning the presence or absence of certain aspects or resources that could promote or hinder a behaviour (Al-Swidi et al. 2014; Farah 2017). Various studies have used the PBC construct of the TPB to explore its influence on consumers' PI of GMFPs (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Ghoochani et al. 2017; Khouloud & Sameh 2018; Zhang et al. 2018; Saha et al. 2021). The study further aimed to explore PBC to describe its role in participants' PI toward GMFPs. The aim of the study was also to explore the influence that knowledge had on consumers' beliefs about GMFPs, which was explored by gaining more

insight into the participants' state of knowledge of such food products. Therefore, the data that emerged in this theme relates to an exploration into the participants' PBC and knowledge of GMFPs – as some of the same questions were used to explore PBC and knowledge – and has thus been presented together.

In addition to the food products purchased regularly that were assumed to contain GM ingredients, as seen in Theme 3 of this chapter, interactions with GMFPs on the market emerged as a theme from the data. The most salient and sub-salient contributing aspects are shown in Figure 8.10.

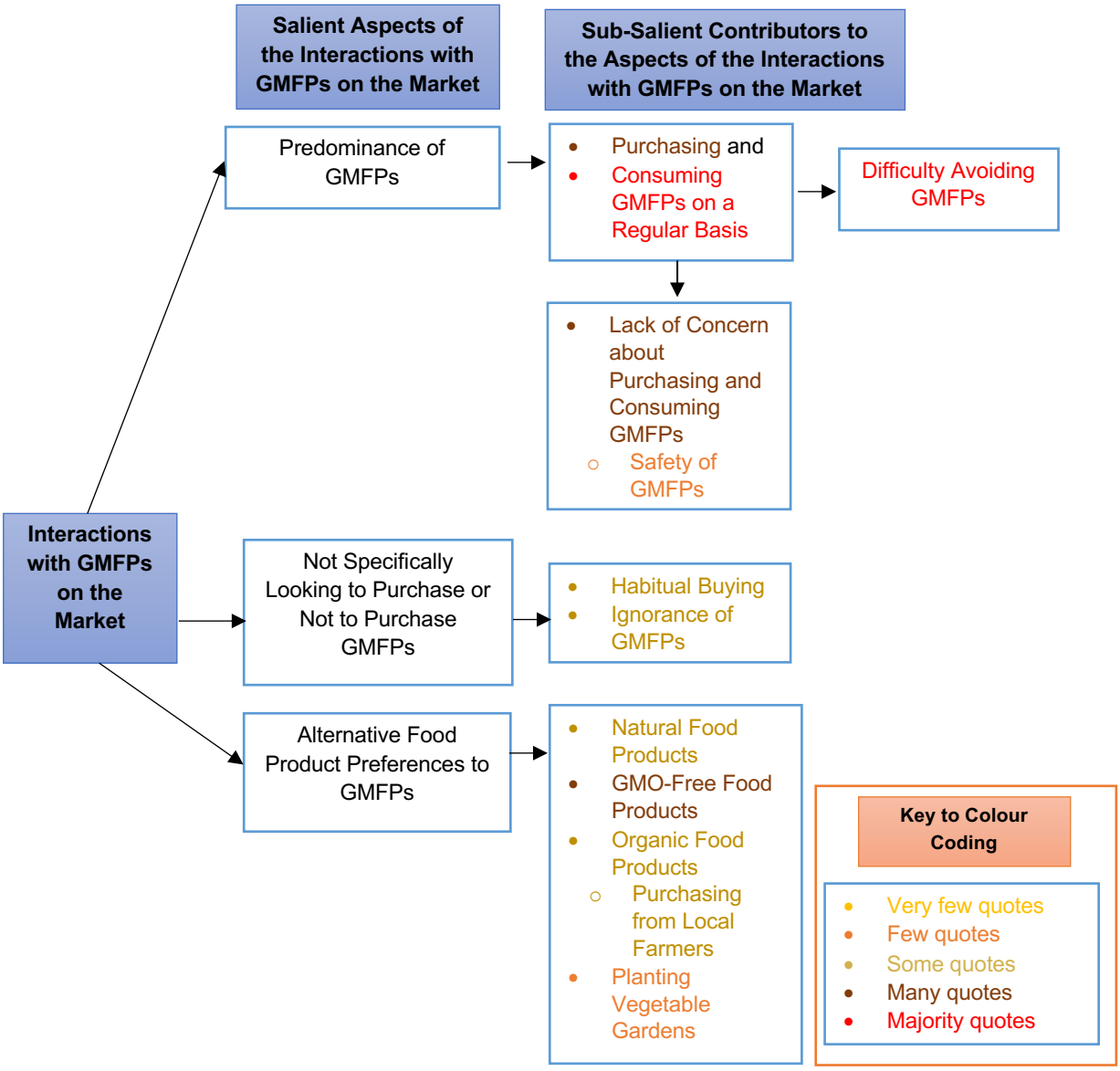

Figure 8.10: Interactions with GMFPs on the Market

From the data analysis, three salient aspects were identified in terms of interactions with food products on the market, namely the predominance of GMFPs; not specifically looking to purchase or not purchase GMFPs; and alternative food product preferences to GMFPs, as seen in Figure 8.10. A discussion of these aspects follows.

8.5.1 Predominance of GMFPs

From the previous theme it could be seen that the participants assumed numerous food products contained GM ingredients that they were purchasing frequently. Therefore, in terms of the GMFPs in supermarkets, this study suggests that the data that emerged from Theme 3 in this chapter led to the assumption that *"I feel like most things are genetically modified that we buy in the local supermarkets"*; that *"there's probably more food on the shelves that is genetically modified than isn't"*; and *"I know it's probably predominantly what we get from shops"* because *"the product is so prevalent in South Africa"*. As a result, in terms of GMFPs, *"they are sort of the default thing on the shelf"* and *"is obviously becoming fairly mainstream these days"* and is therefore *"so engrained in our food production"*. Subsequently, it was stated that *"the big farmers"* supply *"GM products to Pick n Pays, Spars and the big stores"*; therefore, assuming that the food products sold in supermarkets such as *"Pick 'n Pay"* and *"Spar*" contain GM ingredients. As a result, it was assumed that *"our supermarkets probably have them readily available"* for consumers to purchase. The **predominance of GMFPs** emerged as an important salient aspect in terms of interactions with such food products on the market. It was added that, in turn, *"this makes me feel that I am not control"*, that *"I don't have control over what I buy"*, and that *"there is no control for the consumer"*.

This study suggests that – in terms of PBC – the participants had the control belief that, due to the prevalence of GMFPs in SA supermarkets, limited conventional food products were available to purchase. Thus, their control when purchasing food products that contained GM ingredients was compromised. This was evident in the previous theme, where it was assumed certain food products contained GM ingredients, which led to the identification of food products that were purchased regularly, which did not contain GM ingredients. In terms of knowledge, it is thus suggested that the participants' lack of GMFP knowledge, which contributed to their assumptions about food products containing GM ingredients, further led to the assumption that food products in SA supermarkets are predominantly GM. Assuming that almost every food product sold on the SA market contains GM ingredients reflects the participants' ignorance of GMFPs. However, although the participants were adamant that almost all food products available contain GM ingredients, they lacked the confidence to identify which GMFPs they purchased regularly in Theme 3 of this chapter. This shows their hesitancy and

lack of confidence in taking a firm stand when it comes to GMFPs, which could emanate from their lack of knowledge.

In the SA context, only GM maize, cotton and soya crops are produced, and although GM maize can feature in many maize-containing food products in SA, products that are not derived from maize, cotton or soya, as well as vegetables and fruit, do not contain GM ingredients (Jaffer 2014; African Centre for Biodiversity 2015b; Thomas et al. 2020; Woolworths 2020; Gbashi et al. 2021). In terms of meat, no GM meat products are available for consumption purposes in supermarkets, with the exception of the AquAdvantage Salmon©, which is only available in the USA, Canada, Argentina, Brazil and India (Kalds et al. 2019; Weir & Sproul 2019; Hallerman et al. 2022; Waiblinger et al. 2023). In terms of animal-derived food products, dairy products are also non-GMO (Idaho Milk Products 2023). Furthermore, as mentioned in Section 8.4 of this chapter, there are foods that remain in their natural form, which include, but are not limited to, oats, sorghum, barley and rice (Badore 2018; Chandra 2019; CBAN 2022a). Therefore, this study suggests that, although there are various GM maize-containing food products on the SA market and GM soybean can feature in many food products (GMOs in South Africa Series 2012; Jaffer 2014), it cannot be assumed that, currently, almost every food product available specifically on the SA market contains GM ingredients.

In terms of the availability of GMFPs on the market, findings from two respective studies conducted in SA found that consumers were of the opinion that GMFPs were available to purchase in SA supermarkets but did not know which food products had been GM (Jonker 2017; Van Zuydam 2020). Another two studies conducted in SA found that consumers were unsure if GMFPs were sold on the market, while consumers in the USA and Nigeria were also unaware of which food products available on the market contained GM components (Pouris 2003; Peter & Karodia 2014; Wunderlich & Gatto 2015; Dirisu et al. 2020). A study in Canada found that consumers could not confidently indicate the degree to which GMFPs were available in their supermarkets (Charlebois et al. 2019). These studies show that, generally, consumers are unfamiliar with the GMFPs available on the market (Glasgow 2015). This was evident in this SA study, where the participants could not confidently identify which food products contained GM ingredients, as discussed in Theme 3 of this chapter.

The assumption that the food products available to consumers in supermarkets are predominantly GM led to many participants assuming that *"I know for a fact that I'm purchasing GMFPs"*; *"probably a lot of what I buy at the grocery store is genetically modified"*; and that *"I think half of the people don't even realise that they are already purchasing and enjoying GM foods"* as *"you would have to look very hard for something that isn't genetically modified"*

because *"I think it would very hard for you to walk in the shop and buy a foodstuff that hasn't been genetically modified"*. Purchasing GMFPs on a regular basis thus emerged as a sub-salient aspect to the salient aspect, reaffirming an array of food products assumed to contain GM ingredients and purchased frequently by the participants (see Theme 3 in Section 8.4). In terms of purchasing GMFPs, it has been opined that consumers are unconsciously purchasing GMFPs, and they are unaware of the use of science in the production of food products (Uddin et al. 2018; Science for Sustainable Agriculture 2022). Results from various studies showed that Chinese, Canadian and Peruvian consumers were unknowingly purchasing GMFPs, which could have been attributed to their ignorance and unfamiliarity with such food products (Kim & Choi 2018; Charlebois et al. 2019; Delgado-Zegarra et al. 2022). However, consumers in Botswana were aware that they could, in fact, be purchasing GMFPs (Hulela et al. 2019). Nevertheless, these studies show that, generally, consumers are unaware that they could be purchasing GMFPs.

In addition to the frequency with which GMFPs were assumed to be purchased, it further emerged from the data that *"I think it's 99% of what we eat"*, and as a result *"I'm sure I have consumed GM food without knowing it, I'm sure that it's possible"*. Subsequently, *"I think that probably most of what we eat is genetically modified"* because *"they basically in everything we eat"*; and therefore *"I think everything on our plate today is modified in some way"*. As a result, *"the chances of me eating them is very high"*; and *"we are eating these things even when we don't know it"*. The majority of the participants thus assumed that they were consuming GMFPs on a regular basis, and this sub-salient aspect emerged from the data, confirming the salient aspect. It has been suggested that SA consumers could be consuming GMFPs daily – specifically referring to GM-maize-containing food products – but may not know it (Ndlovu 2016; Marx 2017). Other authors agree that food products containing GM ingredients are being consumed daily across the globe (Kim & Choi 2018; Hwang & Nam 2021). This was seen in a study conducted in Athens, where it was found that consumers believed they were frequently consuming GMFPs (Arvanitoyannis & Krystallis 2005). Echoed by Jonker (2017), it was established that SA consumers were of the opinion that they had consumed GMFPs, which the findings of this study suggest is still the case. However, a study in Pakistan found that consumers were unsure if they were consuming GMFPs on a daily basis (Amin et al. 2021).

The assumption that GMFPs are purchased and consumed regularly led to the majority of participants stating that *"I don't think any of us can really escape it"* and *"it's very hard to go without them"* because *"they are all over the place"*, and because *"GM food or GM technology has been on the market and has been going for many years"*. Therefore, *"to sit back and say*

we are not eating genetically modified food is naïve" because *"I think everything has been genetically modified in some way"* and thus *"it's very easy to purchase GM"*. In terms of PBC, this could further illustrate the participants' compromised control when purchasing food products containing GM ingredients because, in their opinion, it is difficult to avoid GMFPs and thus easy to purchase these food products. Therefore, difficulty avoiding GMFPs emerged as a sub-salient aspect. In the SA context, it has been highlighted that many rural consumers rely on maize porridge as a staple food, and they consequently consume GM ingredients daily, as a variety of maize meals contain GM ingredients (Vermeulen et al. 2005; Jaffer 2014). A specific demographic in SA could thus be consuming GM maize-containing food products daily.

The data showed that the participants assumed food products available in supermarkets are mostly GMFPs, which – based on the volume of quotes relating to the predominance of GMFPs on the market – is suggested to play an influential role in relation to their PBC and knowledge. This assumption contributes to them purchasing and consuming such food products on a regular basis because they are difficult to avoid. Based on the extent of elaboration, as evidenced by the volume of quotes indicating the prominence of these three sub-salient aspects, these were influential aspects in the participants' PBC and knowledge. Evidently, it is suggested that, in terms of PBC, the participants' control over purchasing or not purchasing GMFPs was compromised by their assumption that food products available in the supermarkets were predominantly GM and that they were already purchasing and consuming GMFPs on a regular basis.

This study further suggests that the participants had the control belief that the predominance of GMFPs on the market encourages the purchasing of GMFPs, thereby making it easy to purchase such products and difficult to avoid. This could suggest that the participants believed they were not given the resources or opportunity to purchase alternative or conventional food products since they assumed the majority of food products contained GM ingredients. Thus, drawing from Theme 3 in this chapter (food products purchased regularly assumed to contain GM ingredients), it is also suggested that the numerous food products assumed to contain GM ingredients that were purchased regularly contributed to the assumption that almost all food products available in SA supermarkets have been GM. This view is suggested to contribute to participants' compromised control over the food products they purchased, which contained GM ingredients. It is suggested that the assumption that most food products in SA supermarkets contain GM ingredients could point to the participants' lack of GMFP knowledge. In terms of food security, the assumption that various food products contain GM ingredients (and thus that the majority of food products available on the market are GMFPs) could be

favourable to the GM food industry as it was indicated that the participants already assumed they were purchasing and consuming GMFPs. However, it could leave the participants thinking they were forced to purchase GMFPs.

8.5.1.1 Lack of Concern over Purchasing and Consuming GMFPs

As it emerged from the data, the majority of participants assumed that they were purchasing and consuming GMFPs frequently, which *"is frustrating"*, but according to many of the participants, it *"is not something that bothers me that I have purchased something that has GM in it and I didn't know it"*. Therefore *"it's not something I'm going to lose sleep about"*; *"it doesn't bug me entirely"*; and *"I suppose I'm not really that worried"*. The lack of concern towards purchasing and consuming GMFPs could be attributed to the assumption that most food products available in supermarkets have been GM, and although it is suggested that the participants' control over purchasing food products that contain GM ingredients could be compromised (as discussed in Section 8.5.1 above), *"there is nothing I can do about it"*; *"it is what it is"*; and therefore *"you can't dwell on"* the fact that, in their opinion, GMFPs are purchased and consumed regularly. It was added that *"I think there's more important things to worry about than that"*, *"so if I do buy something and I know it's genetically modified, it's not really going to make such a big difference in my life"*. As a result, a lack of concern over purchasing and consuming GMFPs emerged as a sub-salient aspect of the data. It could explain why the participants did not seek information about GMFPs to assist them in recognising GMFPs in-store. However, it has also been found that some consumers are specifically concerned about consuming GMFPs due to the possible health effects that could occur (Raman 2017; Ruth & Rumble 2019; Kubisz et al. 2021), as seen in a study in Canada where it was determined that consumers were worried about the fact that they were consuming GMFPs (Macall et al. 2021).

In this study, the lack of concern regarding the purchasing and consumption of GMFPs was attributed to the safety of GMFPs, which emerged as a further sub-salient aspect, as a few participants stated that *"I have trust in the suppliers and hoping that whatever I have purchased is still healthy for me"* because *"I hope that research has been done behind the scenes"*. Therefore, *"it just boils down to trust that 'okay, I might well have purchased GMO food, but it's not going to harm me"*.

Although it is suggested that the participants lacked PBC over purchasing GMFPs, had the control belief that the predominance of GMFPs makes it easy to purchase these items, thereby compromising their control when purchasing products that contain GM ingredients, and were

ignorant, it is evident that the participants did not get anxious about purchasing GMFPs. This finding was further attributed to them trusting that the food products available on the market were safe to consume. Based on the volume of quotes, it is suggested that the participants' lack of concern over purchasing and consuming GMFPs was an influential sub-salient aspect in terms of their PBC and knowledge. Not displaying concern toward purchasing and consuming GMFPs is a promising aspect to promoting the food security status of the SA population.

8.5.2 Not Specifically Looking to Purchase or Not to Purchase GMFPs

Even though the participants assumed that they were purchasing and consuming GMFPs on a regular basis, *"I don't go looking for GMFPs"*; *"I don't specifically look if it's GM or not"*; therefore *"I won't go intentionally to go and search for them"*. As a result, *"I wouldn't say that I would go out of my way to purchase GMFPs or not to purchase GMFPs"* because *"I don't feel strong enough about it to go to the specific effort of finding them in the shop"*. Thus, an important salient aspect that emerged from the data, contributing to interactions with GMFPs on the market, was that the participants **did not specifically look to purchase or not to purchase GMFPs**. This salient aspect could have stemmed from the participants' lack of concern about whether they were purchasing GMFPs, as discussed in Section 8.5.1.1. In terms of seeking GMFPs in-store, a study conducted in Europe and Switzerland found that consumers did not actively seek to refrain from purchasing GMFPs (Sleenhoff & Osseweijer 2013; Lucht 2015). Not seeking to specifically purchase or not to purchase GMFPs was illustrated by some participants' claims that *"I just buy the products that I know and what I like"*; *"I usually buy the stuff that I know and trust over years"*; and *"I kind of just buy the products that I really like"*. Therefore, *"it's more habit of buying what you know and what you've used before"*. Thus, habitual buying emerged as a sub-salient aspect of the data, contributing to participants not specifically looking to purchase or not to purchase GMFPs. A study conducted by Verdurme and Viaene (2003) also found that habitual buying and brand loyalty influenced consumers' intent to purchase GMFPs.

Not specifically looking to purchase or not to purchase GMFPs was further attributed by some participants to their ignorance of GMFPs, which was a sub-salient aspect that emerged from the data. Participants indicated, *"I don't think I know enough about it"* because *"I haven't done enough research on the benefits or the negative effects of it"*; therefore, the *"lack of awareness of the effect or pros or cons";* and the *"lack of knowledge"* and *"my lack of understanding"* of GMFPs contributed to not specifically looking to purchase or not to purchase GMFPs. Although the participants shared that almost all food products contain GM components

(Section 8.5.1), they could not confidently identify which food products they regularly purchased contained GM ingredients. This could explain why the participants were not specifically looking to purchase or not to purchase GMFPs, as they were unsure which food products contain GM ingredients. Section 8.2.1 of this chapter also showed that the participants lacked knowledge regarding GMFPs, whereas Section 8.3 showed that the participants did not currently consult sources of GM-related information, which could have contributed to the participants not looking to purchase or not purchase GMFPs as they were possibly not fully acquainted with these food products to seek them out or avoid them. Various authors have agreed that consumers' lack of awareness and knowledge of GMFPs could influence their purchasing of such food products (Marx 2017; Cui & Shoemaker 2018; Zhang et al. 2018; Zhu et al. 2018; Dirisu et al. 2020).

The data thus showed that, in terms of the participants' interactions with GMFPs on the market, they did not specifically look to purchase or not to purchase such food products. The volume of quotes suggests that it was an important aspect. The data also showed that habitual buying and ignorance of GMFPs contributed towards participants not specifically looking to purchase or not purchase GMFPs. This study suggests that participants had the control belief that food products available in supermarkets are predominantly GM. Therefore, it is easy to purchase GMFPs, which compromises their control when purchasing food products with GM components. This could explain why the participants did not actively intend to purchase or not purchase GMFPs. It is suggested that the participants' lack of PBC over purchasing food products that contain GM ingredients could also be influenced by not specifically looking to purchase or avoid GMFPs. Specifically looking to purchase GMFPs was absent as a resource to assist them when purchasing GMFPs. This could be concerning for the role that GMFPs could play in terms of assisting consumers with their food security status as the participants were not actively looking to purchase GMFPs – which could indicate a lack of desire for GMFPs. The prominence of their beneficial beliefs about such food products is thus questioned. However, not specifically looking to refrain from purchasing GMFPs could be ascribed to the beneficial beliefs being more prominent than the risks and concerning beliefs in Chapter 5. Nevertheless, it could be promising to the GM food industry in terms of producing GMFPs to enhance food security. However, despite benefits as well as risks and concerns being coupled with GMFPs in the beliefs, values and expectations data, it did not carry through to a specific PI among the participants, thereby suggesting uncertainty around GMFPs and questions whether their beliefs, values and expectations (particularly beliefs, since it was the most prominent component) carried any credibility to fuel a certain PI.

8.5.3 Alternative Food Product Preferences to GMFPs

Although the participants were not anxious or concerned about purchasing and consuming GMFPs and did not specifically seek to purchase or avoid such food products, the data reflected that *"if I knew it had GM food, I wouldn't specifically go for it"*, and that *"I would steer clear of it if possible"*, if possible, *"until I know more"* about these food products. Thus, if it was known that a food product contains a GM ingredient, *"I would try to avoid them where possible"*; *"I would try stay away from the things"* that are GM. Subsequently, *"I would not knowingly buy GMFPs"*, thereby indicating a preference for alternative food products. Based on the data, **alternative food product preferences to GMFPs** were an important salient aspect. Since participants lacked GMFP knowledge, as discussed in Section 8.2.1, it could explain why they preferred alternative food products as they perhaps lacked confidence in what GMFPs could offer them, thereby driving them towards other food products.

The salient aspect was attributed to sub-salient aspects namely purchasing natural, GMO-free and organic food products as well as planting vegetable gardens. In terms of natural food products, some participants would prefer to purchase such food products as *"I've always wanted to consume stuff that is natural"*; therefore, *"personally, I'd go for natural things"* because *"I prefer everything to be as original as possible"* and because *"I prefer food that is pure and raw"*. As a result, *"I would rather purchase a product that is in its standard form than a modified product"*. Results from studies in SA and China showed that consumers would prefer natural, unaltered food products to GMFPs (Cui & Shoemaker 2018; Dovey & Ntuli 2020). Various other authors have also suggested that consumers prefer to purchase food products that do not contain any GM ingredients (Glasgow 2015; Sanlier & Sezgin 2020; Heng et al. 2021). In terms of purchasing GMO-free food products, it was stated by many participants that *"if I had to choose between the two, that would throw me towards the non-genetically modified food"*; therefore, *"I would definitely choose GMO-free products over GM products any day"*. Subsequently, *"I would rather find something else that didn't have GMO in it"*, and therefore, *"I'll rather give them a miss"* when it comes to purchasing GMFPs. It has been highlighted that consumers prefer to purchase non-GMFPs, which was confirmed in a study conducted in Peru, where consumers would rather purchase food products that did not contain any GM components (Sebastian-Ponce et al. 2014; Delgado-Zegarra et al. 2022).

Some participants would also prefer to purchase organic food products as an alternative to GMFPs. They stated that *"I'd rather eat organic ones"* and *"I would rather do organic"* because *"I'm more attracted to organic food over GM"*; and as a result, *"I would be more inclined to buy organic"* rather than GMFPs. These findings were also reflected in a study conducted by

Macall et al. (2021), who found that Canadian consumers preferred to purchase organic food products instead of GMFPs. A preference for organic food products emerged from the data because, for some participants, *"in a farming community like ourselves, we can buy food directly from farmers and from various types of farms"*; thus, *"it just feels good knowing that I've bought an organically made food that is locally produced"*. Therefore, *"I would rather buy organic food products directly from farmers in the area"*; and as a result, *"I [can] support the local farmers market"* because *"I buy at farmers markets"*. Furthermore, *"I would prefer knowing that I could support a local farmer"*, and *"I try to go to things like Earth Market and things like that where they only sell organic fruit and veg"*. Purchasing from local farmers emerged as a further sub-salient aspect of why organic food products would be preferred as an alternative to GMFPs. This could have stemmed from participants' residential location in the countryside, where many organic food products could be farmed. A study conducted in Nigeria also established that consumers preferred to purchase food products that were produced locally, instead of purchasing GMFPs (Dirisu et al. 2020).

With regards to vegetable gardens – drawing from Section 8.4.5 in this chapter where it was assumed that a variety of GM vegetables and fruits were available on the SA market – although not the case (Woolworths 2020) – a few participants stated that *"I've got a vegetable garden at home, I will only plant what's called heirloom seeds"*; *"I've starting growing some heirloom vegetables"*; *"I grow my own vegetables"*; and *"I have my own vegetable garden"*, which will rather be utilised instead of purchasing GM vegetables and fruits from the supermarkets. Macall et al. (2021) also found that Canadian consumers preferred to purchase their fruits and vegetables from farmers' markets or grow their own.

Thus, based on the volume of sub-salient aspects and the volume of quotes relating to a preference not to buy GMFPs, it appeared participants would prefer to purchase alternative food products, which was an important aspect to them. Considering the prominence of the sub-salient aspect (based on the volume of quotes), GMO-free food products would specifically be preferred. Other food products, such as natural and organic food products from local farmers, as well as planting their own vegetable gardens, would also be preferred.

While the participants did not intend to purchase or not purchase GMFPs – which could be attributed to their lack of knowledge and inability to confidently identify GMFPs – they would prefer alternative food product options. However, purchasing alternative food products would prove to be difficult as the participants had a suggested control belief that more GMFPs were on the market than conventional food products. This study suggests this finding could contribute to a lack of PBC as the participants preferred conventional food products over

GMFPs but felt it was not possible to exercise this preference (in their opinion). Therefore, their preference for alternative food products to GMFPs could compromise the control they think they have in purchasing food products that contain GM ingredients; they had the control belief that it would be easier to purchase GMFPs than other food products. Nevertheless, although consumer-related benefits were prominent in the beliefs, values and expectations data, a desire for alternative food products still emerged, which could pose a potential challenge to the role that GM food production could play in terms of advancing food security in the SA context.

8.5.4 Summary of the Interactions with GMFPs on the Market

In addition to the most salient aspects that emerged in Themes 1 to 3, the most salient aspect of Theme 4, namely interactions with GMFPs on the market, is depicted in Table 8.4.

Table 8.4: Summary of the Most Salient Aspects of Themes 1 to 4

Theme	Salient Knowledge, Sources of GM-Related Information and PI Aspects of GMFPs					
Theme 1: Lack of Knowledge about GMFPs	Ignorance of GMFPs	Lack of Information Sharing	Platforms to Disseminate Information			
Table 2: Sources of GM-Related Information that would be Consulted	Internet	Published Scientific Journal Articles	Word-of-Mouth	University Resources	Agricultural Publications	Consulting Multiple Sources
Theme 3: Food Products Purchased Regularly Assumed to contain GM Ingredients	GM Crops Cultivated in SA	Maize or Corn-Containing Food Products	Bread	Grain-Based Food Products	Vegetables & Fruits	Meat Products
Theme 4: Interactions with GMFPs on the Market	Predominance of GMFPs	Not Specifically Looking to Purchase or not to Purchase GMFPs	Alternative Food Product Preferences to GMFPs			

Theme 1 illustrated that the participants lacked GMFP knowledge; Theme 2 illustrated that they did not consult GM-related information sources, but did indicate which sources would be consulted should there be a need to know more about GMFPs; whereas Theme 3 illustrated that there were particular food products assumed to contain GM ingredients which were

purchased on a regular basis. Theme 4 illustrated the participants' interactions with GMFPs on the market, from which salient aspects such as the predominance of GMFPs, not specifically looking to purchase or not to purchase GMFPs, and the preference for alternative food products to GMFPs emerged – all of which is depicted in Table 8.4.

GMFPs are becoming increasingly available on the international market, and consumers are therefore frequently purchasing and consuming such food products unknowingly, which could be attributed to their lack of knowledge about such food products and not being able to determine which food products contain GM components (Vermeulen et al. 2005; Cui & Shoemaker 2018; Kim & Choi 2018; Charlebois et al. 2019; Dirisu et al. 2020; Hwang & Nam 2021; Delgado-Zegarra et al. 2022). It has further been found that consumers are not seeking to avoid purchasing GMFPs; however, a preference for natural, non-GM, and organic food products has emerged among consumers (Sleenhoff & Osseweijer 2013; Lucht 2015; Dovey & Ntuli 2020; Heng et al. 2021; Macall et al. 2021; Delgado-Zegarra et al. 2022).

Based on the assumption that food products containing GM ingredients were purchased frequently in Theme 3, in this study it is suggested that, in terms of PBC, the participants had the control belief that it is easy to purchase GMFPs because of the predominance of GMFPs on the market. However, due to the predominance of GMFPs on the market (salient aspect) and its sub-salient aspects, the participants' control was compromised because they lacked resources and the opportunity to purchase conventional food products. This is proposed to unfavourably influence their PBC over purchasing food products that contain GM ingredients (showing that control beliefs influence PBC in an unfavourable way), thereby leading to a lack of control over purchasing such food products, which is suggested to contribute to a perceived threatened PBC.

This study also proposes that, although a threatened PBC was demonstrated, not specifically looking to purchase or not to purchase GMFPs (salient aspect) – together with its sub-salient aspects – compromised participants' control over their purchasing of food products containing GM ingredients. They were not looking or, in fact, looking for such food products (indicating a lack of resources to purchase conventional food products), which leads to an unfavourable influence on PBC and a lack of PBC over purchasing GMFPs, reflecting a threatened PBC. It is also suggested that, although alternative food products were preferred, the participants had the control belief that they did not have the resources to purchase conventional food products, which compromised their control (as illustrated through the use of a purple arrow in Figure 8.11 below), as seen in the first salient aspect of this theme. This leads to an unfavourable influence on PBC, thus a threatened PBC was demonstrated. The lack of PBC stemming from

the three salient aspects is further postulated to influence the participants' PI of GMFPs in an unfavourable way, thereby contributing to a perceived threatened PI. In this study, a perceived threatened PI refers to aspects that were unfavourable to the participants, unfavourably influencing the PI. The perceived threatened PI is also proposed to unfavourably influence behaviour toward GMFPs, contributing to a perceived threatened behaviour.

Since this study also aimed to explore the influence that knowledge had on participants' beliefs, it is proposed that the assumed predominance of GMFPs on the market and not specifically looking to purchase or not to purchase GMFPs, together with their sub-salient aspects, is an indication of the participants' lack of GMFP knowledge. This could influence their interaction with such food products. It is suggested that the lack of GMFP knowledge influences the participants' beliefs unfavourably, which leads to perceived factually unfounded beliefs regarding such food products. It is further suggested that the participants' lack of GMFP knowledge could explain their preference to purchase alternative food products, as they perhaps did not know enough to feel confident in their beliefs about such food products to drive their purchasing of GMFPs.

A summary of the most salient and sub-salient aspects pertaining to interactions with GMFPs on the market is depicted in Figure 8.11, together with the proposed influence of control beliefs on the participants' PBC and thus PI and behaviour towards GMFPs. The proposed state of the participants' knowledge and its influence on the beliefs of GMFPs are also illustrated in Figure 8.11.

Figure 8.11 shows that in this theme, it is suggested that the participants lacked PBC when it came to purchasing GMFPs, resulting in a perceived threatened PBC, PI and behaviour toward these food products – all of which could be concerning to the participants' food security status and the realisation of SDG 2: Zero Hunger. Due to a perceived threatened PBC, it is proposed that control beliefs about GMFPs influence PBC in an unfavourable manner, which, in turn, unfavourably influences PI and behaviour. In terms of the participants' perceived state of knowledge of GMFPs, in this theme it is suggested the participants demonstrated a lack of knowledge, thereby contributing toward beliefs that were perceived to be factually unfounded.

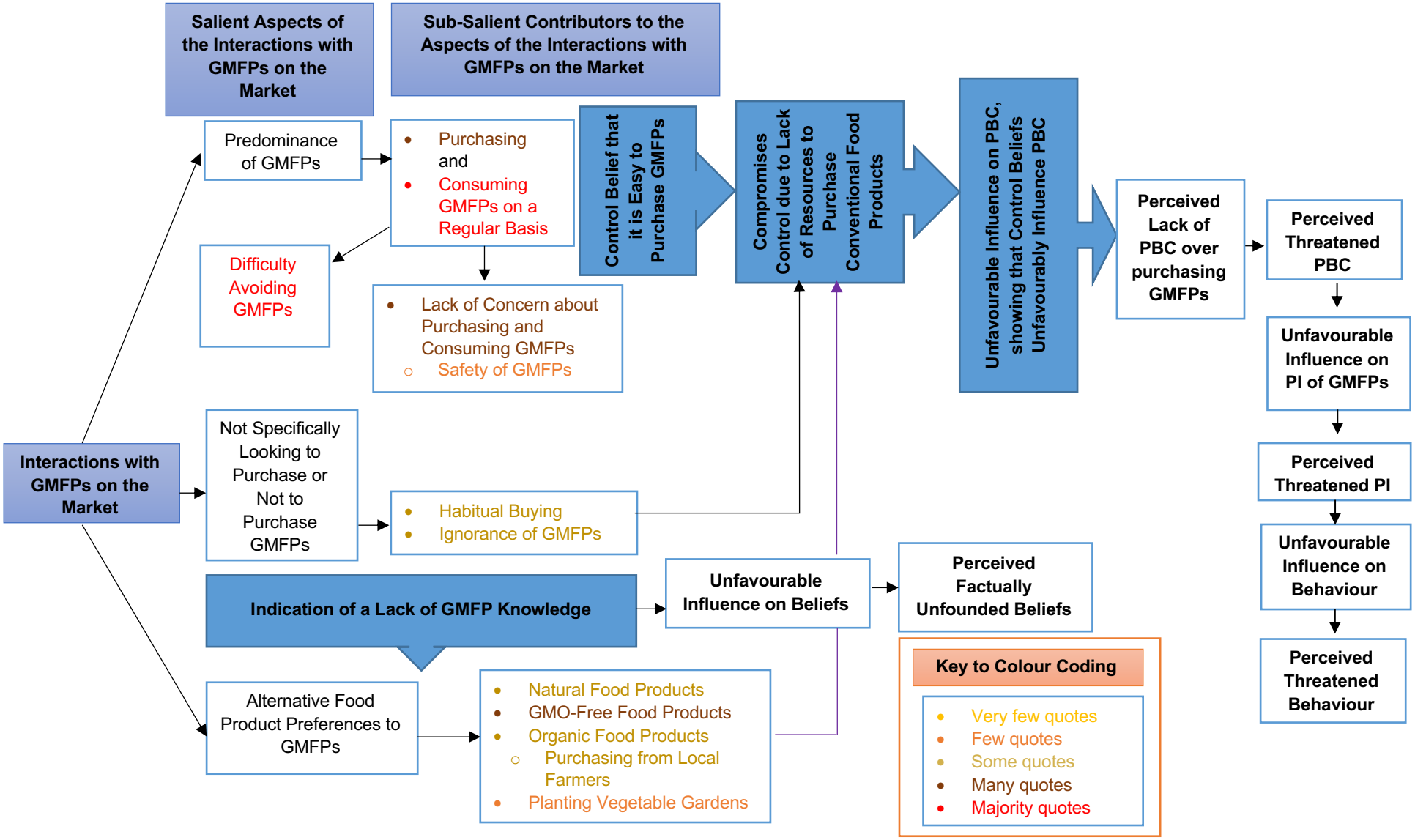

Figure 8.11: The Interactions with GMFPs on the Market and the Proposed Influence of Control Beliefs on PBC, PBC on PI, PI on Behaviour, the Perceived State of Knowledge, and the Proposed Influence of Knowledge on Beliefs about GMFPs

Considering the participants' assumption about GM-containing food products and their interactions with these food products, when an analogy is drawn to the beliefs data in Chapter 5 (beliefs component of the EV Model of Attitudes), the data suggests that the attributes linked to GMFPs were not based on experience with such food products, indicating that their actual awareness of their experience of GMFPs was limited. Instead, it is suggested that the attributes came from an assumption basis. However, based on the depth of data, it is proposed that interactions with GMFPs on the market played an important role in understanding participants' PBC and their state of GMFP knowledge.

8.6 SUMMARY

In this chapter, the data indicated that the participants lacked knowledge of GMFPs due to their ignorance and lack of information dissemination, potentially unfavourably influencing their knowledge and leading to factually unfounded beliefs. These findings demonstrate that there is a link between knowledge and beliefs in terms of GMFPs. Their lack of knowledge also led to the self-admittance that they were not conducting sufficient research on GMFPs, and they were unable to identify GMFPs on the market. However, platforms that could be used to remedy their lack of GMFP knowledge were suggested, specifically television and social media. Still, the participants did not consult GM-related information sources to learn about such food products, although they did highlight which sources they would visit if they wished to do so, with the internet being the most predominant source of information and word-of-mouth. The absence of seeking GM-related information was suggested to have an unfavourable influence on knowledge and thus contribute to factually unfounded beliefs. This reflects the importance of including a knowledge component in the EV Model of Attitudes in relation to the beliefs component, with the inclusion and consideration of the sources of GM-related information when exploring consumers' attitudes towards GMFPs. Participants assumed numerous food products contained GM ingredients and were purchased regularly, with maize or corn-containing food products, grain-based food products and fruit and vegetables – particularly tomatoes – being the most prevalent GMFPs assumed to be on the SA market. Although they knew that maize and soya were GM crops cultivated in SA, the incorrect identification of food products containing GM ingredients indicates their lack of GMFP knowledge and thus their unfamiliarity with these food products. However, it is also suggested that the assumed food products containing GM ingredients could unfavourably influence beliefs about GMFPs, leading to perceived factually unfounded beliefs.

Furthermore, the participants' interactions with GMFPs indicated that they assumed food products on the market were predominantly GM, thereby contributing to their assumption that

they purchased and consumed GMFPs on a regular basis because they were difficult to avoid. A demonstrated lack of concern over purchasing or not purchasing GMFPs was also seen. While they did not seek to purchase or not purchase GMFPs, they would prefer alternative food choices, specifically GMO-free food products.

It is proposed in this study that these aspects could compromise their control in terms of PBC and thus lead to a threatened PBC, PI and behaviour towards GMFPs. A further indication of the participants' lack of GMFP knowledge was illustrated through their interactions with GMFPs on the market, which is proposed to lead to factually unfounded beliefs about such food products, all of which could hinder food security efforts. This suggests that the participants' beliefs, based on their lack of knowledge, did not come from experiences with GMFPs, but instead were perhaps formed from their own thoughts about these food products. Referring to the EV Model of Attitudes, the lack of knowledge could suggest that the beliefs component was constructed from an uncertain foundation, as experience was suggested to be absent in terms of GMFPs, which could filter through to an unconfident attitude toward GMFPs. Further interpretations of these aspects are discussed in the conclusion chapter, namely Chapter 10. A continuation of the presentation of the participants' knowledge and PI towards GMFPs follows in Chapter 9.

CHAPTER 9
SECOND PART OF THE FINDINGS AND DISCUSSION OF THE KNOWLEDGE AND PURCHASE INTENTION DATA OF GENETICALLY MODIFIED FOOD PRODUCTS

Continuing from Chapter 8, in this findings and discussions chapter, the additional five themes regarding participants' knowledge and PI of GMFPs are discussed.

9.1 INTRODUCTION

In Chapter 8, the first four of nine themes regarding participants' knowledge, sources of GM-related information and PI of GMFPs were presented. The participants' knowledge of GMFPs was explored to see what influence knowledge had on their beliefs about such food products. Moreover, the sources from which the participants gained information about GMFPs were explored and considered as an influential aspect of their knowledge of such food products. The TPB framework, namely attitudes, subjective norms and PBC, was used to explore the participants' PI, which was done by exploring behavioural, control and normative beliefs (Ajzen 1985) regarding GMFPs to further aid in promoting food security. This study explored aspects of the participants' knowledge and PI towards GMFPs during the interview sessions. The findings that emerged regarding knowledge and PI of GMFPs are thus discussed together in this chapter, as some of the same questions were used in the interview sessions to explore the participants' knowledge and PI of such food products. The proposed influence that knowledge could have on beliefs and the proposed influence that attitudes, PBC and subjective norms – respectively – could have on the PI of GMFPs are also presented. Colour coding was used to represent the prominence of each sub-salient aspect that emerged from the data. Each salient aspect has been presented in bold. The remaining quotes relating to the aspects in this chapter are available in Appendix E.

In this chapter, the remaining five themes in terms of the participants' knowledge and PI are discussed, namely the perceived known benefits of purchasing GMFPs; perceived known risks of purchasing GMFPs; lack of PBC over purchasing GMFPs; lack of PBC over purchasing GMFPs in terms of GMFP labelling; and subjective norms in terms of GMFPs. These five themes are more applicable to the participants' PI of GMFPs and are thus discussed together in this chapter. However, the first two themes in this chapter also relate to the participants' knowledge of GMFPs. The results of consumer studies that have used the three elements of the TPB to predict consumers' attitudes toward GMFPs are also presented.

9.2 THEME 5: PERCEIVED KNOWN BENEFITS OF PURCHASING GMFPS

Within the context of the TPB framework, this study aimed to explore the role of attitudes on consumers' PI of GMFPs. The perceived benefits of GMFPs were explored based on the participants' behavioural beliefs of such food products, which refers to the belief that a behaviour will be positive and is therefore linked to the perceived benefits of a behaviour (Zakaria et al. 2016; Bakti et al. 2020), such as purchasing GMFPs. Since this study proposes that the EV Model of Attitudes feeds into the attitude element of the TPB, the data that emerged from exploring the three components of the EV Model of Attitudes (namely beliefs, values and expectations) were considered in relation to the behavioural beliefs that emerged from the data to investigate the role of attitudes on the intent to purchase GMFPs.

Many studies have used the attitude construct of the TPB to explore its influence on consumers' PI of GMFPs (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Khouloud & Sameh 2018; Zhang et al. 2018; Saha et al. 2021). In terms of using the attitude construct of the TPB, many authors have agreed that an exploration of the perceived benefits of GMFPs can contribute to understanding consumers' attitudes and PI of GMFPs (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Kim 2010; Ghasemi et al. 2013; Rodriguez-Entrena et al. 2013; Khouloud & Sameh 2018; Zhang et al. 2018; Hwang & Nam 2021; Saha et al. 2021; Sleboda & Lagerkvist 2022). For the purpose of this study, the benefits of GMFPs were also explored to better understand the state of participants' knowledge of GMFPs by seeing if they knew which benefits GMFPs offered, thereby investigating the influence of knowledge on the participants' beliefs about such food products. Although the participants had a natural instinct rather to purchase non-GMFPs, as indicated in Chapter 8, Section 8.5.3, some aspects emerged from the data that they knew about and would drive them towards purchasing GMFPs. The most salient aspects, as well as the sub-salient aspects contributing to the perceived known benefits of purchasing GMFPs, are illustrated in Figure 9.1.

In terms of the perceived known benefits of purchasing GMFPs, five aspects were identified, including increased nutritional value; increased availability; lower price; improved aesthetic properties; and improved food processing properties, as depicted in Figure 9.1. These aspects are discussed next.

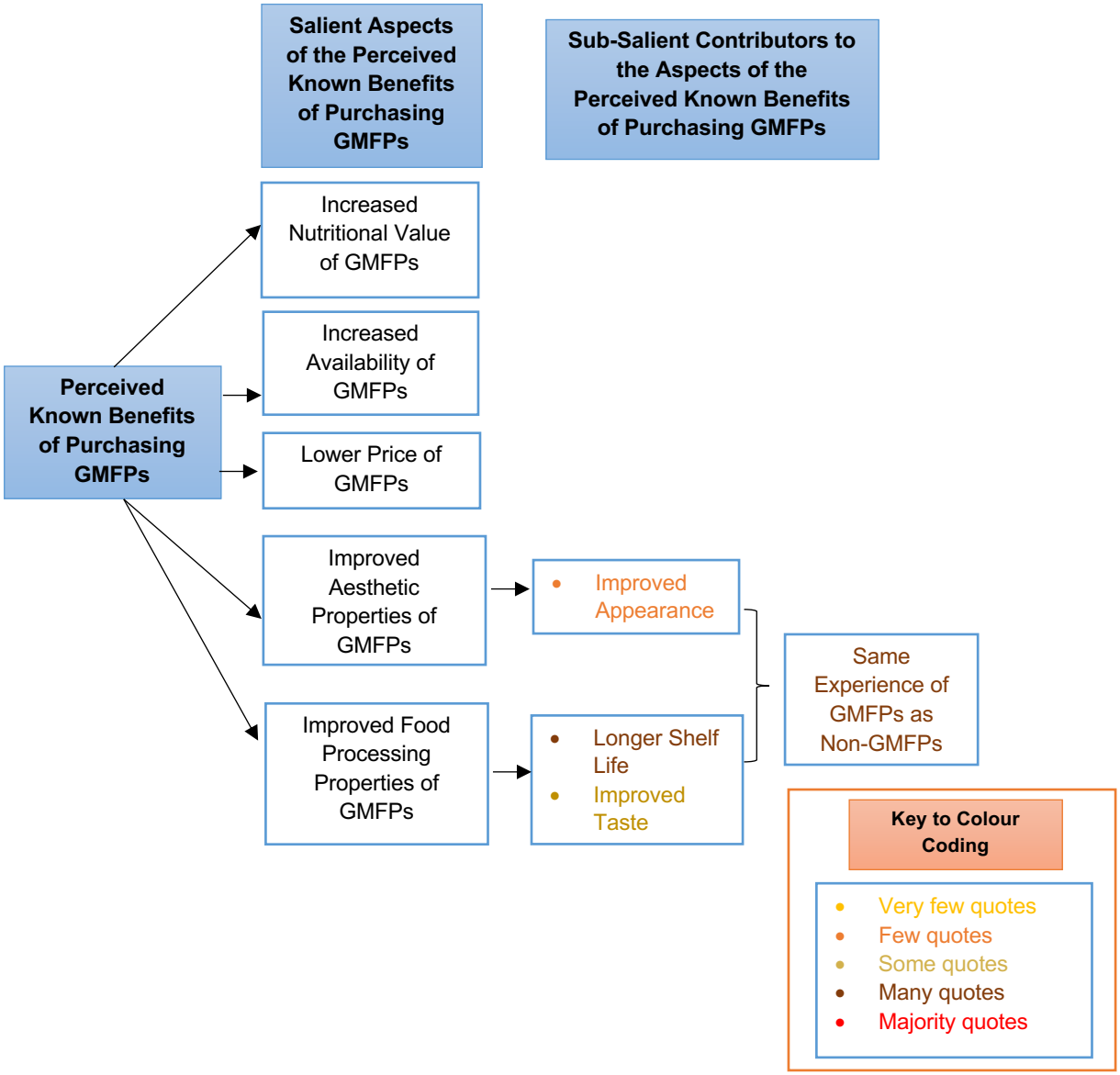

Figure 9.1: Perceived Known Benefits of Purchasing GMFPs

9.2.1 Increased Nutritional Value of GMFPs

From the data, it emerged that *"nutritional benefit"*, *"nutritional value",* and *"enhanced nutritional content"* was a perceived benefit of purchasing GMFPs that participants knew about. Therefore, *"I would actively purchase it because of the nutritional value"* because *"I'd rather have my food genetically modified and knowing that it would actually make it less harmful because farmers aren't adding all of those chemicals"*. According to numerous authors, the use of fewer herbicides, health benefits, and nutritional benefits of GMFPs are perceived benefits that might influence consumers' attitudes and PI of such food products in a positive way (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Ghoochani et al. 2017; Zhang et al. 2018; Gheysen et al. 2019; Hwang & Nam 2021). It was added that *"the nutritional*

benefits that genetically modified foods could have" would *"definitely"* be a perceived benefit of purchasing such food products because it allows consumers to *"make a better health choice"*. Thus, *"[due to] the added benefits to it"* and because *"it can be healthy"*, *"then yes"*, it is a perceived benefit of purchasing GMFPs and *"I would be happy to purchase it for my children"*, because *"especially with small kids" "you want them to eat all their vitamins and minerals"*. Therefore, the participants knew that GMFPs could have an **increased nutritional value**, and it was also a salient aspect of the perceived benefits of purchasing GMFPs. Since the profile of the participants in this study indicated that they were between the ages of 25 to 40 and married or living with a partner, it could suggest that they were parents, potentially contributing to the importance of purchasing and consuming food products with nutritional and health benefits. GMFPs could provide these benefits for participants and their children. In terms of nutritional and health benefits, these findings were supported by a study conducted in SA that found health benefits were more important to consumers than taste when deciding whether or not to purchase GMFPs (Dovey & Ntuli 2020).

Two additional studies in SA determined that consumers would be willing to purchase GMFPs if they provided health benefits and contained more nutrients (Pouris 2003; Peter & Karodia 2014), which a study in Belgium supported (Verdurme & Viaene 2003). It was further established that Australian, Nigerian and Canadian consumers would be willing to purchase GMFPs if they had an increased nutritional value (Bray & Ankeny 2017; Emmanuel et al. 2021; Macall et al. 2021). These studies show that nutritional and health benefits were important to consumers when purchasing GMFPs.

In the current study, the participants knew that increased nutritional value could be a benefit of GMFPs, and they had the behavioural belief that purchasing and consuming GMFPs could lead to a favourable result in terms of increased nutritional intake. Increased nutritional value also emerged as a perceived benefit of GMFPs, which is suggested to have a favourable influence on the participants' attitudes and PI of such food products.

In the beliefs data, as seen in Chapter 5, Section 5.6.1, the participants expressed their belief that GMFPs had increased nutritional value. They also expressed this as being a valuable aspect of GMFPs in Chapter 6, Section 6.3.2.1, and they expected this of such food products, as seen in Chapter 7, Section 7.3.1 (although it emerged as a less influential aspect in the expectations data as opposed to be beliefs and values data). Although increased nutritional value was an aspect that emerged from the data when exploring the participants' behavioural beliefs in the context of their attitudes and PI, there was a lack of quotes and an absence of sub-salient aspects, suggesting that increased nutritional value was an aspect most important

to the participants when discussing their beliefs, values and expectations of GMFPs (although the aspect was suggested to lack influence in their beliefs, values and expectations, respectively, in terms of the consumer-related benefits of GMFPs). In addition, when comparing the extent of elaboration on the aspect and the prominence of the aspect through the volume of quotes and sub-salient aspects in the beliefs, values and expectations data, it is suggested that increased nutritional value was a less prominent aspect in terms of participants' PI of these food products in the context of their attitudes. It is suggested that the aspect was not influential on the intent to purchase GMFPs. Although the identification of the aspect could show that the participants had some state of knowledge, the lack of elaboration on this aspect could suggest that they lacked confidence in their knowledge regarding the nutritional value of GMFPs.

9.2.2 Increased Availability of GMFPs

The data showed that *"pretty much the availability"* of GMFPs is a perceived benefit of such food products *"just because they can be so widely available"*. Therefore, due to GMFPs *"being readily available"* and *"becoming freely available"*, **increased availability of GMFPs** was a salient aspect of the data the participants' knew about and was linked to the perceived benefits of purchasing GMFPs. Increased availability of GMFPs could have been important to the participants, considering that they resided in a rural area where food options might been restricted. Thus, if the availability of certain foods could be increased, it could assist them in not having to travel to nearby cities to purchase particular food products since genetic modification could make it possible to have certain food products available in smaller towns – which would be beneficial. To this effect, it has been stated that the availability of food products can be increased by growing GM crops, thereby increasing consumers' choice of products due to their availability; this is a perceived benefit among consumers, positively influencing their attitudes and PI of GMFPs (Bredahl 2001; Qaim & Kouser 2013; Dizon et al. 2016).

In this study, the data showed that the participants knew and perceived that the production of GMFPs can contribute to an increased availability of food products (which is a favourable outcome of GMFPs). This suggests that they had the behavioural belief that purchasing such food products is beneficial as these food products are readily available. Thus, increased availability emerged as a perceived benefit of purchasing GMFPs. The increased accessibility and availability of GMFPs also emerged as a salient aspect when the participants expressed their beliefs and values about GMFPs in Chapter 5, Section 5.6.2 and Chapter 6, Section 6.3.2.2 (but was not prominent in their expectations). However, compared to the beliefs and values data, it was not elaborated on in as much detail in the PI context, which is evident by

the lack of quotes and the absence of sub-salient aspects. This could suggest that the increased availability of GMFPs was a more important aspect when portraying their beliefs and values of these food products (although the aspect was suggested not to be influential in the participants' beliefs and values of the consumer-related benefits and value of GMFPs), but an even less prominent aspect when the participants discussed it as favourably influencing their PI of GMFPs through their attitudes. It is also suggested that the lack of discussion on this aspect points to the participants' lack of knowledge that increased availability of foods can be achieved through the development of GMFPs.

9.2.3 Lower Price of GMFPs

The **lower price of GMFPs** was a further salient aspect that emerged from the data that the participants knew about and was a perceived benefit of purchasing GMFPs, as *"definitely price"* and *"pretty much the price"* would lead to purchasing GMFPs. It was added that *"I would purchase them because they are cheaper"*, price *"would probably be one of the highest factors for me to buy GMFPs"*, and *"price would be the main factor in me purchasing them"*. Canadian consumers were also willing to purchase GMFPs if they cost less than conventional food products (Macall et al. 2021). The reduced price was a perceived benefit of purchasing GMFPs because *"in the current economic climate"*, *"especially post COVID"*, *"it just means that your money can go further"*, meaning that *"I can buy more food with cheaper options like GM"*. As a result, *"our money food budget can go further"*, and therefore *"you can feed those in your home"* as *"I have 5 kids"* and *"six children"*, respectively, *"that I need to feed"*. Some participants were parents (as indicated in the quotes), which could point to why the affordability of GMFPs was a particular benefit that would promote their purchasing of such food products. They needed to purchase food for their families and had a financial obligation toward their families. Although the profile of the participants suggested that they were financially stable, price remained an important aspect for them to consider when purchasing food products.

In terms of the reduced cost of GMFPs being a perceived benefit when purchasing such food products, it *"would end up having to play a massive role"* because *"at the end of the day, price is probably the largest factor when it comes to shopping"*. Therefore, *"at the end of the day, money talks"* because *"cost is a major thing"* and because *"money is always an issue"*; as *"ultimately it's about the cost"*, and *"it's about affordability"*. Another study showed that cost influenced SA consumers' decisions when purchasing food products, and cheaper food products, such as GMFPs, were preferred (Dovey & Ntuli 2020). This was also found in another study conducted by Emmanuel et al. (2021) in Nigeria and in Jordan by Alalwan et al. (2023). Therefore, the reduced price of GMFPs is considered a perceived benefit that

positively influences consumers' attitudes and PI of GMFPs and attracts consumers toward GMFPs (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Zhang et al. 2018; Dovey & Ntuli 2020; Prianto et al. 2020; Hwang & Nam 2021; Abdoul et al. 2023).

The data, therefore, showed that the participants knew that GMFPs could cost less than other food products, and it is proposed that they had the behavioural belief that purchasing GMFPs would save them money, which is suggested to be a favourable outcome of purchasing such food products. Therefore, lower prices emerged as a perceived benefit of purchasing GMFPs, since less money would have to be spent when purchasing GMFPs. The lower price of GMFPs emerged as an important aspect to the participants sharing their beliefs and values of the consumer-related benefits and value of GMFPs, as indicated in Chapter 5, Section 5.6.3 and Chapter 6, Section 6.3.2.3, but it was a less influential aspect in the expectations data, as seen in Chapter 7, Section 7.3.2. Although no sub-salient aspects emerged in this section, based on the volume of quotes relating to the reduced price of GMFPs, it is suggested that lower price was a prominent aspect when discussing participants' PI of such food products. Therefore, it is suggested that lower prices were particularly important to the participants' beliefs and values but also prominent and influential on their PI of GMFPs based on their attitudes. Although it is suggested that the participants lacked GMFP knowledge, the volume of quotes relating to the lower price of GMFPs suggests that the participants were aware that these food products could cost less.

9.2.4 Improved Aesthetic Properties of GMFPs

In addition to the increased nutritional value of GMFPs, increased availability, and their reduced price (which were perceived benefits of purchasing GMFPs), **improved aesthetic properties of GMFPs** were a further salient aspect the participants knew about and was a perceived benefit of purchasing GMFPs. A few participants stated that *"the GM product looks better on the shelf"*, which is a perceived benefit; therefore, *"I am going to purchase it"*. It was stated that GMFPs *"looked good"* and *"looked nicer"*, therefore *"I would purchase it"*. One participant added that *"colour is a very real incentive"* to purchasing GMFPs. Thus, *"as a consumer, I typically go for what looks more appetising"* because *"I have six children to feed, so they want to eat something that looks good"*. GMFPs' improved appearance was thus a perceived benefit of purchasing these food products. As a result, improved appearance emerged as a sub-salient aspect in terms of the improved aesthetic properties of GMFPs. Since some participants in this study were parents, it is suggested that the improved aesthetic properties of GMFPs could have influenced their PI as it allowed them to purchase products that encourage their children to consume food products that look appetising. Other studies

concurred that improving the appearance and colour of food products through genetic modification are aspects that attract consumers (Shetty et al. 2018; Kubisz et al. 2021).

The participants knew that genetic modification could lead to the production of food products with improved aesthetic properties, such as improved appearance, which was a perceived benefit of GMFPs. It is suggested that the participants had the behavioural belief that purchasing GMFPs could lead to better-looking food products being purchased. In Chapter 5, Section 5.6.4, improved aesthetic properties were an important and influential aspect in terms of the participants' beliefs but less so in terms of what they expected of GMFPs, as seen in Chapter 7, Section 7.3.3 (although it was suggested to be an influential aspect in the consumer-related expected outcomes of GMFPs). It was the least influential in the values data, as seen in Chapter 6, Sections 6.3.2.4. Based on the extent to which the aspect was elaborated on in this section and the volume of sub-salient aspects compared to the beliefs, values and expectations data, it is suggested that the improved aesthetics of GMFPs did not play an influential role in the participants' intent to purchase GMFPs. The lack of elaboration also potentially points to insufficient GMFP knowledge regarding the improved aesthetic properties that can be found in these products.

9.2.5 Improved Food Processing Properties of GMFPs

In addition to improved aesthetic properties emerging as a perceived benefit of purchasing GMFPs, **improved food processing properties of GMFPs** were another aspect the participants knew about. This salient aspect of the data was a perceived benefit when purchasing GMFPs, attributed to sub-salient aspects such as longer shelf life and improved taste. In terms of longer shelf life, it was stated that *"they last longer in the fridge"* and *"it's going to be on your shelf for longer",* which *"does help and is beneficial*" and is thus a perceived benefit when it comes to purchasing GMFPs. As a result, according to many of the participants, *"shelf life is a major point"*, and is *"shelf life definitely"* a perceived benefit of GMFPs, which would drive them toward purchasing these food products because *"I would purchase the one that will last me a week longer than the normal one"*. Therefore, *"longer shelf life" "would make me buy it because it is going to last a little bit longer"*. It was further stated that *"I would buy it because it lasts longer"* and *"it simply means that it [would] save me money at the end of the day because I don't have to throw things away as often or as quickly"*, which *"I often find myself in the position doing" "which is a waste of money"*; and because:

> *"life does get busy, and I'm finding that I work late and if I could keep that food in the fridge or on the shelf a bit longer for me to make it, it would put me at ease"*.

Since participants had permanent full-time employment – thereby proposing that they led busy lifestyles – it could explain why the longevity of GMFPs was a benefit that contributed toward their intent to purchase GMFPs since they last longer on the shelf. Participants therefore did not have to be concerned that the product would go off and they would not need to purchase them frequently. However, contrasting findings were observed from a study conducted in SA, where results showed that a longer shelf life was the least favourable characteristic influencing consumers to purchase GMFPs (Dovey & Ntuli 2020). Nevertheless, other studies reported that longer shelf life is a characteristic of GMFPs that attracts consumers (Popek & Halagarda 2017; Sendhil et al. 2022; Abdoul et al. 2023), which was also the case in the current study.

According to some participants, in terms of GMFPs' improved taste, due to *"its' flavour"*, it *"tastes nicer"* and *"I would actually purchase it".* Thus, *"taste is a very major point to me"* and *"if I am happy with the taste"* of GMFPs, *"I am going to purchase it more"*. Therefore, the improved taste is *"definitely"* a perceived benefit when purchasing GMFPs because *"taste does matter",* especially considering that *"I have very fussy children"*. Subsequently, *"GM is tasty and sweet, so they are going to eat it"*, thus *"I will buy it"* due to its perceived improved taste. Since some participants were parents, the improved taste of GMFPs could contribute to their PI of such food products to prompt their children to eat their food. Similarly, a study carried out in Australia established that consumers would purchase GMFPs if they tasted better (Bray & Ankeny 2017), while a study in Malaysia found that improved taste, flavour and aroma positively influenced consumers' attitudes and intent to purchase GMFPs (Hassan et al. 2016). Therefore, improved taste emerged as a perceived benefit influencing attitudes and PI of GMFPs, and it is thus an attractive trait to consumers (Verdurme & Viaene 2003; Dovey & Ntuli 2020; Sendhil et al. 2022).

The data suggest that the participants knew GMFPs could have improved food processing properties, particularly in terms of longer shelf life and improved taste. It was also a perceived benefit of GMFPs from which a favourable outcome could be enjoyed. It is proposed that the participants had the behavioural belief that when purchasing GMFPs, they could consume a better-tasting food product that lasts longer. Regarding the longer shelf life of GMFPs based on their improved food processing properties, the sub-salient aspect shared the same prominence in the beliefs data of Chapter 5, Sections 5.6.5 and values data in Chapter 6, Section 6.3.2.5. However, it was less influential in terms of what was expected of such food products in Chapter 7, Section 7.3.4. Considering the prominence of the sub-salient aspect in this section based on the volume of quotes relating to longer-shelf life, it is suggested that longer shelf life, due to the improved food processing properties of GMFPs, was an influential aspect when discussing the intent to purchase these food products in relation to the

participants' attitude. This could also suggest that, although their GMFP knowledge was limited, the participants knew GMFPs could have a longer shelf life.

9.2.5.1 Same Experience of GMFPs as Non-GMFPs

Although perceived benefits of GMFPs were highlighted by the participants, including their improved aesthetic and food processing properties, which could lead to *"a positive experience"*, many of the participants mentioned in their conversations that their experience of GMFPs would *"be exactly the same as any other product"* because *"I wouldn't be able to tell the difference"*; *"I don't know whether I am purchasing a GM or non-GM food product"*, and because *"I can't say that I've taken a non-GM food and a GM food and kind of tested them against each other"*, and therefore *"my personal experience wouldn't be different"* in terms of GMFPs. Thus, the data reflected that the participants had the behavioural belief that their experience of GMFPs would be the same as non-GMFPs. This was a further sub-salient aspect of the data, which – based on the volume of quotes – was important to the participants. Having the same experience when it came to GMFPs could be attributed to the participants' self-admitted lack of GMFP knowledge in Chapter 8, Section 8.2, suggesting that they would not know when they were purchasing a GM or non-GMFP to make a comparison in terms of their experience. It is further suggested that their experience cannot be affected in terms of GMFPs as they did not have the desire to consult sources of GM-related information (as seen in Chapter 8, Section 8.3) to identify GMFPs and compare them to traditional food products. The consequence of this was seen in Chapter 8, Section 8.4, where the participants could not confidently identify GM-ingredient-containing food products, which were purchased regularly. In Chapter 8, Section 8.5.1, it was further illustrated that it was assumed that most food products on the market contained GM ingredients, thereby suggesting that, in the participants' opinion, they were purchasing limited conventional food products. This may not have given them the chance to compare GM and non-GMFPs, leaving their experience of GMFPs unaffected. Nevertheless, considering that maize-containing food products in SA could contain GM ingredients, which are primarily herbicide and insect-resistant (Gbashi et al. 2021), a clear experience of GMFPs could be difficult to ascertain as obvious GM traits such as improved appearance or taste may not be noticeable to the SA consumer. Drawing an analogy to the beliefs component of the EV Model of Attitudes, the lack of experience with GMFPs suggests that the participants' beliefs could have stemmed from assumptions and not from experience. In terms of the phenomenological research design followed in this study, this could suggest that the participants did not have a personal experience with GMFPs, but that their experience with these food products was based on hearsay.

9.2.5.2 The Absent Beneficial Aspects in the Intent to Purchase GMFPs

It has been suggested that increased availability of GMFPs, being able to produce more food and assisting in food security are perceived benefits of GMFPs that can influence consumers' attitudes and PI in a favourable manner (Verdurme & Viaene 2003; Ghoochani et al. 2017; Hwang & Nam 2021); all of which are benefits to producing GM crops. In this study, several benefits were linked to GM crop production, particularly in terms of increased productivity and enhanced food security. These benefits were particularly prominent when the participants expressed their beliefs, less prominent in assigning value to producing GM crops, and the least prominent in terms of their expectations of producing such crops. However, during the exploration of the participants' PI toward GMFPs, these aspects did not emerge, suggesting that the benefits coupled with the production of GM crops did not influence the participants' intent to purchase GMFPs. Regarding GM crop production benefits, it has further been suggested that an environmental benefit is a perceived benefit of GMFPs, which can positively influence the attitudes and PI of consumers (Bredahl 2001; Verdurme & Viaene 2003; Zhang et al. 2018; Hwang & Nam 2021). However, it was not an aspect that emerged as a perceived benefit of GMFPs in this study.

GM crops' ability to resist harsh weather conditions such as droughts and floods was also not mentioned as a perceived benefit of GMFPs. However, the participants elaborated on these aspects when conversing about their beliefs regarding the benefits of producing GM crops. Increased yields have also been regarded as a perceived benefit of GMFPs that positively influences consumers' attitudes and PI of GMFPs (Chen 2008; Ghoochani et al. 2017; Zhang et al. 2018), but increased yields did not emerge from the data as a perceived benefit when the participants spoke about their PI of GMFPs. Instead, they elaborated on the sub-salient aspect, particularly when discussing their beliefs and values in terms of increased productivity, although the sub-salient aspect was less influential in values compared to beliefs and the least influential in the expectations data. It has further been suggested that pest resistance is considered to be a perceived benefit of GMFPs (Ghoochani et al. 2017). Pest resistance emerged as a sub-salient aspect in the beliefs data, it did not emerge in the values data, and was less prominent in terms of expectations. However, although GM crop production benefits were prominent in the beliefs component, as seen in Chapter 5, Section 5.5, the aspects did not emerge as being influential in the PI of GMFPs based on attitudes, which could perhaps be attributed to their lack of prominence in the values and expectations data. The absence of GM crop production benefits shows that such benefits were not considered by the participants when purchasing GMFPs. It also shows that – when conversing particularly about their GMFP knowledge – the participants lacked confidence in the benefits of producing GM crops and

therefore did not mention nor elaborate on these aspects, pointing to their lack of GMFP knowledge.

9.2.6 Summary of the Perceived Known Benefits of Purchasing GMFPs

Continuing from the four themes in Chapter 8, the most salient aspects of Theme 5, namely the perceived known benefits of purchasing GMFPs, are summarised in Table 9.1 to show how each theme develops and builds on each other.

Table 9.1: Summary of the Most Salient Aspects of Themes 1 to 5

Theme	Salient Knowledge, Sources of GM-Related Information and PI Aspects of GMFPs					
Theme 1: Lack of Knowledge about GMFPs	Ignorance of GMFPs	Lack of Information Sharing	Platforms to Disseminate Information			
Table 2: Sources of GM-Related Information that would be Consulted	Internet	Published Scientific Journal Articles	Word-of-Mouth	University Resources	Agricultural Publications	Consulting Multiple Sources
Theme 3: Food Products Purchased Regularly Assumed to contain GM Ingredients	GM Crops Cultivated in SA	Maize or Corn-Containing Food Products	Bread	Grain-Based Food Products	Vegetables & Fruits	Meat Products
Theme 4: Interactions with GMFPs on the Market	Predominance of GMFPs	Not Specifically Looking to Purchase or not to Purchase GMFPs	Alternative Food Product Preferences to GMFPs			
Theme 5: Perceived Known Benefits of Purchasing GMFPs	Increased Nutritional Value	Increased Availability	Lower Price	Improved Aesthetic Properties	Improved Food Processing Properties	

Themes 1 to 4 showed that the participants lacked GMFP knowledge; that they did not seek information from GM-related sources; mentioned which food products they assumed contained GM ingredients that were purchased regularly; and showed their interactions with GMFPs on the market. Perceived known benefits of purchasing GMFPs also emerged from the data in Theme 5, as seen in Table 9.1.

Various authors have ascertained in their respective studies that the perceived benefits of GMFPs can have a positive influence on consumers' attitudes toward such food products (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Zhu et al. 2018). As a result, numerous benefits of GMFPs have been found to drive consumers' PI, such as resistance to pests as well as a changing climate; increased nutritional value; lower price; improved appearance and colour; longer shelf life; and improved taste (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Bray & Ankeny 2017; Popek & Halagarda 2017; Nazir et al. 2018; Zhang et al. 2018; Dovey & Ntuli 2020; Macall et al. 2021; Saha et al. 2021; Sendhil et al. 2022). Regarding consumers' knowledge of GMFPs, consumers generally have limited knowledge (Lucht 2015; Jonker 2017; Marx 2017; Cui & Shoemaker 2018; Dirisu et al. 2020), which was also particularly evident in this study, as seen in Theme 1 of Chapter 8.

It is suggested in the context of this study that the salient and sub-salient aspects in terms of participants' behavioural beliefs about the perceived benefits of GMFPs could elicit an acceptable view of GMFPs due to the favourable outcomes that can be attained by purchasing such food products, influencing attitudes in a favourable manner (showing that behavioural beliefs favourably influence attitudes), contributing to an optimistic attitude towards GMFPs. It is further suggested that the perceived optimistic attitude of GMFPs can favourably influence the participants' PI and thus also contribute to a perceived optimistic PI. In the context of this study, a perceived optimistic PI refers to aspects that were favourable to the participants, favourably influencing their PI. It is further proposed that a perceived optimistic PI can favourably influence behaviour toward GMFPs, resulting in an optimistic behaviour (see Figure 9.2).

The study also postulates that the identification of these aspects could be an indication that the participants had some knowledge of GMFPs, but it is suggested that their knowledge remains limited, thereby influencing beliefs in an unfavourable way, contributing to perceived factually unfounded beliefs. In Figure 9.2, a summary of the salient and sub-salient aspects regarding the perceived known benefits of purchasing GMFPs is illustrated. The proposed influence of behavioural beliefs on attitudes is also depicted in Figure 9.2, followed by the suggested influence of attitudes on the PI of GMFPs. The proposed influence of PI on behaviour toward GMFPs is also illustrated. The suggested state of the participants' knowledge of GMFPs and its influence on beliefs is also presented in Figure 9.2.

As shown in Figure 9.2, this theme illustrated that the behavioural belief of perceived beneficial aspects contributed toward a perceived optimistic attitude. This led to a perceived optimistic

PI and behaviour regarding GMFPs, which could be beneficial in terms of attaining a food-secure status and SDG 2. Considering the lack of elaboration, quotes, volume and prominence of sub-salient aspects on the majority of the aspects, specifically concerning the beliefs and values data, it appears consumer-related beneficial aspects of GMFPs were not influential in the intent to purchase GMFPs based on participants' attitudes towards such food products. Only GMFPs' lower price and longevity appeared to influence their PI of such food products. GM crop production benefits were also not influential in PI due to their absence from the conversations with participants. The lack of influence on PI illustrates that even when an aspect or attribute emerges or is prominent in the beliefs or values component of the EV Model of Attitude, it does not mean that it will have an influence on PI (through attitude) regarding GMFPs. Therefore, the beliefs, values and expectations components did not influence the PI of GMFPs. Although it is suggested that behavioural beliefs had a favourable influence on attitudes, as seen through the beneficial aspects that emerged from the data, it is, however, suggested that the behavioural beliefs did not result in a prominent attitude toward GMFPs since the majority of the aspects lacked depth.

While perceived benefits were identified, indicating some state of knowledge, the study suggests that, based on the data that emerged in Chapter 8 and the lack of elaboration on the majority of aspects and their lack of prominence in this theme, participants' knowledge remains limited. Overall, there was a demonstrated uncertainty among the participants when discussing their knowledge of GMFPs' benefits.

In the following theme, the perceived known risks of purchasing GMFPs are presented.

9.3 THEME 6: PERCEIVED KNOWN RISKS OF PURCHASING GMFPS

The participants' behavioural beliefs (the belief that a behaviour will be negative) of GMFPs were explored by exploring the perceived risks of GMFPs (Zakaria et al. 2016; Bakti et al. 2020). The exploration into the participants' behavioural beliefs of GMFPs contributed to understanding what influence behavioural beliefs have on attitudes and the role that attitudes play in the PI of GMFPs, which this study aimed to explore. Since this study proposes that the EV Model of Attitudes feeds into the attitude element of the TPB, the data that emerged from exploring the three components of the EV Model of Attitudes (namely beliefs, values and expectations) were considered in this section to explore the role that attitudes play in the intent to purchase GMFPs. Many studies have used the attitude construct of the TPB to explore its influence on consumers' PI of GMFPs (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Khouloud & Sameh 2018; Zhang et al. 2018; Saha et al. 2021).

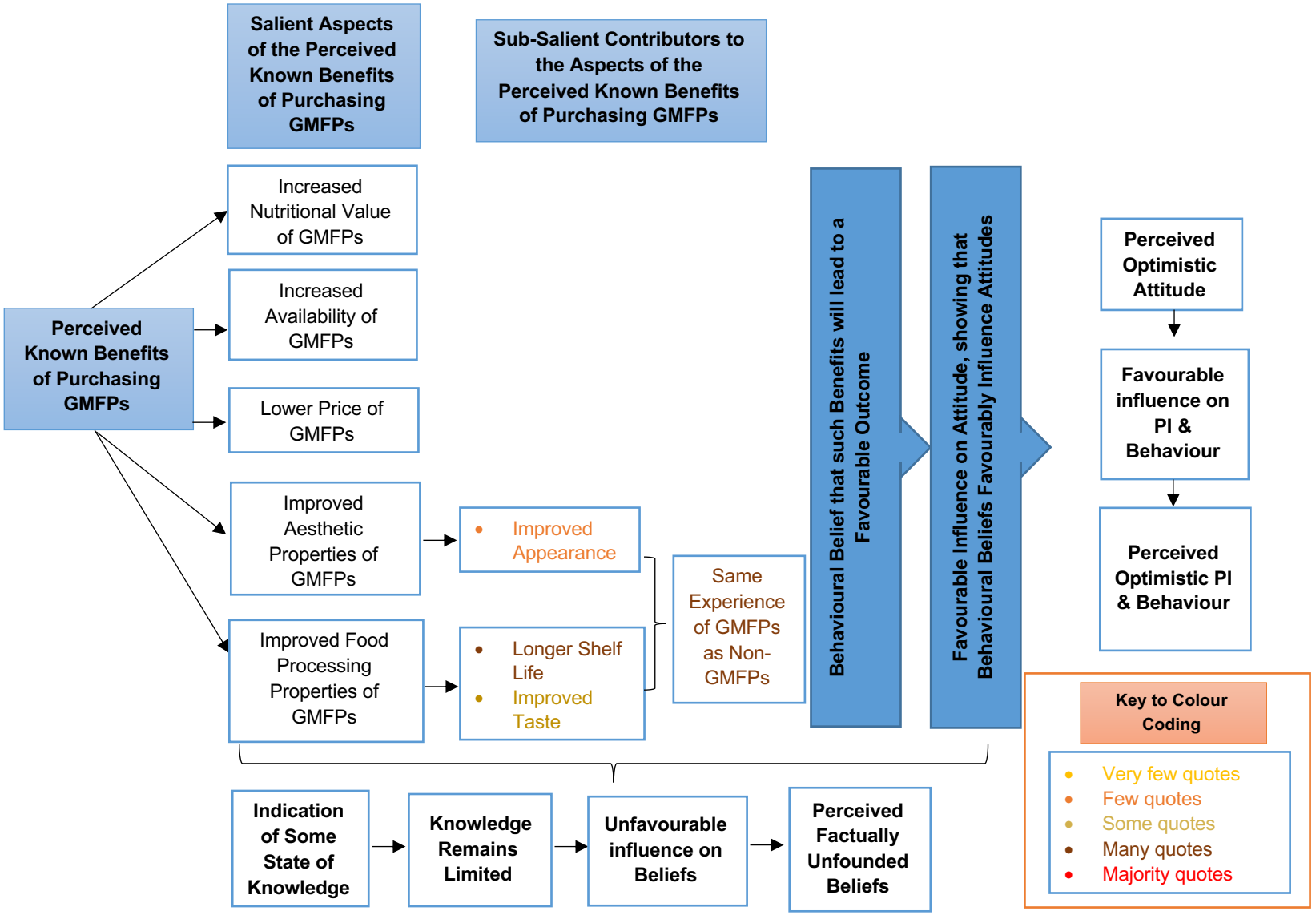

Figure 9.2: The Perceived Known Benefits of Purchasing GMFPs and the Proposed Influence of Behavioural Beliefs on Attitude; Attitude on PI; PI on Behaviour; the Perceived State of Knowledge; and the Proposed Influence of Knowledge on Beliefs

Authors have also agreed that exploring the perceived risks of GMFPs can contribute to understanding consumers' attitudes and PI of GMFPs (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Kim 2010; Ghasemi et al. 2013; Rodriguez-Entrena et al. 2013; Khouloud & Sameh 2018; Zhang et al. 2018; Hwang & Nam 2021; Saha et al. 2021; Sleboda & Lagerkvist 2022).

To investigate the influence of knowledge on their beliefs about GMFPs, the risks of GMFPs were further used to explore participants' GMFP knowledge and see which risks they knew such food products could have. Although the data in the previous theme reflected that there were perceived benefits to purchasing GMFPs, perceived risks also emerged. The most salient aspects and their respective contributing sub-salient aspects regarding the perceived known risks of purchasing GMFPs are shown in Figure 9.3.

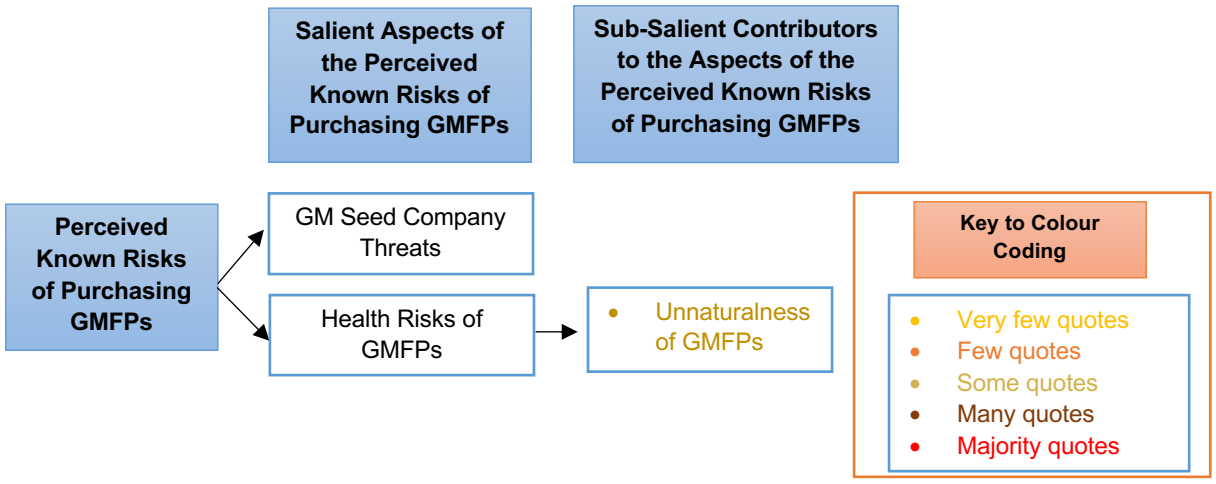

Figure 9.3: Perceived Known Risks of Purchasing GMFPs

As shown in Figure 9.3, only two aspects regarding the perceived known risks of purchasing GMFPs were identified from the data analysis. These include GM seed company threats, as well as health risks related to GMFPs, and are subsequently presented.

9.3.1 Risks in terms of GM Seed Company Threats

GM seed company threats emerged as a salient aspect in terms of the perceived risks of GMFPs, which the participants knew about because such companies could have *"control over the seeds"* and because GM seeds *"are created by companies who patent the seeds"* and thus *"they have legal rights over the seeds"*. It was added that *"the control of companies over seeds is a risk of GMFPs"*. Participants shared that GM seed companies could be

"manipulating the farmer" because they are *"trying to make more money out of consumers"* from selling GM seeds, which is a perceived risk of GMFPs. It has been opined that consumers are particularly concerned about GM seed companies in terms of their dominance over GM seeds in their quest for financial gains (Bonny 2017; Van Acker et al. 2017), which could negatively influence consumers' attitudes and PI of GMFPs.

The data indicated that the participants knew about the possible threat that GM seed companies could pose in selling GM seeds; the aspect also emerged as a perceived risk of GMFPs. It is proposed in this study that the participants had the behavioural belief that purchasing GMFPs could increase the threat that GM seed companies were perceived to hold, which is an unfavourable outcome of purchasing such food products. This aspect was elaborated on in more detail by the participants in Chapter 5, Section 5.7.3, where their beliefs about the risks and concerns of producing GM crops were discussed but were less prominent in Chapter 6, Section 6.4.4 when assigning an ethical value to GMFPs. The aspect was also considerably less prominent in terms of the participants' expectations regarding the unfavourable outcomes of GM crop production, as seen in Chapter 7, Section 7.4.3. In this theme, this aspect was not elaborated on, as seen in the absence of quotes and lack of sub-salient aspects. GM seed company threats thus did not emerge as a prominent aspect in the PI context based on attitudes. It is, therefore, proposed that GM seed company threats were not an influential aspect in the participants' PI of GMFPs. Although the aspect was identified as a perceived risk of GMFPs that could point to some state of knowledge, the lack of elaboration indicates the participants' lack of confidence in conversing about this aspect, indicating a lack of GMFP knowledge.

9.3.2 Health Risks of GMFPs

The participants knew about the possible perceived **health risks of GMFPs**, which emerged as a salient aspect. It was stated that *"they could be harmful to humans"* and *"there's a risk in terms of your health"* because *"it could affect my health in a negative way"*; thus, the perceived health risks of GMFPs *"might stop me from purchasing these products"*. Therefore, *"I would say the long term health risks"* and *"definitely how it affects me and my health"* are perceived risks of purchasing GMFPs. It has been found that consumers are particularly concerned about the health risks associated with consuming GMFPs, which could prompt them to avoid GMFPs (Ruth & Rumble 2019; Kubisz et al. 2021; Siddiqui et al. 2022; Abdoul et al. 2023; Zhaleh et al. 2023). Thus, health risks are considered to be perceived risks of GMFPs, which could affect consumers' attitudes and PI unfavourably (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Hassan et al. 2016; Ghoochani et al. 2017; Zhang et al. 2018; Zhu

et al. 2018; Akbari et al. 2019; Hwang & Nam 2021), as demonstrated among consumers from Denmark, Germany, Italy, and the UK as well as Iran (Bredahl 2001; Akbari et al. 2019).

In this study, individual participants added that *"GM foods could put people at higher risk for cancer"*, that there could be *"allergies enhancements"* as well as *"higher chances of birth defects",* which are perceived health risks linked to GMFPs. It has been alleged that possible cancer development and allergic reactions are factors consumers are anxious about (Rzymski & Krolczyk 2016; Lefebvre et al. 2019; Emmanuel et al. 2021; Shen et al. 2022), as seen in a study conducted in Europe, where allergic reactions were a factor negatively influencing consumers' PI of GMFPs (Popek & Halagarda 2017). It has also been stated that consumers are worried about possible infertility after consuming GMFPs (Rzymski & Krolczyk 2016; Keshani et al. 2020). Subsequently, health risks, such as allergies, toxicity, cancer and antibiotic resistance have been regarded as perceived risks influencing consumers' attitudes and PI in an unfavourable way (Bredahl 2001; Chen 2008; Ghoochani et al. 2017).

The health risks GMFPs posed were attributed by some participants to knowing that *"they are not natural"* and that *"they are not in their most natural form"* because *"it's not the original process"* in terms of how GMFPs are produced and because *"they are manipulating chromosomes"*, therefore *"foods have changed"*. Therefore, the unnaturalness of GMFPs emerged as a sub-salient aspect contributing to the perceived health risks linked to purchasing such food products. Regarding the genetic changes of GMFPs, many consumers have viewed these food products as being unnatural due to the alteration of their genetics (Popek & Halagarda 2017; Raman 2017; Dovey & Ntuli 2020; Pakseresht et al. 2021). This was seen in a study conducted by Bredahl (2001), who found that the unnaturalness of GMFPs was a perceived risk that negatively influenced consumers' attitudes and PI of GMFPs. Therefore, the unnaturalness of GMFPs is considered a perceived risk influencing attitudes towards GMFPs (Bredahl 2001). However, in Chapter 5, Section 5.4.2, the unnatural state of GMFPs was discussed more extensively, indicating this aspect was prominent in the participants' beliefs but not in their intent to purchase these food products.

From the data obtained in this study, the participants knew possible health risks could be associated with the consumption of GMFPs, attributed to the unnaturalness of such food products; it was also a perceived risk of purchasing such food products. Thus, it is suggested that the participants had the behavioural belief that purchasing and consuming GMFPs could lead to negative health effects. In Chapter 5, Section 5.8.1, health risks emerged as an important belief and in Chapter 6, Section 6.2.2, the participants demonstrated concern in terms of compromising on their health to attain GMFPs, but it was a less influential aspect

than in the beliefs data. It also emerged as a less influential aspect in the expectations data, as discussed in Chapter 7, Section 7.5.1, but was more influential than in the values data. However, health risks were not elaborated on when the PI of GMFPs was discussed – as seen in the limited quotes that emerged from the data and lack of sub-salient aspects – suggesting that health risks were not a prominent aspect affecting the participants' attitudes regarding their intent to purchase GMFPs. It is thus suggested that health risks were not influential on PI, indicating that the risks linked to the consumer were not influential in the intent to purchase GMFPs in the context of their attitudes. This could be explained by the theme (consumer-related risks and concerns of GMFPs) being the least influential in the beliefs component of the EV Model of Attitudes, although health risks were influential on consumer-related risks and concerns about GMFPs. The lack of elaboration on health risks in this section suggests that the participants were not confident about the possible health risks that could, in fact, be linked to GMFPs, pointing to their limited knowledge.

9.3.2.1 The Absent Aspects in the Intent to Purchase GMFPs

The environmental risks linked to producing GM crops and the use of GM seeds were important aspects affecting participants' beliefs, but less influential on their values and the least influential on their expectations. Also, the aspects did not emerge as perceived risks influencing PI, thereby suggesting that the risks and concerns of producing GM crops were not considered by the participants and did not affect their intent to purchase GMFPs based on their attitudes. The lack of influence could be ascribed to the theme (risks and concerns of GM crop production) being the least influential theme in the beliefs data, which carried through to the values and expectations data.

Ethical and religious concerns have been considered as perceived risks of GMFPs, playing a role in the attitude and PI of such food products (Verdurme & Viaene 2003; Chen 2008; Hassan et al. 2016; Ghoochani et al. 2017; Akbari et al. 2019). In Chapter 5, Section 5.4, the altered state of existence emerged as a particularly important theme when discussing the participants' beliefs about genetic modification, which included their religious views about GMFPs (Section 5.4.4). Also, in Chapter 6, Section 6.4.1, the religious ethical values of genetic modification were an important and influential aspect in assigning value to GMFPs. However, religious and ethical aspects linked to genetic modification did not emerge as perceived risks when purchasing GMFPs. The altered state of existence of GMFPs in terms of their biological change and technological intervention were also not mentioned, suggesting that these aspects did not play a role in the participants' PI of GMFPs, guided by their attitudes. As discussed in Chapter 8, Section 8.5.1.1, the participants were not particularly concerned about purchasing

GMFPs, which could suggest why the possible risks and concerns and the altered state of existence linked to GMFPs did not play an influential role in their intent to purchase these food products, based on their attitudes. Not mentioning such aspects – in the knowledge context of GMFPs – indicates that the participants were unsure about the actual risks or possible concerns linked to GMFPs, thereby pointing to a lack of knowledge about GMFPs.

9.3.3 Summary of Perceived Known Risks of Purchasing GMFPs

To continue illustrating the participants' knowledge of and PI toward GMFPs, the most salient aspects in Themes 1 to 5 are shown in Table 9.2, together with the salient aspects of Theme 6, namely the perceived known risks of purchasing GMFPs.

Table 9.2: Summary of the Most Salient Aspects of Themes 1 to 6

Theme	Salient Knowledge, Sources of GM-Related Information and PI Aspects of GMFPs					
Theme 1: Lack of Knowledge about GMFPs	Ignorance of GMFPs	Lack of Information Sharing	Platforms to Disseminate Information			
Table 2: Sources of GM-Related Information that would be Consulted	Internet	Published Scientific Journal Articles	Word-of-Mouth	University Resources	Agricultural Publications	Consulting Multiple Sources
Theme 3: Food Products Purchased Regularly Assumed to contain GM Ingredients	GM Crops Cultivated in SA	Maize or Corn-Containing Food Products	Bread	Grain-Based Food Products	Vegetables & Fruits	Meat Products
Theme 4: Interactions with GMFPs on the Market	Predominance of GMFPs	Not Specifically Looking to Purchase or not to Purchase GMFPs	Alternative Food Product Preferences to GMFPs			
Theme 5: Perceived Known Benefits of Purchasing GMFPs	Increased Nutritional Value	Increased Availability	Lower Price	Improved Aesthetic Properties	Improved Food Processing Properties	
Theme 6: Perceived Known Risks of Purchasing GMFPs	GM Seed Company Threats	Health Risks				

Building on the previous themes (as depicted in Table 9.2), although perceived known benefits of purchasing GMFP emerged from the data, perceived known risks of purchasing GMFP were also highlighted by the participants.

In terms of attitudes, the perceived risks of GMFPs have been found to negatively influence consumers' attitudes toward these food products (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Costa-Font & Gil 2011; Zhu et al. 2018). Particular risks linked to GMFPs, such as health concerns, have been found to influence consumers' PI of GMFPs negatively (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Ghoochani et al. 2017; Zhang et al. 2018; Kubisz et al. 2021; Saha et al. 2021). Regarding consumers' knowledge about GMFPs – as discussed in Chapter 8, Section 8.2.1 of this study – consumers generally have limited knowledge about such food products (Lucht 2015; Jonker 2017; Marx 2017; Cui & Shoemaker 2018; Dirisu et al. 2020).

In the current study, it is postulated that the salient and contributing sub-salient aspects regarding behavioural beliefs of the perceived risks of GMFPs – which can lead to an unfavourable outcome after purchasing such food products – can create conflict with the participants' attitudes toward GMFPs, thereby influencing their attitudes in an unfavourable way, leading to a perceived threatened attitude towards these food products. It is further proposed that the perceived threatened attitude can influence participants' PI unfavourably, leading to a perceived threatened PI of GMFPs. In addition, it is proposed that the threatened PI can influence behaviour towards GMFPs in an unfavourable manner, thereby threatening the participant's behaviour.

Although some state of knowledge was indicated by participants mentioning perceived risks linked to purchasing GMFPs, the lack of elaboration on the possible risks of GMFPs and the participants' self-admitted ignorance of GMFPs, as seen in Chapter 8, suggests that their limited knowledge could influence their beliefs in an unfavourable way and lead to perceived factually unfounded beliefs regarding GMFPs. The salient and sub-salient aspects of perceived risks of purchasing GMFPs, which the participants knew about, together with its suggested influence on attitude and PI, are depicted in Figure 9.4. The influence of behavioural beliefs on attitudes, attitudes' influence on PI, and thus the influence of PI on behaviour, as well as the suggested state of the participants' knowledge of GMFPs and its influence on beliefs, are also illustrated in Figure 9.4.

In this theme, it is proposed that the participants' behavioural beliefs about the perceived risks of purchasing GMFPs influence attitudes in an unfavourable manner, as shown in Figure 9.4.

It leads to a threatened attitude and subsequent threatened PI and behaviour in relation to GMFPs, which could pose a challenge to the GM food industry's efforts to enhance food security among the SA population, while seeking to achieve SDG 2. In terms of the risks of GMFPs, this could pose a problem to the GM food industry since a focus on the benefits of these food products to increase GMFP purchases and create a desire for such food products on the market may be compromised. However, due to the lack of depth of data and lack of elaboration (as seen through the lack of quotes), the volume of sub-salient aspects, as well as the absence of aspects compared to the beliefs, values and expectations data, it is suggested that the perceived risks of GMFPs were not a prominent aspect affecting the participants' intent to purchase GMFPs, based on their attitudes. It also shows that beliefs, values and expectations did not drive a specific PI. It is further proposed that behavioural beliefs unfavourably influenced attitude, as evident in the risk aspects that emerged from the data. Nevertheless, it is suggested that the behavioural beliefs did not result in a pertinent attitude toward GMFPs, and based on the lack of salient aspects, behavioural beliefs were not prominent in participants' attitudes towards GMFPs in the context of purchasing such food products. In addition, when participants were probed about purchasing GMFPs, hesitancy was demonstrated through their lack of confidence in articulating what perceived benefits and risks they linked to GMFPs would affect their purchasing of GMFPs, which could have ensued from the participants' beliefs being factually unfounded.

Although some state of knowledge was demonstrated by highlighting some perceived risks of GMFPs, the study suggested that the participants' GMFP knowledge is limited, thereby contributing to perceived factually unfounded beliefs. There was a lack of elaboration and prominence of the aspects in the data, and participants showed hesitancy during the conversations regarding the perceived risks they knew about. The lack of quotes in this section and in Section 9.2 could further show that the participants held back in terms of which benefits and risks they attributed to GMFPs, as they were not confident and sure if certain GMFP benefits and risks – which they believed GMFPs had, as seen in Chapter 5 – were in fact the case. When probed to determine whether a perceived benefit or risk was known to be factual, the participants again demonstrated hesitancy and were unsure, contributing to the lack of elaboration. This shows that the participants did not have a factual basis from which GMFPs could be viewed and were thus not confident in their knowledge regarding the benefits and risks of GMFPs. This theme could further suggest that perhaps knowledge influences PI towards GMFPs.

The seventh theme, namely the lack of PBC over purchasing GMFPs, is discussed next.

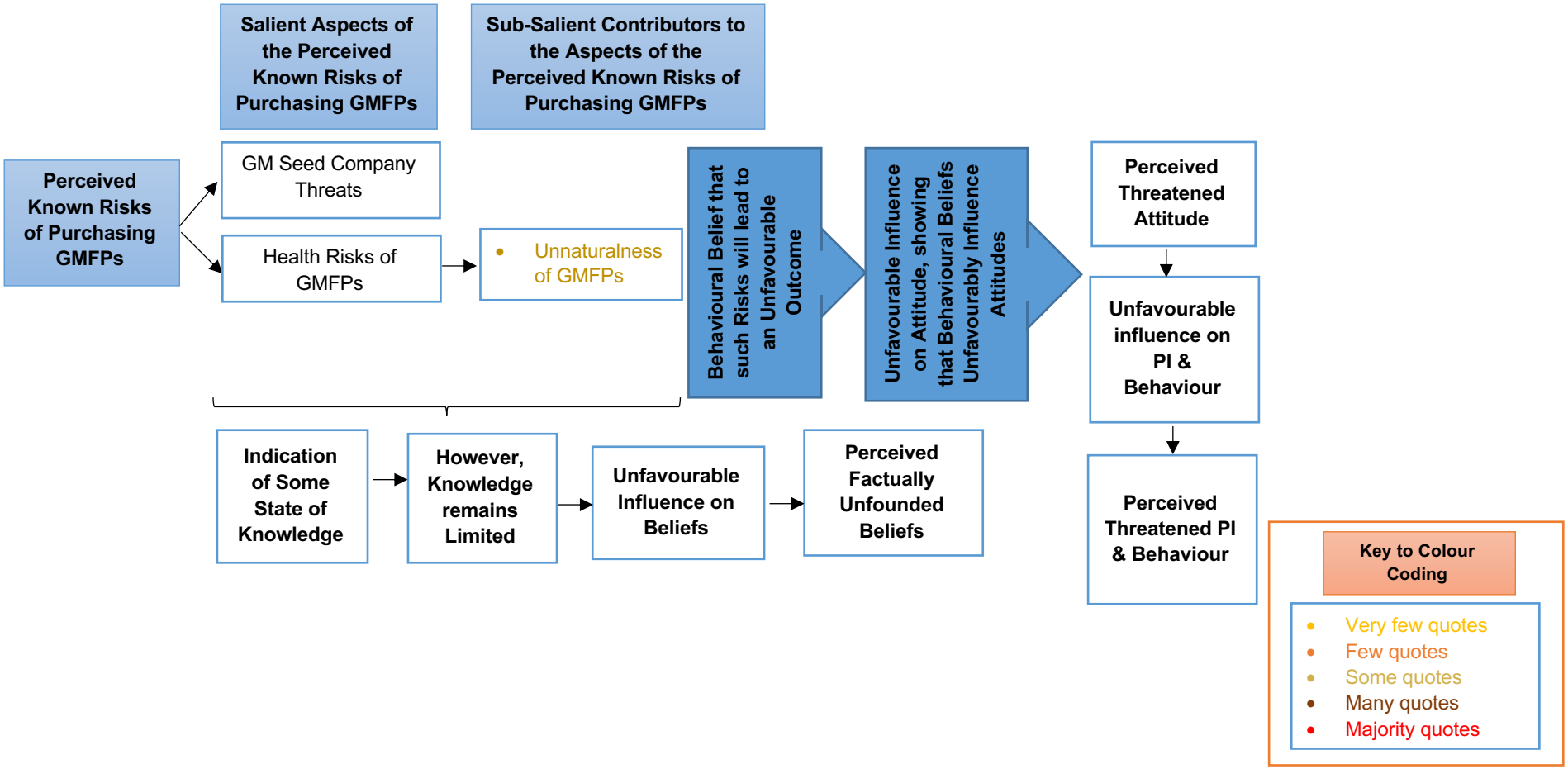

Figure 9.4: The Perceived Known Risks of Purchasing GMFPs and the Proposed Influence of Behavioural Beliefs on Attitude; Attitude on PI; PI on Behaviour; the Perceived State of Knowledge; and the Proposed Influence of Knowledge on Beliefs

9.4 THEME 7: LACK OF PERCEIVED BEHAVIOURAL CONTROL OVER PURCHASING GMFPS

Continuing from Theme 4 in Chapter 8, further aspects emerged from the data that the participants believed, in their opinion, did not give them control in terms of purchasing GMFPs. These aspects influenced their lack of PBC over purchasing GMFPs, and the most salient aspects and respective sub-salient contributing aspects are depicted in Figure 9.5.

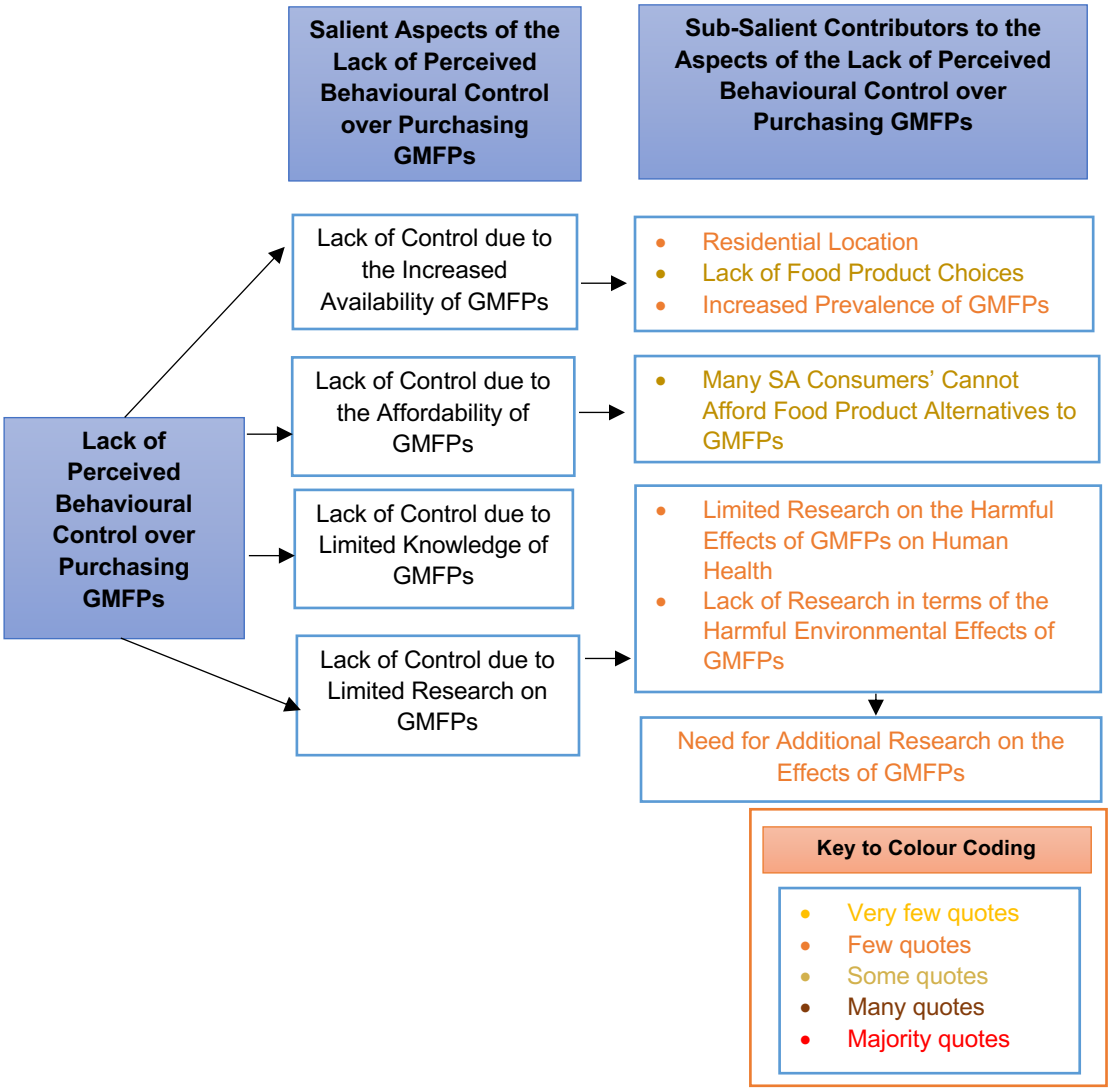

Figure 9.5: Lack of PBC over Purchasing GMFPs

As illustrated in Figure 9.5, the aspects that participants perceived they had no control over in terms of purchasing GMFPs, which contributed to their lack of PBC, included a lack of control due to the increased availability of GMFPs; lack of control due to the affordability of GMFPs; lack of control due to limited knowledge of GMFPs; and lack of control due to limited research on GMFPs. A discussion on these aspects follows.

9.4.1 Lack of Control due to the Increased Availability of GMFPs

It emerged from the data that, according to the participants, *"I'm not in control at all"* and *"I don't think I'm in control of it at all"* in terms of purchasing GMFPs. Therefore, regarding the purchasing of GMFPs, *"it is not something that you kind of control because you have to buy what's available"* and *"whatever your town has or has provided"*, which, in this study, the participants assumed were predominantly GMFPs, as seen in Chapter 8, Section 8.5.1. Therefore, a **lack of control due to the increased availability of GMFPs** emerged as a salient aspect of the data. This was specifically attributed by a few participants to the location where they resided and by some participants to their lack of food product choices. In terms of the participants' residential location and lack of food product choices – considering that the participants resided in the Midlands, which is inland (Midlands Meander 2020) – it was stated that *"where I'm living, we are limited in what we have in our local shops"* as *"we don't have a large range of shops to choose from"*, and therefore *"we just buy what we have in the shops and have available to use"*. Subsequently, *"I don't really have an option [to buy non-GMFPs] unless I really want to drive like an hour to somewhere else"*; therefore, *"in the location I find myself living in, I am purchasing genetically modified food"*. It was summarised that *"in our capacity in a rural area, you don't have control because there's no other choice"* but to purchase GMFPs; and *"in our rural context, we have less control over what we are able to purchase because of availability and variety"*, thereby compromising the participants' PBC in terms of purchasing GMFPs. It was further added that *"you can't really go out and want to drive to a bigger city to go and just buy a few products that might be a natural product"*, which also compromised the participants' control over purchasing GMFPs. In terms of the availability of GMFPs, it has been opined that such food products could be more readily available (Qaim & Kouser 2013; Dizon et al. 2016; Charlebois et al. 2019), and according to Verdurme and Viaene (2003) and Chen (2008), the availability of food products can influence PBC and thus the intent to purchase food products.

Drawing from Chapter 8, Section 8.5.1, the participants assumed that the food products available in supermarkets were predominantly GM, and a few participants assumed they would have to purchase GMFPs because *"there are more GM products than there are non-GM"*; *"there is more of them"*; and *"it would be difficult to buy foods that are not genetically modified, I would probably go as far as to say that it's impossible"*. Thus, the increased prevalence of GMFPs emerged as another sub-salient aspect contributing to the salient aspect, as the participants indicated that they lacked PBC over purchasing GMFPs. On the international market, GMFPs are also becoming increasingly available to consumers, thereby

increasing consumers' chances of purchasing such food products (Vermeulen et al. 2005; Charlebois et al. 2019; Hwang & Nam 2021).

Even though the availability of GMFPs emerged as a perceived benefit in Section 9.2.2 of this chapter, the increased availability of GMFPs also contributed to the participants' lack of PBC when it came to purchasing such food products. Therefore, it is suggested in this study that the participants had the control belief that, due to the increased availability of GMFPs, they lacked control when purchasing food products that contained GM ingredients. They believed they had to purchase GMFPs due to the location where they resided, their lack of food product choices, and the increased prevalence of GMFPs in supermarkets. Thus, in their own opinion, they did not have the opportunity or resources to purchase alternative or non-GMFPs. Although a lack of PBC was demonstrated in terms of purchasing GMFPs, it is also suggested that the control belief that there is increased availability of GMFPs in supermarkets could promote the participants' purchasing of GMFPs because, in their opinion, it is easy to purchase such food products. The data from this section correlate to Chapter 8, Section 8.5.1, where the participants articulated that they did not have PBC over purchasing GMFPs due to the assumption that almost all food products available in SA supermarkets contained GM ingredients, and increased availability made it easy to purchase GMFPs. Based on the volume of sub-salient aspects, it is proposed that the increased availability of GMFPs was an influential aspect in the participants' lack of PBC over purchasing GMFPs.

9.4.2 Lack of Control due to the Affordability of GMFPs

In addition to having a lack of control due to the perceived increased availability of GMFPs, **the affordability of GMFPs** also emerged as an important salient aspect of the data. It contributed to the participants' lack of PBC over purchasing GMFPs because *"it's about what I can afford, and I think that's true for the majority"*; therefore, *"in some ways I am not in control"* over purchasing GMFPs because of their *"affordability"* compared to traditional food products. Therefore, the participants were *"not in complete control because the problem is that it is cheaper"* because *"genetically modified and not genetically modified is not equally weighted"* in terms of price, and *"that's the issue"* when it comes to purchasing GMFPs. Although the profile of the participants who took part in this study suggested that they were financially stable individuals, *"the financial side of it becomes a pull, it pulls you in that direction"*, as *"the cost of it would dictate what I purchase"*, the question was asked: *"do you really have control over it?'"* because *"you don't really have much of an option"* as *"you'll go for what you can afford"* such as GMFPs. It was added that because *"they are cheaper"*, *"it forces people to buy cheaper food",* thus *"you are sort of trapped into buying them"*, thereby contributing to the lack

of control due to the perceived reduced price of GMFPs compared to other food products. Other studies concur that GMFPs could cost less than their traditional counterparts (Dovey & Ntuli 2020; Prianto et al. 2020; Emmanuel et al. 2021).

In terms of the affordability of GMFPs, it was stated by some participants that *"not a chance, I am not in control"* and *"currently I am not in control"* over purchasing such food products because *"I am not in that bracket that can pick and choose which product I want to buy. I think 1% of the South African population are in that bracket, everybody else is in the other bracket"*. Therefore, *"I think a large majority don't have control"* because *"there are a lot of South Africans out there who don't even have a choice whether it's GM or not"* since they purchase what they can afford. It was added that *"I think for the communities and South Africa as a whole, being a nation with a lot of poverty, I think many people don't have the choice"* over what food products they can purchase and therefore *"people buy GM because it is just cheaper"*. It was further assumed that GMFPs were purchased because *"the natural stuff is way more expensive, so it's out of reach to lots of South Africans who just need to feed their families"*, therefore *"it's not always easy for people living hand-to-mouth to eat in a certain way and to purchase in a certain way"*, so *"for many people in our country, it's not an option for them to afford alternatives [to GMFPs] because they will automatically go for what's cheaper"*. As a result, many SA consumers not being able to afford food product alternatives to GMFPs emerged as a sub-salient aspect contributing to the salient aspect, thereby limiting the participants' control over purchasing GMFPs. In 2020, 11 million people in SA earned approximately R800.00 per month (Galal 2021), illustrating that many people in SA can only afford cheaper food products.

Although the reduced price of GMFPs emerged as a perceived benefit of GMFPs (as seen in Section 9.2.3 of this chapter), the affordability of GMFPs also emerged as an aspect contributing to the participants' lack of PBC in purchasing GMFPs. Therefore, in this study, it is proposed that the participants had the control belief that, although the affordability of GMFPs promoted and made it easy to purchase such food products, the affordability of GMFPs reduced their purchasing control. From a financial point of view, they did not have the financial resources or opportunity to purchase other food products because, in their opinion, they could not afford more expensive food products that were non-GM (although they were proposed to be financially stable), nor did many other SA consumers, thereby contributing to a lack of PBC in terms of purchasing GMFPs. This could indicate that the participants were, in their own opinion, forced to purchase GMFPs due to their affordability. Drawing an analogy to Section 8.5.3 in Chapter 8, where GMFPs' interaction with the market was discussed, it was expressed that alternative food products would be preferred instead of GMFPs. However, the preference

could potentially not be exercised due to the perceived prevalence of GMFPs on the market and perhaps the affordability of these food products. Due to the volume of quotes relating to the affordability of GMFPs, it is suggested that this was an important and influential aspect impacting participants' lack of PBC over purchasing GMFPs.

9.4.3 Lack of Control due to Limited Knowledge of GMFPs

As seen in Chapter 8, Section 8.2.1, the participants' self-admitted **limited knowledge of GMFPs** was also a salient aspect that emerged from the data when their PBC and PI were explored. Limited knowledge of GMFPs compromised their PBC in terms of purchasing GMFPs. Participants stated they were *"probably not in control because I would say I'm largely not aware of what products are genetically modified and what are not"*, and *"we buy products without knowing if it's GM or not"*. As a result, in terms of purchasing GMFPs, *"I suppose not as in control as I could be where I know more"* about such food products; therefore, *"in that way, not 100% in control"* over purchasing GMFPs. In Chapter 8, Section 8.3, the data showed that the participants did not consult sources to gain information about GMFPs, which could have contributed to their lack of knowledge and PBC when purchasing such food products.

It has been opined that, generally, consumers do not understand GMFPs, which influences their confidence when deciding whether or not to purchase GMFPs (Delgado-Zegarra et al. 2022). This view was confirmed in a study conducted in Malaysia and SA, which found that consumers were unaware of GMFPs (Tanius & Seng 2015; Gastrow et al. 2018). Korean consumers were also found to have a low level of GMFP knowledge, which subsequently caused hesitancy in purchasing such products (Hwang & Nam 2021). Jiang and Zhang (2021) concurred that limited GM knowledge is a contributing factor resulting in consumers refraining from purchasing GMFPs, as illustrated in studies carried out in Japan and Iran, where it was found that consumers' limited knowledge negatively influenced their PI of GMFPs (Kim 2010; Ghasemi et al. 2013). Therefore, limited knowledge has been found to be an aspect influencing the PI of GMFPs (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008; Zhang et al. 2018; Zhu et al. 2018), which was also seen in this study.

Thus, limited knowledge emerged as an aspect contributing to the participants' lack of PBC over purchasing GMFPs. This study, therefore, postulates that the participants had the control belief that they had limited knowledge of GMFPs, which compromised their control over purchasing GMFPs as they did not have knowledge as a resource to assist them in purchasing non-GMFPs. This made it difficult for them to purchase or not to purchase these products. In Chapter 8, Section 8.5.2, the data showed that the participants did not specifically seek to

purchase or not purchase GMFPs, thereby compromising their PBC due to the proposed control belief that insufficient knowledge was present to aid them when purchasing such food products. This further reiterates the participants' lack of GMFP knowledge, as seen in Chapter 8, Section 8.2.1. In the context of purchasing GMFPs, it is suggested that limited knowledge of GMFPs could pose a challenge in aiding consumers in their food security status; however, due to the lack of depth of data (as seen through the limited quotes and absence of sub-salient aspects), it is suggested that limited knowledge did not play an influential role in terms of PBC and PI in the context of this study.

9.4.4 Lack of Control due to Limited Research on GMFPs

Limited research on GMFPs emerged as a salient aspect contributing to the participants' lack of PBC. They stated that *"I'm not in control"* and *"I think [I have] limited control as a consumer"* over purchasing food products, which makes it difficult to purchase GMFPs *"because of limited research"* on GMFPs. They said, *"this is not sufficiently researched"*, because *"it's something I don't know if they have done enough background research on"*. According to a few participants, *"[I am] not in control"* because *"not enough research into the long-term health effects"* have been done in terms of GMFPs; *"I don't think that there has been enough long-term research into what the effect is on the human body"*; *"there is just not enough research over the long-term [health] effects to GMO products"*, which further limits their control over purchasing GMFPs. It thus emerged from the data that limited research on the harmful effects of GMFPs on human health was a sub-salient aspect, contributing to the salient aspect. In terms of research on health risks in the GM context, studies have not found GMFPs to be harmful to human health (Russo et al. 2020; Addey 2021; Rodriguez et al. 2022).

According to a few participants, *"there can be environmental side effects"* to producing GMFPs, and *"these effects are not being looked at, they are not being studied, especially its impact on nature"*. Therefore, in terms of GMFPs, *"they haven't been investigated enough to see the effect the environment"*, and "*the potential impact that the production of GMFPs could have on the environment"* has not been investigated, which makes it difficult to purchase GMFPs. Thus, the lack of research in terms of the harmful environmental effects of GMFPs emerged as a further sub-salient aspect, contributing to the salient aspect. It has been found that consumers are concerned about the effect that GM food production could have on the environment (Ghimire et al. 2023). However, numerous organisations have suggested that findings from existing research on GMFPs have shown there were no environmental or health risks linked to these food products (Ghanian et al. 2016; Ruth & Rumble 2019; Gbashi et al. 2021; Pakseresht et al. 2021; Gbadegesin et al. 2022). In terms of protecting the environment,

the ACB was also developed in SA to control the risks in GM crop production, thereby aiming to protect the environment (African Centre for Biodiversity 2020), which consumers can find comfort in.

Due to the perceived lack of research on GMFPs, a few participants stated that *"a lot more study needs to be done into exactly what the long-term effects are"* of consuming GMFPs; *"more research needs to be conducted"* on the possible health and environmental risks of GMFPs. Therefore, *"it needs a lot more study*" because *"better research"* can create a better *"understanding"* of GMFPs, can increase the control over having the resources available to purchase such food products, and can *"prove these things either wrong or right"*. Therefore, the need for additional research on the effects of GMFPs emerged as a sub-salient aspect of the data. It is suggested that the participants were educated, potentially contributing to their understanding of the importance of conducting and using research to verify aspects, such as the safety of GMFPs. In terms of GM-related research, the possible risks linked to such food products should be thoroughly researched, and the data received from environmental and health risk assessments of GMOs should be distributed and made available to consumers, when proven safe (Adenle et al. 2012; Islam et al. 2020); thereby creating a sense of comfort among the consumers in terms of GMFPs.

In the current study, it is suggested that the participants had the control belief that there was limited research on GMFPs and insufficient GM-related research on the harmful effects these food products could pose to human health and the environment. This belief compromised their control (PBC) over purchasing GMFPs. In their opinion, they did not have sufficient resources to consult and research findings to assist them in purchasing GMFPs, making it difficult to purchase such food products. Subsequently, a need for more research on the possible harmful effects of GMFPs was demonstrated. This could be contradicting as the participants admitted that they did not seek information about GMFPs in Chapter 8, Section 8.3, indicating that their control belief that there is limited research about the harmful effects of GMFPs is an assumption. Nevertheless, considering the volume of sub-salient aspects that emerged from the data, it is suggested that limited research on GMFPs was an important and influential aspect contributing to the participants' lack of PBC in terms of purchasing such food products.

9.4.5 Summary of the Lack of Perceived Behavioural Control over Purchasing GMFPs

The main aspects of Theme 7, namely the lack of PBC over purchasing GMFPs, as well as the salient aspects of Themes 1 to 6, are illustrated in Table 9.3.

Table 9.3: Summary of the Most Salient Aspects of Themes 1 to 7

Theme	Salient Knowledge, Sources of GM-Related Information and PI Aspects of GMFPs					
Theme 1: Lack of Knowledge about GMFPs	Ignorance of GMFPs	Lack of Information Sharing	Platforms to Disseminate Information			
Table 2: Sources of GM-Related Information that would be Consulted	Internet	Published Scientific Journal Articles	Word-of-Mouth	University Resources	Agricultural Publications	Consulting Multiple Sources
Theme 3: Food Products Purchased Regularly Assumed to contain GM Ingredients	GM Crops Cultivated in SA	Maize or Corn-Containing Food Products	Bread	Grain-Based Food Products	Vegetables & Fruits	Meat Products
Theme 4: Interactions with GMFPs on the Market	Predominance of GMFPs	Not Specifically Looking to Purchase or not to Purchase GMFPs	Alternative Food Product Preferences to GMFPs			
Theme 5: Perceived Known Benefits of Purchasing GMFPs	Increased Nutritional Value	Increased Availability	Lower Price	Improved Aesthetic Properties	Improved Food Processing Properties	
Theme 6: Perceived Known Risks of Purchasing GMFPs	GM Seed Company Threats	Health Risks				
Theme 7: Lack of PBC over Purchasing GMFPs	Lack of Control due to the Increased Availability	Lack of Control due to Affordability	Lack of Control due to Limited Knowledge	Lack of Control due to Limited Research		

As illustrated in Table 9.3, building on the previous themes, the data from Theme 7 showed that the participants lacked PBC over purchasing GMFPs, attributed to salient aspects such as a lack of control due to the increased availability of GMFPs; their affordability; limited knowledge of these food products; and limited research on GMFPs.

In terms of the salient aspects that emerged from the data in this theme, the availability of GMFPs is increasing in the international marketplace, and a variety of GMFPs are becoming available for consumers to purchase (Dizon et al. 2016; Charlebois et al. 2019; Hwang & Nam

2021). The lowered cost of GMFPs has also been highlighted as a possible influential factor in terms of purchasing such food products (Dovey & Ntuli 2020; Prianto et al. 2020; Emmanuel et al. 2021). However, consumers' knowledge of these food products remains low, which could be influencing their PI of GMFPs (Gastrow et al. 2018; Hwang & Nam 2021; Zhang et al. 2021; Delgado-Zegarra et al. 2022). In addition, it has been argued that sufficient research needs to be conducted to ensure that GMFPs are safe for human health and the environment; current studies show that GMFPs are safe (Islam et al. 2020; Gbashi et al. 2021; Gbadegesin et al. 2022).

The current study aimed to explore the participants' PBC of GMFPs through their control beliefs to better understand their PI. It is suggested that they had the control belief that they lacked control due to the increased availability of GMFPs and their affordability, making it easy to purchase such food products, which influenced their PBC in an unfavourable way. In their opinion, these aspects limited and compromised their control over purchasing GMFPs as they did not have the necessary resources and did not have the choice or financial opportunity to purchase other food products. It is also suggested that the control belief that limited GMFP knowledge and research contributed to not having such resources to aid them in their purchasing of GMFPs, thereby hindering them and making it difficult to purchase GMFPs, compromising their control over purchasing GMFPs and influencing their PBC in an unfavourable manner. It is proposed in this study that the salient and sub-salient aspects in this theme contributed to a perceived lack of PBC over purchasing GMFPs, leading to a perceived threatened PBC which influenced PI in an unfavourable way, thereby causing conflict and a perceived threatened PI toward GMFPs. It is also proposed that the perceived threatened PI leads to a perceived threatened behaviour toward GMFPs. Figure 9.6 offers a summary of the most salient and contributing sub-salient aspects that emerged in this theme in terms of the lack of PBC over purchasing GMFPs, as well as the proposed influence of control beliefs on PBC, the influence of PBC on the participants' PI, and the influence of PI on behaviour towards GMFPs.

As depicted in Figure 9.6, it is suggested that the participants' control beliefs unfavourably influenced PBC, which led to a perceived lack of PBC, thereby contributing to a threatened PBC, PI and behaviour in terms of GMFPs. This could pose an obstacle to promoting food security in the SA context and attaining SDG 2.

The following theme regarding the lack of PBC in terms of GMFP labelling is discussed next.

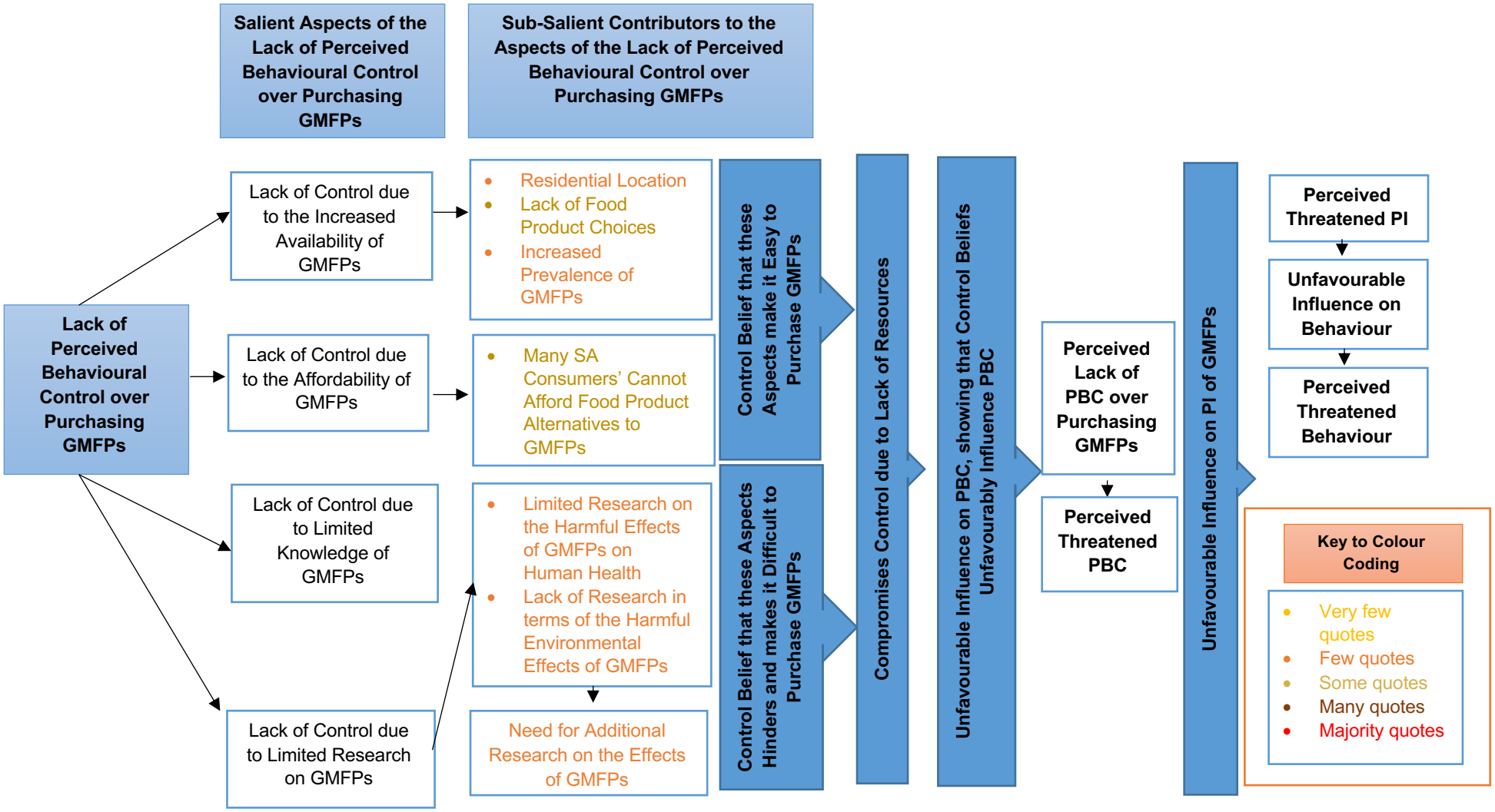

Figure 9.6: The Lack of PBC over Purchasing GMFPs and the Proposed Influence of Control Beliefs on PBC; PBC on PI; and PI on Behaviour

9.5 THEME 8: LACK OF PERCEIVED BEHAVIOURAL CONTROL OVER PURCHASING GMFPS IN TERMS OF GMFP LABELLING

A variety of data emerged regarding the lack of PBC over purchasing GMFPs, specifically in terms of GMFP labelling. It is subsequently presented as a separate theme, although it relates to the data in the previous theme, namely Theme 7 of this chapter (Section 9.4). The most salient aspects that emerged from the data regarding the lack of PBC over purchasing GMFPs linked to labelling and its contributing sub-salient aspects are illustrated in Figure 9.7.

Three aspects were identified regarding the lack of PBC over purchasing GMFPs in terms of GMFP labelling, which included the lack of GMFP labelling; ignorance of the information on GMFP labels; and not actively reading food labels. A discussion on these aspects follows.

9.5.1 Lack of GMFP Labelling

In addition to the lack of control due to the increased availability of GMFPs, affordability, limited knowledge and research on such food products, it emerged from the data that a lack of GMFP labelling restricted the extent of control participants had over purchasing GMFPs and thus hindered their purchasing of GMFPs. Lack of control due to a **lack of GMFP labelling** was therefore an important salient aspect that emerged from the data regarding participants' PBC when purchasing GMFPs because *"people aren't, in general, in control over food products they are buying or purchasing that have GM in it, or have been genetically modified"* due to lack of *"labelling"*; and because *"I don't think people in general are in control over what GMFPs they are specifically eating, because I think they don't really label it that well"*. As a result, *"I might not be in control"* because *"not all food products are disclosed that they have been modified"*. Therefore, *"maybe I can take a product that has been modified, but it doesn't say so, and therefore I wouldn't have control over that"*, compromising their control when purchasing GMFPs. Subsequently, *"I'm definitely not in control"* when it comes to purchasing GMFPs because *"most of the packaging does not stipulate if it's normal or GM"*.

In terms of the role that labelling plays in PBC, studies conducted in Belgium and Britain found that the labelling of GMFPs increased consumers' PBC over purchasing such food products, and thus has been argued to be an influential aspect in PBC and PI towards GMFPs (Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008), as can be seen in this study. It has further been argued that the lack of transparency regarding GM ingredients in food products contributes to consumers refraining from purchasing GMFPs (Zhang et al.

2021). Therefore, it has been suggested that producers must inform consumers when food products contain GM ingredients (Jiang & Zhang 2021).

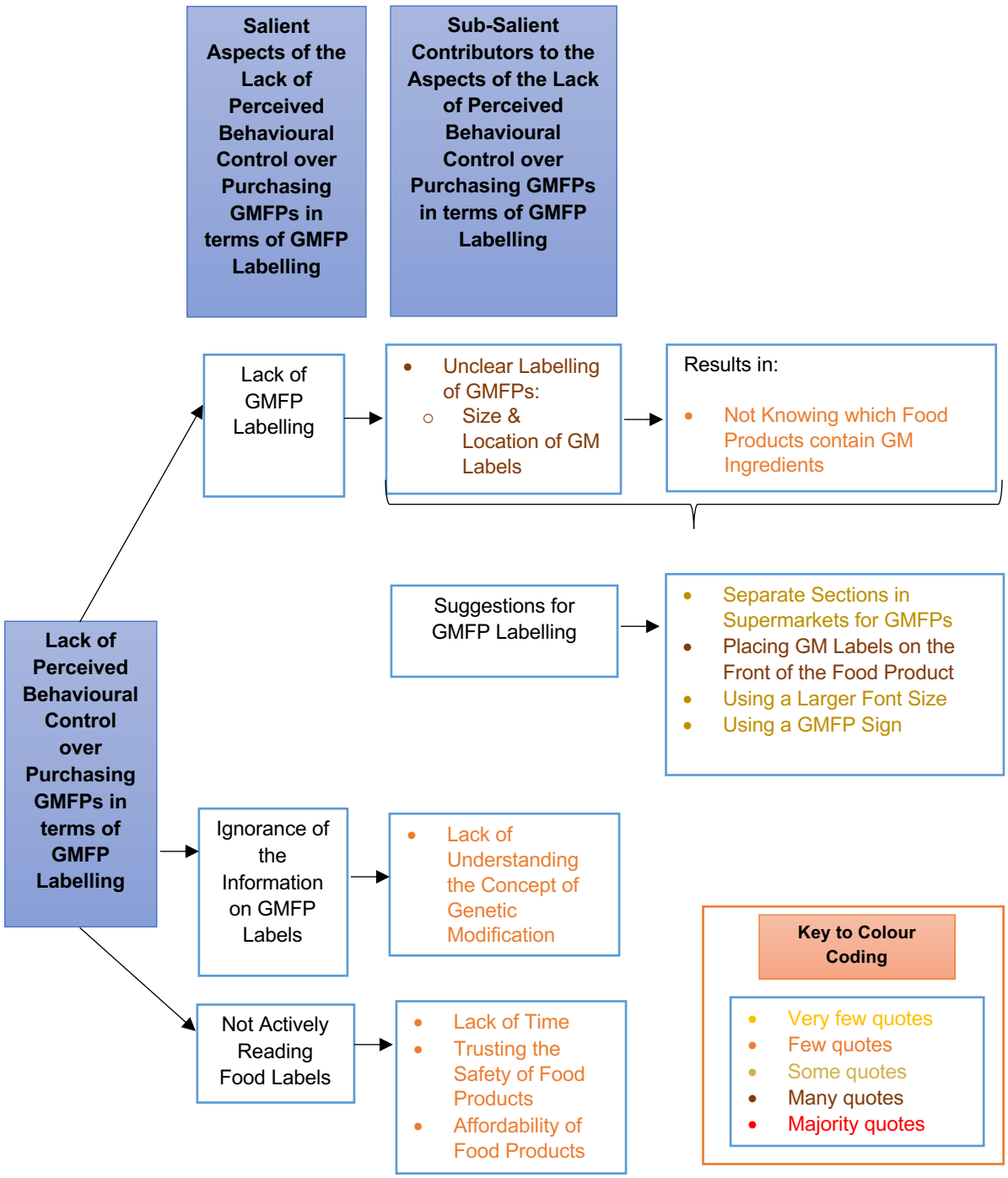

Figure 9.7: Lack of PBC over Purchasing GMFPs in terms of GMFP Labelling

In addition to the lack of GMFP labelling, *"I think people aren't in control"* over purchasing GMFPs because, for many participants, *"it is unclear"* because they *"think a lot of the goods sold that have a GM label, is at the back and it's written in small text that you can't really read it"*. They claimed the labelling is *"usually on the side [where] it says 'GMO'"* and *"that is very frustrating"*, which further limits their control and hinders the purchasing of GMFPs. Particular

reference was made to Kellogg's cornflakes by one participant, in that *"it says on the side in small written letters 'might contain genetically modified organisms', but it's very hidden and they don't really want you to see it"*. It was further added that *"I don't think they are always labelled in a way that would perhaps catch a buyers attention, sometimes it's a bit descript"*; and the *"display"* of the labelling of GMFPs is *"not in your face"*; *"it's not very noticeable"*; and *"it's not clear"* therefore *"it isn't actually sufficiently labelled"*. The unclear labelling of GMFPs was thus a sub-salient aspect that emerged from the data specifically attributed to the size and location of GM labels, compromising the participants' perceived control over purchasing GMFPs. In terms of the location of labels, food labels are generally placed at the back of a food product and are often tucked away so that they are not obvious to consumers (Jiang & Zhang 2021). It has also been suggested that the size of the letters on GM labels must be considered, that the label needs to appear on the front of the food product, and that the colour of the label must stand out and be visible to the consumer (Delgado-Zegarra et al. 2022).

Due to the lack of GMFP labelling clarity, a few participants stated that *"most of the time I would not know if it is or isn't GM"* as *"I can't see from the packaging whether it has or not"* because *"there's no information"*; thus, *"we are not really in control"* because *"I think the consumer is pretty much in the dark all the time"*. However, it was added that *"I would like to know if there are ingredients which have been genetically modified"*. As a result, *"lack of adequate labelling means we don't generally know if products we buy contain GMOs"* and therefore behavioural control *"comes down to labelling"* and *"obviously labelling will play a role"* in terms of having more control over purchasing GMFPs. Not knowing which food products contain GM ingredients, due to the unclear labelling of GMFPs, emerged as a sub-salient aspect confirming the salient aspect. These findings were supported by Popek and Halagarda (2017), who stated that consumers do not know whether they are purchasing GM or non-GMFPs due to a lack of labelling. Moreover, consumers in Botswana wanted to be informed of any GMFPs available in store, which labelling can assist with (Sebastian-Ponce et al. 2014; Hulela et al. 2019).

In this study, respective participants added that *"I think it's important to have things labelled that they have been genetically modified" "then you know exactly what you are purchasing"*; *"so that you can see the difference"* between a GM and non-GMFP, to make *"people aware of what they are buying"*; and *"so that people have got a choice"* and are *"more fully informed"* about the ingredients in the food products they are purchasing. Various authors have concurred that consumers are demanding that food products containing GM components should be labelled as such (Sleenhoff & Osseweijer 2013; Popek & Halagarda 2017; Gheysen

et al. 2019; Sanlier & Sezgin 2020). For example, it was found that consumers in Malaysia and China desired mandatory labelling of GMFPs (Uddin et al. 2018; Zhang et al. 2021).

In this study, participants had the control belief that the presence of GMFP labelling was lacking, which compromised their control in terms of purchasing GMFPs. This lack of control was specifically attributed to the unclear labelling of GMFPs, due to their size and location, which meant participants did not know which food products contained GM ingredients. This finding was also mentioned in Chapter 8, Section 8.2.1, where participants' ignorance of GMFPs was discussed. As a result, a lack of labelling made it difficult for the participants to purchase GMFPs since they did not have labelling as a resource to assist them in purchasing such food products. Drawing an analogy to Chapter 8, Section 8.5.1, participants expressed that – in their opinion – the majority of food products sold on the SA market contained GM components, thereby contributing to them purchasing and consuming GMFPs frequently; in Section 8.5.1.1, the participants demonstrated their lack of concern over purchasing GMFPs; and in Section 8.5.2 they demonstrated no particular need to specifically purchase or not purchase GMFPs. Despite this, they expressed that they did not have control over what they purchased when it came to GMFPs, and – in their opinion – they required appropriate labelling. Reflecting on participants' values and expectations of GMFPs, labelling also emerged in Chapter 6, Section 6.2.3, as an aspect contributing to a high degree of effort to attain such food products since labels were inadequate and unclear. It further emerged in Chapter 6, Section 6.4.5, that GMFPs need to be labelled from an ethical point of view; while in Chapter 7, Section 7.5.1, GMFP labelling was expected due to their possible health risks. The findings suggest that the appropriate labelling of GMFPs was important to the participants in terms of their values and expectations, but also in their PBC and intent to purchase such food products.

From the depth of data and extent of elaboration, as seen by the volume of quotes relating to the lack of GMFP labelling and the volume of sub-salient aspects, it is evident that a lack of GMFP labelling contributed to and was influential in the participants' lack of PBC when it comes to purchasing such food products. This was a particularly important aspect to them. Considering the prominence of the sub-salient aspects (based on the volume of quotes), the unclear labelling of GMFPs and insufficient size and location of GM labels were also important to the participants and thus influential in their lack of PBC. This led them to not knowing which products are GM.

9.5.1.1 Suggestions for GMFP Labelling

Regarding the discussions on the lack of GMFP labelling, participants made suggestions to remedy the lack of GMFP labelling, potentially contributing to consumers gaining more PBC over purchasing GMFPs. Therefore, **suggestions for GMFP labelling** emerged as a salient aspect of the data. Suggestions included having separate sections in supermarkets for GMFPs; placing GM labels on the front of the food product; using a larger font size for GM labels; and using a GMFP sign – all of which were sub-salient aspects that emerged from the data. In terms of having separate sections in supermarkets, some of the participants suggested that *"grocery stores could have two baskets, one labelled GM and the one non-GM – at least then you could make the choice"*, and there can be *"a section [in the supermarket] that is just [for] GM [food products]"*. Therefore:

> *"I think GMFPs should be in one area of the supermarket, so that one knows when you go there that these are genetically modified, and not mixed in between the other stuff"*.

By doing so, this *"will just make my life a bit easier in terms of a shopper"*, while also *"creating awareness"* of GMFPs in store. However, it was stated that, currently, *"I can't say in supermarkets that they are making us aware of it"* in terms of GMFPs. Participants proposed that supermarkets can be used to assist consumers in identifying GMFPs in-store, thereby promoting their PBC when purchasing GMFPs. In Chapter 8, Section 8.2.3, the participants also suggested that supermarkets could be a useful platform to share information about GMFPs.

In terms of placing GMFP labelling on the front of food products and using a larger font size, many participants suggested that *"it should be front and central"*; *"rather than on the back in small print"*; while some participants suggested that *"a larger font size"* or *"bolder print"* would be better. Regarding the use of a GMFP sign, some participants further suggested that *"an icon or a picture or a badge could be put in the front"* of the GMFP or *"like a stamp or a sticker"* or *"a GM symbol"* or *"an emblem" "to make it more recognisable" "which could attract you instantly as you walk in"* as *"you could see it immediately"* because *"it would be easier to read"*. A GMFP sign would be beneficial to consumers as:

> *"people don't have time to go and sit and take every single product off the shelf and have a read at the ingredients or the label at the back"*.

According to Kim et al. (2022), the design of labels, in terms of colour and style, influences the manner in which consumers react to GM labels. Therefore, it has been suggested that GM labels must stand out clearly to consumers, which can be achieved by using an icon or simple text and vocabulary such as 'GMO' (Yeh et al. 2019). It has also been recommended by Yeh et al. (2019) that GM labels should be kept uniform to make it easier for consumers to identify. To illustrate, a circular 'bioengineered' symbol was approved by the USDA, while in Brazil, GM-containing food products need to use a caution sign in the form of a yellow triangle with a T inside the label, which represents the word 'transgenic' (Jaffe 2017; Shreeves 2018).

Moreover, due to the perceived lack of GMFP labelling and its poor clarity and location, the participants suggested that separate supermarket sections could be used for GMFPs. They advised placing GM labels on the front of the food product, and a larger font size and a GM sign could be used; all of which could address the lack of GM labels while promoting PBC in terms of making it easier to purchase GMFPs. The suggestions for GMFP labelling were an important aspect based on the volume of sub-salient aspects. Considering the volume of quotes, the sub-salient aspect, namely placing GM labels on the front of the food product, was the most important suggestion among the participants.

9.5.2 Ignorance of the Information on GMFP Labels

From the data, it emerged that, in terms of GMFP labels, *"people are ignorant of it"*; thus, *"if they don't know what they are reading"* on food labels, then *"there is no control"* over purchasing GMFPs. Therefore, **ignorance of the information on GMFP labels** emerged as an important salient aspect limiting PBC when purchasing GMFPs, which was attributed to the sub-salient aspect of a lack of understanding of the concept of genetic modification. According to a few participants, *"even if you can label something big 'GMO', the average consumer doesn't know what GMO is"* because *"it's just a lack of understanding of what GM is"*; and *"I think a lot of people don't have a full understanding of genetically modified foods"*. Therefore, *"I think it's difficult for the general public, they are not well-informed enough yet to grasp the concept"* of genetic modification as *"it's not a very common topic"*, which could further contribute to their lack of control when it comes to purchasing GMFPs. Consumers have also been found to misinterpret or misunderstand the information on GM labels, which could hinder their PI of these food products (Sanlier & Sezgin 2020). Therefore, it has been suggested that consumers need to be educated on the information on GM labels, thereby allowing them to interpret the meaning of such labels and create confidence in their purchasing of GMFPs (Chagwena et al. 2019; Lefebvre et al. 2019). For example, in the USA, it has been suggested that companies could use bar codes on GM labels, from which information about genetic

modification can be obtained (Jaffe 2017). Struggling to interpret the information on GMFP labels also emerged as a sub-salient aspect when the participants discussed the effort involved in attaining such food products, as seen in Chapter 6, Section 6.2.3. This suggests that not being able to understand the terminology on GM labels could increase the effort involved in acquiring such food products and affect the participants' PBC. This could be attributed to the participants' ignorance of GMFPs, as discussed in Chapter 8, Section 8.2.1.

The participants' ignorance of the information on GMFP labels therefore contributed to their lack of PBC when purchasing GMFPs. Their limited understanding of the concept of genetic modification was a further hindrance. Thus, it is suggested that the participants had the control belief that their ignorance of the information on GMFP labels compromised their control over purchasing GMFPs as they did not have knowledge as a resource to aid them in purchasing GMFPs. However, although the data in Chapter 8, particularly Section 8.2.1, showed that the participants lacked GMFP knowledge, the lack of elaboration on this aspect – as seen through the lack of quotes and volume of sub-salient aspects – suggests that their ignorance of the information on GMFP labels did not play an influential role in the participants' lack of PBC in terms of purchasing GMFPs.

9.5.3 Not Actively Reading Food Labels

The data showed that the lack of labelling on GMFPs played a role in the participants' lack of PBC over purchasing GMFPs, but it was also stated that *"I don't check the labels"*; *"to be honest, I don't really read labels"*; and *"I don't read the labels"* of food products because *"it's not something that I really pay attention to when I'm choosing a product"*. It was added that, *"I probably would say 70% of the people don't actually look at what's in the ingredients"* when it comes to food products. Thus, the participants admitted that they do not read food labels and **not actively reading food labels** emerged as a salient aspect of the data, contributing to the participants' limited PBC over purchasing GMFPs. Research has suggested that food labels are generally not read by consumers (Popek & Halagarda 2017). This phenomenon can be seen in SA, South Korea and Canada, where it was established that, generally, consumers did not read food labels or check food labels regularly to establish whether a food product contained GM ingredients (Jonker 2017; Kim & Choi 2018; Macall et al. 2021). Drawing an analogy to Chapter 6, Section 6.2.3, not actively reading food labels also increased the participants' effort involved in acquiring such food products and the cost value of GMFPs.

Not actively reading food labels was attributed to sub-salient aspects such as a lack of time, trusting the safety of food products and the affordability of food products. Regarding the lack

of time, according to a few participants, *"I don't have the time"* to read food product labels because *"I'm always in a rush";* therefore, *"I don't spend the time to look at labels*"; and *"I just kind of go with the flow"*. This could be attributed to the participants having permanent full-time work commitments and busy schedules. According to Verdurme and Viaene (2003) and Chen (2008), time is considered to be an aspect influencing consumers' PBC and PI of GMFPs. As reflected in the values data in Chapter 6, Section 6.2.4, the participants also verbalised that there was an effort involved in obtaining GMFPs because they would need time to investigate whether a food product contained GM ingredients or not, suggesting that time was influential in the effort to attain GMFPs and purchase such products.

In terms of trusting the safety of GMFPs, a few participants stated *"I'm willing to trust that the food that is on the shelves is safe to consume"* because *"consumers have got to trust that the food that they are buying off the shelves of supermarkets is trustworthy or is safe"*, and therefore food labels are not read. In SA, the ACB regulates the safety of GM crops (African Centre for Biodiversity 2020). Even though the participants were considered financially stable individuals, the affordability of GMFPs was still highlighted as an aspect limiting PBC over purchasing GMFPs (see Section 9.4.2). Thus, in terms of the affordability of food products, a few participants stated that food labels were not read because *"I just buy what I can afford"* because *"in this day and age, the price of food has gone up"* and *"I think a large portion of not checking labels boils down to price"* because *"groceries can add up and become expensive very quickly, so I think most of us are quite frugal in how we shop"*. A study in SA established that food labels were not frequently read due to factors such as a lack of interest, lack of time, habitual buying, and the price of food products; however, it was also found that consumers did not trust the information presented on food labels and this contributed to them not reading the food labels (Basson 2018). Nevertheless, it has been generally opined that consumers do not have the time to read food labels when shopping, and they are more concerned about the price of the items they purchase (Koen 2016), which could be problematic for the usefulness of GMFP labels.

In terms of the labelling of GMFPs, the data showed that not actively reading food labels contributed to the participants' lack of PBC when purchasing GMFPs. A lack of time, trust in food products' safety, and affordability contributed to participants not reading food labels. It is thus postulated that the participants had the control belief that not actively reading food labels compromised their control over purchasing GMFPs. They believed by not reading food labels, these could not be used as a resource to assist them in their purchasing of GMFPs; thereby making it difficult to purchase these food products. Not actively reading food labels could possibly be attributed to the participants assuming that almost all food products are GM, they

were not concerned about purchasing and consuming GMFPs, and they had no specific need to purchase or not to purchase GMFP, as discussed in Chapter 8, Sections 8.5.1, 8.5.1.1 and 8.5.2. Based on the volume of quotes and sub-salient aspects that emerged from the discussions specifically relating to participants not reading food labels, it is suggested that participants' disinterest in actively reading food labels played an influential role in limiting their PBC in the GMFP context. The aspect does, however, leave ambiguity in terms of how the participants knew GMFP labels were lacking if they were not reading food labels.

9.5.4 Summary of the Lack of Perceived Behavioural Control over Purchasing GMFPs in terms of GMFP Labelling

To add to the salient aspects of Themes 1 to 7 across Chapters 8 and 9, the most salient aspects of Theme 8 – the lack of PBC over purchasing GMFPs in terms of GMFP labelling – are illustrated in Table 9.4.

Table 9.4: Summary of the Most Salient Aspects of Themes 1 to 8

Theme	Salient Knowledge, Sources of GM-Related Information and PI Aspects of GMFPs					
Theme 1: Lack of Knowledge about GMFPs	Ignorance of GMFPs	Lack of Information Sharing	Platforms to Disseminate Information			
Table 2: Sources of GM-Related Information that would be Consulted	Internet	Published Scientific Journal Articles	Word-of-Mouth	University Resources	Agricultural Publications	Consulting Multiple Sources
Theme 3: Food Products Purchased Regularly Assumed to contain GM Ingredients	GM Crops Cultivated in SA	Maize or Corn-Containing Food Products	Bread	Grain-Based Food Products	Vegetables & Fruits	Meat Products
Theme 4: Interactions with GMFPs on the Market	Predominance of GMFPs	Not Specifically Looking to Purchase or not to Purchase GMFPs	Alternative Food Product Preferences to GMFPs			
Theme 5: Perceived Known Benefits of Purchasing GMFPs	Increased Nutritional Value	Increased Availability	Lower Price	Improved Aesthetic Properties	Improved Food Processing Properties	

Theme	Salient Knowledge, Sources of GM-Related Information and PI Aspects of GMFPs					
Theme 6: Perceived Known Risks of Purchasing GMFPs	GM Seed Company Threats	Health Risks				
Theme 7: Lack of PBC over Purchasing GMFPs	Lack of Control due to the Increased Availability	Lack of Control due to Affordability	Lack of Control due to Limited Knowledge	Lack of Control due to Limited Research		
Theme 8: Lack of PBC over Purchasing GMFPs in terms of GMFP Labelling	Lack of GMFP Labelling	Ignorance of the Information on GMFP Labels	Not Actively Reading Food Labels			

Table 9.4 shows that, in addition to Themes 1 to 7, Theme 8 illustrated that GMFP labelling emerged as an additional aspect participants elaborated on in-depth in terms of contributing to their lack of PBC when purchasing GMFPs. Salient aspects such as the lack of GMFP labelling, ignorance of the information on GMFP labels and not actively reading food labels were identified as contributing aspects to the participants' lack of PBC when purchasing GMFPs.

The labelling of GMFPs has become a controversial topic, particularly linked to the debate around informing consumers about the ingredients in the food products they are purchasing (Jiang & Zhang 2021; Zhang et al. 2021). Due to the absence of or insufficient labelling of GMFPs, consumers do not know when they are purchasing food products containing GM ingredients (Popek & Halagarda 2017; Jiang & Zhang 2021). It has further been proposed that particular attention should be given to the size, location and colour of GM labels so that the labels can clearly be seen by consumers to assist them when purchasing GMFPs (Delgado-Zegarra et al. 2022). However, it remains concerning that consumers' lack of knowledge of genetic modification and GM information on labels could create further confusion among them and result in hesitancy to purchase GMFPs (Lefebvre et al. 2019). Another concern that has been highlighted is that food labels are not frequently consulted by consumers (Popek & Halagarda 2017; Macall et al. 2021).

In the context of this study, it is postulated that the control belief that such salient and contributing sub-salient aspects – in terms of the labelling of GMFPs – were present, compromising the participants' control over purchasing GMFPs. They lacked the necessary resources to purchase such food products, which hindered their efforts and made it difficult to

purchase GMFPs. It is suggested that this influenced their PBC in an unfavourable way (illustrating that control beliefs unfavourably influence PBC), leading to a lack of PBC over purchasing GMFPs. The lack of PBC is proposed to lead to a threatened PBC, which unfavourably influences PI and causes conflict with their PI, thereby leading to a perceived threatened PI towards GMFPs. This is then suggested to unfavourably influence behaviour and lead to a perceived threatened behaviour regarding GMFPs. A summary of the most salient and sub-salient aspects that emerged from the data regarding the lack of PBC over purchasing GMFPs in terms of GMFP labelling is depicted in Figure 9.8. The suggested influence that control beliefs have on PBC, the influence that PBC has on the participants' PI of GMFPs due to GMFP labelling, and the influence of PI on the behaviour toward GMFPs are further illustrated in Figure 9.8.

In this theme, as depicted in Figure 9.8, it is proposed that the control belief about the inadequate labelling of GMFPs, ignorance of the information on GM labels, and not reading food labels contributed to a lack of PBC when it came to purchasing such food products, thereby resulting in a threatened PBC, PI and behaviour toward GMFPs. This could be an issue to the participants' food security status and in the realisation of SDG 2: Zero Hunger. It is, thus, suggested that control beliefs influence PBC and that PBC influences PI and behaviour toward GMFPs in an unfavourable manner. Based on the volume and variety of data that emerged regarding the labelling of GMFPs – evident by the volume of quotes relating to the salient and sub-salient aspects – in comparison to the other respective aspects that emerged linked to participants' PBC, it is proposed that GMFP labelling was the most prominent influencer of PBC.

The subjective norms in terms of GMFPs are presented in the following theme.

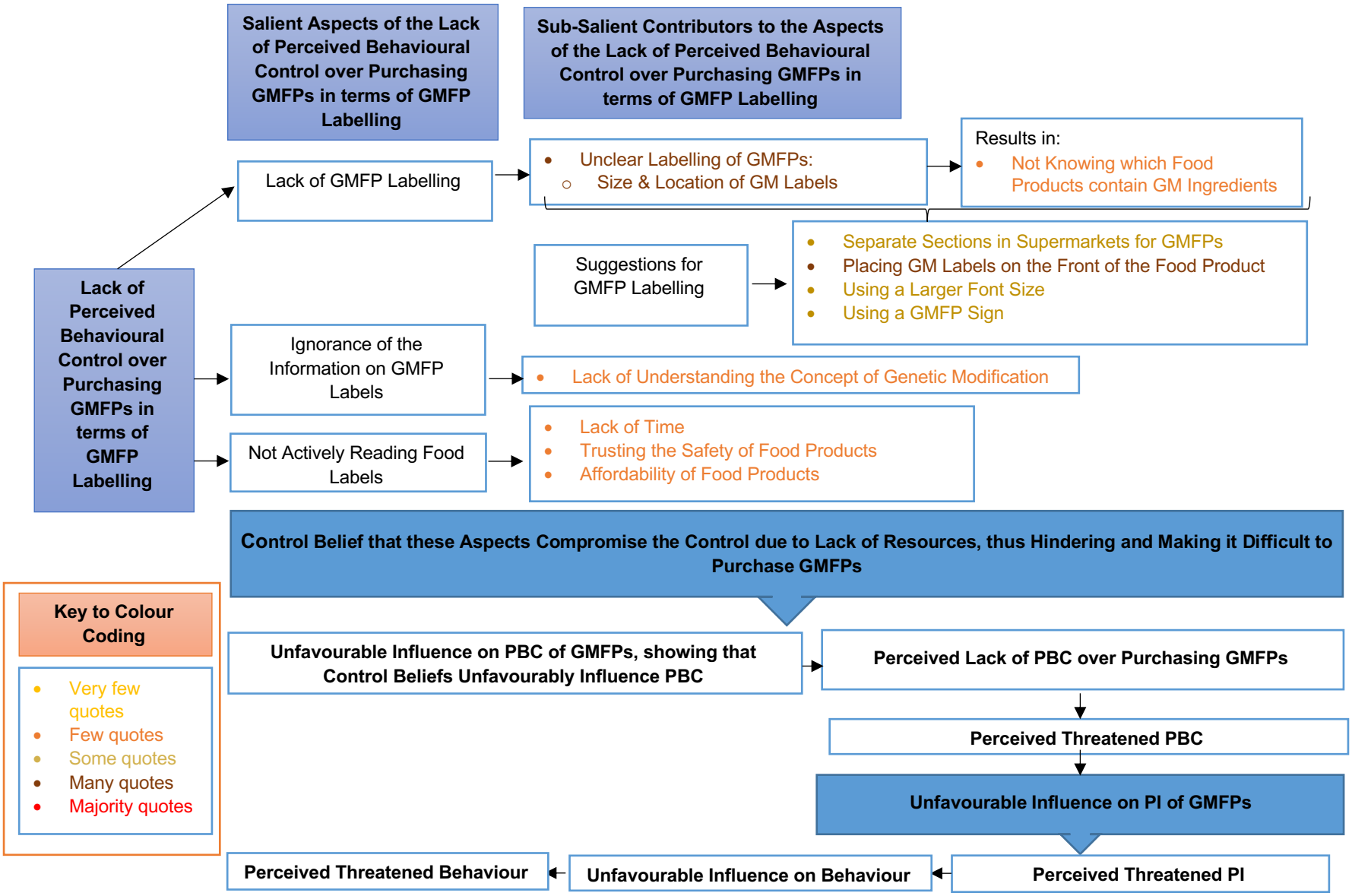

Figure 9.8: The Lack of PBC over Purchasing GMFPs in terms of GMFP Labelling and the Proposed Influence of Control Beliefs on PBC; PBC on PI; and PI on Behaviour

9.6 THEME 9: SUBJECTIVE NORMS IN TERMS OF GMFPS

Subjective norms refer to the perception that referent people expect a specific behaviour to be performed, which is influenced by normative beliefs (Phillips 2008b). These refer to the belief that referent people expect a particular behaviour, and the views referent people will have when a specific behaviour is performed (Ajzen 1985; Phillips 2008b; Al-Swidi et al. 2014; Nickell & Hinsz 2023). In this study, the normative beliefs were explored to investigate their influence on subjective norms within the TPB, and to further describe the role that subjective norms played on consumers' PI of GMFPs. Other studies have also used the subjective norms construct of the TPB in collaboration with the attitude, and PBC constructs to explore its influence on consumers' PI (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Zhang et al. 2018; Saha et al. 2021). From the data in this study, subjective norms emerged, and the most salient and sub-salient aspects are illustrated in Figure 9.9.

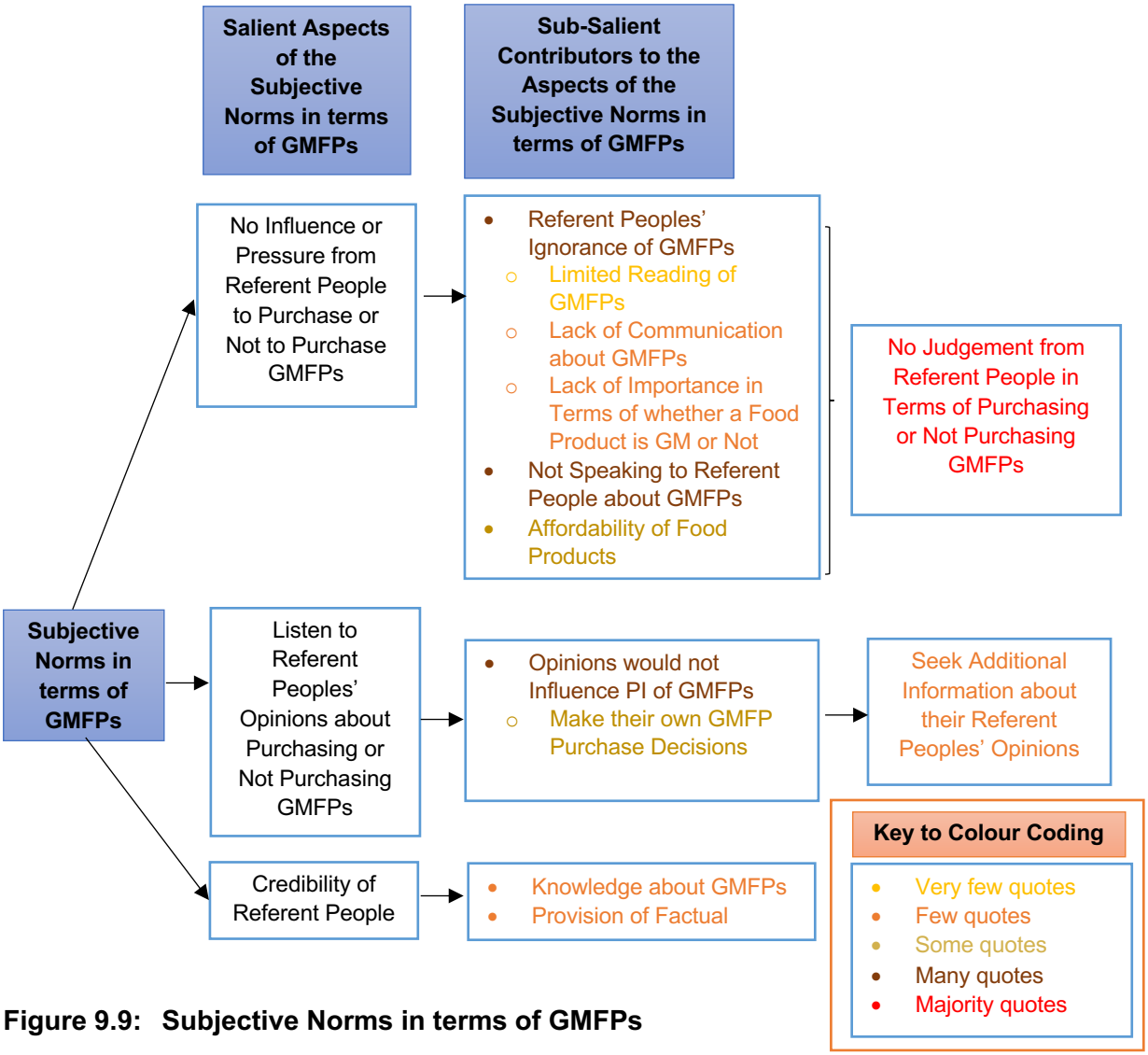

Figure 9.9: Subjective Norms in terms of GMFPs

Through the data analysis, as seen in Figure 9.9, three aspects were identified regarding subjective norms of GMFPs, namely no influence or pressure from referent people to purchase or not to purchase GMFPs; listening to referent people's opinions about purchasing or not purchasing GMFPs; and the credibility of referent people. These aspects are presented next.

9.6.1 No Influence or Pressure from Referent People to Purchase or not to Purchase GMFPs

In terms of the subjective norms relating to the purchasing of GMFPs, a participant stated that:

> *"I don't think that anyone has ever really pressured me to either buy or not buy a GM food product, whether that be family, friends or any other third party, or person that I have met"*.

Another added that *"I've never met someone who would say don't buy that because it's got GMO, or buy that because it has GMO, that hasn't happened"*; and as a result, *"there's no pressure from friends or family perspective at all"* when it comes to purchasing or not purchasing GMFPs. Thus, **no influence or pressure from referent people to purchase or not to purchase GMFPs** emerged as an important salient aspect of the data in terms of subjective norms. In Italy, Canada and China, it was also determined that subjective norms did not influence consumers in their PI of GMFPs (Prati et al. 2012; Huang 2018; Zhang et al. 2018). Another study, including consumers from the UK, Italy, Germany and Denmark, also ascertained that subjective norms did not influence consumers' PI of GMFPs (Bredahl 2001). However, it has been suggested that referent people such as friends and family could influence consumers' PI toward GMFPs (Huang 2018); for example, Brosig and Bavorova (2019) found that the PI among young female adults in the Czech Republic and Russia regarding GMFPs was influenced more by their mothers than their best friends, and subjective norms thus influenced their PI regarding GMFPs. Furthermore, subjective norms were also found in respective studies in New Zealand, Britain, Taiwan, Iran, Tunisian and Senegal to positively influence the PI of GMFPs (Cook et al. 2002; Spence & Townsend 2006; Chen 2008; Ghoochani et al. 2017; Khouloud & Sameh 2018; Abdoul et al. 2023).

In the current study, influence or pressure from referent people was not experienced by the participants in their decision to purchase or not purchase GMFPs because, in their opinion, many of the participants stated that *"a lot of [my] friends and family don't even know enough about GMFPs to actually pressurize me to purchase them or not"*; and that *"I don't think they even know what GMFPs are" "because they don't have the knowledge",* therefore, *"they don't*

know about the topic" "probably because they aren't very informed on it". Referent peoples' ignorance of GMFPs emerged as a sub-salient aspect, attributed to additional sub-salient aspects, namely limited reading of GMFPs, lack of communication about such food products, and the lack of importance in terms of whether a food product is GM or not. In Chapter 8, Section 8.2.1, the participants demonstrated a lack of GMFP knowledge, which – in their opinion – was also the case among their referent people. Numerous authors were united in their opinion that, generally, consumers lack awareness and knowledge of GMFPs (Cormick & Mercer 2017; Mahdi & Zin 2018; Dirisu et al. 2020; Hwang & Nam 2021). Canadian consumers were found not to be influenced by their referent people in terms of their PI of GMFPs possibly attributed to their limited GMFP knowledge (Huang 2018). In terms of limited reading, very few participants stated that *"they haven't read up on it"* and that *"my family haven't read as much and they are not following it"*. It has been suggested that a lack of interest in GMFPs contributes to consumers not reading about such food products (Bonah et al. 2017). The lack of research into GMFPs was also evident in Chapter 8, Section 8.2.1, where the participants ascribed their lack of GMFP knowledge to limited research on the topic. In Chapter 8, Section 8.3, the participants also admitted that they did not consult sources to gain more information about these food products, which was believed to be the case with their referent people as well.

With regards to a lack of communication about GMFPs, according to a few participants, "*I think it's sort of just an unspoken thing"*, and *"I don't think that it is something that is spoken about a lot"* because *"I just think maybe because there's not a great understanding of it and it's maybe not talked about or spoken about much, it's very rare"*. Therefore, *"I think if it was something that was spoken about more and if there's more out there, then it would definitely be more of a topic to discuss".* This could influence the role that referent people could play in consumers' intent to purchase or not purchase GMFPs. This sub-salient aspect links back to Chapter 8, Section 8.2.2, where the participants attributed their lack of GMFP knowledge to the lack of information sharing about such food products. To this effect, authors have argued that there is not an adequate amount of information being shared with the public about GMFPs (Bonah et al. 2017; Kim & Choi 2018). Regarding the lack of importance of whether or not a food product is genetically modified, according to a few participants, *"in the whole scheme of things, it's not really important, because life on earth is like a flash of light"*; therefore, in terms of referent people, *"I don't think that they see too much importance in whether something is genetically modified or not"*. As a result, *"they don't really think about it on a day-to-day basis"* because *"it's on outskirts of one's consciousness"*. Although this sub-salient aspect is linked to participants' referent peoples' point of view, Chapter 8, Section 8.5.1.1, showed that the participants were not concerned by their assumption that they were purchasing GMFPs on a

regular basis, suggesting that the participants themselves, as well as their referent people (in their own opinion), may not be particularly concerned about whether a food product contains GM ingredients.

Many participants added that *"I don't discuss it specifically with them, it's never come across as being anything worth making a discussion [about]"*; and that *"in my family, it's actually not something we really discussed in detail"* because *"it just doesn't come up in conversation"*. Subsequently, in terms of GMFPs, *"I haven't really discussed it with them"*. The lack of conversations about GMFPs with acquaintances could have been attributed to the participants not having family or friends who farmed with GM crops, and their lack of GMFP knowledge could lead to a refrainment from engaging in conversations about such food products with their referent people. It could further suggest that GMFPs were not a topic of interest among the participants and their referent people. Not speaking to referent people about GMFPs thus emerged as a sub-salient aspect, contributing to the salient aspect. The data analysis further showed that referent people would not influence some of the participants' PI toward GMFPs because *"we just buy whatever is the cheapest"*; and *"we buy what we can afford"* as *"we would still go back to affordability"*; because *"at the end of the day, it depends on what I'm able to do within my capacity"*. Therefore, the affordability of food products emerged as a further sub-salient aspect even though participants' profiles suggested they were financially stable. Regarding the affordability of food products, authors have opined that price influences consumers' decision to purchase GMFPs (Dovey & Ntuli 2020; Prianto et al. 2020; Emmanuel et al. 2021). The affordability of GMFPs also emerged as an important aspect when the participants shared their beliefs and values about GMFPs in Chapter 5, Section 5.6.3 and Chapter 6, Section 6.3.2.3. It was also a perceived benefit of purchasing these food products, as indicated in Section 9.2.3, and an aspect compromising their PBC, as seen in Section 9.4.2. It appears that affordability was important to the participants regarding their intent to purchase GMFPs.

Due to there being no influence or pressure from referent people to purchase or not to purchase GMFPs, it was stated that *"they wouldn't care if I purchased that product"*; *"if I do purchase a GM food product, they won't have any problem with that"*; and therefore *"it's not an issue for anyone in our family"*. Thus, the majority of participants had the normative belief that their referent people would not judge them for purchasing or not purchasing GMFPs; thus, this sub-salient aspect emerged from the data. The absence of judgement from referent people suggests that the GM food industry can primarily focus on the consumer where GMFPs are concerned and not on the influence of their referent people as well.

Therefore, based on the volume of quotes relating to this salient aspect and the volume of sub-salient aspects, it is suggested that no influence or pressure from referent people to purchase or not to purchase GMFPs was particularly important in terms of subjective norms. Referent peoples' ignorance of such food products (due to limited reading, lack of communication, and a lack of importance ascribed to whether a food product contains GM ingredients) and not speaking to referent people about GMFPs specifically contributed to this finding, particularly considering the volume of quotes relating to these two sub-salient aspects. The affordability of GMFPs further contributed to the lack of referent people's influence on participants' PI of GMFPs. As a result, referent people did not judge the participants for purchasing GMFPs, which, based on the prominence of the sub-salient aspect, was of particular importance. In the current study, it is suggested that the participants had the normative belief that their referent people did not expect them to behave in a specific way toward GMFPs and referent people did not approve nor disapprove of their behaviour towards purchasing or not purchasing GMFPs. This finding proposes that subjective norms did not influence the participants' PI of such food products.

9.6.2 Listen to Referent Peoples' Opinions about Purchasing or not Purchasing GMFPs

Although the participants' referent people did not influence their PI toward GMFPs, it was stated that *"I'd definitely hear them out"*; that *"I will definitely listen to their opinion"*; and that *"I will listen to them because everyone has a right to their own opinion"*. After all, *"it's a fascinating topic"*; *"there's a lot to learn about it"*; *"everyone has different ideas on things and we can all learn from one another"*; and because *"it's good to get a different point of view"*. Therefore, the participants were willing to **listen to the opinions of their referent people about purchasing or not purchasing GMFPs**, which emerged as an important salient aspect of the data in terms of subjective norms. Contrarily, Canadian consumers were found not to be interested in their referent peoples' opinions about GMFPs (Huang 2018).

Even though the participants were willing to listen to their referent peoples' opinions about GMFPs, the data incited that these opinions would not influence their PI of GMFPs, and many participants acted according to their own notions about such food products. They stated, *"I must say I will make the decision for myself beyond that"*; *"I will stick to how I feel"* about GMFPs; therefore, *"I don't think that would really influence me too much"* in terms of the opinions of their referent people. Thus, *"I probably wouldn't take it, I probably wouldn't follow it"* and, as a result, *"I don't think it would influence my intention at all"* to purchase or not to purchase GMFPs as *"I feel that they wouldn't easily sway me"* regarding referent peoples'

opinion about these food products. Evidently, the opinions of referent people would not influence the participants in their PI of GMFPs, which was a sub-salient aspect that emerged from the data. The sub-salient aspect was further supported by an additional sub-salient aspect of making their own purchase decisions regarding GMFPs because *"I can't just take one person's opinion on it, it's not fair to the product"*; and because *"I've pretty much made up my mind as to how I feel"*. It was further stated by some participants that *"it's a personal choice I make and I decide for myself"* and that *"I can choose what I buy, it's at my own discretion"*; and *"I'm quite happy to make my own decisions"*, therefore *"I am not going to be swayed by popular opinion"* regarding the purchasing of GMFPs. The lack of influence from the participants' referent people could have been linked to the participants' lack of anxiety about their assumption that they were purchasing GMFPs regularly, as seen in Chapter 8, Section 8.5.1.1.

Even though the opinions of referent people did not affect the participants' PI toward GMFPs, a few participants *"would try and find reason in why they would feel that way"* regarding their opinion about GMFPs; *"I would want to know why they say that"*; after which *"I will go try do some of my own research on that opinion"*; and *"I'll possibly read further if they raise something that I don't know about and make my own decision accordingly*". Therefore, seeking additional information about their referent peoples' opinions emerged as a sub-salient aspect of the data. Although the participants articulated that they would have to read up more about the information presented by their referent people to corroborate whether their opinions are factually correct, it does pose a contradicting aspect as the data in Chapter 8, Section 8.3 showed that they did not currently seek information about GMFPs. However, it could suggest that the participants could be encouraged by their referent peoples' opinions about GMFPs to acquire more information. Nevertheless, there was no demonstrated need to comply with their referent peoples' opinions about GMFPs.

Considering the volume of quotes relating to the salient aspect and the volume of sub-salient aspects that emerged, it is suggested that listening to referent peoples' opinions on whether or not to purchase GMFPs was an important aspect in terms of participants' subjective norms. It also appeared that the opinions of referent people (that would not influence the PI of GMFPs) were important to the participants, which is based on the prominence of the sub-salient aspect due to its volume of quotes. Thus, participants would make their own decisions about purchasing GMFPs, but would consider looking into the opinions of their referent people.

9.6.3 Credibility of Referent People

Although the participants were not influenced by their referent people to purchase or not to purchase GMFPs, the data indicated that the participants could potentially be influenced in terms of their PI towards GMFPs in the future. They said, *"it depends on the person who is providing the opinion and the credibility of that opinion"*; therefore, **the credibility of referent people** emerged as an important salient aspect from the data in terms of subjective norms, which was attributed to sub-salient aspects namely knowledge about GMFPs and the provision of factual information. In terms of GMFP knowledge among referent people, a few participants stated that *"I would act upon whether they are informed or not"*; it depends on *"if somebody gives me an opinion on a GM food product and they do have a lot of knowledge and extensive research on it"*. It would depend on whether *"the person has gone and studied in this direction because [then] they have a lot of knowledge about that"*; and *"if it was someone I respected that had a fair amount of knowledge about it, it could influence me"* in terms of purchasing or not purchasing GMFPs. In Chapter 8, Section 8.3.3, the participants also expressed that they would consult knowledgeable acquaintances if they wanted to gain more information about GMFPs. This claim could be fuelled by their educational status and understanding of the importance of credible information. In terms of knowledgeable acquaintances, Latvian consumers were willing to speak to acquaintances who knew something about GMFPs, but many consumers do not think GMFPs should be discussed with friends and family as their information lacks credibility (Wunderlich & Gatto 2015; Cormick & Mercer 2017; Cui & Shoemaker 2018; Russo et al. 2020).

According to a few participants, regarding the provision of factual information based on referent peoples' opinions, *"I would want them to back it up with facts"*; *"I need to have absolute facts on that, not just a person's opinion"*; and that *"they have to come at me with facts and studies"* because *"a lot of the time it's more emotional reasoning that people are using around this topic"*, thus *"they don't have a lot of credibility"*. Requiring their referent people to provide factually sound information about GMFPs could be contradicting as the participants admitted that they, themselves, did not seek information about GMFPs, as seen in Chapter 8, Section 8.3. Still, the participants expected their referent people to base their opinions about GMFPs on facts, which could have been ascribed to their referent peoples' perceived lack of knowledge. This could suggest that the participants were more concerned about whether the opinions of their referent people were factually sound rather than investigating whether their own beliefs about GMFPs were factually founded.

Therefore, referent people's credibility contributed to participants' subjective norms of GMFPs, which was attributed to referent people's knowledge about GMFPs and the provision of factual information about such food products. However, based on the lack of elaboration and the limited sub-salient aspects, it is suggested that referent people's credibility did not play an influential role in participants' subjective norms regarding GMFPs.

9.6.4 Summary of the Subjective Norms of GMFPs

The most salient aspects of Themes 1 to 8 are depicted in Table 9.5, as well as the most salient aspects of Theme 9, which involves the subjective norms of GMFPs.

Table 9.5: Summary of the Most Salient Aspects of Themes 1 to 9

Theme	Salient Knowledge, Sources of GM-Related Information and PI Aspects of GMFPs					
Theme 1: Lack of Knowledge about GMFPs	Ignorance of GMFPs	Lack of Information Sharing	Platforms to Disseminate Information			
Table 2: Sources of GM-Related Information that would be Consulted	Internet	Published Scientific Journal Articles	Word-of-Mouth	University Resources	Agricultural Publications	Consulting Multiple Sources
Theme 3: Food Products Purchased Regularly Assumed to contain GM Ingredients	GM Crops Cultivated in SA	Maize or Corn-Containing Food Products	Bread	Grain-Based Food Products	Vegetables & Fruits	Meat Products
Theme 4: Interactions with GMFPs on the Market	Predominance of GMFPs	Not Specifically Looking to Purchase or not to Purchase GMFPs	Alternative Food Product Preferences to GMFPs			
Theme 5: Perceived Known Benefits of Purchasing GMFPs	Increased Nutritional Value	Increased Availability	Lower Price	Improved Aesthetic Properties	Improved Food Processing Properties	
Theme 6: Perceived Known Risks of Purchasing GMFPs	GM Seed Company Threats	Health Risks				

Theme	Salient Knowledge, Sources of GM-Related Information and PI Aspects of GMFPs					
Theme 7: Lack of PBC over Purchasing GMFPs	Lack of Control due to the Increased Availability	Lack of Control due to Affordability	Lack of Control due to Limited Knowledge	Lack of Control due to Limited Research		
Theme 8: Lack of PBC over Purchasing GMFPs in terms of GMFP Labelling	Lack of GMFP Labelling	Ignorance of the Information on GMFP Labels	Not Actively Reading Food Labels			
Theme 9: Subjective Norms in terms of GMFPs	No Influence or Pressure from Referent People to Purchase or not to Purchase GMFPs	Listen to Referent Peoples' Opinions about Purchasing or not Purchasing GMFPs	Credibility of Referent People			

Throughout Themes 1 to 8 in Chapters 8 and 9, as seen in Table 9.5, it was illustrated that the participants lacked GMFP knowledge; they did not seek GM-related information; they identified food products they assumed contained GM ingredients that were purchased regularly; and they demonstrated their interactions with GMFPs on the market while highlighting the perceived known benefits and risks of purchasing GMFPs. In these themes, it was further shown that the participants lacked PBC over purchasing GMFPs, and that their lack of PBC in terms of purchasing such food products was specifically attributed to GMFP labelling. To add to these themes, it was evident in Theme 9 that no influence or pressure from referent people to purchase or not to purchase GMFPs, listening to referent peoples' opinions about purchasing or not purchasing GMFPs, and referent people's credibility contributed towards the subjective norms of such food products, which is also seen in Table 9.5.

It has been found that consumers are not influenced by their referent people regarding their PI of GMFPs, which could be a result of consumers' lack of GMFP knowledge (Prati et al. 2012; Huang 2018; Zhang et al. 2018; Dirisu et al. 2020; Hwang & Nam 2021). Since this study aimed to explore the influence of normative beliefs on subjective norms and its role on the PI of GMFPs, it is postulated that the most salient and sub-salient aspects that emerged under this theme suggest the participants had the normative belief that their referent people did not expect a specific behaviour from them in terms of purchasing GMFPs. It is, therefore, postulated that participants' PI and behaviour toward GMFPs remained unchanged by their

referent people, although it was evident that normative beliefs did influence subjective norms. However, it is suggested that there was no influence from subjective norms on their PI, and no influence from PI on behaviour, thereby leading to a perceived unchanged PI and behaviour toward GMFPs. The perceived influence of normative beliefs on subjective norms, the perceived influence of subjective norms on the participants' PI of GMFPs, and the proposed influence of PI on the behaviour toward such food products are illustrated in Figure 9.10.

As seen in Figure 9.10, it is proposed that although there was a normative belief that the participants' referent people did not expect a specific behaviour toward GMFPs, normative beliefs did influence their subjective norms due to the salient and sub-salient aspects that emerged. However, it is suggested that there was no influence of subjective norms on their PI, and no influence of PI on behaviour, thereby contributing to a perceived unchanged PI and behaviour. From a food security and SDG 2: Zero Hunger point of view, this could be concerning yet promising as referent people did not encourage nor discourage a particular behaviour towards GMFPs. Based on the extent of elaboration as seen through the volume of sub-salient aspects, it is suggested that – although subjective norms did not influence PI – the subjective norms element of the TPB did play a useful role in exploring consumers' PI of GMFPs.

A discussion of the findings from consumer studies using the three constructs of the TPB in exploring PI in relation to GMFPs follows. This discussion presents an overview of the usefulness of these three elements in exploring the PI of GMFPs.

9.7 CONSUMER STUDIES USING THE ATTITUDE, PBC AND SUBJECTIVE NORMS CONSTRUCTS IN INVESTIGATIONS INTO CONSUMERS' PI OF GMFPS

Many quantitative studies have made use of the attitude and PBC constructs in their attempt to determine consumers' PI of GMFPs (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Khouloud & Sameh 2018; Zhang et al. 2018; Saha et al. 2021). Studies in Denmark, Germany, Italy and the UK; as well as in Britain; Taiwan; and China found that positive attitudes positively influenced consumers' PI and was a strong predictor of consumers' PI of GMFPs (Bredahl 2001; Spence & Townsend 2006; Chen 2008; Zhang et al. 2018). Thus, it has been argued that attitudes are a strong predictor of the PI of GMFPs, and a positive attitude influences the PI of GMFPs in a positive manner (Spence & Townsend 2006; Kim 2010; Hassan et al. 2016; Zhang et al. 2018; Zhu et al. 2018).

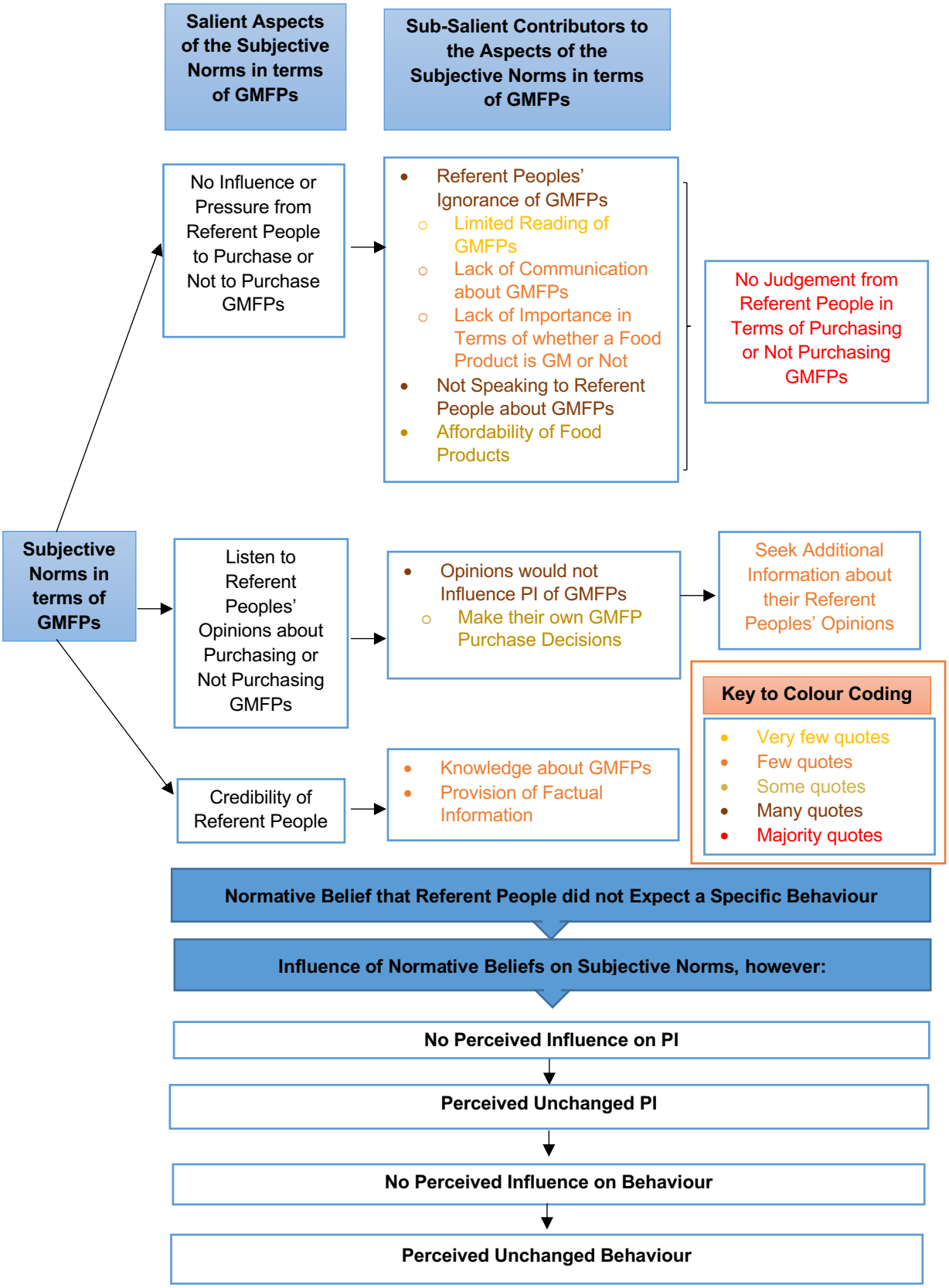

Figure 9.10: Subjective Norms in terms of GMFPs and the Proposed Influence of Normative Beliefs on Subjective Norms; Subjective Norms on PI; and PI on Behaviour

This was further illustrated in two respective studies conducted in Iran, where it was found that attitudes were a significant determinant of PI towards GMFPs (Ghoochani et al. 2017; Akbari et al. 2019). Another study in China found that positive attitudes resulted in a positive influence on the intent to purchase GMFPs (Zhu et al. 2018). However, a different study conducted in China found that perceived benefits did not influence PI but that perceived benefits did positively influence PI of GMFPs through attitudes (Zhang et al. 2018). Studies carried out in Taiwan and Iran also found that there was a positive correlation between perceived benefits and attitudes towards GMFPs (Chen & Li 2007; Ghoochani et al. 2017). Through these studies, it is proposed that the attitude construct is useful in determining consumers' PI of GMFPs, that perceived benefits of GMFPs influence consumers' attitudes positively, and that positive attitudes influence PI in a positive way.

In terms of perceived risks, studies in Malaysia and two respective studies in China found that an exploration into perceived risks of GMFPs was a strong predictor of consumers' PI of GMFPs (Hassan et al. 2016; Zhu et al. 2018; Yang et al. 2022). However, a study carried out in China reported no strong correlation between perceived risks and PI of GMFPs, but the perceived risks decreased consumers' PI through their attitudes (Zhang et al. 2018). A study carried out in Taiwan further found that perceived risks negatively influenced consumers' attitudes towards GMFPs (Chen & Li 2007). These studies could suggest that perceived risks linked to GMFPs influence consumers' attitudes in a negative manner, and that, in turn, negatively influences their PI. It has, however, been argued that consumers' attitudes and PI of GMFPs are driven more by perceived risks than perceived benefits (Bredahl 2001; Hassan et al. 2016; Zhang et al. 2018). Through these studies, it can also be seen that the attitude construct of the TPB played a significant role when exploring consumers' PI of GMFPs.

It has been suggested that the PBC construct is a predictor of PI (Spence & Townsend 2006; Yang et al. 2022), as seen in studies conducted in Taiwan, India and China (Chen 2008; Saha et al. 2021; Yang et al. 2022). However, results from two studies (one from Denmark, Germany, Italy and the UK, and another from Iran) revealed that PBC did not emerge as a strong predictor of consumers' intent to purchase GMFPs (Bredahl 2001; Ghoochani et al. 2017). A study from Britain found that consumers did not have a particular PBC and did not demonstrate that they were in control or not in control over purchasing GMFPs (Spence & Townsend 2006). Another study in China found that attitudes were a stronger predictor of consumers' PI of GMFPs than PBC (Zhang et al. 2018). These studies could propose that the PBC construct of the TPB may not consistently emerge as a strong predictor of consumers' PI of GMFPs.

The subjective norms construct of the TPB has also been used by many studies to investigate consumers' PI of GMFPs (Germany, Italy and the UK; New Zealand; Belgium; Britain; Taiwan; China and India) (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Zhang et al. 2018; Saha et al. 2021). Although subjective norms can have a positive influence on PI, it has been found that subjective norms were not a prominent driver in terms of consumers' PI of GMFPs (Bredahl 2001; Cook et al. 2002; Spence & Townsend 2006; Chen 2008; Ghoochani et al. 2017; Zhang et al. 2018). These studies could suggest that the subjective norms construct of the TPB does not consistently emerge as a strong predictor of consumers' PI in the GMFP context.

Regarding the constructs of the TPB, it is proposed in this study that attitude did not play a prominent role in consumers' intent to purchase GMFPs, while PBC did. It is further proposed that subjective norms did not influence the participants' intent to purchase GMFPs, but all the elements were useful in exploring the participants' intent to purchase GMFPs. Further interpretations of the influence of the attitude, PBC and subjective norms constructs of the TPB on PI in this study are made in Chapter 10.

9.8 SUMMARY

Perceived benefits, particularly reduced price and longer shelf life in terms of the food processing properties of GMFPs, were highlighted by the participants and proposed to have led to a perceived optimistic attitude, PI and behaviour toward GMFPs. However, participants' experience of GMFPs was the same as other food products. Perceived risks emerged as being aspects that would contribute to a perceived threatened attitude, PI and behaviour toward GMFPs, showing that behavioural beliefs influence attitudes in a favourable and unfavourable way, which could be promising yet concerning in the attainment of food security and SDG 2: Zero Hunger as well as the acceptance of GMFPs as food aid. However, the majority of the aspects lacked prominence when compared to the beliefs, values and expectations data, thereby indicating that the attitude element of the TPB did not play a prominent role in consumers' PI of GMFPs. The lack of influence could further suggest that the participants lacked confidence in their beliefs, which filtered through to their values and expectations regarding GMFPs. This hampered their ability to take a firm stand on whether certain aspects or attributes of such food products would influence their intent to purchase or not to purchase GMFPs based on their reality of these food products. The lack of influence could also be fuelled by a dual attitude, causing confusion in purchasing or not purchasing such food products. It is, however, suggested that an optimistic attitude needs to be reinforced while a threatened attitude can be changed by sharing beneficial information about GMFPs. The lack

of influence further illustrates that neither the beliefs, values or expectations component of the EV Model of Attitudes fuel consumers' PI of GMFPs. The perceived benefits and risks participants linked to GMFPs appeared to indicate some knowledge of these products, but their suggested lack of GMFP knowledge (through the lack of elaboration) was proposed to lead to unfounded beliefs regarding such food products.

The participants lacked PBC over purchasing GMFPs, specifically attributed to the increased availability of such food products, their affordability, and limited research on GMFPs. However, the lack of PBC was primarily driven by GMFP labelling, specifically the lack of clarity, size and location of GM labels. Placing GM labels on the front of food products was a specific suggestion that was made in terms of the labelling of GMFPs. Not actively reading food labels was also influential on the lack of PBC regarding GMFP labelling; all of which are suggested to contribute to a threatened PBC, PI and behaviour. Therefore, it is suggested that control beliefs influenced PBC in an unfavourable way and could create a challenge in maintaining a food-secure status and attaining SDG 2.

Based on the depth of data and extent of elaboration as seen through the volume of quotes and the salient and sub-salient aspects that emerged in relation to the attitudes and subjective norms data, it is proposed that the PBC element of the TPB played the most influential role in consumers' PI and subsequent behaviour towards GMFPs. Therefore, to promote food security, consumers' PBC needs to be considered. Regarding subjective norms, although normative beliefs influenced subjective norms, there was no influence or pressure for the participants to purchase or not to purchase GMFPs due to their referent people's ignorance and lack of conversations about such food products. This meant there was no judgement from referent people to behave in a specific way toward GMFPs. Participants were prepared to listen to referent people's opinions about whether or not to purchase GMFPs, but expressed that it would not alter their PI; suggesting that their PI and behaviour towards GMFPs remained unchanged by subjective norms. Therefore, it is proposed that the subjective norms element did not play a role in PI, but was useful in exploring the PI of GMFPs. Consumer studies using the TPB have, however, showed that attitudes are the most prominent predictor of PI toward GMFPs.

Further interpretations of the data are made in the conclusion chapter, namely Chapter 10. The conclusions are based on the study's objectives, and the study's newly proposed conceptual framework, its contribution, recommendations, limitations, and suggestions for future research are presented in the following chapter.

CHAPTER 10
CONCLUSION OF THE STUDY

In the conclusion chapter, a summary of the findings is presented, the data are interpreted, and the findings are evaluated in terms of the study's aim and objectives. The study's new conceptual framework is presented in this chapter, followed by the study's contribution. Recommendations are made, the limitations of the study are described, and suggestions for future research are presented.

10.1 INTRODUCTION

In Chapter 9, the second part of the findings of participants' knowledge and PI data of GMFPs was presented. This chapter concludes the thesis, and an interpretation of the main findings, as presented in Chapters 5 to 9, is given based on each study objective. The most important salient beliefs, values and expectations of GMFPs are discussed concerning the role each component of the EV Model of Attitudes played in attitude formation toward GMFPs. The participants' lack of knowledge is discussed along with its proposed influence on beliefs in the GMFP context and the role that the three elements of the TPB – namely attitudes, subjective norms and PBC – played in the intent to purchase GMFPs. A new conceptual framework based on the study's findings is introduced, which can be used to explore consumer attitudes and PI towards GMFPs. The study's contributions to methodology, the body of knowledge and theory are suggested, and recommendations are made to the GM food industry in terms of promoting GMFPs and disseminating GM-related information. Recommendations for theory are also made that can be considered to promote food security in SA. The study's limitations and suggestions for future research are presented in terms of using the EV Model of Attitudes to gain further insight into what constitutes consumers' attitudes and PI towards GMFPs.

10.2 OVERVIEW OF PARTICIPANTS' DEMOGRAPHIC PROFILES

In this study, the dialogue and debate around GMFPs emanated from educated participants' views, rendering the particular view on GMFPs captured in this study. The majority of participants were female, of working age, financially well off – thus, food secure – and sophisticated consumers who could afford a variety of food products and were able to pay more for their food products. This could have led to them viewing GMFPs through a particular lens. The arguments and views on GMFPs were obtained from participants who resided in a

location where they were not spoilt for choice in terms of having access to a variety of supermarkets and food products.

The participants in this study were not GM crop farmers themselves, nor did they directly engage with GM crops or family and friends farming with GM crops. The participants were therefore general consumers who did not have contact with GM crop farming and had limited interaction with GMFPs, which may have haltered their understanding of these food products. They were participants with opinions about GM crops that may or may not have been influenced by those they knew were farming with GM crops. Some participants were aware of GM farming in the Midlands area – while others were not – which may or may not have influenced their views toward GMFPs in general. Nonetheless, this study did not set out to select participants specifically based on what they knew or did not know about GMFPs. This study intended to obtain opinions from general consumers and determine what they thought of the concept and what GM crops and, subsequently, GMFPs represented to them.

A conclusion on the main findings of the study according to each objective is discussed next, starting with Objective 1.

10.3 OBJECTIVE 1: DESCRIBE WHAT ROLE THE THREE COMPONENTS OF THE EV MODEL OF ATTITUDES PLAY ON ATTITUDES TOWARDS GMFPS IN TERMS OF BELIEFS, VALUES AND EXPECTATIONS

A conclusion and interpretation of the main findings of participants' salient beliefs, values and expectations of GMFPs are presented to describe each component of the EV Model of Attitudes' role in consumers' attitudes toward GMFPs. A discussion on the conclusion and interpretation of the main findings on participants' beliefs about GMFPs is presented first, followed by their values and expectations.

10.3.1 Objective 1.1: Consumers' Salient Beliefs about GMFPs

It has been argued that beliefs relate to the attributes associated with a product, and a product's attributes contribute to the formation of an attitude toward the product (Ajzen & Fishbein 2000). The role of the beliefs component in the EV Model of Attitudes, with regards to GMFPs, confirms this argument as the beliefs component comprised the attributes that were linked to GMFPs. Thus, when it comes to GMFPs, attributes drive beliefs. Within the beliefs component, GMFPs and the GM crop itself are influential in forming beliefs. Thus, the beliefs component in the GM context plays a dual role in exploring GMFPs and the crop itself.

The beliefs component therefore comprises GMFPs and GM crop attributes that, in turn, influence consumers' attitudes toward GMFPs; consumers' beliefs are therefore driven by GMFPs and GM crop attributes. Thus, GM crops' attributes play an influential role within the beliefs component of the EV Model of Attitudes when an attitude of GMFPs is investigated. With regards to attributes, benefits and risks and concerns related to GMFPs and crops worked in collaboration; there were production and consumer-related benefits as well as production and consumer-related risks within the beliefs component, meaning that both the food product and crop were influential within the beliefs component.

Regarding the benefits of GMFPs to the consumer, the most important attributes were that such food products were deemed cheaper with improved aesthetic and food processing properties. GMFPs' improved appearance and longer shelf life were also important attributes to the participants; all of these attributes could lead to consumers being more accepting of GMFPs. The attributes can also be used to change an unfavourable attitude to a more favourable one. In terms of the production benefits of GM crops, attributes such as being weather resistant, specifically to droughts and floods; having resistant characteristics, particularly against pests and diseases; having increased productivity due to their ability to increase yields; and having the potential to promote food security were particularly important to the participants. Holding such a belief could create acceptance and support among farmers who incorporate GM crops into their existing farming practices. Production benefits to the farmer were thus linked to GMFPs, which is promising, particularly since participants resided in a location surrounded by farmers, making them sensitive to farmers' well-being.

The risks and concerns for consumers were driven by the long-term health risks linked to GMFPs, which could cause hostility towards such food products. Regarding the risks and concerns of producing GM crops, the most pertinent attributes were ascribed to the participants' belief that GM crop production poses environmental risks. These risks could be concerning to consumers who reside in rural areas, surrounded by an agricultural community, and it could have been attributed to the participants' sensitivity toward the impact that GM crop production could have on the environment, creating resistance toward GMFPs. The risk and concern linked to producing GM crops were also driven by the impact that GM seeds could have on the farmer. Moreover, participants believed that GM crop production was representative of GM companies posing a threat to the GM seed market, particularly in terms of their greed for profitability, which could create apprehensiveness toward the acceptance of growing GM crops. However, the depth of data indicated that participants' beliefs were fuelled or driven more by the collaboration of the benefits of GMFPs and crops rather than their respective risks and concerns. Nevertheless, it shows that the benefits and risks work together

within the beliefs component to fuel consumers' beliefs and attitudes in the GMFP context. Therefore, the beliefs component of the EV Model of Attitude plays a pertinent role in the formation of a dual consumer attitude in the GMFP context. A quantitative study also found a positive relationship between beliefs and attitudes in the context of pregnancy terminations (Smetana & Adler 1980).

Although beliefs are predominantly driven by the collaboration of GMFPs and crop benefits – confirming that the more favourable a belief is, the more prominently it is held (Ajzen 2008) – GMFPs' altered state of existence also played a fundamental role in the beliefs component of the EV Model of Attitudes. The altered state of existence in terms of the developmental process through which a biological change occurs where DNA and genetics are altered represents an unnatural food product to the participants. This was a pertinent influencer on participants' beliefs regarding GMFPs. Thus, the process through which GMFPs are developed may be concerning to the participants, and linking GMFPs with an altered state of existence could create anxiety and hesitancy toward such food products among consumers, potentially impeding the success of GMFPs in the marketplace. However, due to their altered state of existence, GMFPs were associated with food products that contain enhanced product features, potentially promoting consumers' sense of comfort in these food products, fuelling acceptance towards GMFPs. Therefore, GMFPs' altered state also drives beliefs regarding GMFPs. Considering the depth of data, the belief is driven by the collaboration between the risks and concerns linked to GMFPs and crops, but not to the same extent as the benefits of GMFPs and crops and their altered state of existence. Therefore, the beliefs component of the EV Model of Attitudes is representative of GMFP and crop benefits, risks and concerns, and their altered state of existence, but is particularly dominated by the collaboration between GMFP and crop benefits followed by their altered state of existence, with risks and concerns being the least influential. This finding confirms that different beliefs do not always carry the same significance in attitude formation (Sheth & Tuncalp 1974). It furthermore shows that participants experienced benefits and risks when it came to GMFPs as well as having an altered state of existence; this is what GMFPs meant to them and what they understood about these products.

The depth of data indicates the consumer is bombarded with many and varied beneficial and concerning beliefs about GMFPs, which could cause confusion as beliefs could be favourable or unfavourable. The beliefs component is thus vital to consider in the GMFP context linked to attitude formation to understand where the consumer is coming from when considering such food products. Since the participants had limited interactions with GMFPs, these beliefs could have been unfounded, and such an array of beliefs thus emerged because they were

unsubstantiated by actual experience or factual information, causing confusion or uncertainty. Therefore, the variety of attributes mentioned was possibly related to the participants' own insecurities about what GMFPs truly are. The participants' beliefs could have emanated from hearsay or an idea they created in their own minds about GMFPs. The beliefs component could therefore be representative of numerous unfounded beliefs, fuelling an uncertain, unconfident, and unsubstantiated attitude towards GMFPs. This points to the fact that when it comes to GMFPs, consumers' beliefs about such food products are not straightforward.

Nevertheless, the beliefs component of the EV Model of Attitudes has been argued to serve as the basis of a person's attitude (Ajzen & Fishbein 2000). According to the authors, it is considered the core element of this attitude model, which can be confirmed in the GMFP context. Thus, when looking into consumers' attitudes towards GMFPs, the main focus should be on the beliefs component, which drives the ultimate attitude toward these food products. Literature also suggests that attitudes toward a product originate directly from beliefs, which should be explored first (Ajzen 2008; Brousmiche et al. 2016), which was also the case with GMFPs.

Based on the depth of data obtained when exploring the participants' salient beliefs about GMFPs and the insight that was gained into how beliefs influence attitude formation regarding GMFPs, the beliefs component of the EV Model of Attitude has a pertinent influence and plays a prominent role in terms of understanding what constitutes attitudes towards GMFPs. The beliefs component is particularly valuable in exploring the benefits and risks or concerns of GMFPs as well as GM crop production, thereby gaining two different perspectives and attitudes toward genetic modification. Thus, the beliefs component of the EV Model of Attitudes can be used in two different fields, namely the GM food industry and the agricultural industry.

10.3.2 Objective 1.2 (a-d): Consumers' Salient Value Assigned to GMFPs in terms of the Cost, Attainment, Intrinsic and Utility Value relating to GMFPs

The values component is the second important element of the EV Model of Attitudes. It entails the values assigned to attributes coupled with a food product through beliefs, which influence attitudes toward a product (Goedegebure et al. 2022), such as GMFPs. In the GMFP context, the values component of the EV Model of Attitudes is primarily driven by the consumer-related value of GMFPs. These products are valued specifically for their reduced price and longer shelf life due to their improved food processing properties, indicating that the participants connected the traits of GMFPs and their direct value to them. When comparing the consumer-

related beneficial aspects of GMFPs in the values component to the beliefs component (to understand the significance of each component's role within the EV Model of Attitudes), aspects such as increased nutritional value, increased accessibility and availability, lower price and improved food processing properties shared the same prominence in the values component as in the beliefs component. However, improved aesthetic properties were a less influential aspect when assigning value to such food products. It has been argued that beliefs and values are associated with each other (Ajzen & Fishbein 2000), which is the case in the GMFP context where the consumer-related benefits of GMFPs were concerned. Using GMFPs in the same way as other food products was an important influencer on the values component of the EV Model of Attitudes, indicating that even if a GMFP was purchased, consumers were not driven to consider using the food product in a different way. This finding creates a sense of optimism for the GM food industry as it shows that the participants did not demonstrate a sense of anxiety when using GMFPs, further illustrating a sense of comfort.

Enhanced productivity and the promotion of food security were believed to be a benefit of GM crop production. Enhanced productivity in terms of GM crops' ability to increase yields was influential in the values component, but the aspects lacked depth during the discussion and were not as prominently mentioned in the values component. Drawing an analogy to the beliefs component where GM crop production's benefits were a prominent driver, its lack of influence in the values component shows that even when there is a prominent belief about a GMFP, it does not consistently carry through to the values component as a valuable driver. The collaboration among the benefits of GMFPs and crops was thus prominent in the beliefs component, but GM crop production benefits were not influential in the values component. Thus, in the GMFP context, the beliefs component does not consistently influence the values component and work together to form an attitude.

Ethics also played an important role in the values component of the EV Model of Attitudes when valuing GMFPs. Ethics were particularly linked to genetic modification conflicting with the participants' religion, specifically in terms of playing with God's creation when it came to developing GMFPs. Making such a connotation could create ethical opposition toward such food products and detract from the beneficial value given to GMFPs, unfavourably influencing the value assigned to GMFPs, which the GMFP industry can ill-afford in their quest to advance food security. When comparing the aspects to the beliefs components, in terms of religion, the environment, the use of GM seeds, and the threat GM seed companies pose, these aspects were more prominent in the beliefs component than the values component. These aspects were therefore more influential in the participants' beliefs about GMFPs and less influential when assigning value to such food products based on their ethical standing toward such food

products. Nevertheless, although these aspects were less prominent in the values component than the beliefs component, based on the volume of salient aspects that emerged contributing to the variety of data obtained, ethics played an influential role when assigning value to GMFPs, which could create resistance toward such food products.

While the high level of effort cost assigned to GMFPs – which was especially ascribed to labelling – played a role within the values component, the cost value of GMFPs was not prominent and did not carry real influence. When comparing aspects in the values component to the beliefs component, health risks – contributing to the cost assigned to GMFPs – was a considerably more prominent aspect influencing participants' beliefs about GMFPs, but lacked influence in the values component. Therefore, a more prominent belief was shown among the participants regarding GMFPs' potential health risks, but was not as influential when assigning value to such food products, indicating that health risks did not compromise GMFPs' value. Although beliefs and values are argued to be associated with each other (Ajzen & Fishbein 2000), when it comes to GMFPs, beliefs may not consistently result in a value of the same prominence, particularly in terms of the unfavourable aspects of GMFPs, such as their risks or concerns and ethics. According to Ajzen (2011), after a product has been associated with an attribute through beliefs, the identified attribute is evaluated in terms of its value, which was also the case with GMFPs. However, although beliefs and values are argued to be connected and work together to contribute to attitude formation (Ajzen & Fishbein 2000), due to the lack of prominence of many of the aspects that were less influential in the values component compared to the beliefs component, the beliefs component is not a prominent influencer on the values component when it comes to GMFPs. Therefore, despite the link between beliefs and values, the connection between beliefs and values is not particularly prominent as the values component does not carry the same prominence as the beliefs component in attitude formation toward GMFPs. Nevertheless, values emanate from beliefs (Ajzen 2001), which can be confirmed in the GMFP context as the same aspects emerged in the values data as the beliefs data. This illustrates that although the EV Model of Attitudes has been criticised because beliefs and values could be considered as functioning separately from each other (Yi 1989; Ajzen 2001), that is not the case because there is a link between beliefs and values regarding GMFPs. With regards to GMFPs, the values component is particularly representative of consumer-related benefits of GMFPs, and the ethics linked to such food products play a role in attitude formation.

Even though literature regarding the EV Model of Attitudes does not discuss the four categories of task values (cost value, attainment value, intrinsic value and utility value), these values have been argued to be influential in the exploration into values where the attitude of

a product is concerned (Sheth & Tuncalp 1974; Ajzen & Fishbein 2000; Ajzen 2001; Ajzen 2008; Ajzen 2011; Ahn et al. 2019; Dietrich et al. 2019; Loh 2019; Meyer et al. 2019; Bostrom & Palm 2020; Jones & Hite 2020; Umarji et al. 2021). The attainment (relevance of a product in relation to consumers personal values), intrinsic (rewardable attributes of a product) and utility (functional use and usefulness of a product) value categories should be merged (Dietrich et al. 2019; Loh 2019; Meyer et al. 2019; Bostrom & Palm 2020; Jones & Hite 2020; Umarji et al. 2021). In the GMFP context, the participants did not elaborate on the cost task value category, showing that it was not of particular importance to them. Therefore, the cost task value category was less influential in assigning value than the other task categories of values and did not have a meaningful position in the larger value context, although it did give some limited understanding of where consumers stand when considering the cost task value of GMFPs. Furthermore, although some aspects were less influential compared to the beliefs component, others shared the same influence; combining the attainment, intrinsic and utility task value categories was valuable as it led to an exploration into the value of the attributes coupled with GMFPs. However, based on the depth of data compared to the beliefs component, merging the attainment, intrinsic and utility task value categories was more useful in exploring the value assigned to the benefits consumers can gain from GMFPs rather than the production benefits that can be attained through GM crop production. It is also important to note that the findings showed that the risks and concerns linked to GM crop production and GMFPs emerged based on ethical connotations that were made to genetic modification in the values data.

Although the ethical aspects were less prominent in the values component than in the beliefs component, a variety of data was still obtained; thus, the attainment task value was useful in exploring the ethical connotation made to GMFPs. Therefore, ethics fuel the attainment task value category of the values component of the EV Model of Attitudes. Even though the values component of the EV Model of Attitudes was less prominent than the beliefs component, the variety of data shows that the values component is useful in exploring what constitutes consumers' attitudes towards GMFPs. Therefore, the values component does influence consumers' attitudes towards GMFPs, particularly in terms of the attainment, intrinsic and utility task value categories, but not to the same extent as the beliefs component; thus, it is not the primary influencer of attitude formation in the GMFP context.

Since the values component was less influential in attitude formation toward GMFPs compared to the beliefs component, it shows that the participants could have struggled to assign value to GMFPs; they did not understand what values were, or they lacked confidence in terms of what they valued about GMFPs.

10.3.3 Objective 1.3: Consumers' Salient Expectations of GMFPs

The third element of the EV Model of Attitudes comprises the expectations component, which encompasses the attributes expected of a product, what attributes the product should offer, and the consequence of those attributes (Cohen et al. 2014; Suvittawat 2022), which influence attitudes toward the product. With regards to GMFPs, expected attributes of such food products were reported among the participants, confirming that the expectations component is representative of expected attributes in the GMFP context.

The expectations component was driven by the beneficial consumer-related expected outcomes of GMFPs, specifically improved aesthetic properties. The participants therefore expected that when they came across GMFPs, these products should have improved aesthetic traits. However, if GMFPs fail to offer these traits, consumers' expectations are not met, which could create disappointment and possibly lead to them questioning whether such traits are, in fact, attainable through genetic modification. Nevertheless, when comparing the influence of aspects in the expectations component to the beliefs and values components, respectively, the expectation aspects lacked depth and were considerably less prominent compared to the participants' beliefs and values of such food products. An exception was the improved aesthetic properties, which were more influential on expectations than values, but less influential than beliefs. The lack of depth of data regarding what benefits participants expected for themselves from GMFPs still leaves a gap in understanding which beneficial attributes the participants expected GMFPs to offer. Although the beliefs and values linked to consumer benefits of GMFPs were prominent, they did not carry through to the participants' expectations. Moreover, such benefits were not specifically reinforced as expected attributes of GMFPs among the participants. The participants were, therefore, hesitant about which benefits they expected GMFPs to offer and whether they were reasonable expectations. The expectations component of the EV Model of Attitudes was also representative of the beneficial expected outcomes of GM crop production, such as enhanced productivity. However, when comparing the aspects in the expectations component to the beliefs and values component, respectively, enhanced productivity and the promotion of food security were aspects that lacked depth in the expectations component and were considerably less prominent compared to their influence on the beliefs component. The lack of influence on expectations indicates that the participants questioned whether there were, in fact, attainable benefits to producing GM crops or they were unsure of what they expected in terms of GM crop production.

Regarding the risks and concerns linked to GMFPs, concerning outcomes (specifically related to the consumer) were indicated in the expectations component in terms of expected long-

term health outcomes. Having an unfavourable health expectation from GMFPs could be problematic in terms of remedying such fears and creating acceptance towards such food products. Health risks were more prominent in the participants' expectations data as opposed to the value assigned to such food products. Based on the volume of sub-salient aspects related to the labelling of these food products, the aspect was influential in the expectations component as consumers expected to face health risks after consuming GMFPs. The aspect, therefore, held prominence in the participants' expectations. However, the lack of discussion regarding specific health risks does raise questions about the significance of the aspect on their beliefs and could further point to uncertainty in terms of whether health risks can indeed be expected from the consumption of GMFPs. Thus, health risks were the most influential aspect affecting participants' beliefs, followed by their expectations, and the least influential on the value they assigned to such food products.

In terms of GM crop production concerns for the environment, the use of GM seeds and the threat of GM seed companies also lacked depth in the expectations component of the EV Model of Attitudes and were considerably less influential than the beliefs component on concerns and risks attributed to growing such crops. It was also less influential than the value given to the production of GM crops. Therefore, concerns about producing GM crops were the least influential in terms of the expectations component; thus, the expectations that GM crop production caused concern lacked prominence.

The expectations component was, therefore, representative of GMFP and crop attributes, but the consumer-related benefits of GMFPs were the most prominent aspect within the expectations component. However, by comparing the aspects in the expectations component to the beliefs and values components, respectively, it is evident none of the aspects stood on their own and were not prominent influencers in the expectations component. Although certain aspects drove the expectations component, they did not carry real influence, indicating that the expectations component of the EV Model of Attitudes was not influential in attitude formation when it comes to GMFPs.

Literature has argued that an expectation refers to which attributes an individual seeks in a particular product (Panchal et al. 2012; Cohen et al. 2014); however, evidently, when it came to GMFPs, a particular expectation of GMFP attributes was not demonstrated. In the GMFP context, an expectation of product attributes is not of real significance to the consumer, meaning their experience with a GMFP is not evaluated in relation to consumers' expectations, which literature suggests is an important part of expectations (Hansen 2008). Furthermore, according to literature, an expectation emanates directly from beliefs and values (Sheth &

Tuncalp 1974), which could be the case in the GMFP context as the same aspects emerged in the expectations data as in the beliefs and values data. However, the collaboration between beliefs and values resulted in a poor expectation, illustrating that there is not a direct or prominent flow from beliefs and values to expectations. Thus, irrespective of the prominence of the beliefs or values component, it does not contribute to a prominent expectation. Literature has further stated that values (stemming from beliefs) and expectations work together in attitude formation (Zhang et al. 2008). However, in the GMFP context, this is not the case. The expectations component lacked depth, which illustrated that it did not work with the values component, demonstrating that the beliefs, values and expectations did not work together to form an attitude toward GMFPs. Although the same aspects in the beliefs and values component emerged in the expectations component, the aspects were considerably less influential. This shows that, in terms of the EV Model of Attitudes, the beliefs and values of GMFP do not drive an expectation of such food products. Therefore, the expectation component is not a prominent contributor to attitude and does not play an influential role in attitude where GMFPs are concerned because there is no prominent expectation of GMFPs; thus, the attitude is not centred around an expectation.

In the investigation into consumers' attitudes towards GMFP, it is not necessary to consider expectations as a valuable component of the EV Model of Attitudes. Although three other respective quantitative studies have shown (through statistical analysis) that the expectations component was more influential in attitude formation compared to the values component (Sheth & Talarzyk 1972; Sheth & Tuncalp 1974; Ahn et al. 2019), another study found that values were more influential in attitude formation as opposed to expectations (Belch & Belch 1987); when the participants were asked to vocalise their expectations of GMFPs (in a qualitative study), they were unable to do so. This shows that when they need to reason to defend their expectations of GMFP attributes, instead of merely identifying with a question or statement, they were unable to do so in a confident way. These studies were conducted in terms of product brands, hair shampoo, persuasive messages and boycotters versus non-boycotters.

The lack of prominence of the expectations component further shows that the participants struggled to articulate and lacked confidence in what they expected of GMFPs. This could be ascribed to beliefs about GMFPs coming from a factually unfounded, unsolid foundation of information and experience. As a result, it left the participants unable to articulate an expectation because they were unsure about their beliefs and whether their beliefs carried any real relevancy or were, in fact, substantiated. Considering that the values component was also less influential in GMFP attitude formation, the foundation on which the beliefs component was

built explains the lack of influence on the values and expectations components, respectively. This shows that the beliefs component of the EV Model of Attitudes remains vital, but its unsubstantiated, unfounded or unconfident foundation deems the expectations components invaluable in exploring attitudes in the GMFP context. It also leads to the values component not being as influential in attitude formation and not functioning in its entirety, although it remains an insightful component in the EV Model of Attitudes in the context of GMFPs. Unclear expectations of GMFP attributes could also suggest that the participants did not have previous experience with these food products to establish a specific expectation. Literature suggests this could be the case as previous experience could influence expectations (Olsson et al. 2022). However, consumers' beliefs need to be addressed and should emanate from factual information. A factual basis would mean the values and expectations components can perform adequately in attitude formation and can be considered valuable and prominent influencers in the EV Model of Attitudes when exploring attitudes to GMFPs.

10.3.4 The Role of the Components of the EV Model of Attitudes in Achieving SDG 2: Zero Hunger

This study was framed within the context of contributing to the achievement of SDG 2: Zero Hunger by using the EV Model of Attitudes as a framework through which attitudes toward GMFPs were explored. Therefore, in the context of this study, the aim was to explore which findings are relevant to understanding consumers' attitudes and standpoints towards GMFPs to aid in attaining SDG 2. SDG 2 aims to achieve zero hunger through food security, thereby addressing aspects such as poverty and hunger (Gil et al. 2019). It has been suggested that GMFPs can act as a tool to achieve food security (Olabinjo et al. 2020; Muzhinji & Ntuli 2021). However, before GMFPs can be used to achieve zero hunger and become accepted as food aid, it is critical to understand where the consumer stands when it comes to these food products.

With regards to the EV Model of Attitudes, the beliefs component is the most prominent and influential driver in terms of attitude formation regarding GMFPs, followed by the values component. These two components' prominence in attitude formation illustrates that in order for GMFPs to be used in promoting the achievement of SDG 2, it is important to focus on the beliefs component – which can be supplemented with the values component – when exploring attitudes towards GMFPs. Therefore, to understand the consumer's position toward GMFPs, their beliefs and values must be investigated, confirming that beliefs and values are connected and influential in consumers' attitudes (Ajzen 2001). In the GMFP context, the expectations component of the EV Model of Attitudes has been shown to be of little value in exploring the

consumer's attitude towards GMFPs. It is thus not a valuable component to use to promote the use of GMFPs among consumers to promote food security.

This finding is based on the comparisons that were made between the influence of the aspects in the beliefs, values and expectations components, respectively, of the EV Model of Attitudes (based on the depth of data and extent of elaboration). The comparison demonstrated aspects about beliefs toward GMFPs were most prominent, except for the majority of aspects relating to the consumer-related benefits, which shared the same prominence in values as beliefs; the majority of aspects were the least influential in the expectations component. Nevertheless, the study has shown that, in order to promote SDG 2 and food security efforts, the EV Model of Attitudes can be used to understand consumers' views about GMFPs, and the obtained information can be used to promote a favourable viewpoint towards GMFPs. A sense of desire for these food products can be created, allowing consumers to become more GM-orientated, which, in turn, can contribute to enhancing food security among SA consumers. For example, GMFPs' and crops' beneficial attributes and the food products' altered state of existence drove the beliefs component. Thus, to attain food security, attributes towards GMFPs and crops need to be considered and promoted among consumers so that consumers become aware that the production of GM crops can assist local farmers with their livelihoods, while fears toward GMFPs' altered state can be remedied so that consumers are unafraid of these food products on the market. In terms of the values component, in addition to the consumer-related benefits of GMFPs, ethics played an important role, and if GMFPs are to be valuable in attaining food security, the ethical connotations linked to these food products need to be addressed to comfort and remedy any concerns. When considering the drivers of each component, the EV Model of Attitudes is primarily representative and driven by the consumer-related beneficial attributes of GMFPs. Therefore, to use GMFPs as a tool to achieve SDG 2 through consumer acceptance and favourable attitudes towards such food products, the attributes from which the consumer can benefit directly need specific attention and should be promoted. This can further aid in changing a threatened attitude to a more optimistic attitude toward GMFPs.

It is important to note that – when it comes to consumers' reality, view and image of GMFPs in terms of the constructivist paradigm – benefits and risks and concerns were linked to GMFPs and GM crops as well as having an altered state of existence. These affected participants' salient beliefs, values and expectations of such food products, which shows that the participants' beliefs, values and expectations had a favourable and unfavourable influence on their attitudes. It is indicative that the participants had an optimistic and threatened attitude toward GMFPs, and a dual attitude thus existed. Therefore, to promote food security through

GMFPs, it is important to consider that a dual attitude toward such food products can exist, as demonstrated by the EV Model of Attitudes being representative of the exploration into a dual attitude in the GMFP context. The existence of a dual attitude could create hesitancy toward GMFPs and could halt a favourable view of such food products. Consequently, the consideration of the presence of a dual attitude is essential in enhancing food security among SA consumers where GMFPs are concerned. Holding an overall dual attitude toward GMFPs could encourage and impede food security and SDG 2: Zero Hunger efforts, showing that it remains vital to reinforce favourable attitudes toward GMFPs and change unfavourable attitudes.

Although a dual attitude is demonstrated in the GMFP context, solace can be found in the fact that an attitude can be changed. Therefore, a threatened attitude can be addressed and altered by sharing information about the benefits of GMFPs – particularly consumer-related benefits – with consumers that can negate unfavourable connotations made to such food products. To reaffirm an optimistic attitude, information about the benefits of GMFPs should be conveyed to consumers so that GMFPs can be accepted on the market. This needs to be considered by the food industry if GMFPs are to play a role in promoting food security efforts.

A conclusion of Objective 2 is discussed next.

10.4 OBJECTIVE 2: EXPLORE THE INFLUENCE OF KNOWLEDGE ON CONSUMERS' BELIEFS ABOUT GMFPS

A conclusion and interpretation of the main findings of the participants' knowledge and the influence of knowledge on their beliefs toward GMFPs, and the sources where GM-related information was acquired, are presented next.

10.4.1 Objective 2.1: Consumers' State of Knowledge of GMFPs and Objective 2.2: Identifying the Sources where GM-Related Information is acquired that Influence Knowledge of GMFPs

The participants lacked GMFP knowledge, which was attributed to their ignorance and thinking that not enough information was shared about these products. This indicates that it remains vital to use information dissemination to enhance consumer knowledge of GMFPs. The lack of GMFP knowledge could have ensued from them not farming with GM crops, not having friends or family who farmed with GM crops, not being aware of GM farming in the Midlands area, or insufficient GMFP information reaching the consumer in general.

Various sources of information allow knowledge to be built (Wunderlich & Gatto 2015; Abdoul et al. 2023), which can be confirmed in the GMFP context. The lack of knowledge was driven primarily by the participants not consulting official GM-related sources for information about such food products. However, the internet and word-of-mouth were popular sources participants would consult for GMFP information. The preference for these sources could have been linked to their age in terms of familiarity with technology, knowing someone who farmed with GM crops, and residing in the Midlands area. When it comes to GMFPs, not seeking information about GMFPs influences consumers' state of knowledge in an unfavourable manner, contributing to their lack of GMFP knowledge, unfavourably impacting their beliefs and fuelling factually unfounded beliefs about GMFPs. It has been argued that attitudes result from a solid knowledge foundation (Hwang & Nam 2021); however, in the GMFP context, a lack of knowledge shows that the beliefs component of the EV Model of Attitudes is based on an unsolid foundation of knowledge. A lack of knowledge ensues directly from the absence of information-seeking behaviour, and since knowledge is suggested to be based on facts (Baruwa & Shutaleva 2022), beliefs about GMFPs are not objective as they do not have credibility or authenticity. This leaves the consumer unable to objectively evaluate their beliefs regarding GMFPs.

Participants did not seek information about GMFPs, and no reference was made to academic data, meaning that their beliefs were not developed from an academic point of view or substantiated facts – but rather from hearsay – thereby lacking authenticity. As a result, in the GMFP context, consumer beliefs are factually unfounded and lack viability. Therefore, the values and expectations components of the EV Model of Attitudes cannot function adequately in attitude formation in the GMFP context because the beliefs component is factually unfounded. It also shows that, regarding GMFPs, GM-related information sources influence knowledge, and knowledge influences beliefs, which has a subsequent influence on consumers' confidence in assigning value and articulating a specific expectation about such food products. As a result, knowledge does not only fuel the beliefs component of the EV Model of Attitudes, but it also filters through to the values and expectations components.

It has been argued that knowledge and beliefs cannot function without each other (Griffin & Ohlsson 2001), which can be confirmed in the GMFP context. Thus, the EV Model of Attitudes, and specifically the beliefs component, cannot exist without a knowledge component. Knowledge influences attitude formation (Hoque et al. 2018), and when exploring GMFPs through the EV Model of Attitudes, a knowledge component is relevant and needs to be incorporated into the beliefs component to understand where consumers' beliefs originate from, whether they are factually founded or not, and to further understand the functionality or

lack of functionality of the values and expectations components. These findings point to criticism of the beliefs component in that the source and “truthfulness” of beliefs are important to consider (Ajzen 2008). However, Ajzen (2008) adds that the source of beliefs is not considered in the beliefs component of the EV Model of Attitudes.

It also shows that the addition of a knowledge component within the beliefs component of the EV Model of Attitudes further needs to consider the sources where knowledge is attained to understand the foundation from which knowledge is built (before the knowledge component can be considered in relation to the beliefs component). Subsequently, sources of GM-related information and knowledge work together, as suggested by Abdoul et al. (2023), who state that knowledge is influenced by information. This collaboration forms the foundation from which a belief originates, and thus needs to be collaborated into the beliefs component of the EV Model of Attitudes in the exploration of consumers’ attitudes towards GMFPs.

A lack of knowledge foundation (ignorance) due to not consulting GM-related sources of information and conducting enough research about these food products meant the participants admitted that they were unable to identify GM-containing food products. They did not know which food products they purchased regularly contained GM ingredients, thereby showing that they were unaware of their actual experience with GMFPs, or they did not have actual experience with these food products. It led to the assumption that many GM-containing food products are being purchased on a regular basis, primarily including maize or corn-containing food products, grain-based food products, and vegetables and fruits. The identification of vegetables and fruits being GMFPs (particularly tomatoes) could have been ascribed to the participants’ belief that GMFPs have improved aesthetic and food processing properties. This could be the case in vegetables and fruits, although their aesthetic appearance is not achieved through genetic modification. It could also indicate that fresh produce was associated with genetic modification. This shows that a lack of knowledge results in consumers drawing assumptions when identifying GM-containing food products, reflecting their inability to pick out GMFPs from other traditional food products. This further shows that when it comes to GMFPs, the beliefs component of the EV Model of Attitudes could stem from assumptions, leaving the other two components (namely values and expectations) vulnerable in their performance and usefulness in exploring attitudes toward GMFPs. Nevertheless, the participants knew that GM crops, specifically maize and soya, were cultivated in SA, and this knowledge could have emerged from discussions with someone they knew who farmed with GM crops.

The lack of GMFP knowledge was also illustrated by another assumption that there is a predominance of GMFPs on the market and that the majority of food products available in

supermarkets are GM and were thus purchased and consumed regularly because it is difficult to avoid these food products in the supermarket – which they were not concerned about. Their lack of GMFP knowledge was further evident in that the participants were not specifically looking to purchase or not to purchase GMFPs. However, their lack of GMFP knowledge could have led to their preference for alternative food products to GMFPs, particularly GMO-free food products, which is problematic in achieving SDG 2. Seeking GMFP alternatives shows a lack of confidence in the attributes linked to GMFPs and crops in the beliefs component, illustrating the hesitancy with which beliefs are established about GMFPs. This further shows that GMFP attributes are not evaluated from an experience point of view, but rather from an assumption point of view, thereby confirming that the beliefs component of the EV Model of Attitudes comprises factually unfounded beliefs. To demonstrate, consumer-related benefits of GMFPs and potential health risks linked to GMFPs were important aspects within the beliefs component. However, it did not translate into participants pursuing or avoiding purchasing GMFPs, thereby indicating that their beliefs about GMFPs are unfounded, resonating with consumers' lack of confidence to take a firm stand when it comes to GMFPs. A lack of knowledge could thus play a role in consumers' interaction with GMFPs on the market.

The participants knew about limited benefits (particularly their lower price and longer shelf life in terms of improved food processing properties) and risks associated with GMFPs, which could point to some state of knowledge. However, when drawing an analogy to the beneficial and risk-related attributes within the beliefs and values component, the aspects were not elaborated on in the knowledge context of GMFPs. No GM crop production benefits were mentioned, and neither were environmental risks, the impact of GM seed usage, and ethical or religious aspects when conversing about knowledge. This illustrates that there was a lack of confidence among the participants relating to their knowledge of GMFPs. They consequently refrained from elaborating on such aspects, further showing that the beliefs of these food products originate from a factually unfounded basis, which they were not entirely sure about. A lack of knowledge ultimately hinders consumers' certainty when it comes to GMFPs. Thus, the benefits and risks of GMFPs could not stand on their own as an influential aspect of knowledge. In terms of the uncertainty around the benefits of GMFPs, it could stop consumers from specifically seeking food products in-store. However, to remedy the lack of knowledge in the GMFP context and contribute to a more factually founded belief, platforms such as television and social media can share GM-related information with consumers.

In the GMFP context, it is evident that knowledge does influence the accuracy with which beliefs are formed, and knowledge and the sources from where GM-related information is acquired are influential in understanding the beliefs component of the EV Model of Attitudes.

Thus, knowledge has a place, is relevant, and plays an influential role in the consideration of beliefs regarding GMFPs when attitudes toward GMFPs are explored. However, factually unfounded beliefs about GMFPs could compromise SA consumers' food security status and impede the achievement of SDG 2: Zero Hunger, which is a concern. It is, therefore, vital to address consumers' lack of GMFP knowledge so that a more confident belief structure can emerge.

A conclusion and interpretation of the main findings of Objective 3 follow.

10.5 OBJECTIVE 3: DESCRIBE WHAT ROLE THE THREE ELEMENTS OF THE TPB PLAY ON THE INTENTION TO PURCHASE GMFPS

A conclusion and interpretation of the role of attitudes, subjective norms and PBC on the intention to purchase GMFPs follow.

10.5.1 Objective 3.1: Attitudes and Behavioural Beliefs' Influence on Attitudes

Since the EV Model of Attitudes feeds into the attitudes element of the TPB, its aspects were considered in terms of the participants' salient beliefs, values and expectations of GMFPs when exploring the influence of attitudes on PI. When comparing the consumer-related beneficial aspects of GMFPs between the beliefs, values and expectations components, increased nutritional value and increased availability and accessibility were more influential on beliefs and values, but were less prominent in the expectations component. In terms of improved aesthetic properties of GMFPs (improved appearance), this aspect was the most influential on beliefs, followed by expectations, and the least influential on participants' values. However, based on the depth of data and extent of elaboration in comparison with the consumer-related benefits of GMFPs data (particularly in the beliefs and values components), these perceived beneficial aspects were not prominent in terms of their influence on PI in the context of attitudes. These were not perceived benefits that influenced the participants' PI because they did not influence their purchasing of GMFPs based on their attitudes. Therefore, although GMFPs' consumer-related benefits were a prominent influencer in the beliefs and values component of the EV Model of Attitudes, such benefits did not drive the participants to purchase these food products, showing that even when beliefs are fuelled by specific attributes, it does not carry through as being influential in consumers' attitudes when it comes to purchasing GMFPs, and is thus not influential in their intent to purchase such food products. Nevertheless, from a PI point of view, it has been argued that attitudes consist of many beliefs (Farah 2017), which can be confirmed in the GMFP context.

Within the GMFP context, limited consumer-related beneficial attributes, such as the behavioural belief that a cheaper and longer-lasting food product can be purchased when it comes to GMFPs, emerged. These were prominent aspects in the beliefs and values components, but less so in the expectations component. However, it was illustrated that the lower price and longer shelf life in terms of improved food processing properties were aspects that were influential on participants' intent to purchase GMFPs. Since some of the participants were parents, it might explain why affordability was an important benefit to them in terms of purchasing GMFPs, as they had a financial obligation to take care of their families. The longevity of food products could also have been influential in the participants' intent to purchase GMFPs due to their busy lifestyles, as indicated by their work commitments. Longer-lasting food products could be purchased, thereby assisting consumers in not purchasing food products as often. It further shows that, when it comes to GMFPs, certain consumer-related beneficial aspects influence PI. As a result, affordability and longer shelf life are consumer-related GMFP traits that drive the intent to purchase such food products. However, there is inconsistency regarding the influence that GMFPs' consumer-related beneficial attributes have on their intent to purchase from an attitude point of view.

The benefits of GM crop production, in terms of increased productivity and the promotion of food security, had the most prominent impact on the beliefs component of the EV Model of Attitudes, followed by the values component, and was least prominent in the expectations components. These aspects were, however, absent and thus not influential in the participants' PI toward GMFPs based on their attitudes. The beliefs component was primarily driven by a collaboration between GMFP and crops' beneficial attributes. In terms of GM crop production benefits, salient aspects such as being beneficial to the environment; being weather resistant; having resistant characteristics; and increasing farmer profitability were evident in the beliefs component. Resistant traits and farmer assistance were sub-salient aspects in the participants' values, while only an individual resistant trait was expected (pest resistance); all of which indicate that the benefits of producing GM crops were the most evident in the beliefs component, less prominent in the values component, and the least prominent in the expectations component. However, these aspects were also absent when it came to the participants' intent to purchase GMFPs.

This indicates that the intent to purchase GMFPs was not driven or influenced by the benefits of producing GM crops, further showing that even when aspects are prominent within the beliefs component, it does not carry through as being influential in purchasing GMFPs in the attitude context. The absence of GM crop production benefits' influence could have been ascribed to the aspects being less influential in the values and expectations component,

thereby hindering the benefits' influence on the intent to purchase GMFPs. Thus, even though it has been argued that a favourable attitude results in a favourable intent to purchase food products (Nam et al. 2017), in the GMFP context, this is not the case.

The perceived risks linked to GM seed company threats were the most influential aspect in the beliefs component, less so in the values component, and the least influential in the expectations component. In terms of health risks, this aspect was the most influential in the beliefs component, followed by the expectations component, while being the least influential in the values component. However, these aspects in the beliefs, values and expectations components of the EV Model of Attitudes were considerably less prominent in the context of the participants' PI – indicating that the perceived risks and concerns of GM crop production and GMFPs were not influential aspects contributing to their PI of GMFPs based on their attitudes. This could be ascribed to the risks and concerns of both GMFPs and crops being the least prominent drivers in the beliefs component of the EV Model of Attitudes, which led to their lack of influence in the values and expectations components. Furthermore, the environmental risk of producing GM crops and the use of GM seeds were influential aspects of beliefs, less so on values, and the least influential on expectations; however, they were not perceived as risks influencing the PI of GMFPs as they were not mentioned. This illustrates that, in the attitude context, the intent to purchase GMFPs is not driven by GMFP and crop risks and concerns. Therefore, although literature suggests that an unfavourable attitude results in an unfavourable intent to purchase food products (Nam et al. 2017), in the GMFP context, this is not the case.

Religion was a prominent aspect in the beliefs component, while ethics and religion were important in the values component; however, these aspects did not play a role in participants' PI of GMFPs based on their attitudes. The altered state of existence believed to be coupled with GMFPs in terms of their biological change through technological intervention was also not influential on the intent to purchase such food products, as it was not mentioned by the participants. Although the unnaturalness of GMFPs emerged as a sub-salient aspect in the PI context, it was less prominent than in the beliefs data in terms of their altered state of existence. These findings indicate that although the beliefs component of the EV Model was fuelled by GMFPs' altered state of existence, these aspects were not relevant to the participants' intent to purchase GMFPs.

The lack of influence that GMFPs' and crops' beneficial and concerning attributes had on the intent to purchase GMFPs could stem from the beliefs component being built upon an unsolid knowledge foundation, fuelling unsubstantiated beliefs. Therefore, the uncertainty through

which beliefs are constructed challenges the functionality of the values and expectations components, which, as a result, leaves the consumer vulnerable and hesitant in terms of purchasing GMFPs. The lack of intent to purchase GMFPs therefore emanates from a lack of confidence through which the beliefs, values and expectations components of the EV Model are constructed and through which GMFPs are viewed.

Even though there was seemingly a lack of influence from the EV Model of Attitudes' components on the intent to purchase GMFPs (based on the attitude element), the participants' experience with GMFPs was the same as any other food product. This finding could be ascribed to their lack of GMFP knowledge and disinterest in searching for information, as well as their inability to know when a GMFP is purchased to make a comparison to other non-GMFPs. The assumption that most of the food products in supermarkets contain GM components shows that, in the participants' own opinions, they were unable to make comparisons between their experiences of GM and non-GMFPs. It indicates that they did not have the opportunity to compare the benefits of GMFPs to other food products and establish whether their experience of GMFPs' beneficial attributes was the same or perhaps better than traditional food products. One reason food products are GM is to enhance the consumers' experience with GMFPs. Therefore, if no comparison is made between GM and non-GMFPs, the benefits of GMFPs are not experienced, which could defeat the purpose of genetically modifying food products' aesthetic and processing properties. However, not comparing GMFPs to non-GMFPs could be ascribed to the fact that the majority of GMFPs in SA are found in maize and soya-containing items, derived from crops that were GM to retain herbicide and insect-resistant traits (African Centre for Biodiversity 2015b; Gbashi et al. 2021). Thus, these are beneficial traits that are not visually noticeable to the SA consumer, and it is suggested that the participants could not compare GM and non-GMFPs as aesthetic and food processing traits could not be physically experienced. Still, the participants would not have known which food products are GM and which attributes they have been GM with. This again illustrates that the beliefs component of the EV Model of Attitudes emanates from an assumption basis, and not from an experience basis. This phenomenon contributes to a lack of comfort among consumers when purchasing GMFPs based on their attitudes, further illustrating from a phenomenological point of view that the participants did not have any actual experience with GMFPs, but rather experienced these food products through hearsay.

The aspects that contributed to the attitude toward GMFPs were the most influential in the beliefs component, followed by the value component (except for the consumer-related benefits believed to be coupled with GMFPs and the value given to these attributes, which were prominent in both the beliefs and values components with the exception of improved aesthetic

properties), with the aspects being the least influential in the expectations component. An exception was improved aesthetic properties, which were more influential in the expectations than the values component. In essence, although these aspects favourably and unfavourably influenced PI and behaviour toward GMFPs, leading to a perceived optimistic or threatened PI and behaviour toward GMFPs, the majority of aspects did not play an influential role in participants' intent to purchase GMFPs based on their attitudes. Considering that the participants' attitudes were explored through the use of the EV Model of Attitudes, which comprised beliefs, values and expectations components, the influence of the majority of the aspects contributing to attitudes within the context of their PI (in comparison to the three components) was lacking and was not elaborated on. Therefore, when it comes to GMFPs, attitudes are possibly not influential enough on the PI of GMFPs.

Even though literature suggests that behavioural beliefs refer to the benefits and risks of a behaviour, which is indicative of a positive or negative outcome and thus influences the attitude (Zakaria et al. 2016; Farah 2017), when it comes to GMFPs – although benefits and risks were linked to GMFPs – the participants' behavioural beliefs did not filter through to an attitude prominent enough to fuel a favourable or unfavourable PI. Therefore, although participants' behavioural beliefs about perceived GMFP benefits and risks favourably and unfavourably influence attitudes, a lack of data on aspects that contribute to attitudes illustrates it did not play a prominent role in their PI of GMFPs; behavioural beliefs thus have an influence on attitudes, but these beliefs lack prominence to drive a pertinent attitude. The correlation between behavioural beliefs and attitudes thus seems to lack prominence. Although attitudes are argued to be driven by behavioural beliefs in terms of benefits and risks (Zakaria et al. 2016), this is not the case with GMFPs, as the prominence of such beliefs are lacking. Therefore, the attitude element within the TPB framework is not particularly driven by the benefits and risks linked to GMFPs.

It has been argued that the attitude element of the TPB is the strongest forecaster of the intent to purchase (McSporran 2017), but in the GMFP context, this element does not play a prominent role in the PI of GMFPs. This further illustrates that the beliefs, values and expectations component of the EV Model of Attitudes does not have a specific influence on consumers' intent to purchase GMFPs. Quantitative studies have found that the attitudes element of the TPB is the strongest predictor of attitudes toward GMFPs, which was statistically validated (Bredahl 2001; Spence & Townsend 2006; Chen 2008; Zhang et al. 2018; Saha et al. 2021). However, when the participants were asked to substantiate their attitudes and explain what their attitudes are and whether they lead to a specific PI or not, they were unable to confidently and convincingly articulate their views. Therefore, a different image

is established when consumers are verbally confronted – such as in the case of this qualitative study – because the participants had an opportunity to explain where they stood in terms of the influence of their attitudes (beliefs, values and expectations) on the intent to purchase GMFPs, which was not supported in quantitative studies. In this study, considering that the participants lacked knowledge, which contributed to their beliefs being factually unfounded and unjustifiable, it could explain why the participants could not confidently and convincingly articulate whether their beliefs, values and expectations (attitudes) would lead them to purchasing or not purchasing GMFPs as they were possibly unsure whether their attitudes were formed from factually sound information. Therefore, the unfounded beliefs about GMFPs could be a diminishing factor in the participants' attitudes. In addition, quantitative studies could have made use of specific questions or scenarios to evaluate consumers' attitudes toward GMFPs, which the respondent could possibly identify with, but did not have to think about before responding and providing an answer, such as in the case of this study. Therefore, it could have been easy to choose an answer without thinking about the question. In the case where an explanation was required, and participants had to provide an argument or a sense of reasoning about purchasing GMFPs, from their attitude point of view, the participants in this study showed they did not have the knowledge to justify their attitudes (through their beliefs, values and expectations) due to not having academically sound facts as seen through the absence of consulting information sources.

Regarding the perceived benefits and risks of GMFPs, quantitative studies have shown that perceived risks influence the PI of GMFPs more than perceived benefits (Bredahl 2001; Hassan et al. 2016; Zhang et al. 2018). However, when participants were asked to verbally articulate the benefits and risks (as emerged when exploring beliefs, values and expectations) that influence their PI, they could not confidently do so. Some confusion again stemmed from a lack of knowledge, contributing to unfounded beliefs. Therefore, the results from quantitative studies cannot be taken at face value because when participants need to start reasoning about their attitudes in the context of purchasing GMFPs, they are unable to do so. Drawing an analogy to the constructivist paradigm that was used in this study, the study showed that the reality is that consumers cannot confidently and convincingly explain and construct their attitudes – this is their view and position of GMFPs.

However, in the GMFP context, the attitude element of the TPB was useful to see what influence attitudes had on PI when the attitude element is fed through the components of the EV Model of Attitudes, thereby allowing an exploration into the influence of attitudes on PI towards GMFPs. To promote the usefulness of the attitude element in exploring attitudes' influence on PI by using the EV Model of Attitudes (as a feeder of the attitude element of the

TPB), the origin and foundation from which beliefs are formed need to come from a factually founded basis before a particular PI toward GMFPs can be confidently shown among consumers. When it comes to GMFPs, consumers lack certainty, which has made its way through to their attitudes and ultimate PI, since participants demonstrated some hesitancy and doubt due to the foundation through which their beliefs, values, expectations and ultimately attitudes are formed. The existence of a dual attitude could also contribute to the lack of influence that the attitude element has on PI, which could make it difficult for the participants to decide whether or not to purchase GMFPs. Furthermore, the attitude element of the TPB has been criticised in that attitudes are not consistent with behaviour, and consumers say one thing about a product yet behave differently toward the product (Ajzen & Fishbein 2005; Caruana et al. 2016), which the findings of this study suggest may be the case.

10.5.2 Objective 3.2: Subjective Norms and Normative Beliefs' Influence on Subjective Norms

Subjective norms have been argued to be a contributor to predicting PI (Farah 2017), which is the case in the GMFP context. Literature has suggested that subjective norms are directly influenced by normative beliefs (Farah 2017; Nickell & Hinsz 2023), and this view can be confirmed when it comes to GMFPs due to the various aspects that emerged from the data. The subjective norms element was primarily driven by the participants' normative belief that there is no influence or pressure from their referent people to purchase or not purchase GMFPs, attributed to their referent peoples' ignorance and not speaking to them about GMFPs. There was consequently no judgement from referent people toward such food products. Thus, it can be confirmed in the GMFP context normative beliefs refer to the expectations of referent people to behave in a particular way (Farah 2017), and an element of judgement is representative of normative beliefs (Al-Swidi et al. 2014). Not speaking to their referent people about GMFPs could have been ascribed to the participants not having any friends or family who farmed with GM crops, their own lack of knowledge, as well as their referent peoples' lack of knowledge; hence, no one conversed with their referent people about such food products. It could also indicate that GMFPs are not a common topic in conversations between family members and friends. Nevertheless, the absence of judgement from referent people is promising as it allows the GM food industry to focus only on the consumer and not the possible unfavourable influence that referent people could have on their intent to purchase GMFPs.

Although participants were willing to listen to the opinions of their referent people regarding the purchasing of GMFPs, their intent to purchase these food products would not be influenced

by such opinions, which could have been ascribed to them not being anxious about purchasing GMFPs. This illustrates that the opinions of referent people do not play an influential role in the intent to purchase GMFPs. Authors have argued that subjective norms relate to the motivation to comply with a referent person's expectation and are indicative of their willingness to act or behave in a way referent people expect of them (Zakaria et al. 2016). However, in the GMFP context, there is no motivation or willingness to behave according to referent people's expectations. Nevertheless, there is a normative belief that a specific behaviour toward GMFPs was not expected by their referent people, and no specific behaviour toward such food products was approved or disapproved of, thereby confirming that normative beliefs are representative of referent peoples' approval or disapproval of a behaviour (Phillips 2008b; Jung et al. 2020).

Previous quantitative studies have found subjective norms do not influence PI when it comes to GMFPs (Bredahl 2001; Chen 2008; Zhang et al. 2018), which was also seen in this study as subjective norms did not play a role in the participants' PI of GMFPs. It shows that the subjective norms element of the TPB remains a consistent element whether it is explored from a quantitative or qualitative approach. However, it does appear to be an insightful element in exploring the influence and prediction of subjective norms on PI in the GMFP context, as seen by the extent of elaboration and volume of data. Thus, the subjective norms element of the TPB needs to be considered when exploring consumers' PI of GMFPs.

10.5.3 Objective 3.3: PBC and Control Beliefs' Influence on PBC

Authors have argued that control beliefs refer to the absence or presence of resources required to execute a performance, which can assist or impede a behaviour (Farah 2017). This claim can be confirmed in the GMFP context, based on the control belief that adequate labelling of GMFPs is lacking and unclear, particularly regarding their size and location on the food product. Due to the depth of data, the PBC element of the TPB – in the GMFP context – is primarily driven by and representative of the labelling of GMFPs; there is a perception that consumers are not facilitated in their purchasing of GMFPs by adequate labelling. To promote consumers' control when it comes to purchasing GMFPs, it was suggested that GM labels could be located on the front of the food product to indicate the presence of GM ingredients, thereby aiding in the identification of GMFPs. In the GMFP context, control in purchasing such food products is further compromised by participants not actively reading food labels, further illustrating the prominent role that labelling plays in consumers' PBC with regard to GMFPs. Not actively reading food labels does raise questions about how the participants knew that GM labels were inadequate; however, not reading food labels could be attributed to their

assumption that almost all food products on the market are GM, they are not concerned about purchasing and consuming GMFPs, and they have no specific intent to purchase or not to purchase GMFPs.

In the GMFP context, the lack of PBC in terms of purchasing such food products is also fuelled by interactions with GMFPs on the market. The participants had the control belief that GMFPs are predominantly available on the market, which led to the assumption that many GM-containing food products are purchased and consumed regularly and it is difficult to avoid these food products, but easy to purchase GMFPs (which they were not concerned about), which played an important role in the lack of PBC when it comes to purchasing GMFPs. Having such a control belief encouraged the purchasing of GMFP and not conventional food products, confirming that when it comes to GMFPs, a control factor encourages a behaviour (Ajzen 2011). However, from a GMFP point of view, the encouragement to purchase such food products emanated from a lack of control. It also indicates that there was already an assumption that GMFPs were purchased and consumed regularly, showing that a lack of PBC stemmed from an assumption basis. These findings illustrate that the continuous introduction of GMFPs on the market could possibly be accepted by SA consumers. However, having this assumption could indicate that the GM food industry does not give consumers the option to purchase traditional food products, which could lead to consumers thinking that they are coerced into purchasing GMFPs, which could create scepticism. The assumption basis from which PBC originates could thus be of concern in terms of promoting the acceptance and PI of GMFPs.

The participants were not specifically looking to purchase or not to purchase GMFPs, potentially since they assumed they were already purchasing GMFPs on a frequent basis; once again illustrating that the lack of PBC in the GMFP context stems from an assumption. This does, however, indicate that they were not actively looking for GMFPs in store to ensure that they would or would not purchase them, which compromised their PBC. Not taking note to specifically purchase GMFPs could indicate that the participants were not entirely convinced of the beneficial attributes that GMFPs offer, illustrating a lack of confidence in the construction of beliefs and the unfounded basis from where the beliefs component of the EV Model of Attitudes emerged. It also questions why they were not specifically looking to avoid purchasing GMFPs, considering the risks and concerns coupled with such food products as well as their altered state of existence. This finding could relate back to the finding that the risks and concerns of GMFPs and crops were the least influential in the beliefs component of the EV Model of Attitudes. This shows that, within the PBC element, the foundation from where beliefs are built could influence consumers' PBC regarding GMFPs. A preference for alternative food

products, particularly GMO-free food products, was demonstrated but would not be possible due to the assumption that the majority of food products contain GM ingredients, indicating a sense of lack of control. This poses a challenge as it shows that, although GMFPs have been credited for their beneficial attributes, a desire for alternative food products was still demonstrated. Hesitancy in consumers' beliefs regarding GMFPs thus exists, which filters through to their PBC and PI.

When it comes to GMFPs, the PBC element of the TPB is also driven by the control belief that there is an increased availability of GMFPs, and they are affordable, making it easier to purchase GMFPs than conventional food products. This indicates that even when consumers have financial stability, affordability plays a role in their PBC. Moreover, in the GMFP context, although beneficial aspects could be linked to such food products, such aspects could also result in compromising PBC, further illustrating that the beneficial aspects of GMFPs possibly play an influential role in PBC. The control belief that there is limited research on GMFPs – making it difficult to purchase GMFPs – was also influential in the participants' lack of PBC, all of which show that the PBC element is a complex element in the GMFP context. These aspects further confirm that a control belief (in the GMFP context) is indicative of present or absent aspects that are needed to perform a behaviour (Farah 2017).

In essence, in the GMFP context, the lack of PBC is primarily driven by the labelling of GMFPs followed by the assumption that GMFPs are predominantly available on the market; not specifically looking to purchase or not to purchase GMFPs; having a preference for alternative food products; increased availability, affordability and limited research on GMFPs. Although it can be confirmed that control beliefs refer to either the presence or absence of aspects which promote or hinder the behaviour (Al-Swidi et al. 2014; Farah 2017), in the GMFP context, there are aspects that both promote and hinder the purchasing of GMFPs. From the findings, it can also be confirmed in the GMFP context PBC refers to the ease or difficulty associated with performing a particular behaviour (Boguszewics-Kreft et al. 2020). Consequently, there is perceived ease and difficulty in terms of purchasing such food products, both of which result in a lack of control. Therefore, although there is a perceived state of ease regarding purchasing GMFPs, the state of ease is directly linked to a lack of control. Thus, in the GMFP context, the state of ease is indicative of a lack of control.

Control beliefs favourably and unfavourably influenced PBC, which resulted in perceived optimistic and threatened PI and behaviour toward GMFPs, although a more threatened PBC was demonstrated. Therefore, when it comes to GMFPs, it can be confirmed that control beliefs directly influence PBC, as suggested by Al-Swidi et al. (2014) as well as Nickell and

Hinsz (2023). Furthermore, through these aspects that emerged, it can confirmed that PBC refers to the control that is perceived to be had over a specific behaviour, as suggested by Ajzen (1985). Based on the depth of data and the extent of elaboration on the attitudes and subjective norms elements of the TPB, the PBC element of the TPB plays a pertinent role in the PI of GMFPs, which was also found in some quantitative studies (Chen 2008; Saha et al. 2021; Yang et al. 2022), while others did not (Bredahl 2001; Spence & Townsend 2006; Ghoochani et al. 2017). The prominent role that PBC played in the TPB in this study could be attributed to participants being supported to articulate how and why they felt they did not have control over purchasing GMFPs, which was not possible in quantitative studies.

10.5.4 The Role of the Three Elements of the TPB in Achieving SDG 2: Zero Hunger

In this study, the TPB was used as a framework through which its three elements, namely attitudes, subjective norms and PBC (Ajzen 1985), were explored to investigate consumers' intent to purchase GMFPs, thereby aiding in the achievement of SDG 2: Zero Hunger. Thus, when it comes to the intent to purchase GMFPs, which of the three elements of the TPB are relevant to consider in the attainment of food security through SDG 2? In the context of this study, all three elements of the TPB provided insight into consumers' PI of GMFPs. However, considering the depth of data, the PBC element of the TPB was the most influential, followed by attitudes, with subjective norms being the least influential on the participants' PI of GMFPs. It was further indicated that where GMFPs are concerned, attitudes and subjective norms do not play a prominent role in the intent to purchase GMFPs and its subsequent behaviour toward these food products, while PBC does. Therefore, to aid in the promotion of food security in SA by using GMFPs, it is essential to focus on consumers' PBC when it comes to purchasing such food products – particularly focusing on labelling – to assist them and make it easier for them to purchase GMFPs and give them more control when purchasing GMFPs. By doing so, their purchasing of GMFPs can be encouraged, which, in turn, can contribute to GMFPs' success in promoting the food security status of the SA consumer.

Although the attitude element (which was fed through the components of the EV Model of Attitudes) was not as influential in the intent to purchase GMFPs, consumer-related beneficial aspects such as affordability and longer shelf life were two primary aspects that fuelled participants' intent to purchase GMFPs based on their attitudes. Thus, to advance food security in SA and contribute to the attainment of SDG 2: Zero Hunger, these two aspects need to be reinforced among consumers to promote their intent to purchase GMFPs. However, it could be problematic to food security efforts that the beneficial attributes linked to GMFPs and crops are currently not compelling consumers to seek out and purchase such food

products. Conversely, it is encouraging to note that the risks and concerns linked to GMFPs are not hindering consumers' intent to purchase GMFPs either. Nevertheless, it demonstrates that the attributes associated with GMFPs are irrelevant to the participants when it comes to their intent to purchase GMFPs, which is of concern in terms of utilising these food products to achieve SDG 2: Zero Hunger. Moreover, the absence of subjective norms' influence on PI and behaviour towards GMFPs could hinder yet promote food security efforts and the achievement of SDG 2: Zero Hunger as there was no demonstrated encouragement or discouragement to purchase GMFPs, thereby leaving their behaviour toward GMFPs in the hands of the consumer.

Although attitudes, subjective norms and PBC had varying influences in terms of the roles they played on the purchasing intention and behaviour of GMFPs, the participants did not specifically look to purchase or not purchase GMFPs. This possibly raises the question as to whether any of these elements had any prominent influence on their intent to purchase GMFPs and whether their behaviour would at all be affected by their attitudes or PBC. This could indicate that there was potentially no specific intent to purchase GMFPs among the participants. From a food security point of view, this could pose a challenge that needs to be addressed to encourage consumers to specifically look for GMFPs on the market and promote their purchasing of such food products.

Objective 4 is addressed next.

10.6 OBJECTIVE 4: PROPOSE A FRAMEWORK REFLECTING THE COMPONENTS OF THE EV MODEL OF ATTITUDES AND THE SALIENT BELIEFS, VALUES AND EXPECTATIONS THAT CONSTITUTE CONSUMERS' ATTITUDES TOWARDS GMFPS AND ATTITUDES' INFLUENCE ON THEIR INTENTION TO PURCHASE GMFPS

The final objective of the study was to develop a framework that reflects consumers' attitudes towards GMFPs, showing the components of the EV Model of Attitudes that lead to the formation of an attitude and how it further influences the intention to purchase GMFPs. A visual depiction of the proposed framework is illustrated in Figure 10.1.

Since this study was framed within the constructivist paradigm, it led to an improved insight (through the eyes of the participants) into participants' views of GMFPs, what subjective reality they constructed about these food products, what they understood and have learnt about such food products, what their idea or image of such food products was (knowledge), and the

meaning they ascribed to these food products (Creswell 2008; Fox 2008; Qutoshi 2018; Kaushik & Walsh 2019; Neubauer et al. 2019; Omodan 2022). This contributed to a better understanding of their position regarding GMFPs in terms of their attitudes and PI. Using a phenomenological research design led to further insight into the participants' lived experiences (Tomaszewski et al. 2020) of GMFPs, thereby understanding how they experienced such food products by exploring the truth of GMFPs through their eyes. The two frameworks were thus combined in this study.

In the proposed conceptual framework of this study, as seen in Chapter 3, Section 3.7, it was suggested that attitude flows from salient beliefs, values and expectations. Thus, the three components of the EV Model of Attitudes, namely beliefs, values and expectations were proposed to be influential in forming attitudes toward GMFPs. As suggested by Ajzen (2001, 2008), beliefs and values are related, and expectations emanate from beliefs and values; thus, attitudes are formed by beliefs, values and expectations (Sheth & Tuncalp 1974). However, as mentioned in the problem statement in Chapter 1 (Section 1.2), insight into the prominence that each component plays in attitude formation remains limited. This claim could be ascribed to the absence of using the EV Model of Attitudes in the exploration of attitudes' development toward GMFPs by previous studies, where other attitude models were considered (Bredahl 2001; Verdurme & Viaene 2003; Chen 2008). Other SA studies (Joubert 2002; Pouris 2003; Vermeulen et al. 2005; Lanzillotti 2007; Peter & Karodia 2014; Gouse et al. 2016; Kotey et al. 2016; Jonker 2017; Gastrow et al. 2018) and international studies (Popek & Halagarda 2017; Brosig & Bavorova 2019; Chagwena et al. 2019; Deng et al. 2019; Kwade et al. 2019; Sanlier & Sezgin 2020; Amin et al. 2021) omitted using a model in their respective studies.

Even less insight has been gained into the influence of knowledge on beliefs, particularly in the SA context. Thus, the proposed conceptual framework in Section 3.7 of this thesis proposed that knowledge and the sources where knowledge is attained influence consumers' beliefs about GMFPs. In terms of the TPB framework, it was proposed, within the conceptual framework, that attitudes, subjective norms and PBC – together with their respective beliefs, namely behavioural, normative and control beliefs – influence PI toward GMFPs. Although literature has established that the three elements of the TPB framework are useful in exploring consumers' PI toward GMFPs due to the framework's application in various studies where the PI toward such food products was investigated (Bredahl 2001; Cook et al. 2002; Verdurme & Viaene 2003; Spence & Townsend 2006; Chen 2008; Zhang et al. 2018; Saha et al. 2021), insight into SA consumers' intent to purchase GMFPs remain limited due to the lack of studies that have investigated the phenomenon in the SA context. A lack of investigation into SA consumers' attitudes and PI toward GMFPs could possibly be ascribed to the context in which

plant-based food products are developed in SA, which is to provide GM crops with herbicide and resistant traits (Gbashi et al. 2021). It could suggest that the consumer was not the focal point of GM crop and food product production in SA, but the focus was rather on the integration of GM crops in existing SA agricultural practices.

An amended conceptual framework has thus been developed based on the findings obtained from the participants in this study to understand what constitutes consumers' attitudes toward GMFPs and the influence it has on their intent to purchase these food products, as seen in Figure 10.1. Through the exploration of consumers' salient beliefs of GMFPs – by applying the EV Model of Attitudes in this study – the attributes associated with these food products were explored (Ajzen & Fishbein 2000). Since the participants were consumers who reside in a rural area where access to a variety of supermarkets is limited, and since some were parents with a financial responsibility towards their family, it is suggested that the most important attributes impacting their beliefs were the benefits that consumers could enjoy from GMFPs. Keeping in mind that participants resided in a rural area where they were amid an agricultural community consisting of farmers and were attentive to the well-being of farmers, the benefits of producing GM crops were also the most important attributes of beliefs, and is illustrated in the framework.

This illustrates that the beneficial attributes of GM crops and food products were considered most influential in terms of the beliefs component, based on the collaboration between these attributes (as depicted through the use of dark grey colour). It is further illustrated in the framework in Figure 10.1 that the process through which GMFPs are developed influences beliefs and thus attitude formation as GMFPs' altered state of existence were also important within the beliefs component, but less prominent than the beneficial attributes of GMFPs and crops, as illustrated through the use of a lighter grey colour. The light grey colour's use suggests that although GMFP and crop risks and concerns were considered important in forming participants' beliefs about GMFPs, it was the least prominent in the beliefs component. This is based on the depth of data as evidenced by the volume of quotes, salient and sub-salient aspects. Literature suggests that beliefs are the most prominent element in attitude formation in relation to the EV Model of Attitudes and that attitudes stem from beliefs (Ajzen & Fishbein 2000; Ajzen 2008; Brousmiche et al. 2016). This view is supported in this study in the GMFP context, as illustrated through the use of a bold, bright red colour in the framework (see Figure 10.1). It is, thus, suggested that the beliefs component of the EV Model of Attitudes was the most influential in the formation of attitudes regarding GMFPs.

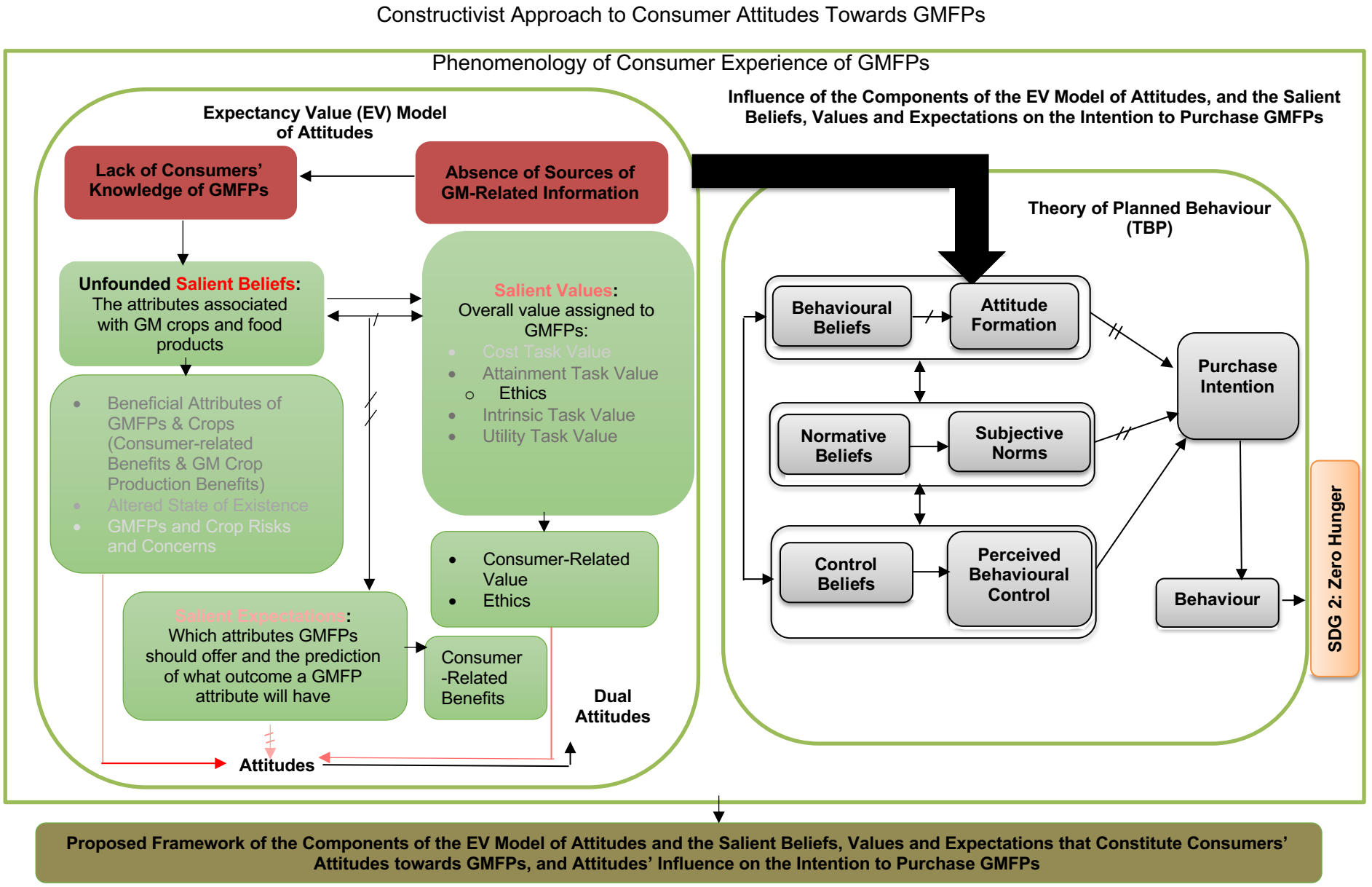

Figure 10.1: New Proposed Conceptual Framework

The cost, attainment, intrinsic and utility task categories were used (Meyer et al. 2019) to explore the salient overall value of GMFPs within the values component of the EV Model of Attitudes. It is suggested that the consumer-related value of GMFPs and – considering consumers to whom their religion was important – the ethics of genetic modification were the most important aspects as seen in the framework. Within the EV Model of Attitudes, the model suggests that beliefs and values are associated (Ajzen & Fishbein 2000). However, the single broken arrow from the beliefs component (salient beliefs) to the values component (salient values) in the framework in Figure 10.1 illustrates that although there is a link between beliefs and values when it comes to GMFPs, the association between these two components are not as prominent as anticipated due to the depth of values data as opposed to the beliefs data. Therefore, even though there is an association, there is a halt and thus not a natural flow from beliefs to values regarding these food products. The prominence of the link between beliefs and values is based on the lack of prominence of many aspects that carried through from the participants' beliefs to their values when assigning value to GMFPs, particularly in terms of the risks and concerns of GM crops and food products and the benefits of GM crop production. However, the straight arrow from salient beliefs to values in Figure 10.1 indicates that values stem from the beliefs attributed to GMFPs, as suggested by Ajzen (2001), since the same aspects that emerged in beliefs emerged in values. Nevertheless, their ability to work together in attitude formation, as suggested by Ajzen and Fishbein (2000), is lacking when it comes to GMFPs, and it is thus proposed that, although beliefs influence values, the influence is not prominent.

It has been proposed that the cost, attainment, intrinsic and utility task categories of values need to be considered when exploring the value of a product (Meyer et al. 2019). However, when the cost task value category is considered where GMFPs are concerned, it does not seem to have a prominent role in influencing consumers' value of GMFPs. This is based on the fact that the participants could not expand on this concept, resulting in limited quotes and aspects stemming from this concept. Therefore, within the newly proposed conceptual framework, it is suggested that the cost task value category was the least influential within the values component, as seen through the use of a light grey colour. It is further suggested that the attainment, intrinsic and utility task category values should be considered in the values component of the EV Model of Attitudes when exploring GMFPs, as the depth of data illustrates its prominent influence on the value of GMFPs, as seen through the use of a dark grey colour. It is also proposed that ethics should be specifically considered within the attainment task value category. The attainment, intrinsic and utility task categories of values can be combined to explore value (Dietrich et al. 2019), which this study suggests doing in the GMFP context. As seen in Figure 10.1, it is proposed that the combination of attainment,

intrinsic and utility task categories of values were the most influential categories in the values component, as seen through the use of a dark grey colour. However, as seen in the framework, it is proposed that the values component is less influential in the formation of attitudes toward GMFPs compared to the beliefs component, as indicated through the use of a lighter red colour in Figure 10.1. This finding could be ascribed to the beliefs component stemming from an unsolid, unsubstantiated and unconfident foundation base, thereby leaving the values component vulnerable in terms of the certainty with which values are assigned to GMFPs.

The salient expectations were explored to understand which product attributes consumers feel or believe GMFPs should offer and the predicted expectation of the outcome a GMFP attribute will have (Panchal et al. 2012; Suvittawat 2022); consumer-related beneficial outcomes of GMFPs are proposed to be the most important. Although the EV Model of Attitudes proposes that expectation stem directly from beliefs and values (Sheth & Tuncalp 1974), as seen through the use of a double broken arrow from the association between the beliefs and values component (salient aspects) to the expectations component (salient expectations aspects) in Figure 10.1, beliefs and values did not lead to a prominent expectation of GMFPs. Therefore, the restricted flow from the expectations component to the attitude, indicated in a broken arrow in Figure 10.1, limits its influence on attitude formation due to the lack of elaboration on aspects, lack of the emergence of sub-salient aspects, and thus depth of all the aspects. It is proposed in the new conceptual framework that, based on the findings of the study and the prominence of the aspects compared to their influence in the beliefs and values component, attitude was not influenced by the salient expectations of GMFPs. Thus, as indicated through the use of the light red arrow in Figure 10.1, it is proposed that the expectations component of the EV Model of Attitudes played the least prominent role in attitude formation toward GMFPs.

By applying the EV Model of Attitudes in this study, its components were explored, thereby leading to the identification that beliefs are the primary driver of consumer attitudes towards GMFPs, followed by values, while expectations are not considered to be a driver. Therefore, the framework suggests that, in terms of the components of the EV Model of Attitude, the beliefs component (salient beliefs) appears most influential in the formation of attitudes, followed by the values component (salient values), with the expectations component being the least influential (salient expectations). This is based on the depth of the aspects in the beliefs, values and expectations data, respectively, in terms of the extent to which the aspects were elaborated on, the volume of quotes and the emergence of sub-salient aspects. To illustrate, the majority of consumer-related benefits were suggested to be the most influential aspects in

the beliefs and values component, and the least in expectations, while the GM crop production benefits, as well as the GM crop production risks and concerns, were the most influential in beliefs, followed by values, and the least influential in expectations. Moreover, the consumer-related risks and concerns (in terms of health risks) were the most influential in beliefs, followed by expectations, and the least influential in values.

Based on the depth of data, attitude formation toward GMFPs could therefore not only be limited to salient beliefs, but could be influenced by the salient values of GMFPs as well. This is based on the consideration that the depth of data on the salient aspects of GM crop production's benefits, and risks and concerns, as well as the consumer-related benefits of GMFPs (except for improved aesthetic properties), were more prominent in values than in the expectations data. Based on the findings of the study, it is further proposed that salient beliefs and values – which were of an optimistic and threatened nature – could lead to a dual attitude toward GMFPs, meaning that consumers could have more than one attitude (Wilson et al. 2000; Ajzen 2001; Zhang et al. 2022) toward GMFPs. Since the findings indicate a lack of GMFP knowledge, which could stem from the absence of consulting appropriate sources of information, it is proposed that it leads to unfounded beliefs toward GMFPs. Therefore, the new conceptual framework further proposes that knowledge and sources where knowledge is attained play an influential role in beliefs and a subsequent influential role in values and expectations. It means that the unfounded beliefs of GMFPs influenced the prominence of the role that the values and expectations components played in attitude formation toward these food products. Therefore, it is proposed that knowledge and sources of information play a relevant role in the foundation from which beliefs are formed and thus need to be considered as important aspects in relation to the beliefs component of the EV Model of Attitudes.

Since the EV Model of Attitudes is a framework used to explore how consumers' attitudes are formed and how consumers make decisions and behave in a specific way based on their beliefs, values and expectations (Ajzen & Fishbein 2000; Ahn et al. 2019; Jia et al. 2023), this model and the TPB framework were combined to better understand how consumers' attitudes influence their PI of GMFPs. As depicted in Figure 10.1, the beliefs, values and expectations components of the EV Model of Attitudes (salient beliefs, values and expectations) flow naturally to the attitude element of the TPB framework. However, there is a restricted flow from the attitude element to PI, indicated in a double broken arrow in Figure 10.1. This indicates that attitudes' (salient beliefs, values and expectations) influence on the intent to purchase GMFPs and the behaviour toward such food products is lacking. Based on the depth of data as evidenced by the sub-salient aspects and volume of quotes compared to their prominence in the beliefs, values and expectations of GMFPs (particularly their beliefs since

the aspects carried the most prominence in the beliefs component), the consumer-related benefits of GMFPs, with the exception of lower price and longer shelf life; GM crop production risks and concerns; and consumer-related risks and concerns of GMFPs were suggested not to be prominent contributors to PI. These aspects were less prominent in the PI context. Aspects believed to be related to the altered state of GMFPs, including religion, the benefits believed to be linked to GM crop production, and ethical aspects that led to valuing GMFPs – which were aspects suggested to influence attitude formation of GMFPs – did not play an influential role in the intent to purchase these food products. It is, therefore, proposed that attitudes towards GMFPs did not play a prominent role in consumers' intent to purchase such food products. As seen in the framework, a single broken arrow in Figure 10.1 illustrates that although behavioural beliefs influence attitudes – as suggested by Farah (2017) – the influence is lacking and does not contribute to a prominent attitude in terms of GMFPs.

Although subjective norms have been argued to influence PI (Farah 2017), the double broken arrow from the subjective norms element to the PI in Figure 10.1 restricts the influence on PI and behaviour. Thus, the proposed conceptual framework proposes that subjective norms did not influence the intent to purchase or not purchase GMFPs as there was no influence from referent people on consumers' behaviour toward GMFPs, leaving the behaviour toward these food products unaffected and unchanged. Even though it is proposed that subjective norms lack influence in the intent to purchase GMFPs, the flow from normative beliefs to subjective norms, as seen in the framework, suggests that normative beliefs did influence subjective norms, as suggested by Farah (2017). This is based on the volume of salient and sub-salient aspects that emerged.

According to Farah (2017), there is a natural flow from PBC to PI and behaviour, proposing that PBC played an influential role in the PI of GMFPs due to the depth of data and extent of elaboration on the majority of aspects that contributed to PBC. Within the new conceptual framework, the natural flow from control beliefs to PBC shows that control beliefs did influence PBC. Therefore, even though it has been argued that attitudes are the most prominent contributor to PI (McSporran 2017), this study suggests that PBC is the most influential in the intent to purchase GMFPs. It is also the most influential on behaviour toward these food products, as indicated through the use of the arrow from PI to behaviour in Figure 10.1.

A contribution of this study is a new proposed conceptual framework in which salient unfounded beliefs and salient values lead to the formation of a dual attitude. It is evident a lack of knowledge and an absence of sources from which to obtain knowledge influence beliefs, leading to unfounded beliefs. Moreover, attitude and subjective norms do not influence

PI, while PBC does, thus providing insight into the behaviour toward GMFPs, which can contribute to the achievement of SDG 2: Zero Hunger. To aid in the achievement of SDG 2, it is suggested that the beliefs component of the EV Model of Attitudes requires specific attention in terms of the consumer-related benefits of GMFPs and the GM crop production benefits and their altered state of existence. The values component, in terms of consumer-related values and ethics of genetic modification, should also be considered. Where the intent to purchase GMFPs is concerned, PBC needs to be focused on in the context of promoting the attainment of SDG 2: Zero Hunger. However, the conceptual framework illustrates that attitudes do not drive or influence the intent to purchase GMFPs.

10.7 CONTRIBUTION OF THE STUDY

A discussion of the study's contribution to methodology, the body of knowledge and theory follows.

10.7.1 Study's Contribution to Methodology

Research into what contributes to the formation of consumers' attitudes toward GMFPs and the intent to purchase GMFPs remains limited in the SA context. The majority of national and international studies followed a quantitative methodology while focusing on an urban population. This study thus contributed by showing rural consumers' attitudes regarding GMFPs and their influence on PI. The study contributed by illustrating the depth of data that can be obtained using a qualitative approach, allowing conversations to take place where the views of GMFPs were vocalised and participants could be probed to gain further insight into their views and reality of GMFPs. This approach led to an understanding of consumers' attitudes toward GMFPs in the SA context and the influence attitudes have on the intent to purchase GMFPs. This showed that it was useful to explore consumer attitudes toward GMFPs by framing the study in a constructivist paradigm.

The study further contributed to the methodology by demonstrating the significance of using a phenomenological, descriptive and exploratory research design through which the lived experiences of GMFPs could be explored. Meaning was given to the facts and statements made, thereby also allowing an in-depth exploration into consumers' attitudes towards GMFPs. The study showed that the application of these research designs was useful in the exploration of consumers' attitudes towards GMFPs. The study also contributed to methodology by showing that the use of purposive, convenience and snowball sampling was helpful in the recruitment of sufficient participants to obtain data saturation. The study did,

however, also point to the difficulty of holding mini-focus groups on an online platform due to various restraints such as having access to a technological device, reliable internet connectivity and different load-shedding schedules; thus, only individual interviews were conducted.

10.7.2 Study's Contribution to Theory

The study has contributed to theory by showing the EV Model of Attitudes' usefulness as a framework – particularly the beliefs component – to explore consumers' attitudes toward GMFPs, which other studies have not done. This study has further contributed by illustrating the role that each component of the EV Model of Attitudes plays in attitude formation toward GMFPs. This study has contributed to theory by showing that a constructivist paradigm was useful when exploring consumers' attitudes toward GMFPs as this allowed the study to explore how GMFPs were viewed, what they understood and have learnt about GMFPs, their subjective reality and the meaning they had given to these food products; all of which aided in understanding attitudes in the GMFP context through the eyes of the consumer. The study also showed that the ethics associated with GMFPs emerged as an aspect impacting SA consumers, specifically when assigning value to these food products. The study also contributed to existing literature in terms of the association between knowledge and beliefs, as it was indicated that it is important to consider knowledge and the sources of information from which knowledge stems when exploring beliefs toward GMFPs to add context to consumers' beliefs.

Within the SA context, the intent to purchase GMFPs remains limited; thus, this study has contributed insight into consumers' intent to purchase GMFPs by using the TPB framework and showing that the PBC element was the most influential in consumers' intent to purchase such food products. By joining the EV Model of Attitudes and the TPB framework, the study contributed to theory by indicating how the components of the EV Model of Attitudes (beliefs, values and expectations) feed into the attitude element of the TPB and the role that attitudes, subjective norms and PBC played in SA consumers' intent to purchase GMFPs. The study further contributed by illustrating the influence of behavioural beliefs on attitudes, normative beliefs on subjective norms, and control beliefs on PBC. The study has also contributed to literature and theory by showing the usefulness of combining the EV Model of Attitudes and the TPB framework when exploring consumers' attitudes and PI, specifically regarding GMFPs, which other studies have not done. The study has also shown that the EV Model of Attitudes can be used as a framework to explore dual attitudes toward GMFPs.

The findings from this study, which have contributed to the development of a new conceptual framework, add to the existing literature and research in terms of what plays a role in attitude formation towards GMFPs and what influences consumers' intent to purchase such food products. This information can be used in future studies and by both the agricultural and food industries to understand which GM crop and food product attributes fuel consumers' attitudes toward GMFPs. The new proposed conceptual framework has identified a gap in terms of the EV Model of Attitudes in that knowledge and the sources where knowledge is obtained is a crucial aspect that needs to be considered in relation to beliefs. Moreover, attainment, intrinsic and utility categories of task values are useful to consider within the values component, while ethics is important to include within the attainment category of task values when exploring consumer attitudes in the GMFP context. It has further contributed by identifying that the expectations component of the EV Model of Attitudes is not a prominent influencer on attitudes towards GMFPs, but that the beliefs and values components are (particularly beliefs). The new conceptual framework has also contributed by demonstrating that even though a particular attitude towards GMFPs can be formed, whether it be of an optimistic or threatened nature, it does not mean that the attitude will lead to a subsequent PI. Instead, the new framework suggests that PBC is more influential in PI than attitudes regarding GMFPs in the SA context.

10.7.2.1 Novelty of the Research

The purpose of the study was to explore which of the three components of the EV Model of Attitudes played the most prominent and influential role in consumers' attitudes towards GMFPs. The novelty of this research therefore lies in the fact that the EV Model of Attitudes has not been used before by previous studies to explore consumers' attitudes towards GMFPs. By using the EV Model of Attitudes in this study, the exploration into the three components of the EV Model of Attitudes has shown that consumer attitudes towards GMFPs are primarily driven by the beliefs component, followed by the values component, but that the expectations component did not drive the attitude. A framework has subsequently been developed to show how these three components work together in attitude formation, and broken arrows indicate a lack of influence. This study has thus demonstrated the role that each of the three components plays in influencing consumers' attitudes towards GMFPs and where attention should be focused to change consumers' beliefs regarding GMFPs, which may affect consumers' values and expectations of these food products.

10.7.3 Contribution to the Body of Knowledge

The study has contributed to the body of knowledge by expanding on aspects that play a role in attitude formation towards GMFPs by clarifying which salient beliefs, values and expectations contribute to consumers' attitudes towards GMFPs, which the GM food industry can focus on and use to promote such food products among consumers. The study has further contributed by showing that price and a longer shelf life are important to consider in the context of consumers' attitudes and PI of GMFPs, which can be used to encourage a favourable attitude and PI in the GMFP context. The study has demonstrated that rural consumers lack GMFP knowledge and do not seek information about GMFPs, which could lead to factually unfounded beliefs about these food products. The study has also highlighted that the physical or actual experience of GMFPs is lacking, and comparisons between GM and non-GMFPs are not being made, illustrating that their experience with GMFPs stems from hearsay. The study also emphasised the importance of labelling GMFPs. The study thus contributed to understanding the role that attitudes towards GMFPs could play in attaining food security in SA. Moreover, a better understanding of the PI and behaviour toward GMFPs was illustrated in terms of consumers' attitudes, subjective norms and PBC, thereby further contributing insight into whether such food products can be used in efforts to attain SDG 2: Zero Hunger and be used as food aid. Considering that GM and GE technology is advancing worldwide and in SA, it is also recommended to establish whether consumers are able to identify GM crops and are aware of which crops are GM.

10.8 RECOMMENDATIONS

Although the findings and conclusions based on the findings cannot be generalised to the wider population within SA, recommendations can still be made to the GM food industry in terms of promoting GMFPs, the dissemination of GM-related information, and theory.

10.8.1 Recommendations to the GM Food Industry to Promote GMFPs

To enhance food security, it is recommended that scientifically sound and thoroughly researched information and research findings on GMFPs needs to be advertised and shared. In light of the findings obtained in this study, it is recommended that the benefits of producing GM crops, and specifically the benefits consumers can attain from GMFPs, should be focused on in advertising schemes. Since GM crop production benefits were not influential in the intent to purchase GMFPs, it is recommended that specific attention be placed on equipping consumers with the knowledge that there are GM crop production benefits, which can inform

consumers that farmers could benefit from GM crops, thereby increasing their support in purchasing GMFPs. However, considering that there were GM crop production and health risks coupled with GMFPs, it is suggested that these aspects should be focused on in information dissemination to remedy consumers' concerns and possible hesitancy towards GMFPs, thereby changing a perceived unfavourable attitude to a favourable one. It is also recommended that continuous research should be undertaken to alleviate consumers' concerns about GMFPs. It is also recommended to focus on the affordability and longer shelf life of GMFPs to promote an optimistic attitude and the purchasing of GMFPs. Therefore, if food security is to be enhanced in SA, GMFPs with noticeable beneficial traits, such as aesthetic and food processing properties, must be considered and incorporated into SA's food production system.

10.8.2 Recommendations for GM-Related Information Dissemination

Due to the lack of GMFP knowledge and risks and concerns coupled with GMFPs, it is recommended that the government and GM food industry educate consumers by sharing information about such food products to enhance their knowledge and remedy fears and concerns about changing the DNA structure of food products. Enhanced awareness should be created by offering experiences with GMFPs to create acceptance of these food products. By doing so, it can contribute to consumers forming optimistic attitudes, it can reinforce an optimistic attitude, and it can change a threatened attitude to an optimistic one. This can further assist in forming factually sound beliefs, which can aid in forming a confident attitude that offers comfort and confidence among consumers in purchasing GMFPs. This is essential if food security is to be promoted in SA and if food aid in terms of GMFPs will be accepted.

Educating the consumer can also possibly lead to developing a single optimistic attitude that contributes to greater comfort and confidence when purchasing GMFPs, thereby promoting the purchasing of GMFPs. It is further recommended that consumer-related beneficial aspects need specific attention in information dissemination, which can further be used to change a threatened attitude to an optimistic attitude. Thus, educational programmes need to be developed to communicate information with consumers, and any new developments in the GM food industry need to be shared with consumers to keep them appraised about the progress made in terms of GMFPs. Consumers also need to be informed about how biotechnology works and why it is needed to change the DNA of crops, which can educate the consumer and give them a better perspective and knowledge of why crops are being GM, which can contribute to an optimistic attitude toward GMFPs and assist in changing an

unfavourable attitude to a more favourable one. Consumers could then be encouraged to become more supportive of GMFPs, thereby seeking such food products in-store.

In terms of educating the consumer, it is also recommended that farmers be educated about the benefits of GMFPs, as consumers surrounded by an agricultural community could view farmers as a source of information. Farmers could therefore have an influence on these consumers' knowledge and their subsequent beliefs and attitudes toward GMFPs. It is further recommended that appropriate labelling should be considered by placing GM signs on the front of the food product, which can further assist with the identification of such food products in store, addressing consumers' lack of PBC when purchasing GMFPs. Television and social media should be used to educate consumers about these food products. It remains essential to educate consumers and encourage the purchasing of GMFPs instead of alternative food products.

Since the participants did not consult sources for information about GMFPs, it is recommended that GM-related information be shared with consumers to create an interest in additional research, helping consumers become more equipped about GMFPs and their benefits.

10.8.3 Recommendations for Theory

It is recommended that when attitudes toward GMFPs are explored, the influence that knowledge has on beliefs about GMFPs should be considered, as well as the sources from where knowledge is attained to create a better understanding of where beliefs emanate. Therefore, it is recommended that more qualitative studies should be conducted in SA specifically focusing on beliefs to address consumers' unconfident attitude toward GMFPs. It is recommended that the attainment, intrinsic and utility task value categories should be considered and combined within the values component of the EV Model of Attitudes. In contrast, the cost task value category needs further development to better understand its role in the values component. It is also recommended that ethics need to be considered within the attainment task value category. When exploring the value assigned to GMFPs and the expectations of such food products, it is recommended that a definition of values and expectations be given so that participants can understand the concept of values and expectations, which could assist them to better express their views about values and expectations. It is also recommended that the EV Model of Attitudes is useful in explorations into consumers' attitudes toward GMFPs and that the TPB framework can be considered together with the EV Model of Attitudes to explore the influence of attitudes on the PI in the

GMFP context. It is further recommended that the influence of the beliefs, values and expectations components could be statistically validated.

10.9 LIMITATIONS OF THE STUDY

Due to the study's exploratory nature and the use of non-probability sampling methods such as purposive, convenience and snowball sampling, the participants were recruited subjectively, meaning that the study's findings cannot be generalised to the wider SA population. However, in terms of transferability, links can be made between the findings of the data due to an in-depth presentation and interpretation of the data in this study. Using these non-probability sampling methods could also have led to the inclusion of participants with similar characteristics, which could have resulted in the acquisition of similar data. Not being able to conduct mini-focus groups could also be considered a limitation of this study as it did not offer an opportunity for the participants to feed off other participants' responses, which could have led to additional information about consumers' attitudes regarding GMFPs. The study did not establish what relationship existed between the different demographic characteristics and the participants' attitudes and PI in terms of GMFPs; therefore, additional statistical analyses on the demographic variables were not done and is thus a limitation of the sample and demographics in this study.

Since the study's participants did not seek GM-related information, there is still a lack of understanding regarding which sources SA consumers consult for information about GMFPs, which was a limitation of this study. The lack of depth of data on some aspects of the values component of the EV Model of Attitudes, and particularly from the expectations component, could be a limitation of the study since participants might have been unable to fully articulate themselves in terms of the values and expectations of GMFPs. As consumers are not always forced to think about food products in terms of these concepts, it might have been difficult for them to express the real meaning of these concepts. The findings represent the attitudes and PI of rural consumers and the urban population has thus not been considered, which could be a limitation. The findings are also representative of food-secure consumers; therefore, the attitudes and PI of food-insecure consumers were not considered, which could be different to those of consumers who are food-secure.

10.10 SUGGESTIONS FOR FUTURE RESEARCH

Consumers' attitudes toward GMFPs and their intent to purchase such food products is a complex topic that can be researched and explored even further, particularly considering the

influential role that these food products can play in enhancing food security. To do so, the new conceptual framework proposed in this study or certain aspects of the framework can be used in future studies. It can also be applied in an exploration into food insecure consumers' attitudes and PI of GMFPs. It is also suggested that the single or double broken arrows – depicting a lack of prominence or influence – in the new conceptual framework can be quantitatively researched to confirm whether those identified components or elements are less influential. Future studies could include a larger group of participants from across SA, thereby also including consumers from urban areas, potentially gaining deeper insight into the broader SA consumers' attitude and PI of GMFPs.

Replicating this study specifically in other rural areas is suggested as this could lead to the inclusion of food insecure consumers as it is important to obtain their views about GMFPs as all consumers – whether they are food secure or insecure – need to be considered in the effort to promote the food security of all South Africans. Food-insecure consumers' need for food could give rise to different aspects that might influence their attitude and PI towards GMFPs, which the GM food industry needs to be aware of. Future research is still required to clarify what consumers expect of GMFPs and whether it is influential in food-insecure consumers' attitudes. Future research could also revisit the value that consumers couple with GMFPs and the role it plays in attitude formation toward such food products, while also exploring the value that food-insecure consumers credit GMFPs with.

More research can be conducted on the cost task value category to understand this category better from a consumer perspective and determine the significance of its influence on assigning value to GMFPs. Future research could further investigate why rural consumers – who come from an agricultural community – may not have the desire to enhance their knowledge of GMFPs and why the benefits and risks associated with such food products did not influence their intent to purchase GMFPs based on their attitudes. It can also be explored which benefits and risks of GMFPs influence food-insecure consumers' attitudes and PI of such food products. Therefore, the significance of consumers' beliefs toward GMFPs needs further investigation. Since the participants did not consult GM-related sources of information, future research needs to explore which sources SA consumers consult and trust regarding GM-related information. It should also be explored whether food-insecure consumers seek information about GMFPs and which GM-related sources of information they visit to do so.

Additional research can be conducted into the role that attitudes play in PI to confirm their prominence in influencing consumers' intent to purchase GMFPs, and explore whether the attitudes of food-insecure SA consumers have any influence on their intent to purchase such

food products. Future studies could also explore farmers' attitudes toward GM crops to determine which aspects need to be focused on to encourage the adoption of GM crop production into farming practices, thereby providing consumers with GMFPs, an essential component in enhancing food security in SA. A link between the farmer and consumer and their influential role in attaining food security can thus be made in future research. Future research could also explore consumers' attitudes toward gene-edited food products, which can be compared with attitudes toward GMFPs, thereby creating insight into whether gene-edited food products, or a collaboration of GM and gene-edited food products, could be influential in food security efforts.

10.11 CONCLUSION

In this chapter, participants' demographics were recapitulated, and the main findings of each objective of the study were discussed, which showed that the salient beliefs of GMFPs (beliefs component of the EV Model of Attitudes) were the most prominent influencer on attitude formation, followed by salient values (values component), with the salient expectations (expectations component) being the least influential. A dual attitude was also demonstrated towards GMFPs. A lack of GMFP knowledge was found, which stemmed from an absence of participants consulting sources for information about GMFPs. However, the lack of GMFP knowledge influenced beliefs, resulting in factually unfounded beliefs. Attitudes and subjective norms did not influence PI toward GMFPs, while PBC did; all of which is illustrated in the study's new proposed conceptual framework.

The study has contributed to methodology by showing the usefulness of communicating with participants by conducting a qualitative study; using a phenomenological, descriptive and exploratory research design; and purposive, convenience and snowball sampling. It contributed to theory by illustrating the usefulness of a constructivist paradigm; that knowledge and sources of information need to be considered within the beliefs component of the EV Model of Attitudes; showing that the beliefs and values components of the EV Model of Attitudes (particularly the beliefs component) plays a prominent role in attitude formation, but that the expectations component does not; that ethics plays a role in values; that it is useful to combine the attainment, intrinsic and utility categories of task values; and the usefulness of merging the EV Model Attitudes and the TPB framework when exploring consumers' attitude and PI of GMFPs. The development of a new conceptual framework has also contributed to theory in terms of what constitutes consumers' attitudes towards GMFPs and their influence on PI. To the body of knowledge, this study has contributed by showing which salient beliefs, values and expectations contribute to the formation of consumers' attitudes toward GMFPs;

that unfounded beliefs come from a lack of knowledge and absence of GM-related information sources; that price, longer shelf life and labelling need to be focused on in terms of the intent to purchase GMFPs; and that consumers lack experience with GMFPs.

It was recommended to the GM food industry that advertisements and information about GMFPs should focus on their consumer-related benefits, such as affordability and longer shelf life, while alleviating consumers' health concerns and other potential fears in producing GM crops. Thus, information about GMFPs needs to be shared with the consumer to create awareness and educate the consumer about GMFPs and the processes involved, while attention needs to be placed on the labelling of these food products. To theory, it is recommended that knowledge and sources of information need to be included in the beliefs component of the EV Model of Attitudes; that the attainment, intrinsic and utility task value categories need to be combined in the values component of the EV Model of Attitudes; and that ethics should be included in the attainment task value category. The limitations of the study were that the findings could not be generalised to the entire SA population; that data from participants with similar traits could have been acquired; that mini-focus groups could not be conducted; that the relationship between demographic characteristics was not established in relation to attitudes and PI; that there is still ambiguity in terms of the sources SA consumers consult for information about GMFPs; as well as their values and expectations of these food products; and that urban and food insecure consumers were not included in the study. Suggestions for future research are to use the proposed framework of this study to explore consumers' attitudes and intent to purchase GMFPs; to quantitatively confirm the lack of influence of components or elements in the newly proposed conceptual framework; include more participants in the study who reside in an urban population, while also considering consumers from rural areas who are food insecure. It is also suggested that the cost task value category needs further exploration, consumers' values and specifically expectations need further investigation, and which sources consumers consult for GMFP information.

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APPENDIX A: CAES ETHICS APPROVAL

UNISA university of south africa

UNISA-CAES HEALTH RESEARCH ETHICS COMMITTEE

Date: 30/09/2022

NHREC Registration # : REC-170616-051
REC Reference # : 2021/CAES_HREC/145
Name : Ms SC Van Zuydam
Student #: 55439594

Dear Ms Van Zuydam

Decision: Ethics Approval Confirmation after First Review from 07/10/2021 to 30/09/2026

Researcher(s): Ms SC Van Zuydam
55439594@mylife.unisa.ac.za; 083-520-0615

Supervisor (s): Prof EL Kempen
kempeel@unisa.ac.za; 011-471-2241

Working title of research:

Exploring consumer attitude and its influence on the intention to purchase genetically modified (GM) food products: towards an integrated research framework to advance food security

Qualification: PhD Consumer Science

Thank you for the submission of your yearly progress report to the Unisa-CAES Health Research Ethics Committee for the above mentioned research. Ethics approval is confirmed to continue for the originally approved period, subject to submission of yearly progress reports. **Failure to submit the progress report will lead to withdrawal of the ethics clearance until the report has been submitted.**

The researcher is cautioned to adhere to the Unisa protocols for research during Covid-19.

Due date for next progress report: 30 September 2023

The progress report form can be downloaded from the college ethics webpage:
https://www.unisa.ac.za/sites/corporate/default/Colleges/Agriculture-&-Environmental-Sciences/Research/Research-Ethics

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*The **low risk application** was originally **reviewed** by the UNISA-CAES Health Research Ethics Committee on 07 October 2021 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa Covid-19 position statement on research ethics attached.
2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
8. No field work activities may continue after the expiry date. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:
*The reference number **2021/CAES_HREC/145** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

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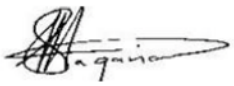
Yours sincerely,



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APPENDIX B: CONSENT FORM

PARTICIPANT INFORMATION SHEET

Ethics clearance reference number: 2021/CAES_HREC/145

18 October 2021

Exploring consumers' attitude towards genetically modified (GM) food products and its influence on purchase intention: applying the expectancy value (EV) model of attitudes

Dear Prospective Participant

My name is Soné van Zuydam and I am doing research with Prof Elizabeth Kempen, a professor in the Department of Life and Consumer Sciences, towards a Doctor of Philosophy in Consumer Science degree at the University of South Africa. We are inviting you to participate in a study entitled Exploring consumers' attitude towards genetically modified (GM) food products and its influence on purchase intention: applying the expectancy value (EV) model of attitudes.

WHAT IS THE PURPOSE OF THE STUDY?

I am conducting this research to explore consumers' attitude towards GM food products and the influence it has on purchase intention. This study is expected to collect important information that could give insight into the salient beliefs, values and expectations consumers' have toward GM food products. Such information can contribute to alleviating food insecurity in South Africa. The purpose of this research is to further determine the influence that knowledge and sources of information has on consumers' beliefs toward GM food products. This study also aims to determine if the two frameworks used in this study, namely the Expectancy Value (EV) model of attitudes and the Theory of Planned Behavior (TPB) are effective when combined in exploring consumers' attitudes and their purchase intention.

WHY AM I BEING INVITED TO PARTICIPATE?

You have been chosen to participate in this study as you are male or female, above the age of 18 who reside in the Midlands, you have heard of GM food products, or you have been in contact with GM food products, or you think you have formed a certain opinion about GM food products, or you think you know something about GM food products, or you have had experience with GM food products. You have also been chosen to participate in this study as you are able to hold a conversation about GM food products and share your thoughts with me. You also have the technological requirements to participate in the study, such as access to Microsoft Teams, a mobile device, tablet, laptop or desktop, internet connection, speakers and a microphone.

To participate in this study, the researcher shared the Facebook post regarding this study with you as you met the inclusion criteria, after which you emailed your contact details (email address) to the researcher using the Gmail address specifically created for correspondence purposes for this study, indicating your interest to participate. Alternatively, another participant shared the study's Facebook post with you, to which you responded and emailed your contact details to the researcher. This study aims to conduct no fewer than 15 interviews and no fewer than six mini-focus groups consisting of no fewer than three participants in each session.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study involves individual interview and mini-focus group sessions which will be held on Microsoft Teams to which you have been invited to either of these. You will be requested to complete a demographic questionnaire. To do so, the demographic questionnaire will be emailed to each participant, which will be accessed, completed and saved on Google Docs. The researcher will then have access to your completed demographic questionnaire on Google Docs. The demographic questionnaire should take approximately 10-15 minutes to complete. The study questions will consist of five sections, namely Section A (consumer salient beliefs and behavourial beliefs), Section B (consumer knowledge, sources of GM-related information, perceived behavioural control and control beliefs), Section C (consumers salient values), Section D (consumers salient expectations) and Section E (consumer subjective norms and normative beliefs). An individual interview session will be expected to take approximately 1 hour, whereas a mini-focus group session is expected to take approximately 1 to 1 and a half hours of your time.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to participate. If you do decide to take part, you will be asked to sign this written consent form. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

Food security is threatened in South Africa. To address this, it is important to understand consumers' attitude towards GM food products. An exploration of consumers' salient beliefs, values and expectations can benefit the GM food industry by identifying the aspects that they need to focus on that will assist the consumer to comfortably use and purchase such products. The consumer will also benefit from this study as the findings may point out educational themes related to GM food products that will enhance consumers' attitude towards GM food products, through which food insecurity may be addressed. This can lead to a boost in production efforts, thereby producing sufficient and nutritious food for the South African population. As a participant in this study you may also benefit by being able to voice your opinion and, through doing so, be given the opportunity to be heard about aspects that matter to you where GM food products are concerned.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

Inconvenience may be experienced as you will be asked to give up an hour to an hour and a half of your time to participate in the study. Connectivity issues may arise during the individual interview or mini-focus group session; if this should occur, the researcher will reschedule a time and date which suits you should you wish to continue. Should any adverse events, injury or harm occur, data gathering will be stopped immediately. The incident will be reported to the supervisor (Prof Elizabeth Kempen), after which the matter will be reported to the Ethics Committee to advise on a way forward.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

You have the right to insist that your name not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, know about your involvement in this research. The individual interview and mini-focus group sessions held on

Microsoft Teams will be recorded, however, your name will not be used anywhere and no one will be able to connect you to the answers you give. You will be asked not to sign up using your name. Instead, the researcher will email an identification number/name to you which will be used to choose an appropriate time/date on Google Docs and to sign up with when the session commences (for example Participant 4-Interview 2). Should you wish not to use this identification number/name you may do so. Your answers will be given this identification number/name and you will be referred to in this way in the data, any publications, or other research reporting methods such as journal articles and conference presentations. Therefore, you will be anonymous in the findings of this study.

The researcher, supervisor and a transcriber will have access to the data. The transcriber has signed a confidentiality agreement, thereby agreeing to maintain confidentiality whilst working with the data. Your answers may be reviewed by people responsible for making sure that research is done scientifically.

Focus groups refer to group discussions that take place, in which participants can share their opinions or feelings about a topic, and can interact with the other participants to encourage dialogue. While every effort will be made by the researcher to ensure that you will not be connected to the information that you share during the mini-focus group session, I cannot guarantee that other participants in the mini-focus group will treat information confidentially. Therefore, an absolute guarantee of confidentiality and anonymity may not always be possible when using focus groups. I shall, however, encourage all participants to respect the other participants and keep all information shared during the session confidential. For this reason, I advise you not to disclose personally sensitive information in the mini-focus group session.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Electronic information will be stored on the researchers' password protected computer in Mooi River, KwaZulu-Natal for future research or academic purposes. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. After 5 years, electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software programme.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

Participation in this study is voluntary and no incentives or compensation will be awarded to the participants.

HAS THE STUDY RECEIVED ETHICS APPROVAL

This study has received written approval from the Health Research Ethics Committee of the College of Agriculture and Environmental Sciences, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Soné van Zuydam on gmfoodstudy@gmail.com. The findings are accessible for 5 years.

The researcher will place the most significant findings on Google Docs, after which it will be emailed to the participants'. The participants' can then access and read the feedback. The Gmail account/address created for this study will be closed after feedback has been emailed to the participants.

Should you require any further information or want to contact the researcher about any aspect of this study, please contact Soné van Zuydam on gmfoodstudy@gmail.com.

Should you have concerns about the way in which the research has been conducted, you may contact Prof Elizabeth Kempen on 011 471 2241 or kempeel@unisa.ac.za. Contact the research ethics chairperson of the CAES Health Research Ethics Committee, Prof MA Antwi on 011-670-9391 or antwima@unisa.ac.za if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.

Soné van Zuydam

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CONSENT TO PARTICIPATE IN THIS STUDY

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the individual interview/mini-focus group session on Microsoft Teams.

I have received a signed copy of the informed consent agreement.

Participant Name & Surname…… (please print)

Participant Signature……..Date……

Researcher's Name & Surname: Soné van Zuydam

Researcher's signature:  Date: 2021/10/18

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APPENDIX C: DEMOGRAPHIC QUESTIONS

Below are the demographic questions which were created on Google Docs.

Demographics

Please complete Section A by marking (**X**) in the appropriate box.

For Office Use Only

Participant Number **V1**

DEMOGRAPHICS											For office use only	
1.	**What is your gender?**				Male	1	Female	2			V2	
2.	**What is your age?**											
	18-24 years	1	25-30 years	2	31-40 years	3	41-50 years	4	51 years or older	5	V3	
3.	**Please indicate your monthly household income range**										V4	
	R1000 or less	1	R1001-R1999	2	R2000-R6000	3	R6001-R6999	4	R7000-R15000	5		
	R15001-R15999	6	R16000 - R20000	7	R20000 or more	8						
4.	**What is your highest level of education?**											
	Lower than matric/ Grade 12									1	V5	
	Matric/ Grade 12									2		
	Grade 12 + a degree/ diploma									3		
5.	**Please indicate your marital status**											
	Single									1	V6	
	Married/living with a partner									2		
	Divorced/ separated									3		
	Widow(er)									4		
6.	**Please indicate your status of employment**											
	Permanent full-time									1	V7	
	Permanent part-time									2		
	Contract work									3		
	Self- employed									4		
	Unemployed									5		
7.	**Do you farm with GM crops?**				Yes	1	No	2			V8	
8.	**Do you have family or friends who farm with GM crops?**				Yes	1	No	2			V9	
9.	**Do you know someone who farms with GM crops?**				Yes	1	No	2			V10	

10.	**Are you aware of GM farming in the vicinity of where you live?**	Yes	1	No	2	V11	

APPENDIX D: INTERVIEW GUIDE

Below is the interview guide that was used for data gathering purposes (individual interviews).

Section	Question Number	Question
A	1.	When you hear the words 'genetically modified', what comes to mind?
	2.	When you hear the words 'genetically modified food products', what comes to mind?
	3.	How do you feel about GM food products in general?
	4.	What do you believe is true about GM food products?
	5.	What do you believe will be your experience of GM food products after you have purchased and consumed them?
	6.	What do you think are the risks of purchasing GM food products?
	7.	If you could point to the most important belief you hold about GM food products, what would that be?
B	8.	Do you know of any GM food products that you purchase on a regular basis?
	9.	Do you specifically look to purchase GM food products?
	10.	How do you feel about the fact that you have purchased GM food products and you perhaps did not know it?
	11.	Is there something that prevents you or makes it difficult for you to purchase GM food products?
	12.	What would you say is the most important thing you know about GM food products?
	13.	What do you think will prevent you from purchasing GM food products?
	14.	What do you think will encourage you to purchase GM food products?
	15.	Do you think you are in control or not in control over the GM food products you purchase?

	16.	Where do you get your information about GM food products from?
C	17.	Will you be willing to purchase GM food products if they cost less than their traditional counterparts?
	18.	In your opinion, what effort does it take to determine whether the product you purchase is in fact a GM food product?
	19.	In your mind, what does GM food products go against in terms of what you believe or hold dear?
	20.	What do you think are the rewards or benefits of purchasing GM food products?
	21.	In your opinion, what functional use does GM food products have? (If you think of the characteristics of GM food products, are these food products doing what they were intended to do or originally designed to do?)
	22.	How differently do you use GM food products to any other food products you purchase and use?
	23.	If you could point to the most important value you hold about GM food products, what would that be?
D	24.	What do you expect of a GM food product?
	25.	In your mind, what are the consequences of using GM food products?
	26.	If you could point to the most important expectation you hold about GM food products, what would that be?
E	27.	To what extend do your friends, family and other parties pressure you to purchase or not to purchase GM food products?
	28.	From which source does this pressure come?
	29.	Which social groups or individuals encourage you to purchase GM food products?
	30.	Which social groups or individuals who discourage you to purchase GM food products?
	31.	To what extent do you feel other people who have a positive influence on you, are important to consider when deciding whether or not to purchase GM food products and why?

	32.	How do you think your friends and family will feel if they know you have purchased GM food products?

APPENDIX E: TABLE OF THE REMAINING QUOTES

The quotes in the tables form part of the aspects in the data chapters of which examples from the data are presented in the discussion in the data chapters. Not all the quotes have been included in the data chapters; thus, the remaining quotes can be seen in the tables below.

REMAINING QUOTES RELATING TO CHAPTER 5: RESULTS, FINDINGS AND DISCUSSION OF THE DEMOGRAPHIC AND BELIEFS DATA OF GENETICALLY MODIFIED CROPS AND FOOD PRODUCTS

Theme 1: Altered State of Existence of GMFPs

Biological Change

"I think of change"
"obviously the food is altered"
"I usually think about it as being changed, so it's been changed in some way"
"changes to the organisms"
"something that has been affected or changed"
"altered or changed or engineered by someone"
"when food is altered"
"the actual cell or the actual seed is altered in order to change the product"
"it's perhaps not ideal to have the genetic information of food altered"

DNA & Genetics

"changing the DNA of products or plants or animals"
"farmers have genetically modified like the DNA structures of crops and maybe some food items"
"just actually alter its DNA"
"it's food or the genetics or the structure of foods at its molecular level that has been modified in some way, shape or form"
"it's got a gene from an insect"
"certain seeds have been taken into a laboratory and they have modified the genetics of that seed"
"implies that a gene from a different species has been incorporated into something like, for example a maize plant, because it has some kind of desirable trait that it is going to confer on that maize plant"

Laboratories

"I think of a lab and scientists that are pricking and prodding and altering the genetic code"
"manipulated in a laboratory"

Unnatural State

"something that has changed from its original form"
"it is a natural product that's been changed"
"products that have been altered from their original form to create something"
"it's changed to the original structure and way of something"
"it's not true to what it was originally, it's been messed with, it's been altered."
"foods that are not naturally made or farmed or harvested"
"changing the original process"
"I think of unnatural"
"they are not natural"
"it's not farming in its purest form"
"something not quite natural"
"by changing it, obviously it's not natural"
"it's not in the original way"
"it's not like an original"
"I always feel like it's something that isn't in its most natural form"
"you are taking away how it was made originally"
"they are not natural"
"it's something that is not natural"

Tampering with GMFPs

"food that has been altered by humans that are not natural"
"people have tampered with food in its purest form"
"there has been a helping hand in producing that food"

Conflicting Religious Beliefs

"it's not how God made them, the chromosomes have been manipulated"
"I do think that we as humans shouldn't tamper too much with what is the natural world, what is God-given, what has worked for all these years"
"why would man want to interfere with something in its organic, pure form when that is how God created it to be good for us?"

Product Feature Enhancement

"there is a lot of positive that can come out of it"
"it's helpful"
"improves food"
"altered for better"
"GM can improve things"
"it stands for the greater good"
"it's obviously been modified for a specific reason"
"they are there for a reason"
"it's there to help us"
"GM foods just stands for something that has become much better than it was initially"
"you've got a big range of what you can do with GM from allowing a crop to withstand chemicals to modifying flavours"
"food has been enhanced"
"stand for enhancement, moving forward and embracing changing plants, changing social economic environments and climate change"
"genetic modification is one of those sort of things that is inevitable for making things better and adjusting to an ever-changing world"
"we've got the skills to do it and we can change foods to meet the needs"
"valuable traits"
"taking genes that are favourable and only using those favourable genes to reproduce something generally seen as 'better'"
"because the reason behind this is to make things better for us as consumers, to be able to have a better product. I'm at ease with it because it's actually giving us something back."
"the whole idea behind GM foods, is to give us something more than just the natural product"

Benefits

"in a lab a seed can be created to have added benefits to a person's needs"
"they can provide a benefit"
"I think there are clear benefits to GM foods"
"so let's say you are talking about maize, there might be a feature that maize on its own doesn't have or doesn't produce, and if you can introduce that feature, genetically, from a different plant, then you can create something that's beneficial"

Theme 2: GM Crop Production Benefits

Environmentally Friendly

Using Fewer Chemicals

"they can require less pesticides"
"reduces the use of something like an insecticide"

Weather Resistance

Drought & Flood Resistant

"to be drought resistant"
"more resistant against droughts"
"drought resistant"
"drought and flood tolerant"
"can deal with droughts"
"can handle drought"
"for drought tolerance"
"to resist drought and flood"
"more hardy and less susceptible to droughts and floods"
"they are drought tolerant and they would survive the harsh climates"
"better protected in a harsh environment like droughts and against things like floods"

Resistant Characteristics

Pest & Disease Resistant

"more resistant to disease"
"pest resistant"
"less disease"
"help with disease"
"better resistant plants that you are not losing half of your crop to pests and diseases"
"more resistant to pests"
"more resistant to disease and pests"
"reducing susceptibility to disease"
"resistant to pests"
"crops that are resistant to pests"
"to be pest resistant"
"a lot of your crops are genetically modified to help with pests"

Insect Resistant

"more resistant to insects"

Chemical Resistant

"to withstand chemicals"
"resistance to a particular herbicide"

Increased Productivity

Improved Growth

"grow better"
"grow faster"
"grow it quicker or bigger"
"to make the actual process quicker of growing"
"crops grow quicker and bigger"

Increased Crop Yields

"to give a higher production"
"get more per hectare"
"get a crop that gives a bigger yield"
"increasing yields for farmers"
"farmers are able to produce bigger quantities at a faster rate"
"more abundance"
"benefit the yield of the product"
"to gain more substantial produce than maybe what that plant or animal was originally developed to produce"
"to produce more"
"create more plants"
"make a lot more of the same product"
"it produces more per plant"
"to get the biggest yield from crops"
"they say it can increase the amount of maize we can plant in a year, you can increase the yields"
"to produce more foods per plant"
"increase their output"
"higher production"

“increase production”
“increase the production”
“better productivity”

Promoting Food Security

“So if we look at food security, it is definitely the way to go and to help and provide for people globally”
“GM can help in securing food”
“they enhance food security”
“I do think they can better food security in countries”
“has huge potential for providing communities in distress with food”
“there is some element of it where it’s to actually help with food security”
“it can ensure that they don’t have a hunger problem”
“the scientists and the government and the world out there actually trying to feed a growing population”
“there is a need for it in the sense that the world’s population is big”
“it’s great because people are then at least not starving and are able to get food in order to survive”
“it can definitely alleviate hunger and food insecurity”
“the use of GM technology allows greater food production, especially in marginal agricultural areas, and so can only improve food security”
“when it comes to feeding, I think there is a benefit for our country”
“I believe it is an attempt at providing a food source”
“businesses say it’s going to feed 10 times more than the usual amount”
“produce more GM crops that are drought resistant, that could be beneficial for food security in the country”

Produce More Food

“they say the purpose is to increase food supply”

Necessity of GM Crops

“we need GM crops in order to continue producing enough food”

Theme 3: Consumer-Related Benefits of GMFPs

Increased Nutritional Value of GMFPs

More Nutrients

"improve the vitamin or mineral content"
"all the nutrients are in there"
"to have more nutrients in it"

Lower Price of GMFPs

"GMFPs are going to be a lot more cheaper than farm fresh or holistic or organic items"
"I think it's a reality, whichever way you look at it, it is cheaper"
"my mind tells me that they definitely cheaper and more reasonable"
"genetically modified food does have the potential to make food more affordable"
"are more likely to be cheaper"
"it's my assumption that genetically modified foods are more affordable"
"potentially produce cheaper food"
"GMFPs are usually priced far more competitively in the market"
"GM would probably end up being more affordable"
"it makes food products cheaper"
"typically they are the cheaper options available"
"GM is cheaper"
GM are cheaper than other food"

Improved Aesthetic Properties of GMFPs

Improved Appearance

"they are more appealing"
"improve the appearance"
"look more appealing"
"better look"
"looks better"
"it will probably look good"

Improved Colour

"different colour of a food product"
"better colour"

Improved Quality

"to gain a better produce"

Improved Food Processing Properties of GMFPs

Longer Shelf Life

"longer lasting"
"extended the longevity of the product"
"better on the shelf, lasts longer"
"their shelf life is more"
"they are probably trying to give them longer shelf life"
"it can affect and change the shelf life if a product, it's going to be on your shelf for longer"
"perhaps a longer shelf life for something"
"make products last longer"
"genetically modified foods do have a longer shelf life"

Improved Taste

"enhanced taste"
"the product might taste better"
"taste better"
"It probably tastes better"
"it has an improved taste"

Theme 4: Risks and Concerns of GM Crop Production

Environmental Risks of GM Crop Production

Threaten the Ecosystem

"would be harmful to the ecosystem"

Impact of GM Seed Usage

Termination of GM Seeds

"it can grow once and then it can't grow again"
"GM seeds are mostly terminated"
"if you try and plant them next year, they don't grow, they just rot, which then forces you to go and buy new GM seed from that company next year"

GM Seed Company Threats

Gain Control Over the Market

"trying to maybe control the market"
"complete control of food"

Greed for Profitability

"there is a greed factor involved"
"my big thing is always the greed"
"I recognise that businesses are out to make money and they are out to make a business profitable, and genetically modified foods might feed into that at the cost of human health."
"it's all about making money"
"it's obviously for an increase in profit in agriculture"
"GMFPs are popular because it makes the big companies, who might have a monopoly in an area, it can certainly secure their wealth and make them wealthier, or make them a greater monopoly"
"it's a financial sort of money-making market"
"financial gain and benefit from it"
"mainly because of money"
"I believe that its money-driven"
"it's all about profitability"
"people trying to make money in a quick way"

Theme 5: Consumer-Related Risks and Concerns about GMFPs

Long-Term Health Risks and Concerns about GMFPs

"there could be future problems with our health"
"I think it would be detrimental to our health"
"people need to realise that there can be possible dangers in other areas as well, such as if you make a crop resistant to round-up, does that now mean that the plants are sprayed more than what they used to and that they could carry additional health hazards because of spraying that they never used to?"
"it ultimately increases the risk of disease"
"I suspect when you add stuff and chemicals and that to animals and foods, I always suspect that there could be problems later"
"I suppose there is some lingering concern in my mind that 20 or 40 or 50 years from now there might be some research showing that there is some kind of negative health implication for it"

"I think that over the long term, it would be unhealthy for me to eat them"

Cancer

"I've heard of the possibility of them being more carcinogenic"
"they do contain levels of toxins, they do have a cancer risk"
"I think that GMO food products have caused a lot of harmful effects on people like cancer"
"not only myself, but my family, we believe that GMO food has a lot to do with creating cancer"
"we are probably in line to get cancer cells introduced into us"

Trusting the Safety of GMFPs

"I suppose there's a level to which we kind of have some trust in what's out there in a shop. We maybe think that if it's got there, if it's on the shelf, there should've been reasonable processes that have been followed to get it there in the first place. So there is that element of trust as well"

Appropriate Control Systems

"But I do think that there are also health and safety standards that exist in countries to prevent companies from selling products that are potentially unhealthy"

REMAINING QUOTES RELATING TO CHAPTER 6: FINDINGS AND DISCUSSIONS OF THE VALUES DATA OF GENETICALLY MODIFIED CROPS AND FOOD PRODUCTS

Theme 1: Cost Value of GMFPs

High Level of Effort Cost Values regarding GMFPs

Back of Food Product

"the label is at the back"
"it is at the back of the product"

Small Text

"not in very big writing"
"the text is small"

Time Cost Values associated with GMFPs

Conduct own Research

"you would have to read up products beforehand and look into it"
"you would probably have to do a fair amount of research"

Effort to Read Food Labels

"there's quite a bit of effort that needs to go into that because you have to now look at the product, turn it over, and look at the labelling; and hopefully the labelling will be good enough to determine it quickly and for you to have enough information from looking at that"
"the only thing you can do is read the label, but it is an effort"

Theme 2: Overall Value of GM Crop Production

Value of the Enhanced Productivity of GM Crops

Increased Yields

"increased yields"
"get a bigger yield of their crop"
"add more volume to crops"
"to mass produce food"
"they can help to produce more food"

Theme 3: Overall Consumer-Related Value of GMFPs

Value of Increased Nutritional Content of GMFPs

"they have added more nutrients"

Value of Affordability of GMFPs

"a specific purpose is to have food at a lower cost"
"they have a reduced price"
"they are made to be cheaper"
"make them more affordable"

Value of Improved Food Processing Properties of GMFPs

Longer Shelf Life

"to have longer shelf life and to last longer in the fridge"
"to reduce the likelihood that it would quickly"
"the intent is to make food last longer"

Improved Taste

"to taste better"

Use GMFPs in the Same Way

"I don't use them any differently"
"I don't use them differently"
"I don't necessarily treat one food differently to another"
"I don't think I would use it any different"
"I use them exactly the same way"
"I don't use them differently"
"I use them exactly the same"
"I can't specifically pinpoint how I would use it differently"
"I can't think of any difference in the way I use GMFP compared to any others"
"I use them the same"
"I wouldn't use them differently"
"I'd use them like I use any other product"
"I use it the same as anything else I would use"
"if I did know that it was genetically modified, I don't think I would use it any differently"

Theme 4: Ethical Values of Genetic Modification

Religious Ethical Values of Genetic Modification

Playing with God's Creation

"I suppose as a Christian, you believe that fruit and veggies that God created are healthy, so it is like sort of at the back of your mind and a concern of how much are we messing with things".
"To me, it's just messing with what God created"
"I believe there is a God that created things, so I believe the crops that are out there are good and natural crops are the healthiest way for our body"
"I think that GM food is not good because it's recreated something that has already been given to us in a complete product"
"From a Christian-word view, I believe that God created stuff perfect the way it is"
"Everything is actually there with its place, doing what it should be doing"
"It's not the way God made it"
"You are messing with something that has already been made in a way that is sufficient or efficient"
"Man was given things to work with, crops and that, why must they also go and manipulate things"

Interfering with the Naturalness of Food Products

"Why would man want to interfere with something in its organic, pure form when that is how God created it to be good for us?"

REMAINING QUOTES RELATING TO CHAPTER 8: FIRST PART OF THE FINDINGS AND DISCUSSION OF THE KNOWLEDGE, SOURCES OF GENETICALLY MODIFIED-RELATED INFORMATION AND PURCHASE INTENTION DATA OF GENETICALLY MODIFIED FOOD PRODUCTS

Theme 1: Lack of Knowledge about GMFPs

Ignorance of GMFPs

"I don't know enough"
"I'm not even aware of genetically modified"
"I have a lack of knowledge or understanding"
"I'm not very knowledgeable"
"it's not knowing enough about it in reality"
"I'm not well-informed"
"I don't know enough about them"
"I don't know an awful lot about them"
"there's not really a great understanding"
"I have a lack of understanding of it"
"I think just a lot of us don't know about it"
"I accept that I don't know enough"
"I don't have a good enough understanding of it"
"I don't think I know enough about it"

Conducting Insufficient GMFP Research

"I haven't read enough about it"
"I haven't looked into it"
"I am not reading about it"
"I haven't really done much research on GM"
"I just have not taken the time to learn more about what GM is"
"I haven't done any reading about GM foods"
"I'm just not doing any research on these foods"

Lack of Education

"I'm not very well educated"

Inability to Identify GM-Containing Food Products

"we actually don't know what GM products would look like"

“I am not even 100% sure”
“in all honesty, I actually don’t know”
“I really don’t know”
“I can’t say that I know”
“I just don’t know”
“I don’t know”
“I don’t know of GM food”
“I really am not sure”
“I don’t which are GM”
“I don’t know off hand”
“I don’t really know”
“I don’t unfortunately know”

Need to Learn More about GMFPs

“I could just educate myself more to know more”
“I should know more”
“I should really become more aware of it”

Platforms to Disseminate Information about GMFPs

Television

“they could maybe in some sort of way, put a short advert on TV”
“through TV I guess”
“I would also say just traditional television”
“a program on TV”
“they would have to advertise it on TV”
“they would put it up on TV”
“probably TV”

Social Media

“social media streaming sort of platforms”
“social media”
“definitely social media”
“I think social media could work”
“perhaps social media”
“social media”

"social media"
"maybe social media"

Theme 2: Sources of GM-Related Information that would be Consulted

Internet

"I would get it from the Internet"
"the Internet would be one"
"you could Google GMFPs"
"the Internet would probably be where I would look"
"I would probably go online"
"Probably just go onto the Internet"
"Mainly the Internet"
"I suppose I'd just go onto the Internet"
"I would probably just look on Google"
"Probably the Internet"
"a Google search would provide some information"
"I'd probably just Google it"
"I would probably go online"
"online sources that are reputable"
"I would probably go the Internet"
"Probably the Internet, like Google"
"I would go on Google"
"most probably the Internet that I will go to"

Published Scientific Journal Articles

"journal articles and scientific papers"

Word-of-Mouth

Consult Knowledgeable Acquaintances

"you'd probably have to find somebody who's involved in the actual deal of it"
"I would ask a certain individual in the field"

Theme 3: Food Products Purchased Regularly Assumed to contain GM Ingredients

GM Crops Cultivated in SA

Maize, Soya and Cotton

"in this country, maize is probably the main one"
"I think the one that stands out for me most is corn and maize that is genetically modified"
"I would probably say we've got a lot of genetically modified maize because that is grown all over"
"most of our maize production is GM"
"all the maize that you buy has been genetically modified"
"a lot of the maize products have been"
"I definitely think that mealies have been"
"maize"
"corn"
"mealies"
"maize and corn"
"the majority of corn in SA"
"maize"
"definitely maize"
"maize, so mealies"
"in South Africa, it is predominantly maize and soy"
"soya and maize, I think definitely maize"
"I categorise soya as GM"
"soya, it's the most genetically modified food in the world"
"obviously our soy products"
"soy bean will also be modified"
"soy"
"soya"
"one of the big ones for sure is a GM food is soya"
"cotton"

Maize or Corn-Containing Food Products

"corn products"
"I think of corn particularly"

Maize Meal

" I would say your mealie meals"
"I think most of our maize meal is GM"
"maize meal"

Sweetcorn

"your sweetcorn are probably all genetically modified"
"sweetcorn"

Grain-Based Food Products

Rice

"rice has been genetically modified"
"things like rice"
"rice has been modified a lot"
"rice has been"

Oats

"Maybe oats"
"I think oats"

Vegetables and Fruits

"I would think a lot of the vegetables that we eat"
"maybe vegetables"
"your traditional vegetables"
"the vegetables that we buy, they probably are genetically modified"
"I would say probably 80% of the vegetables that you buy there has been a helping hand along the lines"
"the vegetables have probably been genetically modified"
"fruits and vegetables"
"definitely fruit and vegetables"
"definitely fruit"
"fruits"

Potatoes

"potatoes definitely"
"potatoes perhaps"

"potatoes"

Tomatoes

"tomatoes is definitely one, they have modified it for longer shelf life"
"tomatoes have been modified to have a longer shelf life"
"I would think tomatoes because they long life now"
"the long life tomatoes that they talk about, those could be GM"
"your tomatoes"
"I know about the tomato"
"I've heard of things like tomatoes"
"definitely tomatoes"
"tomatoes must be one"

Apples

"I think we have probably got some genetically modified apples out there"

Bananas

"bananas"

Meat Products

"cows"
"definitely our meat"
"I think meat products are GM"

Theme 4: Interactions with GMFPs on the Market

Predominance of GMFPs

"probably a lot of what is in the shops" are GM
"I think you'd be shocked at how much GM foods there are, and varying levels of genetic modification"
"I think people don't know that most foods are genetically modified at this point"
"everything is genetically modified"
"I would think that the majority of the food is genetically modified"
"most things are genetically modified"
"I think most products are GM"
"the majority of our food has got some input from genetically modified basic feeds in it"

"just about everything, frankly"
"all the crops have basically been genetically modified at some point"
"I think they are inevitably there"

Purchasing GMFPs on a Regular Basis

"it would be fair to assume that I think that a lot of what I buy has had some sort of assistance"
"I think there's a fair share of what I do buy, or what is purchased in stores, that has been modified in some shape or form"
"I believe I have already purchased them"
"I think most people are purchasing GM foods"
"I don't always think that you cannot purchase GM food in our day and age, I think you'd have to be purchasing them at some point"
"I do think some products, or most products I buy, are genetically modified"
"I no doubt have purchased and consumed GMFPs"
"I'm pretty sure that I have purchased and didn't know, so that's just a fact"

Consuming GMFPs on a Regular Basis

"I have definitely eaten GM"
"I probably am or have eaten or am going to eat GM foods"
"a lot of the stuff we eat is from plants that have been modified at some point"
"I think that most people, including myself, we eat GM foods often"
"I know that I eat GM foods – I think 90% of our population do"
"there are actually very few foods that we eat that haven't been genetically modified"
"we consume them quite regularly"
"I think I eat them"
"I've probably been eating genetically modified products for quite some time"
"I think every single product that we are eating today is genetically modified in some way"
"I probably think that we eat it quite often, that we actually don't even know that we are eating genetically modified foods"
"I think we are actually eating it way more than we think we are"
"we know we've been eating them"
"I do know that most of what we consume at some point has been genetically modified"
"I would not be surprised if some of the products that we eat have not been modified, they probably have been"

"I think most things that we eat have been modified in order to mass produce"
"I'm just starting to assume that I'm eating a lot of it"
"I'm quite sure that probably between 60 and 70% of all the food that I consume, at some point, is genetically modified"
"I think we probably eat 80% genetically modified food. I think we eat a lot more than we think we do"
"it is what I eat, probably every day"
"the chances are I am probably eating GM"
"it is inevitable that we will be eating them"
"we aren't even aware that most of the products we are eating are genetically modified"
"it's simply a fact that I have eaten them"

Difficulty Avoiding GMFPs

"I think it's harder to buy non-GMO food products than it is to buy GMO food products"
"it's very hard to avoid it"
"it's almost impossible to avoid them"
"it's impossible to avoid them"
"you can't really avoid purchasing it"
"I don't think we can get away from it as such"
"I don't think we can get away from it completely"
"it's difficult to get away from GM foods"
"I think genetically modified is so engrained in all of our food, that it is difficult to avoid them"
"you can't get away from them"
"I think it's hard not to purchase GM"
"it's easy to buy a GM product"
"I think it's something that you can't really avoid in a way because I think there are so many products that have GM"

Lack of Concern over Purchasing and Consuming GMFPs

"I'm not really worried about it"
"it does not really concern me"
"it doesn't really worry me that much"
"to be honest, I don't really care"

Not Specifically Looking to Purchase or Not to Purchase GMFPs

"I don't look into each food type to see whether it's been modified or not"
"I don't specifically look for it"
"I wouldn't say it's a conscious thing that I go out to buy GM products"
"I buy what I need and some of the stuff is ultimately going to be a GM food product"
"I just purchase products"
"I don't go out looking for GMFPs"
"I don't specifically look"
"I don't specifically go out and say I want to buy genetically modified foods or not"
"I definitely not ever looked to purchase them"
"I don't specifically look to purchase GMFPs or not to buy them"
"it's not something that I specifically look at"
"I don't specifically go out looking to purchase GMFP, or in fact not to purchase GM"
"I don't search like every item that I buy to see if it's GM or not"

Habitual Buying

"I usually just buy what I feel I use for so long, and I trust that product"
"I look at what I think looks good"
"usually the products that I buy, it's something that I know and trust"
"I think people in general are inclined to buy products that they know and trust"
"If I am used to a certain brand of goods and I have been using it for a long time, then I tend to continue using that product or buying that product"

Alternative Food Product Preferences to GMFPs

"I would try not to knowingly buy any GM products"
"I generally won't purchase them knowingly"
"I would avoid them as much as possible if I could and buy others"
"I would regard it with caution if I actually knew what was GM"
"I would avoid them if I could"
"I would steer clear of any GMO foods"
"I would not buy them if I could"
"I will avoid them as much as possible because I'd rather purchase other food"
"I would like to steer clear of them, but that's not possible"
"if I could, I wouldn't buy them"
"if it were possible, I wouldn't want to purchase them"

Natural Food Products

"I would rather go with unmodified, natural than a modified crop"
"I'd rather go for the natural"
"I've also wanted to consume stuff that is natural"

GMO-Free Food Products

"I would choose to take a GMO-free product as opposed to a GM product"
"I would try to choose a non-GMO product over GMO product"
"if I could choose between GM products and just the standard products, I would rather go for the standard products"
"I think I would prefer the standard product"
"If there are two alternatives and the price difference isn't too much, then I would choose the non-GMO"
"if I had an alternate product, that was not genetically modified, I would use that instead"
"I'd probably go the non-modified route"
"if I had two options and one was unmodified, I would take the unmodified option"

Organic Food Products

"I would gladly just go to doing a complete switch from the GM to organic things"
"if I could, I would buy organic and non-genetically modified fresh produce"
"I'd rather eat organic ones"
"obviously if I had a choice, I would purchase the products that I knew were organic"
"I'd rather eat organic ones"

REMAINING QUOTES RELATING TO CHAPTER 9: SECOND PART OF THE FINDINGS AND DISCUSSION OF THE KNOWLEDGE AND PURCHASE INTENTION DATA OF GENETICALLY MODIFIED FOOD PRODUCTS

Theme 5: Perceived Known Benefits of Purchasing GMFPS

Lower Price of GMFPs

"because GM products cost less"
"definitely buying GM foods means I was paying a little bit less for them"
"they cost less"
"cheaper is better, like people, prices are a thing for us"
"they are cheaper"
"it's well-priced"
"they are the cheaper product, everything is a budget"
"price would end up having to play a role completely"
"it is cheaper in the long run, so I would definitely be interested in it – anybody would be interested in having a cheaper product"
"price will be one of the factors that will influence me"
"in the current environment, it would definitely be price"
"our money food budget can go further"
"GM are cheaper"
"GMFP cost less than their traditional counterparts"
"price would be a factor to me"

Improved Food Processing Properties of GMFPs

Longer Shelf Life

"if it lasts longer"
"it's long shelf life"
"longevity of GM food"

Improved Taste

"if it tastes better, I will buy it"

Same Experience of GMFPs as Non-GMFPs

"there would probably be no experience at the time"
"once you have consumed them, I don't really notice any difference"
"certainly not ever noticed any difference"

"I haven't really noticed a distinct change in sort of flavour"
"certainly be the same"
"If you gave me GM cornflakes and non-GM cornflakes and said which one is GMO, I wouldn't be able to tell you"
"I'm guessing that they would be the same as any other food, it wouldn't really make a difference in my opinion"
"the same"
"I can't exactly tell the difference per se"

Theme 7: Lack of Perceived Behavioural Control over Purchasing GMFPs

Lack of Control due to the Increased Availability of GMFPs

Lack of Food Product Choices

"we don't really have much choice"
"there's limited stores and choices"

Lack of Control due to the Affordability of GMFPs

"not in control because they are cheaper"
"no, because they cost less"
"I don't think so because GM is cheaper"
"GM food costs less than others"
"no control because of their price"
"no I'm not because GM food are cheaper"

Lack of Control due to Limited Research on GMFPs

"I don't know if enough development has occurred for it to be considered a safe product"

Need for Additional Research on the Effects on GMFPs

"there needs to be a lot more research"

Theme 8: Lack of Perceived Behavioural Control over Purchasing GMFPs in terms of GMFP Labelling

Lack of GMFP Labelling

"they don't tell people either when they have genetically modified the food"
"they at least have to acknowledge that they have GM in"
"I don't think they always do it as effectively as perhaps they could"

"there aren't actually many foods that you can see it's been genetically modified, it's not often that they actually put on there that it has been genetically modified"
"you very rarely see that it states whether it's got genetically modified ingredients in it"
"they don't state that it contains genetically modified products"
"there's no sign on it that says 'GMO'"
"I don't think their signage is very good at the moment"
"it doesn't say if its GM, I mean when you buy it on the shelf, it doesn't say these are GM"
"the labelling obviously is not there"
"if large enterprises are allowed to produce GM food and not have to put it on their branding or on their ingredients list or have some notification that this is GM food, then definitely I won't be in control"
"I don't think I have ever really seen anything that actually indicates that it is genetically modified"

Unclear Labelling

"I think it's not clear"
"I haven't really seen anything which makes it clear"
"It seems to be that the food that you buy isn't always clearly indicated as to whether it is or isn't modified"
"there's no clear signage"
"I think there are a lot of GMFP out there in supermarkets that are not clearly labelled"

Size & Location of GM Labels

"it's in the fine print, it's just not clear enough that it's GM"
"they usually have it in very small fine print as well"
"I think it would be better controlled if it was absolutely clear on the labelling and not in the fine print"
"any such labelling is in small print on the back and it is not easy to see"
"it's usually very small, it is usually tucked away on the side somewhere"
"it's more on the back, it doesn't say on the front 'GM' or 'modified'"
"usually on the back"
"it will just be on the back"
"the size is too small"
"I think the size of GM labels are not big enough"
"it's at the back where you can't see it"
"the labels are at the back where you can't see it easily"

"they at the back of the product, so you can't see it"

Suggestions for GMFP Labelling

Separate Sections in Supermarkets for GMFPs

"they could have a separate isle in supermarkets for GMFPs"
"maybe within the shop, you have a section that is just genetically modified foods"

Placing GM Labels on the Front of the Food Product

"it could be a little more prevalent on the front of packaging"
"if they added something on the front, you would be a bit more aware of it"
"it can be put on the front"
"it should be clearly printed in large font on the front of the product and it seldom is"
"if it's in front of you, before you even pick it up, then you can read what's there – that might actually help"
"if it's maybe in the front that it has been genetically modified"
"it would be nice if they could have that clear label on the front of a products so that you see it"
"more detail on the front of the packaging"
"it should be right at the front"
"it must be at the front of the product where you can see it"

Using a Larger Font Size

"it must say there in bold letters 'It's GMO, it's genetically modified"
"we need to see it in like bolder, bigger print"
"think they could probably do it in bigger labelling"
"I think they could make it bigger and more in your face"
"slightly larger icons to say that it's genetically modified"

Using a GMFP Sign

"maybe have something that says 'GM' or some kind of mark, like they do Halal, so that it is more clearly visible"
"having a nice round circle with GMO"
"all foods across the board have to have that emblem that gives an indication to you just so that you know"

Not Actively Reading Food Labels

"I don't specifically look at labelling on GMFPs"
"most of the time I don't check labels"
"people don't really take the time to go and read it"
"I don't really bother with looking to see if it's genetically modified"
"It's not something I look for on a label"
"people don't take the time to read the labels"
"I wouldn't say it's a conscious effort that I will look at every single product lists and the list of ingredients and things like that"
"it's not something that I have actively looked at on the labels"
"people don't read the labels"
"the general population is not even going to bother reading labels"
"I don't check labels, I must admit"
"I'm actually embarrassed to say I don't read labels"
"a lot of people don't read the labels"
"I certainly don't look at the label to see whether or not it's genetically modified"
"a handful of people read food labels"
"I don't think everybody reads the labels that come on the food"
"they don't even look at the product labels"
"you don't always tend to go out to look and read the labelling"
"the general population is not even going to bother" reading GM food labels

Trusting the Safety of Food Products

"I am trusting that food that's bought from these larger supermarkets has been through certain quality controls and has met certain food standards, and therefore is safe to consume"
"consumers have to trust the people you are buying food from are reliable or are producing food of a quality that is acceptable"

Theme 9: Subjective Norms in terms of GMFPs

No Influence or Pressure from Referent People to Purchase or Not to Purchase GMFPs

"I haven't been pressured by anyone to purchase anything"
"I don't think they influence me"
"no, not at all, no influence either way"
"no, they don't"
"not my family directly"

"no, not at all"
"there's no pressure from no one, no"
"they don't pressurise me"
"definitely not under any pressure to buy them or not"
"nobody has ever told me not to buy a genetically modified product"
"there's no pressure at all"
"no one forces me to purchase anything or not to purchase anything"
"there's no one who encourages me to purchase GMFPs that I know of"
"I don't feel pressure from any social groups or individuals to buy GM foods"
"no social groups that persuade me one way or the other about GMFPs"
"friends and family don't influence me much at all in that"

Referent Peoples' Ignorance of GMFPs

"my mom doesn't have a clue, so she can neither pressure nor not pressure me"
"I do think that it is probably something that a lot of people just don't know enough about"
"I don't think they have a good enough understanding of the products"
"they don't know enough about GMFPs"
"they don't know enough about what those GMFPs are"
"I don't think they even know"
"I suppose lack of knowledge about it"
"they don't know much about it"
"I don't think a lot of people have knowledge about this"

Not Speaking to Referent People about GMFPs

"I mean it's not something we talk about every month or every week"
"I can't say that my husband and I have ever discussed our food to that extent where we talk about genetic modification"
"we don't talk about it"
"I don't think there is a lot of conversation about it"
"I wouldn't say that I have really had many discussions with my friends and family about GMFPs"
"it's not something we talk about"
"I never speak to my friends or family about GM foods"

Affordability of Food Products

"it depends on the price of things"

No Judgement from Referent People in Terms of Purchasing or Not Purchasing GMFPs

"I don't think they would be too worried"
"I think they wouldn't have too much to say"
"I don't think they would really care"
"I don't think it's going to cause any splits in my family and friends"
"they probably wouldn't care to be honest"
"my family in general probably would be absolutely fine with it"
"I don't think they mind at all"
"not particularly concerned"
"I don't think they would be too fazed about it"
"I don't think they would think any different of me"
"I don't think they would care"
"I think most of my family members wouldn't have a specific opinion either way"
"I don't think they'd really comment"
"I don't think that they would be bothered"

Listen to Referent Peoples' Opinions about Purchasing or Not Purchasing GMFPs

"I would listen to what they have to say"
"I would definitely hear their opinion and hear what they have to say"
"I would listen"
"I would certainly listen to the opinion"
"I'd listen to it"
"I would listen to their opinion"
"I would listen to them"
"I would never discourage them from sharing theirs and I would listen"
"I would listen to friends or family that have a strong opinion one way or the other about GMFPs"
"I would be interested to hear their conversation about it"
"I would hear what they have to say"
"I would listen"
"I would hear them out"

Opinions would not Influence PI of GMFPs

"it's not necessarily going to influence me"
"I don't think I'd be swayed"
"I will follow my own opinion"
"I wouldn't be easily persuaded that I should be eating GM food"
"it won't influence me because I think I would still stick with my opinion and do my own thing"
"I would be more inclined to stick with my opinion and not theirs. So I don't think it would influence me"
"they don't sway me either way"
"it's not necessarily going to change my view"

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APPENDIX G: EDITING CERTIFICATE

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