(UN)SUSTAINABILITY OF RURAL HOUSEHOLD FOOD SECURITY IN KURFA CHELE WOREDA: EAST HARARGHE ZONE, ETHIOPIA

By

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Submitted in accordance with the requirements for the degree of

Doctor of Philosophy

in the subject

GEOGRAPHY

in the

COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

DEPARTMENT OF GEOGRAPHY

at the

UNIVERSITY OF SOUTH AFRICA

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December 2022

DECLARATION

I **Siyoum Girma Muleta** (student number 57662088) hereby declare that the thesis titled **"(Un)Sustainability of Rural Household Food Security in Kurfa Chele *Woreda*: East Hararghe Zone, Ethiopia"** which I hereby submit for the degree of Doctor of Philosophy in Geography at the University of South Africa, is my own work and has not previously been submitted by me for a degree at this or any other institution.

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DEDICATION

This Thesis is heartily dedicated to my wife Konjit Abera, my children Robel Siyoum and Yonathan Siyoum and all my beloved families.

ACKNOWLEDGEMENTS

I am glad to use this opportunity to express my sincere gratitude and indebtedness to all individuals and organizations for their assistance and support towards the completion of this study:

- Frist and for most, I would like to express my deepest gratitude to my thesis supervisors Dr. Muluneh Woldetsadik (Associate Professor) and Professor Melanie Nicolau (PhD) for their constructive comments and suggestions, overall responsible guidance and follow-up on my thesis.
- I owe my special gratefulness to my lovely wife Konjit Abera, my sons Robel Siyoum, and Yonatan Siyoum, all my parents and family members who directly or indirectly contributed towards the success of my thesis work and their love and moral support all throughout my study.
- I would like to thank Eastern Hararghe Agricultural and Rural Development office, Eastern Hararghe Disaster and Risk management office, Kurfa Chele Agricultural and Rural Development office, Kurfa Chele Disaster and Risk management office, Kurfa Chele Administration office. All these offices, their staffs, experts, and heads deserve my deepest gratitude.
- I would like to express my genuine and heartfelt gratitude to the data collectors Mr. Taju Mohammed, Mr. Yusuf Basha, Mr. Ziyad Jibrial and Chaltu Mohammed for their kind cooperation during data collection process. Many thanks also go to the research participants, without their honest and kind participations this study would not have possible.
- I would like to extend my appreciation to the Ethiopian Ministry of Science and Higher Education (MOSHE) for the provision of scholarship opportunities and Haramaya university postgraduate school for funding of the Thesis.
- My special thanks and appreciation also go to UNISA staff members for providing material support and helpful training during the development of the proposal for this research.
- I would like to also extend my thanks to UNISA bursary class for the financial grant of the study.
- My appreciation also goes to Ethiopian National Metrological Agency for the provision of metrological data of the study area.

- I would like to express my sincere thanks to all staff members of the School of Geography and Environmental Studies, Haramaya University for their encouragement and cooperation during my study.
- It is my pleasure to express my deepest appreciation to Dr. Abenezer Wakuma, Dr. Tegegn Sishaw, Dr. Awol Akmel, Dr. Solomon Tekalign, Dr. Solomon Asfaw, Dr. Adinew Tadesse, Professor Chemeda Fininsa, Professor Nigussie Dechasa, Professor Mengistu Urge, Mr. Anteneh Derribaw, Mr. Ejigu Alem, Mr. Gezegagn Woldu, for their cooperation and moral support in one way or another round towards the completion this Thesis.

ABSTRACT (ENGLISH)

This study examined the status and sustainability of food security. It investigated the socio-economic, demographic, institutional and environmental determinants of the un/sustainability of rural household food security in Kurfa Chele woreda of East Hararghe Zone, Ethiopia. The study employed descriptive and extensive survey research designs. Furthermore, a combination of quantitative and qualitative research approaches and a cross-sectional study was applied, and data were collected from 255 rural farm households using multistage sampling techniques. The collected data were analysed using descriptive (frequency, mean, percentage, SD) and inferential (t-test, one-way ANOVA, chi-square, correlation, logistic regression) statistics. Moreover, the food security status was analysed using three harmonised food security indicators (HFBM, MAHFP and HDDS). The findings suggest that about 76.5% of the sample households are regarded as food insecure, based on HFBM (Kcal), while about 80.4% and 83.1% of respondents seem to be food insecure, based on MAHFP and HDDS thresholds, respectively. The overall incidence of food insecurity was 76.47% while the depth of food insecurity (using HFBM and FGT and expressed as the average percentage increase in calories required to meet the minimum recommended daily requirement) was 22.7%. Besides, the findings implied that food security is not sustainable in the study area as each of the three parametric methods revealed that more than three-quarters of the sampled households have been food insecure. The result of the logistic regression model showed that household size (OR = .318), age of the household heads (OR = 1.122), educational status (OR = 5.959), livestock (OR = 1.558), access to irrigation water (OR = 7.937), drought (OR = .160), per capita off-farm income (OR = 1.000), dietary diversity (OR = 2.207), production diversity (OR = 1.653) and farmland size (OR = 9.441) are identified as the determining factors significantly influencing the un/sustainability of rural farm household food security status. Furthermore, the findings indicated that drought (unreliable rainfall), poor soil fertility, inability to produce sufficient grains, shortage of farmland, poor farming technology, large household size, poor access to infrastructure, lack of access to credit, and lack of training and skills are among the environmental, economic, socio-demographic, and institutional factors perceived to cause food shortages and to influence the un/sustainability of food security in the rural farm households. Limiting the size of meals, reducing the frequency of meals eaten per day, eating less preferred and less expensive food, and selling more livestock to buy food were among the most common coping strategies, while the adaptation strategies identified by rural farm households to cope with food shortages included income and livelihood diversification, crop diversification, cultivation of marginal land, and fattening of livestock, among others. Therefore, the study calls for coordinated efforts among stakeholders and effective fast-tracking of established policies, focusing on rural households' asset building, diversifying livelihoods, and increasing food supply aimed at achieving sustainable food security among rural farm households.

Key words: Sustainability, Rural Farm Households, Food Security, Coping Strategies, Kurfa Chele, Ethiopia

ABSTRACT (ISIZULU)

Lolu cwaningo luhlola isimo kanye nenqubekela phambili yokuvikeleka kokutholakala kokudla. Ikakhulukazi luphenyisise ngesimo sabantu kwezenhlalo nomnotho, izinto ezinomthelela kwizikhungo kanye nesimo sendalo ngokusweleka nenqubekela phambili yokuvikeleka ngokutholakala kokudla emizini eKurfa Chele woreda kwiZoni yeMpumalanga Hararghe, e-Itopiya. Lolu cwaningo lusebenzise i-descriptive ne-extensive survey designs. Nangaphezu kwalokho, inhlanganisela ye-quantitative ne-qualitative research approach kanye ne-cross-sectional study yasetshenziswa, kanti ulwazi luqokelelwe ukusukela emizini yamapulazi yasemakhaya ngokusebenzisa ithekniki ye-multistage sampling. Ulwazi oluqokekelwe luhlaziywe ngokusebenzisa i-descriptive (frequency, mean, percentage, SD) kanye ne-inferential (t-test, one-way ANOVA, chi-square, correlation, logistic regression statistics. Kanti futhi okunye, isimo sokuvikeleka ngokutholakala kokudla kuhlaziywe ngokusebenzisa i-three harmonised food security indicators (HFBM, MAHFP and HDDS). Okutholwe wucwaningo kuphakamisa ukuthi cishe u 76-6% wemizi ibonwa ingenakuvikeleka ngokutholakala kokudla, ngokulandela i-HFBM (Kcal), kanti u 80.4% no 83.1% wabaphendula kucwaningo babonakala bengenakuvikeleka ngokutholakala kokudla ngokulandela i-MAHFP ne-HDDS thresholds, ngokulandelelana. Ukwenaba kokwenzeka kokungavileleki ngokutholakala kokudla kube ngu 76.47% kanti ukujula kokungavikeleki ngokutholakala kokudla (ngokusebenzisa i-HFBM okukhonjiswa nge-average yamaphesente kunyukile ngama-calorie edingekayo ukuhlangabezana nezidingo zansuku zonke kube ngu 22.7%. Nangaphandle kwalokho, okutholakele ngocwaningo kukhombisa ukuthi ukuvikeleka ngokutholakala kokudla akuqhubekeli phambili kumkhakha ebekwenziwa kuwo ucwaningo ngoba ama-parametric method amathathu akhombisa ukuthi isibalo esingaphezulu kwamakota amathathu sesampuli yemizi ayinakho ukuvikeleka ngokutholakala kokudla. Imiphumela ye-logistic regression model ikhombise usayizi wemizi (OR = .318), unyaka wezinhloko zemizi (OR = 1.122), isimo ngokwemfundo (OR = 5.959), imfuyo (OR = 1.558), ukufinyelela amanzi okunisela (OR = 7.937), isomiso (OR = .160), i-per capita off-farm income (OR = 1.000), ukwehluka kwedayethi (OR = 2.207), ukwehluka kokukhiqiza (OR = 1.653) usayizi womhlaba wepulazi (OR = 9.441) kubonwa njengezinto ezinomthelela kwisimo sokusweleka nokuba khona kwenqubekelaphambili yokuvikeleka kokutholakala kokudla ezindaweni zemisi yamapulazi zasemakhaya. Kanti futhi okunye, okutholakele ngocwaningo kukhombise ukuthi isomiso (izimvula ezingani kahle), umhlabathi onganonile, ukungakwazi ukutshala kahle ukolo, ukuswelakala komhlaba wamapulazi, itheknoloji engenhle yokulima, imizi enabantu abaningi, ukungafinyeleli kahle kwizingqalazizinda, ukuswelakala kwezimalimboleko, kanye nokuswela uqeqesho namakhono ngezinye zezinto kwezesimo sendalo, esomnotho kanye nenhlalisano yabantu, kanye nezinto eziphathelene nezikhungo kubonakala kuyimbangela yokuswelakala kokudla kanye nokuba nomthelela ekuswelakaleni nobukhona benqubekela phambili yokuvikeleka ngokutholakala kokudla emizini yezindawo zamapulazi zasemakhaya. Ukuphungula usayizi wokudla, ukuphungula izikhathi zokuhlinzeka ngokudla ngosuku, ukuya ngokudla kancane kancane, nokudla ukudla okungabizi, kanye nokuthengisa imfuyo ukwenzela ukuthenga ukudla ngezinye zamasu avamile okubhekana nesimo, kanti amasu okuhambisana nesimo abonwe yimizi yamapulazi asemakhaya ukubhekana nokuswelakala kokudla kubandakanye ukwehlukanisa ingeniso kanye nezindlela zokuziphilisa, ukutshala izitshalo ezihlukahlukene, ukulima emihlabeni esemaceleni, kanye nokunonisa imfuyo, ngeznye zamasu. Ngakho-ke, ucwaningo lumemezela ukuhlanganisa imizamo phakathi kwababambiqhaza kanye nokusheshisisa imigomo ekhona, ukugxila kakhulu kwimizi yezindawo zasemakhaya, ukwakha impahla, ukuhlukanisa izindlela zokuziphilisa kanye nokwandisa ukusaplaywa kokudla ekufinyeleleni inqubekelaphambili yokuvikeleka kokutholakala kokudla emizini yezindawo zamapulazi zasemakhaya.

Amagama abalulekile: Inqubekelaphambili, Imizi yamaPulazi yaseMakhaya, Ukuvikeleka kokutholakala Kokudla, Amasu okubhekana nesimo, i-Kurfa Chele, E-Itopiya

ABSTRACT (SISWATI)

Lesifundvolucwaningo sicwaninga simo kanye nekusimama kwekubakhona kwekudla. Ikakhulu, sicubungule tenhlalomnotfo, tilawuli tebunyenti bebantfu, tetetikhungo netesimondzawo (tekunga/teku) simama kwekubakhona kwekudla emakhaya lasetindzaweni tasemaphandleni eKurfa Chele woreda eMphumalanga neSigozi saseHararghe, e-Ethiopia. Lesifundvolucwaningo sisebentise emadizayini elucwaningo lweluhlayo lolubanti naloluchazako. Sachubeka, sasebentisa tichamukelo telucwaningo lwelinani nelizingasimo Kanye nesifundvolucwaningo lesigabence, kantsi idatha igcogcwe emakhaya lasetindzaweni tasemaphandleni emapulazini lange-255 ngekusebentisa emasu emasamphuli etigaba letinyenti. Ledatha leyagcogcwa yahlatiywa ngekusebentisa kuchaza (i-frequency, i-mean, emaphesenti, i-SD) kanye lubalobalo lwekusho ngaphambili ngekubuka idatha (t-test, i-one-way ANOVA, i-chi-square, kuhambisana, luhlatiyo lwekusho ngaphambili). Ngetulu kaloko, kwahlatiywa simo sekubakhona kwekudla ngekusebentisa tinkhomba leihlanganisiwe tekubakhona kwekudla (i-HFBM, i-MAHFP ne-HDDS). Lokutfoliwe kukhomba kutsi alinganiselwa ku-76.5% emasamphuli emakhaya atsatseka njengemakhaya lete kudla, ngekubuka i-HFBM (Kcal), bese kutsi lalinganiselwa ku-80.4% na-83.1% yalabo labaphendvulile bakhombisa kubete kudla, ngekubuka emazinga e-MAHFP ne-HDDS, ngekulandzelana. Sehlakalo sekungabi nekudla sesisonkhe besinge-76.47% kantsi kujula kwekungabikhona kwekudla (ngekusebentisa i-HFBM lokuchazwe ngemaphesenti laku-avareji ekkwenyuka kwemakhalori ladzingekile kute ahlangabetane nesidzingo selinaniphasi lelinconywako malanga onkhe) belinge-22.7%. Ngaphandle kwaloko, lolokutfoliwe kukhombe kubakhona kwekudla akusimami kulendzawo lokwentiwe kuyo lesifundvolucwaningo njengaloku leyo naleyo ndlela yepharamethriki kutotintsatfu tivetile kutsi angetulu kwemakota lamatsatfu emakhaya lokwentiwe ngawo emasamphuli ete kudla. Umphumela wemodeli ye-logistic regression ukhombise kutsi isayizi yelikhaya (OR = .318), budzala betinhloko temakhaya (OR = 1.122), simo setemfundvo (OR = 5.959), imfuyo (OR = 1.558), kufinyelela kutfola emanti ekunisela (OR = 7.937), somiso (OR = .160), ngekwemalingena lengaveli epulazini (OR = 1.000), kwehluka kwekudla (OR = 2.207), kwehluka kwekukhicita (OR = 1.653) kanye nesayizi yemhlaba wekulima (OR = 9.441) abonakale njengemaphuzu ladlala indzima ekubeni nemtselela lomkhulu (ekunga/eku)simameni kwesimo sekubakhona kwekudla emakhaya lasetindzaweni tasemaphandleni emapulazini. Kwengeta kuloko, lolokutfoliwe kukhombise kutsi somiso (imvula lengakatsembeki), kunganotsi kwemhlaba, kungakhoni kukhicita lokusanhlavu lokwanele, kweswelakala kwemhlaba wekulima, buchwepheshe bekulima lobungekho ezingeni, emakhaya lanemalunga emndeni lamanyenti, kungafinyeleli kahle kusakhiwonchanti, kungakhoni kufunyelela kutfola sikweleti, Kanye nekungabikhona kwekuceceshwa kanye nemakhono asemkhatsini wemaphzu etesimondzawo, etemnotfo, tenhlalo yebantfu, kanye newetikhungo labonakala ayimbangela yekweswelakala kwekudla kanye nekuba nemtselela (ekunga/eku)simameni kwesimo sekubakhona kwekudla emakhaya lasetindzaweni tasemaphandleni emapulazini. Kunciphisa bungako bekudla, kunciphisa kudla emahlandla ekudla kudla ngelilanga, kudla kudla longakutsandzi nalokungabiti kakhulu kanye nekutsengisa imfuyo kakhulu kute kutsengwe kudla ngulamanye emasubuciko latayelekile ekubukana nesimo, bese kutsi emasubuciko ekutetayeta lentiwa ngemakhaya lasetidzaweni tasemaphandleni emapulazini ekubukana nesimo sekweswelakala kwekudla afaka ekhatsi imalingena kanye nekwehlukahlukana kwendlela yekutiphilisa, kwehlukahlukana kwesilimo, kulinywa kwemhlaba longalimeki, kanye nekunoniswa kwemfuyo, emkhatsini walokunye. Ngako-ke, lesifundvolucwaningo siphakamisa kutsi kube nemitamo lehlanganisiwe emkhatsini walabo labatsintsekako kanye nekuchubekisela embili ngekushesha nangemphumelelo kusungulwa kwetinchubomgomo, kugcilwe ekwakheni imphahla yemakhaya lasetindzaweni letisemaphandleni, kwehlukaniswe tindlela tekutiphilisa kanye nekwandzisa kuphakelwa kwekudla lokuhloswe ngako kutsi kufesekiswe kubakhona kwekudla lokusimememe emakhaya lasetindzaweni tasemaphandleni emapulazini.

Emagama lamcoka: Kusimama, Emakhaya lasetindzaweni tasemaphandleni emapulazini, Kubakhona Kwekudla, Emasubuciko Ekubukana Nesimo, Kurfa Chele, e-Ethiopia

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ARDO	Agricultural and Rural Development Office
CSA	Ethiopian Central Statistical Authority
DPPO	Disaster Prevention and Preparedness Office
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agricultural Organization
HDDS	Household Dietary Diversity Score
HFBM	Household Food Balance Model
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
Kcal	Kilocalorie
MAHFP	Months of Adequate Household Food Provisioning
MDG	Millennium Development Goals
MoA	Ministry of Agriculture
OECD	Organization for Economic Co-operation and Development
PSNP	Productive Safety Net Program
SDG	Sustainable Development Goals
TLU	Tropical Livestock Unit
UN	United Nation
UNCDF	United Nations Capital Development Fund
UNDP	United Nation Development Program
UNICEF	United Nations International Children's Emergency Fund
WFP	World Food Program
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Food is likely essential to our survival (Abebaw and Bertu, 2019; Faridi and Sulphey, 2019; Goshme, 2019; Martin-Rios *et al*., 2020) and one of the most basic human requirements (Dessalegn, 2018; Sani and Kemaw, 2019) and the major source of nutrients required for human survival and growth (Ogundari, 2017; Vandevelde and Swinnin, 2019). Moreover, access to adequate and nutritious nourishment is one of the basic human rights and food security is the need for humans (Dagne, 2016; Devereux, 2018) and is necessary for the United Nations Sustainable Development Goals (SDGs) to be met. Hence, guaranteeing food security for all people is a basic human right and a policy priority for all nations (Peng *et al*., 2018). The United Nations Food and Agricultural Organization (FAO *et al*., 2020, p. 254; FAO *et al*., 2021, p. 190) noted that food security is "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." Food security is a problem for the individual to the global level (Berry *et al*., 2015) and it is also one of the main challenges of human populations for governments and world leaders.

There are four intact dimensions of food security in line with different levels that have been identified as availability (national), accessibility (household), utilisation (individual) and stability (short-term time dimension that affects all the levels) (Adjimoti and Kwadzo, 2018; FAO *et al*., 2017; FAO *et al*., 2021; Feleke, 2019; Peng *et al*., 2018). Additionally, the more recent development emphasizes the importance of sustainability, which may be considered as the long-term time (fifth) dimension of food security (Berry *et al*., 2015; Peng *et al*., 2018; Peng and Berry, 2019) indicating that to achieve food security, it is necessary to ensure the consistent availability and accessibility of sustainably produced, safe and nutritious food, as well as to reduce waste and losses in food production, processing, and consumption. Hence, food security and sustainability issues have been one of the main agendas of all the countries to support the demand of the ever-growing population in the world. Moreover, food security and food systems sustainability have been critical for people and the survival of political administrations throughout history and around the world (Faridi and Sulphey, 2019; Vandevelde and Swinnin, 2019). However, in a world of rapidly increasing human population (Frelat *et al*., 2016) and unprecedented global change (Ferranti, 2019), achieving sustainable food security for all people, including the ability to produce or purchase the food they require without significantly affecting the social and biophysical environment, remains a major challenge. What is more, food security and sustainability in the food sector is a fundamental objective of development policy and a measure of the success thereof and for which almost all governments of developing countries have introduced a variety of regulations and policies to address the phenomenon (Vandevelde and Swinnin, 2019; Welteji *et al*., 2017).

The continuous global food crisis scenarios, particularly in the 1970s, led world leaders to accept for the first time the international community's shared responsibility to eradicate malnutrition and hunger (Endalew *et al*., 2015; Peng and Berry, 2019). Following this, the 1996 World Food Summit held in Rome set a target to reduce the number of hungry people by half in 2015 and at least 20 million reductions every year between 2000 and 2015 (FAO *et al*., 2015) and several commitments have been made by world leaders since then to significantly reduce hunger and malnutrition to achieve sustainable food security for all people. Globally progress has been made and the overall prevalence of undernourishment has decreased from 14.8% in 2000 to 10.6% in 2015 (FAO *et al*., 2017) and developing countries as a whole almost achieved the 2015 Millennium Development Goal (MDG 1) that targeted the reduction of extreme hunger from 23.3% in 1990-92 to 12.9% in 2014-16 (United nation [UN], 2015a). Nevertheless, the number of chronically undernourished people in the world was estimated to have increased to 815 million in 2016 up from 777 million in 2015 (FAO, *et al*., 2017) and the vast majority (an estimated 780 million) of undernourished people were living in developing countries in 2014-16 (FAO *et al*., 2015, UN, 2015a).

Among the developing regions, the African continent faces the greatest challenges, the most vulnerable and food insecure part of the world (Devereux, 2018; FAO *et al*., 2020; FAO *et al*., 2020) and achieving food security is still a major problem for households in most rural areas (Goshme, 2019); Woldie *et al*., 2020), particularly in Sub-Saharan Africa. FAO report revealed that in Africa, the number of undernourished people increased from 182 million (27.6% of the population) in the year 1990-92 (FAO *et al*., 2015) to 282 million people which accounts for 21% of the total population in 2020 (FAO *et al*., 2021) while it was significantly declined in Asia and Latin America (FAO *et al*., 2020; FAO *et al*., 2021). Additionally, the report indicated that Sub-Saharan Africa is the worst of all regions on the continent (Devereux, 2018) in the prevalence of undernourishment and food insecurity with 203 million people (21% of the population) in 2015 (FAO *et al*., 2020) and 264 million people (24% of the population) in 2020 (FAO *et al*., 2021).

Ethiopia is one of the developing and African countries that achieved the targets for Millennium Development Goal 1 of halving the proportion of undernourished people from 74.8% to 32% within two decades (FAO *et al*., 2015). Despite these encouraging results, Ethiopia still faces numerous daunting human development challenges, with over 22 million Ethiopians living in absolute poverty, with many others living just above the poverty line and vulnerable to shocks and food insecurity (Eyasu, 2020; Mekore and Yaekob, 2018). A report by FAO *et al.* (2020) also indicated that Ethiopia ranking number one is the worst of all African countries as an estimated 21.5 million of its population (19.7%) are suffering from chronic undernourishment during the period 2017-19. This indicates that the country remains one of the world's most food-insecure countries, where approximately one in five people live below the poverty line. The country is also one of the poorest and least developed countries in the world (Alemaw and Hailu, 2019) ranking 173 out of the 189 countries and territories in the 2019 United Nations Development Program (UNDP) Human Development Index (UNDP, 2020). In 2019, Ethiopia’s human development index value was 0.485, which is below the average of 0.513 for countries in the low human development category and below the average of 0.547 for countries in Sub-Saharan Africa (UNDP, 2020).

The challenge for Ethiopia is to produce and supply a sustainable, secure availability of safe, nutritionally balanced, and affordable high-quality food to an alarmingly increasing population while using less land, in the context of worldwide climatic and other environmental changes and declining resources. In line with this, the Ethiopian government, in collaboration with its partners, has developed several policies and strategies and has taken a strong leadership role in reducing the prevalence of malnutrition and addressing the problem of food insecurity (Endalew *et al*., 2015). However, despite considerable resources invested each year by the government of

Ethiopia and its partners to fight hunger and reduce food insecurity, both transitory and chronic food insecurity problems are continuing at the individual and household levels in the country (Desalegn and Ali, 2018; Mekore and Yaekob, 2018; Woldie *et al*., 2020). Hence, if the condition continued in such a way the issue of achieving sustainable food security, particularly in the rural area and meeting the sustainable development goal of ending hunger in all its forms by 2030 will be worrying.

The study area, Kurfa Chele is among the food insecure *woredas*[1] located in the East Hararghe Zone of Oromia Regional State of Ethiopia. All the *woredas* of the eastern Hararghe zone are dependent on the Productive Safety Net Programme (PSNP[2]) and emergency relief food assistance and Kurfa Chele, the study area is among the first hot spot and most food insecure *woredas* of the zone. In most cases, the shortage of food supply season in the study area has occurred before the harvest period, when the previous year's stored grain is practically depleted and market prices are high. Therefore, the issue of enhancing resilience to food security and the sustainability of food security should get special attention to feed the alarmingly growing population of Ethiopia and the study area as well. Thus, this study aims to assess the status and condition of food security and to identify the major socio-economic, institutional, and environmental factors that determine the sustainability of rural household food security in Kurfa Chele *woreda* of East Hararghe zone, Ethiopia.

1.2. Statement of the Problem

Ethiopia, which is in the Horn of Africa with an estimated total population of over 120[3] million (UN, 2022) is the second-most populous country in the continent and has achieved impressive economic growth over the past decades (Nkunzimana *et al*., 2016, FAO, 2018; FAO *et al*., 2020; Mekore and Yaekob, 2018). The country has also achieved an overall reduction in food

[1] *Woreda* refers to local adminstrative unit next lower to zone administration level in Ethiopia often used interchangeably with district

[2] PSNP is s social protection programme implemented in the rural Ethiopia since 2005 that provides cash and food transfers to food-insecure households and complemented by the Household Asset Building Programme which aims to provide longer term solution to PSNP households by diversifying and increasing their incomes (Desalegn and Ali, 2018)

[3] The estimation data for "Ethiopian population" is based on the latest demographic and social statistics by United Nations Statistics Division

insecurity and the level of poverty over the past twenty years (Desalegn and Ali, 2018; FAO *et al*., 2015; Woldie *et al*., 2020). The percentage of the population living in poverty has decreased in the country, from 46% in 1995/96 to 44% in 2000, to 29.6% in 2010/11 (CSA and WFP, 2014) and to under 24% in 2015/16 with poverty more prevalent in rural areas than urban (Eyasu, 2020). Furthermore, the United Nation Development Program report (UNDP, 2020) showed that about 23.5% of the Ethiopian population are living below the national poverty line with 61.5% living in severe multidimensional poverty and the remaining 8.9% of its population became vulnerable to multidimensional poverty.

Moreover, the proportion of undernourished people has declined by 38.8% from 74.8% in 1990-1992 to 36% in 2010-12 (FAO *et al*., 2015) to 28.2 % in 2014-2016 (FAO *et al*., 2017) to 19.7% in 2017-19 (FAO *et al*., 2020) and to 16.2% in 2018-20 (FAO *et al*., 2021). However, despite such significant and continuous progress in reducing hunger, food insecurity and poverty, particularly in the rural area remains a big challenge and the country has still one of the highest malnutrition rates in Sub-Saharan Africa (FAO *et al*., 2020; UNDP, 2020) and many people do not have access to the food they require to live an active and healthy life. Besides, the recent FAO report showed that the number of severely food insecure people in Ethiopia were increased from 14.7 million in the years 2014-16 to 15.4 million in 2017-19 (FAO *et al*., 2020) and increased to 18.4 million in 2018-20 (FAO *et al*., 2021). As per the report, if the recent trend persists, the country will be significantly off-track to the zero-hunger target of the SDGs in 2030, despite the fact that the country has adopted a 10-year perspective development plan for the period 2019/20 to 2029/30 which is fully aligned with the 2030 agenda and SDGs and has implemented sustainable agricultural practices that could raise productivity and enhance food system resilience, thereby helping to reduce poverty, malnutrition, and food insecurity.

Furthermore, in 2015/2016 an estimated 10.2 million food-insecure people needed emergency food assistance due to severe drought caused by the El Niño[4] weather phenomenon (Assefa, 2019; Goshme, 2019; Ministry of Agriculture [MoA], 2015; World Health Organization

[4] El Niño is a local warming of surface waters that take place in the entire equatorial zone of the central and eastern Pacific Ocean which affects the atmospheric circulation worldwide (Biggs *et al*., 2014; Kiladis and Diaz cited in Rojas *et al*., 2014; Kogan, 2019). It is a high Oceanic Niño Index (ONI), which refers to the departure of sea surface temperatures from average in the region in the central equatorial pacific and in turn affects the global rainfall patterns in many places.

[WHO], 2016) and about 400,000 children under five years were severely malnourished (Goshme, 2019; MoA, 2015). Furthermore, over 8 million vulnerable and chronically food-insecure people in the country received support (food and cash assistance) under the Productive Safety Net Programme (PSNP) (Goshme, 2019; Nkunzimana *et al*., 2016; Desalign and Ali, 2018). Some of the most recent global El Niño weather period that caused drought episodes in Ethiopia includes 1982-1983 (2.12 Oceanic El Niño Index (ONI[5] value), 1986-1988, 1991-1992, 1997-1998 (2.4 ONI value), 2002-2003, 2004-2005, 2006-2007, 2009-2010, 2011-2012 (Rojas *et al*., 2014) and 2015-2016 resulting 2.04 ONI value (WHO, 2016). The 2015-2016 El Niño ranks among the top three strongest records that occurred over the last 35 years and it is also the worst drought period in Ethiopia over the last 30 years (WHO, 2016) which leaves about 10.2 million people in need of emergency food assistance (MoA, 2015; Tullu, 2017) and threaten the sustainability of food security in the country.

In Ethiopia, the majority of its population (nearly 80%) are rural dwellers (the focus area of this research), primarily depending on rain-fed agriculture (Alemu and Mengistu, 2019; FAO, 2018; Goshme, 2019; Mengistu *et al*., 2021; Mohamed, 2017; Woldie *et al*., 2020) producing crops and rearing livestock and for an overwhelming majority of the people, agriculture is a basic means of livelihood and source of income (Abebe, 2018; Adem *et al*., 2018; Tsegaye *et al*., 2018). Although agriculture is the mainstay of the Ethiopian economy and well progressed in production and productivity (Adem *et al*., 2018; Desalegn and Ali, 2018), it has not been productive enough to sustainably ensure farm household food security as it suffers from adverse climate-related shocks (prolonged drought and unreliable rainfall), pest infection and technologically limited farming practices (Gemechu *et al*., 2016; Tsegaye *et al*., 2018) that severely affected food production and livelihoods. Furthermore, food insecurity is one of the features of rural poverty in the country, mainly amongst the rural population smallholder farmers, moisture deficit and some pastoral areas. Moreover, different natural disasters like recurrent droughts and flooding, environmental degradation, rapid population growth and the high market price also further worsened the problem and resulted in a large percentage of the people becoming food insecure (CSA and WFP, 2014; Gebrehiwot and van der Veen, 2015;

[5] ONI is an index used to monitor the El Niño Southern Oscillation measured by averaging sea surface temperature anomalies in an area of the eastern-central equatorial Pacific Ocean. An ONI value indicates weak (0-1) (, moderate (1-1.5), strong (1.5-2) and very strong (above 2) intensity of El Niño events.

Goshme, 2019) because of the unsustainable agricultural production which is impacted by a number of interconnected factors, noted above and other natural, socio-economic, demographic and institutional factors.

In Ethiopia, the severity of the food shortage problem varies from one part of the country to another based on the state of development and endowment of different natural resources. Oromia is one of the eleven regional states in Ethiopia in which some parts of the region (especially its lowland areas) were seriously affected by the problem of food insecurity. In the region, the most severely affected parts include lowland areas of East and West Hararghe, Arsi and West Arsi, Bale and Borena zone (Nkunzimana *et al.*, 2016). Kurfa Chele *woreda*, the present study area, is recognized as one of the most vulnerable, food insecure and PSNP beneficiary *woredas* of Eastern Hararghe Zone of Oromia region. For instance, in 2016 the number of people that were supported by PSNP and those who received emergency food assistance accounted for 17,079 (22.6%) and 48,753 (64.5%) of the total population of the *woreda* respectively (Eastern Hararghe Disaster Risk Management Office, 2018). Even though the severity of food shortages varied from year to year, rural farm households in the study area often faced chronic and seasonal food shortages almost every year. Shortage of food in the study area is mainly caused by climatic variability of below-normal rainfall conditions that resulted in severe drought. Moreover, even though drought is a major factor in causing food crisis, chronic and seasonal food insecurity in the study area is also determined by various resource endowments (asset ownership), socio-economic, demographic, and other related factors of the households. Hence, the rural farm households should exercise several coping and adaptive strategies based on local or indigenous knowledge for subsistence and to bring positive and sustainable food security outcomes in the long run.

In Ethiopia, including the Oromia region, there have been a few studies on food security issues (Abafita & Kim, 2014; Adem *et al*., 2018; Asmelash, 2014; Bazezew *et al*., 2013; Bedeke, 2012; Berlie, 2015; Beyene & Muche, 2010; Bimerew & Beyene, 2014; Bogale, 2012; Derribew, 2013; Endalew *et al*., 2015; Gemechu *et al*., 2016; Goshu *et al*., 2013; Kassie *et al*., 2017; Maxwell *et al*., 2014; Mitiku *et al*., 2012; Muche *et al*., 2014; Shimeles *et al*., 2011; Tafesse *et al*., 2015; Tafesse *et al*., 2016; Tefera T. & Tefera, 2014; Tsegaye *et al*., 2018; Zemedu & Mesfin, 2014). Most of these studies has focused on only the determinants of household food security (Abafita & Kim 2014; Asmelash, 2014; Beyene & Muche, 2010; Bimerew & Beyene, 2014; Gemechu *et al*., 2016; Mitiku *et al*., 2012; Muche *et al*., 2014). Other studies such as Bedeke (2012), Berlie (2015), Derribew (2013), Tsegaye *et al*. (2018), Tefera T. and Tefera (2014) and Zemedu and Mesfin (2014) mainly focused on coping strategies for food security. A few of them were conducted on vulnerability to food security, gender perspective of household food security, income diversity and food security and so on.

Thus, inadequate research attention was given to the sustainability aspect of food security in the region such as the present study site (Kurfa Chele *woreda*). Furthermore, by examining socio-demographic, economic, institutional, and environmental factors affecting the un/sustainability dimensions of food security in the context of sustainable rural farmers' livelihoods, this study contributes significantly to the existing literature. More importantly, no research study has been conducted on the sustainability of rural household food security in the context of smallholder farmers in the study area. Thus, this study contributes to filling these important knowledge gaps on the sustainability of food security among smallholder rural farmer households in the Eastern Hararghe zone of Ethiopia. Additionally, despite the variety of food security indicators that exist in the literature, there is no single method of all-encompassing indicator of food security that incorporates more than one dimension. Moreover, most of the research done to date in Ethiopia is also based on one or a single indicator of food security analysis. However, this study attempts to harmonize three different indicators of food security (household food balance sheet [dietary energy supply], months of adequate household food provisioning and household dietary diversity score) to reflect its multidimensionality and draw policy conclusions from the analysis. Furthermore, the present study was also attempt to assess the indigenous knowledge-based coping and adaptive strategies practiced by the rural farm households that enhanced the sustainability of food security in the study area, which could help to fill the body of knowledge gaps in this regard. Hence, the main theme of this survey is to explore the level of un/sustainability of food security in the rural farm household of Kurfa Chele *woreda* of East Hararghe zone located in Oromia Region, Ethiopia.

1.3. Objectives of the Study

The main objective of the study is to assess the status and level of sustainability of food security and examine the socio-economic, demographic, institutional and environmental determinants of sustainability of rural household food security in Kurfa Chele *woreda* of East Hararghe Zone, Ethiopia. The specific objectives of this study include:

Objective 1: To assess the food security status in the rural households of Kurfa Chele *woreda* and determine whether it is sustainable or not

Objective 2: To explore the level of farmer's access to productive assets in view of their impact on food production and un/sustainability of food security status at the household level

Objective 3: To identify the main socio-economic, demographic, and institutional determinants that contributed to un/sustainability of rural household's food security in the study area

Objective 4: To assess the indigenous knowledge-based coping and adaptive strategies that enhanced sustainability of food security and recommendation for local authorities, institutions, and development practitioners

1.4. Research Questions

Research Question 1: What are the food security situation and its sustainability in the rural households of Kurfa Chele *woreda*?

Research Question 2: How do productive assets influence the food production and un/sustainability of the rural household food security?

Research question 3: Which and how do socio-economic, demographic and institutional determinants more strongly affect the un/sustainability of food security among the rural household of the study area?

Research Question 4: What is the specific indigenous knowledge-based, coping and adaptive strategies used by rural farmers to enhance the sustainability of food security and policy implication for local authorities, institutions, and development practitioners?

1.5. Significance of the Study

For policy responses, it is important to understand and analyse how the different interconnected socio-economic, institutional, and environmental factors are affecting the sustainability of food security, particularly for the poorest segment of the smallholder rural farm households. Hence, this research contributes to the body of evidence on the un/sustainability of rural farm household food security in Ethiopia using survey data from the rural sample farmers. Moreover, the findings of the study are expected to contribute to the wealth of information currently available on the factors determining the sustainability of food security. It also adds to the growing body of knowledge on food security in underdeveloped countries. Moreover, the study will further enrich knowledge on the broader issues of sustainable food security, which would be indispensable for policymakers, development practitioners, and future researchers. Above all, the communities in the Kurfa Chele *woreda*, east Hararghe zone of Ethiopia could benefit from the findings of this research for designing a more targeted and effective food security development intervention in the study area, as well as in other similar environment in the country.

1.6. Scope of the Study

Though many parts of Ethiopia are prone to food insecurity and require a solution to the problem, the present study was geographically delimited to and conducted in Kurfa Chele *woreda* of Eastern Hararghe Zone of Oromia Region. The study area is characterized by three agro-climatic zones: *dega*[6] (highland or cool agro-climatic zone), *woina-dega*[7] (midland or moderate agro-climatic zone) and *kolla*[8] (lowland or dry agro-climatic zone) and most of the chronically food insecure and PSNP dependent populations are in the *kolla* (lowland) agro-climatic Zone. Hence, this study was confined to four rural *kebeles*[9] of Kurfa Chele *woreda* namely, Arele Tika, Orde Goba, Hula Jenata, and Jiru Gemechu which was selected from each of the agro-climatic zones. Finally, sample respondents for this research were selected

[6] An expression for one of the altitudinal agro-ecological belts in Ethiopia that ranges between 2300 to 3300 masl
[7] An expression for one of the altitudinal agro-ecological belts in Ethiopia that ranges between 1500 to 2300 masl
[8] An expression for one of the altitudinal agro-ecological belts in Ethiopia that ranges between 500 to 1500 masl
[9] *Kebele* refers to the smallest administrative units or tier in Ethiopia next to *woreda*.

proportionally from each *kebeles* and the household is taken as the unit of analysis. From the household memebrs, data were collected from male-headed and female-headed households.

The major variables considered in the study were focused on the factors that affect the sustainability of rural household food security status, such as socio-economic, demographic institutional, and environment-related issues, and asset possession by farmers in the study area. Furthermore, data on resource endowment, accessibility to infrastructure, and modern agricultural inputs, crop production, household food consumption (dietary diversity) were obtained from the sample respondents and concerned stakeholders. In addition, household climatic perception, and meteorological data on temperature and rainfall distribution in the study area were collected. Consequently, the study has used three indicators of food security such as Household Food Balance Model (HFBM) months of adequate household food provisioning (MAHFP) and the Household Dietary Diversity Score (HDDS) to measure and determine the food security status of the surveyed farm households. Finally, household perceptions towards their food security status and its sustainability, and possible coping and adaptive strategies to food shortage were also obtained from the selected sample respondents.

1.7. Limitation of the Study

This study has limitations that need to be addressed in future studies. The household survey was completed all at once (collected only one time). Nevertheless, rural livelihoods and the factors influencing household food security, on the other hand, are dynamic and require a longitudinal survey. Due to time and financial constraints, this was not done. As a result, future research could include a longitudinal survey to detect significant changes over time. Furthermore, an increase in the inflation rate has a direct impact on food security, exacerbating the situation in both urban and rural areas, which was not investigated in this research. Besides, violence and social conflicts, which have a direct and immediate impact on the sustainability of food security status of the households and have more long-lasting effects by disrupting production capacity and access to food, affecting the household's livelihoods, assets, and health and food security status, which was not included in this study. Moreover, the sample households for this study were also restricted to rural areas; though this is does not that urban dwellers are not affected by food security problems. More importantly, the urban food security situations in many parts of Ethiopia has not been well researched. Hence, all these are the limitation of this study that demands future research on food security related topics needs to have focus on rural and urban areas of Ethiopia to adderss these issues.

1.8. Organization of the Thesis

The thesis was organized into ten chapters. Chapter one is an introductory part dealing with the background information of the research problem, statement of the problem, objectives of the study, research questions, significance of the study, the scope of the study and organization of the thesis. Chapter two is concerned with an extensive review of related literature on the sustainability of food security. The topics covered in this chapter include the concept, definition, dimensions, types, and forms of food security. The chapter also highlights a paradigm shift in the concept of food security thinking and sustainable food security, the theoretical foundation of food security, sustainable livelihood, and food security. Moreover, the chapter will present concepts on sustainable diets and food systems; indicators of food security, an empirical review of the determinants of sustainable food security and finally, the conceptual framework of sustainable food security was also discussed.

Chapter three is concerned with the physical and socio-economic settings of Kurfa Chele *woreda* which gives general information about the study area. Chapter four is about the research design and methodology focusing on the source of data and data collection instruments, sample size determination and sampling procedures. The chapter also presents some of the main variables of the study, its measurement, and formulation of hypothesis, statistical methods of data analysis, the analytical model specification used for the study, reliability, and validity of the study and ethical considerations. Moreover, the demographic and socioeconomic characteristics of the sampled rural farm household respondents are discussed in chapter five. This will serve as a foundation for the subsequent chapters. Chapter six and seven will address the first two objectives and research questions. Chapter six documents farm production, food security status quo and its sustainability, which is mainly concerned with household crop and livestock production, trends, and challenges of agricultural production. Furthermore, the chapter deals with an econometric analysis of food security using HFBM, MAHFP and HDDS, the extent of food security and the perceived causes of food shortages and factors affecting the sustainability of food security. In chapter seven, the bivariate analysis of the food security status quo, farmers' access to productive assets and the sustainability of food security are presented. In this chapter the interrelationship between different socio-demographic, and economic variables on the sustainability of rural household food security.

Chapter eight includes the relevant information related to objective three and deals with the factors determining the sustainability of the rural household food security status in the study area. In this chapter, the socio-demographic, economic institutional and environmental (climatic) related determinants of the sustainability of rural household food security were analysed using the logistic regression model. Furthermore, the chapter elaborates on climatic variability, sustainable crop production and food security status of the surveyed sample respondents. Chapter nine documents the research related to objective four (research question 4) and this includes the indigenous knowledge on coping and adaptive strategies used by the local population to enhance food security in the study area. In addition, chapter 9 makes the researchers' recommendation on how the local knowledge and coping strategies can be used by local authorities, institutions, and development practitioners to assist Ethiopia in achieving the SDGs. Lastly, chapter ten provides a summary of the main findings, conclusion, and policy implications (possible suggested recommendations).

CHAPTER TWO

LITERATURE REVIEW

2.1. Concepts and Definitions: An Overview of Food Security and Sustainability

2.1.1. Meaning of Food Security

The concepts and definitions of food security was originated, evolved and expanded over time (Endalew *et al*., 2015) and there are more than 200 definitions of food security in the literature (Berry *et al.,* 2015; Gibson, 2012). Food security is a multidimensional (Abebaw and Betru, 2019; Berry *et al.,* 2015), multifaceted (Abafita and Kim, 2014; Abebaw and Betru, 2019) and complicated concept which is defined and interpreted in various ways. The term "food security" was first originated in the mid-1970s during the global food crisis, when the first World Food Conference 1974 defined food security in terms of food supply issues related to global food availability (Abdulla, 2015; Endalew *et al*., 2015; Tora *et al*., 2021; Welteji *et al*., 2017) and food production (Berry *et al*., 2015). Food security was defined at the 1974 World Food Conference as: "the *availability at all times of an adequate global food supply of basic foodstuffs to sustain a regular expansion of food consumption and to counterbalance fluctuations in production and prices*" (UN, 1975, as cited in Devereux, 2018, p.183). This definition focuses on ensuring food availability (food supply) (Burchi and Muro, 2016) and global and local price stability of basic foods (Berry *et al*., 2015).

In 1983, the FAO broadened the definition of food security to include ensuring that vulnerable people have access to available supplies, resulting in a definition based on the demand-supply balance in the food security equation: ensuring that everyone has constant physical and financial access to the essential foods they require (FAO, 2003 as cited in Purushothaman, 2011). In 1986, the World Bank (as cited in Devereux, 2018) also defined food security as access to sufficient food for everyone to live an active and healthy life. The World Food Summit in Rome in 1996 declared and comprehensively set a more complex and the most widely accepted definition which includes all four dimensions of food security. The Summit stated that food security at global, regional, national, household, and individual levels is achieved "*when all people, at all times, have physical and economic access to sufficient, nutritious and safe food* *that meets their dietary needs and food preferences for an active and healthy life*" (Devereux, 2018, p.183; Moltedo *et al*., 2014, p.3).

Later, in 2001, FAO refined the definition of food security by adding the social aspect of food security, which was missed in the 1996 World Food Summit. Accordingly, food security is defined as a situation that "*exists when all people, at all times have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life"* (FAO *et al*., 2015, p.53; FAO *et al*., 2017, p.107; FAO *et al*., 2021, p.190). Furthermore, the concept of food security was defined in a broader way as "*every individual gaining physical, economic, social and environmental access to a balanced diet that includes the necessary macro and micro-nutrients, safe drinking water, sanitation, environmental hygiene, primary health care and education to lead a healthy and productive life*" (Swaminathan, 2009 as cited in Purushothaman, 2011, p.283).

Committee on Food Security (CFS, 2012) as cited in Trentmann *et al*. (2015, p.15) also stated that "*food security exists when all people have physical, economic, and social access to safe food that is consumed in sufficient quantity and quality to meet their dietary needs and food preferences, and when this access is supported by an environment that includes appropriate sanitation, health services, and care, allowing them to live a healthy and active life*". From these definitions, one can understand that food security is a multidimensional concept (Abebaw and Betru, 2019; Hanson, 2013; Berry *et al*., 2015) which includes four important elements: food availability, accessibility, utilisation and stability over time (FAO *et al*., 2013; Sandhu, 2014). These are the four pillars or dimensions of food security (Ecker and Breisinger, 2012; Pieters *et al*., 2013) which are discussed in the next section.

2.1.2. Dimensions of Food Security

The definition of food security identifies four major distinct dimensions and interconnected elements of food security: food availability, economic and physical access to food, food utilisation, and long-term stability (Adjimoti and Kwadzo, 2018; Ahmed, 2019; Carletto *et al*., 2013; FAO *et al*., 2017; FAO *et al*., 2020; FAO *et al*., 2021; Feleke, 2019; Prosperi *et al*., 2014; Wiranthi *et al*., 2014). The three pillars of food security: food availability, food access and food utilisation determine the state of affairs which refers to the food and nutrition status of a household or an individual and the food stability dimension of food security additionally consists of two elements mainly vulnerability and resilience (Pieters *et al*., 2013) Figure 2.1. Furthermore, recently sustainability as the fifth dimension of food security for the long-term time dimension was also incorporated into food security analysis (Berry *et al*., 2015; Peng *et al*., 2018; Peng and Berry, 2019). Hence, food security is the function of food availability, food accessibility, food utilisation and its sustainability over a long time.

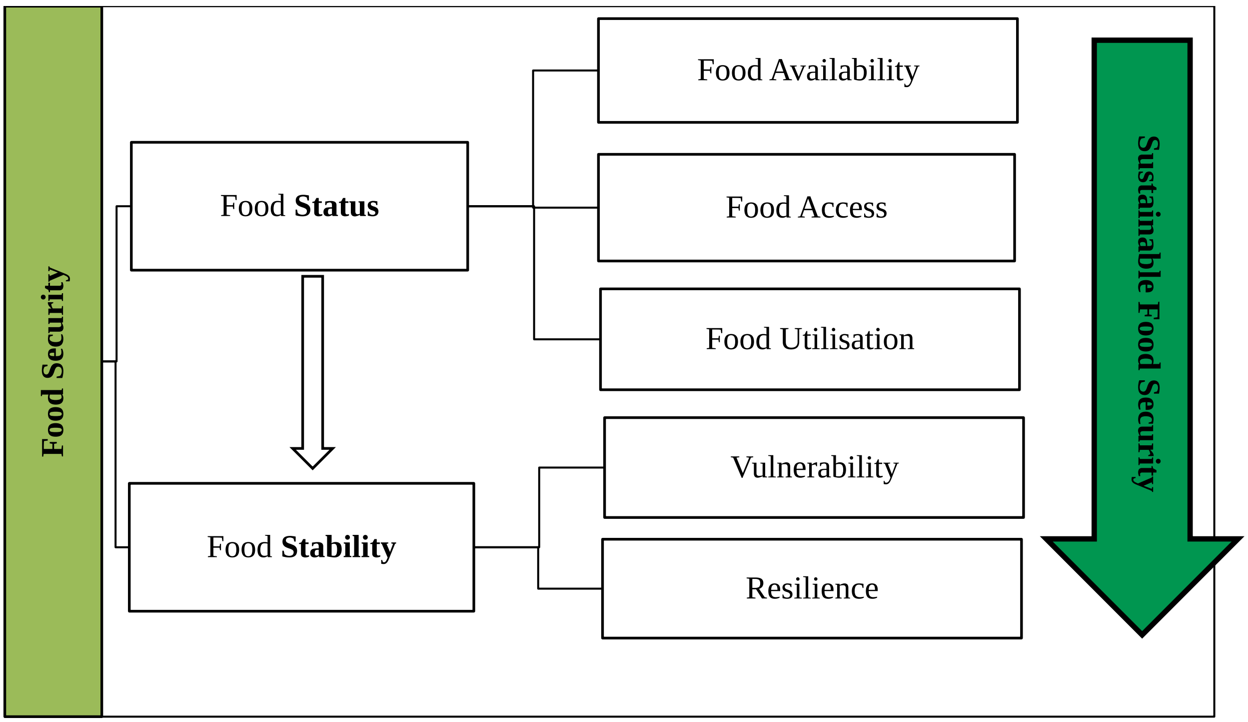

Figure 2.1: Food security dimensions adopted from Pieters *et al*., 2013

Food Availability: The availability dimension of food security is connected with the supply side of the food security which assumes sufficient quantities of food of appropriate qualities that are mainly supplied through household domestic agricultural production or imports and food assistance or any donation/food aid (Ahmed, 2019; Caiafa and Wrabel, 2019; Devereux, 2018; FAO *et al*., 2021; Faridi and Sulphey, 2019; Feleke, 2019; Gibson, 2012; Khalid and Schilizzi, 2013; Trentmann *et al*., 2015; Wiranthi *et al*., 2014) to sufficiently meet the domestic food demand (Ecker and Breisinger, 2012). This refers to whether the available food within a given region/country is enough to feed the total population of that region/country. Food availability is extremely important in terms of food security (FAO *et al*., 2013) and it consists of three elements: food production, distribution, and exchange (Capone *et al*., 2014b). Although the availability of sufficient food for a given population is necessary, it is not enough to ensure that people have sufficient access to food. Hence, the availability of food at the national or regional level alone doesn't guarantee its accessibility at the household and individual levels (Abafita and Kim, 2014).

Food Accessibility: The accessibility dimension of food security requires that food is affordable for everyone, and it indicates the accessibility of individuals and households to adequate resources to obtain appropriate foods for a nutritious diet (Capone *et al*., 2014b; Khalid and Schilizzi, 2013; Mohamed, 2017, Trentmann *et al*., 2015). The accessibility dimension of food security also addresses whether an individual or household has enough resources (adequate income) to obtain or purchase a sufficient or appropriate quantity of quality foods for their needs (Faridi and Sulphey, 2019; Gibson, 2012; Wiranthi *et al*., 2014). It refers to the physical (transport and infrastructure) and economic access to food which is determined by food price and people's purchasing power (Ahmed, 2019; Berry *et al*., 2015; Caiafa and Wrabel, 2019; Carletto *et al*., 2013; Devereux, 2018; FAO *et al*., 2021) which comprises affordability (Capone *et al*., 2014a), local and international market functioning to effectively supply the food.

Food Utilisation: Adequate nutrition (quality of diet and utilisation) and nourishment (calorie intake) are also important aspects of food security (Ahmed, 2019; Devereux, 2018) and as such food utilisation is concerned with food preparation, feeding practices, the care, dietary diversity, and intra-household food distribution for determining the sufficiency of energy and nutrients within the food that is consumed (FAO *et al*., 2021). The utilisation dimension of food security is also related to poverty reduction factors, access to adequate resources such as proper health care, clean water, hygiene, sanitation and educational services, and adequate knowledge of nutritional and physiological needs (Carletto *et al*., 2013; Devereux, 2018; FAO *et al*., 2021; Feleke, 2019; Gibson, 2012; Simmons, 2013; Wiranthi *et al*., 2014; Trentmann *et al*., 2015) which includes the nutritional and social values of food along with quality and safety of food (Caiafa and Wrabel, 2019). Hence, food utilisation is the individuals or households, or members of society use the available food.

Food Stability: Nowadays, the concept of food security has been broadened in its scope by incorporating stability which is a necessary factor (Caiafa and Wrabel, 2019) in addition to its availability at the macro level and present access. Therefore, the concept of stability focuses on the short-term time dimension of food security (Berry *et al*., 2015) which is concerned with changes over time and underlying processes and resilience, sensitivity, and sustainability. To be food secure means an individual, a household, or a population must always have access to sufficient food (Ahmed, 2019; Feleke, 2019; Gibson, 2012; Trentmann *et al*., 2015) in spite of price changes and other factors affecting food availability (Simmons, 2013) and they should not be at risk of losing access to food as a consequence of exposure to various shocks indicating the ability of the food system to withstand the shocks (Berry *et al*., 2015; Carletto *et al*., 2013). Hence, the food stability concept addresses the risks inherent that impact negatively on the availability, accessibility, and utilisation dimensions of food security (Caiafa and Wrabel, 2019; FAO, *et al*., 2021; Feleke, 2019; Gibson, 2012) and sustainable food security can only be achieved when all the four dimensions of food security are fulfilled simultaneously (Trentmann *et al*., 2015).

The stability dimension of food security consists of the concept of vulnerability (household or individual temporary exposure to negative shocks such as economic and climatic crisis or inability to manage the risk and the probability of a household or an individual becoming food insecure) and resilience (households or individual's ability to recover from the shocks and get back to its food and nutrition status as it was before the shock) (Devereux, 2018; Pieters *et al*., 2013). Thus, stability is the absence of risk of food shortage even in times of sudden shocks and it gives rise to the importance of sustainable use and maintenance of resources for its realization.

Sustainability: is the fifth and long-term time dimension of food security (Berry *et al*., 2015; Peng and Berry, 2019), indicating that it is necessary to ensure the consistent availability and accessibility of sustainably produced, safe, and nutritious food, as well as to reduce waste and losses in food production, processing, and consumption, in order to achieve food security. Thus, sustainability refers to the time dimension which incorporates long-term economic and social dimensions and environmental issues influencing the sustainability of future food security that could be achieved through a sustainable diet. Economic, social and environmental sustainability are necessary to ensure long-term sustainable food production, sustainable agriculture, sustainable access, sustainable consumption and sustainable utilisation of all food (Berry *et al*., 2015; Hanson, 2013). Hence, sustainability is considered as a precondition for long-term food security or that underpins long-term stability (Hanson, 2013) and sustainable food security will require: a) availability of food or sufficient food production, b) access to food and ability to purchase food, c) sufficiency in terms of nutrition including energy, proteins and micronutrients as well as safety, and d) the stability and foreseeability of these condition.

2.1.3. Types and Forms of Food Insecurity

Food security as a concept has both temporal and spatial dimensions. The degree of aggregation to which food security is considered is referred to as the spatial dimension of food security. This suggests that food security may be analysed at the individual, household, village, sub-national, national, continental, or global levels. The temporal dimension of food security, on the other hand, refers to the time frame in which food security is considered. Food insecurity is defined as a situation in which people do not have safe access to enough amount of nutritious and safe food for normal growth and development, as well as an active and healthy life has a long-term (chronic), short-term (transitory) and cyclic (seasonal) aspect when viewed in time dimensions (Abegaz, 2017; FAO *et al*., 2017; Gibson, 2012; Sewnet, 2015; Udmale *et al*., 2020).

Chronic (continuous) food insecurity happens when an individual or a household or people are continuously at high risk of inadequate diet, and persistently unable to produce and obtain/buy enough food to meet their minimum food requirements over a long period of time (Abegaz, 2017; FAO *et al*., 2021; Feyisa, 2018; Gibson, 2012; Mohamed, 2017; Sewnet, 2015) that caused by lack of assets, insufficient access to financial or productive resources, continuous bad incidents of shortfalls and extended periods of poverty (Abdulla, 2015; Sewnet, 2015).

Transitory food insecurity is concerned with shocks that cause a temporary or short-term decline in food availability (Abegaz, 2017; Feyisa, 2018; Gibson, 2012; Mohamed, 2017) and its entitlement (Welteji *et al*., 2017) or temporary inability of a household and individuals to access enough food (Purushothaman, 2011) and hence, the risk of failure to meet food needs is of short duration. Several factors can contribute to temporary food security, including exposure to a high incidence of natural disasters, flooding and drought, conflict, economic collapse, instability/fluctuations in food prices, short-term shocks in food production or crop failures and loss of income or variable household income (Abdulla, 2015; Feyisa, 2018; Gibson, 2012; Mohamed, 2017). Successive exposure of an individual and household to temporary food insecurity, in the long run, may increase their vulnerability to chronic food insecurity, causing an individual or household to liquidate assets in their efforts to chronic food consumption.

Finally, **cyclic, or seasonal food security** sits between or alongside chronic food security (inherent in existing patterns of endemic hunger) and transitory food security (associated with seasonal fluctuations in food price or employment trends or cropping patterns) (Gibson, 2012) and it happens when there is a consistent pattern in the frequency of insufficient food access (Mohamed, 2017; Sewnet, 2015).

2.2. Paradigm Shift in Food Security Thinking and Sustainable Food Security

The term food security as a concept was originated, evolved, introduced, developed and diversified by the academic community and different researchers in international development literature since the mid-1970s (Abdulla, 2015; Ahmed, 2019; Endalew *et al*., 2015; FAO *et al*., 2019; Peng and Berry, 2019; Tora *et al*., 2021) in the World Food Conference due to global food crises and major famines in the world and since then, it has received a great deal of attention (Khalid and Schilizzi, 2013). Hence, the history of food security thinking since the World Food Conference in 1974 is marked by three important and overlapping paradigm shifts (Smith *et al*., 1992 as cited in Ramos *et al*., 2008). These shifts are from the global and the national to the household and the individual food security, from a 'food first' perspective to a livelihood perspective and finally from objective indicators to subjective perceptions (Aji, 2020) with more emphasis on food quality, consistency with local food habits, and cultural acceptability (Purushothaman, 2011). Recently there is a tendency toward an additional paradigm shift in food security thinking (because of recent food crises) from a sector-specific approach to a multi-sector system approach with a focus on nutrition outcomes (Ecker and Breisinger, 2012).

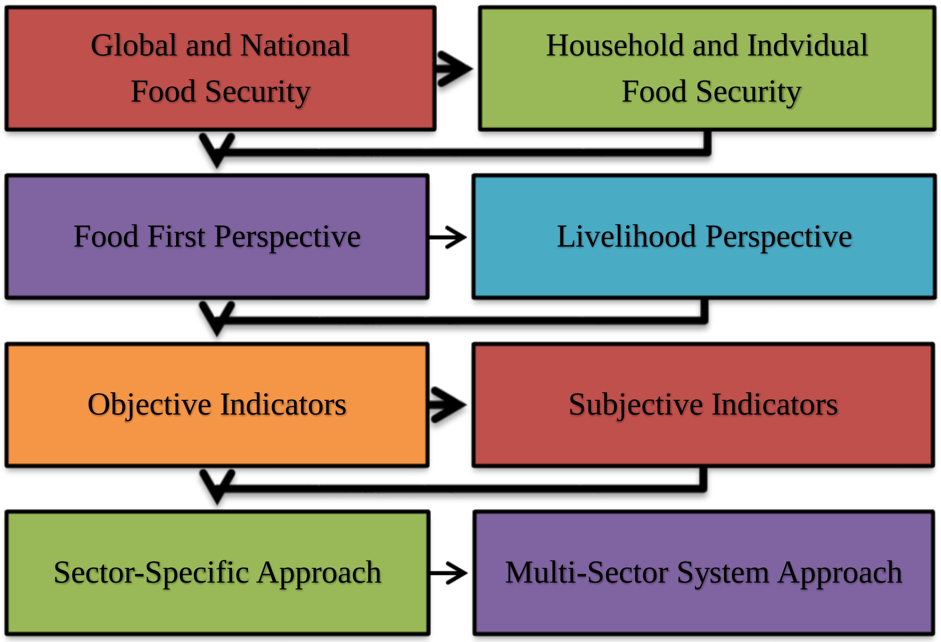

Figure 2.2: Paradigm shifts in food security thinking

2.2.1. From the Global and the National to the Household and the Individual

The first paradigm shift in food security thinking is from the global and national food availability to the household and individual-focused approach, which focuses on food consumption patterns, preferences, and access/entitlement by each person (Mkandawire *et al*., 2014; Welteji *et al*., 2017). Thus, the 1974 first World Food Conferences mainly emphasis on the food supply side and its availability at the global and national levels (Aji, 2020; Endalew *et al*., 2015). The meaning of food security during its origin also focuses on world food supply and national food self-sufficiency and stabilization of production and price of food. However, the problem is that the availability of food at the global and national levels does not guarantee access by households and individuals. This indicated that hunger and food insecurity can co-exist with the presence of sufficient food supply at the global and national levels. Thus, this initiated a paradigm shift in food security thinking from food availability to access by households and individuals named as food entitlement indicating accessibility of food by all people (Eshetu and Guye, 2021). Here the focus is on access to enough food for individuals in the household, in all seasons and all years for active participation in the society (Aji, 2020).

2.2.2. From a Food First Perspective to a Livelihood Perspective

The second paradigm shift took place mainly after 1985 focusing on a shift in food security thinking from a food first perspective to a livelihood approach (Aji, 2020; Welteji *et al.*, 2017) and food security encompasses a wider definition in terms of livelihood. (Ramos *et al.*, 2008). It is well known that the conventional view of food security was that food was a foremost requirement that was basic to all human needs (Dagne, 2016; Dessalegn, 2018; Devereux, 2018; Sani and Kemaw, 2019). Though access to food and short-term nutritional intake is one of the objectives people pursue, it is not enough to avoid hunger and food insecurity. Therefore, building long-term and sustainable livelihood (capacity to generate wealth so that production can be sustained over time) and resilient household is also a necessary condition for achieving sustainable food security (Aji, 2020; Ramos *et al.*, 2008).

2.2.3. From Objective Indicators to Subjective Indicators

The third paradigm shift in the concept of food security is a shift from objective indicators to a subjective approach (Aji, 2020; Welteji *et al.*, 2017), a more recent approach that focuses on qualitative-subjective analysis or measurement of food security (Migotto *et al.*, 2005; Gartaula *et al.*, 2012) rather than only focusing on objective-quantitative methods.

Conventionally the concept of food security depends on objective measurement targeting a certain level of consumption or averagely required calorie intake (Aji, 2020). Nonetheless, the quantitative estimate of nutritional/calorie requirements for an individual varies according to health status, age, weight, environment, and behaviour which makes it difficult to precisely estimate the number of calories needed for different groups in the population. Therefore, because of the multi-faceted nature of the food security concept (Migotto *et al.*, 2005), there is a need to move from analysis of quantity access to food to a more subjective dimension of food security (Ramos *et al.*, 2008) which is particularly valuable for measuring subjective perception of the adequacy of food consumption (Gartaula *et al.*, 2012) and to measure vulnerability to food security (Migotto *et al.*, 2005).

2.2.4. From Sector-Specific to Multi-Sector Approach

The fourth paradigm shift in food security thinking is a shift from a sector-specific approach to a multi-sector and integrated across-sector approach with a focus on nutrition outcomes (Ecker and Breisinger, 2012). Food security and nutrition are multi-level, multi-sectoral and multi-dimensional issues that cannot be adequately addressed by a sectoral approach alone (FAO, 2013; Cistulli, 2015).

Given the complex interplay of causes or various determinants (physical, economic, social, cultural and political factors) and the multi-dimensionality (food availability, accessibility both physically and economically and, utilisation or the nutritional quality of food as well as the consistency of both availability and accessibility dimensions) food and nutritious security require a holistic approach and cross-sectoral nature (Cistulli *et al*., 2013; FAO, 2013; Cistulli, 2015) that integrates agriculture and non-agricultural activities (multi-sectoral approach) to address the food insecurity challenges and long-term undernutrition.

2.3. Sustainable Development Goals for Ending Hunger and Food Insecurity

Following the end of MDGs in 2015, the United Nations has established a new set of ambitious goals and targets that could seem to direct the activities and actions of every country and territory with the interest of achieving a better world. This new global development agenda is known as the Sustainable Development Goals (SDGs), and it calls on all nations to accomplish 17 main development goals with 169 targets by 2030 (Moyer and Hedden, 2020; UN, 2015b; Weiland *et al.,* 2021). It is a worldwide action strategy for the welfare of people, the environment, prosperity, peace, and collaboration (UN, 2015b). The 2030 SDG Agenda acknowledges the intertwined different issues, for instance, hunger, poverty, education, health, sanitation, safe water, gender equality and environmental degradation as such forming the 17 SDGs into an integrated system that recognizes the action in one area would affect the outcomes in others and sustainable development must balance environmental, economic, and social aspects (Moyer and Hedden, 2020; Weiland *et al.*, 2021). This indicates the sustainable development goals cover all economic, social, and environmental dimensions of sustainability which requires concerted action from both developed and developing countries and is aimed at eradicating poverty, promoting socio-economic inclusion, and safeguarding the environment.

SDGs also pointed to promoting sustainable agriculture by 2030 via effective research that would create awareness, increase agricultural production and enhances the fair distribution of food at the grass-root level (Ferranti, 2019; Sibhatu and Qaim, 2018).

The SDGs also urge efforts to ensure food security, better nutrition, and sustainable agriculture, as well as to end all forms of poverty and hunger. Hence, universal access to adequate quantities of food produced sustainably is key to better achieving SGD 2 (end hunger) (Udmale *et al*., 2020). Besides, the SDGs Target 2.1 and 2.2 are intended to end hunger and ensure access to sufficient, nutritious, and safe food for all people all year round as well as to eradicate all forms of malnutrition (FAO *et al*., 2021; Moyer and Hedden, 2020) thought the COVID-19 pandemic has caused a major setback on the progress towards meeting the targets. Additionally, there is an unfolded concern regarding the increase in the number of undernourished people from 785 million in 2015 to 821 million in 2018/2019 (FAO *et al*., 2019; Martin-Rios, 2020; Udmale *et al*., 2020) and decreased government spending on aid and with Covid-19 being affecting progress towards the achievement of SDG2. This evidenced that achieving the first and second SDGs of ending poverty and hunger will require an immense, coordinated effort throughout all levels to address all aspects of food security while also, strengthening the coping and adaptive capacity of the vulnerable communities so that they can respond to the risks and shocks resulting from all-round traits.

2.4. Sustainable Livelihood Approach and Food Insecurity

A household or individuals are food insecure when their entire livelihood systems are changed or when they are failed to adapt to some challenges that resulted from economic, ecological, and environmental shocks like drought. Thus, food security can be viewed as a fundamental component of a sustainable livelihood. A sustainable livelihood approach is people-centric (Massoud *et al*., 2016; Nicolau, 2013; Ndhlovu, 2018; Serrat, 2017) and stresses the relationship between people's vulnerability to food insecurity and their subsequent coping strategies (Gibson, 2012). A livelihood is sustainable if it can withstand and recover from stresses and shocks in the present and future, as well as retain or improve its capabilities and assets, all without adversely affecting the natural resource base (Biggs *et al*., 2014; Morse and McNamara, 2013; Sati, 2014).

The sustainable livelihood approach is an integrated, multidimensional, and rational approach to poverty eradication (Sati and Vangchhia, 2016) and it is an analysis of assets and capabilities alongside vulnerabilities (Davidson *et al.*, 2014) which provides a more rounded picture of the complexities of living and surviving in poor peoples. Moreover, sustainable livelihood is a long-term goal for poverty reduction that prioritizes development at various levels, scales, and sectors (Sati, 2014). Furthermore, sustainable livelihoods are a multifaceted approach that includes five components: livelihood assets, vulnerability context, livelihood strategies, transforming structures and processes, and livelihood outcomes (Biggs *et al.*, 2014; Massoud *et al.*, 2016; Serrat, 2017). From these five elements, the vulnerability context and livelihood assets are the main components of household food insecurity analysis.

The vulnerability context of sustainable livelihoods refers to the external environment in which people lives (Bazezew *et al*., 2013; Serrat, 2017) and it can influence people's livelihood asset. The amount of assets a person has before a crisis and their capacity to use a variety of coping mechanisms determine how vulnerable they are to external shocks. Households or an individual with a large amount of assets for their livelihood are typically more resilient than a household with few assets. The vulnerability context comprises critical trends (demographic/population pressure/trends, technological trends, resources, and environmental degradation), shocks (human health, crop/livestock health, conflicts, economic inflation, or natural disasters) and seasonality (rainfall, market prices, production, and employment opportunities) (Bazezew *et al*., 2013; Biggs *et al*., 2014; Serrat, 2017). All these factors will have an impact on people's assets and, as a result, the sustainability of their livelihoods. Hence, it is critical to consider the types of shocks and trends that expose people to livelihood and food insecurity.

On the other hand, the concept of livelihood asset refers to the resource base of the people and the capability of the household to attain livelihood objectives (Biggs *et al*., 2014) in general and household food security status. Livelihood is the set of assets, capacities, and activities that provide people with the means to meet their basic needs and support their well-being. Besides, a livelihood is made up of the skills, abilities, assets (both social and material), and activities that are necessary for survival (Serrat, 2017). These are the means of production that are available to a specific household or individual for use in their livelihood activities. (Bazezew *et al*., 2013). Five main types of livelihood assets used in the analysis of the sustainable livelihood approach have been identified: natural capital (natural resources), physical capital (physical reproducible goods), human capital (manpower with different skills), social capital (social network of various kinds) and financial capital (monetary resources) (Kamaruddin and Samsudin, 2014; Morse and McNamara, 2013; Ndhlovu, 2018; Sati and Vangchhia, 2016). These capitals are evaluated by means of their susceptibility to shocks as well as the institutional environment within which it operates. Once this is understood, interventions to improve livelihoods and their sustainability can be implemented, possibly by reducing vulnerability or increasing available capital (Morse and McNamara, 2013).

Natural capital: comprises natural resource-based activities (Li *et al*., 2020; Massoud *et al*., 2016) such as land resources, vegetation, tree and forest products, water and aquatic resources, air quality, and biodiversity (Sati and Vangchhia, 2016; Serrat, 2017) that are useful for livelihood. These are the 'life-sustaining layers,' which are the most important assets (Sati and Vangchhia, 2016).

Physical capital includes basic infrastructure as well as producer goods, tools, and production equipment (Davidson *et al*., 2014; Morse and McNamara, 2013; Serrat, 2017) that people need to support the livelihoods that they seek. These involve road, affordable transportation system, sanitation and adequate water supply, affordable energy, secure shelter and buildings, communications (access to information), access to technology, access to improved seed, fertilizer, pesticides, and irrigation (Biggs *et al*., 2014; Massoud *et al*., 2016; Sati and Vangchhia, 2016; Serrat, 2017) that influences the sustainability of a livelihood system.

Human capital: is also one of the livelihood assets which refers to education, knowledge, and skills (Davidson *et al*., 2014; Massoud *et al*., 2016; Morse and McNamara, 2013; Ndhlovu, 2018) ability to labour/capacity to engage in work/employment and good health status (Li *et al*., 2020) that allows people to undertake livelihood strategies and achieve their desired goals. Although human capital varies at the household level, they are essential to make use of any other types of capital/assets (Sati and Vangchhia, 2016).

Social capital: In a sustainable livelihood approach, social capital comprises aspects of social resources from which people can get help to achieve their livelihood outcomes such as networks and connectedness (neighbourhoods, kinship), membership of formal and informal groups or ability to cooperate, community/social relations (Li *et al*., 2020; Ndhlovu, 2018), shared values and behaviours, systems of rules, sanctions and norms, political participation, partnership and collaboration and mechanisms for participation in decision-making.

Economic/Financial capital: refers to the financial resources that people can use to attain their livelihood objectives and enables them to adopt different livelihood strategies. These comprise cash, bank deposits/savings, loans, credit, liquid assets (livestock and jewellery), wages/labour income, pensions, and remittances (Biggs *et al*., 2014; Morse and McNamara, 2013; Ndhlovu, 2018). The financial capital can be used for the direct achievement of livelihood outcomes (purchasing of food to reduce food security) or can be converted to other forms of capital.

Transforming structures and processes refers to the organizations, institutions, rules, and regulations that frame the livelihoods of the people. These structures and processes occupy a central position in the sustainable livelihood frame and are operating at all levels which determine or influence people's access to the different types of capital/assets and feedback to the vulnerability context and livelihood strategy (Serrat, 2017).

Livelihood strategies (coping strategies) on the other hand refer to a range of activities that people undertake to achieve their desired livelihood objectives (Burchi and Muro, 2012). Thus, people's access to different kinds of capital/assets also influences the strategies that they employ depending on the policies and institutions at work (Biggs *et al*., 2014).

Lastly, livelihood outcomes comprise the achievement of people's livelihood strategies (Serrat, 2017) such as reduced vulnerability, increased well-being, more income, sustained natural resource use, livelihood resilience, and improved food security (Shahbaz, 2008 cited in Bazezew *et al*., 2013).

2.5. Sustainable Diets, Food Systems, and Sustainable Food Security

Sustainable food security is an all-encompassing process and a multi-dimensional concept that involves several factors to be considered. It encompasses aspects such as food availability through agricultural production, physical and economic access to food, and adequate use and utilisation of available food by households or individuals throughout the year/stability (Aborisade and Bach, 2014; Trentmann *et al*., 2015). Simultaneously attaining both sustainable and food security requires looking at the overall food system rather than simply focusing on agricultural production, market function and household food baskets (Ingram as cited in Prosperi *et al*., 2014). Aborisade and Bach (2014) also noted that achieving sustainable food security requires minimizing environmental impacts while improving agricultural productivity and its profitability.

The concept of sustainable food security is also interconnected with the term sustainable diets which refers to those diets that have minimal environmental implications and contribute to food and nutrition security as well as a healthy lifestyle for current and future generations. Moreover, sustainable diets are biodiversity and ecosystems-protective, culturally acceptable, economically affordable, fair and accessible as well as nutritionally adequate, safe and healthful while maximizing natural human resources (FAO and Bioversity International, 2012). Hence, assuring nutrition security without jeopardizing the long-term viability of the ecosystems and essential cultures that source our food is what food sustainability means.

Sustainable food systems allow to produce enough and nutrient-dense food while protecting the resources that the food system depends on and minimizing its negative environmental effects (Auestad and Fulgoni, 2015). Such a kind of sustainable food system is based on the idea that all activities related to food (food-producing, food processing, food storing, food transporting, food marketing and food consumption) are interactive and interconnected (Auestad and Fulgoni, 2015). A study conducted by Capone *et al*. (2014a, p.13) shows that a "*sustainable food system supports food security and makes optimal use of natural and human resources, which is culturally acceptable and accessible, environmentally sound, economically fair and viable, and provides the consumer with nutritionally adequate, safe, healthy and affordable food for present and future generations*." Moreover, Story *et al*. as cited in Allen and Prosperi (2016) also stated that a sustainable food system is one that continuously provides healthy food to meet current food needs while also maintaining healthy ecosystems that can provide food for future generations with minimal environmental impact. This indicates that to ensure sustainable food security, a sustainable food system plays a vital role (FAO and Bioversity International, 2012) and sustainable food security cannot be pursued in the absence of nutrition and food security. Hence, sustainability of the food system and food security are indispensable prerequisites to each other, and they need to be mutually examined.

2.6. Theoretical Foundation of Food Security

The general theoretical approach to food security explains many socio-economic and environmental factors that are anticipated to affect famine and food security. Poverty and food insecurity are also described by the human environment relationships because of their spatial and temporal dimensions. In line with this, different academicians, researchers, and scholars identified different theories related to food security at different times which could be categorized under the socio-economy theories, political economy theories, and vulnerability theories (Eshetu and Guye, 2021; Moroda *et al*., 2018), multidimensional and territorial approaches (FAO, 2013). These food insecurity theories explain the factors that influence the four aspects of food security: food availability, food access, food use, and food stability.

2.6.1. Socio-Economy Theory

Food availability and food entitlement decline are the two main socio-economic approaches that have been developed to explain the causes of food insecurity and famine. The concept of socio-economic theory regarding food accessibility and availability decline approaches are related to lack of access to purchase basic needs, weak marketing infrastructure (malfunctioning markets) and lack of agricultural input delivery to boost production and productivity (Engler *et al*., 2014).

2.6.1.1. Food Availability Decline Theory

The food availability decline theory is the traditional model of famine explanation for food crisis referring to an aggregate decline in the quantity of food availability and is called the supply-oriented theory (Engler *et al*., 2014; Burchi and Muro, 2016; Eshetu and Guye, 2021; Sewnet, 2015; Udmale *et al*., 2020). The term food availability decline refers to a decrease in the availability of food per capita for consuming units. This indicates that the food availability decline theory largely focuses on the problems of food supply and argues food insecurity happens when there is a decline in aggregate food supply (Sewnet, 2015). According to this theory, people became starved because food availability declined at the national, regional or local scale to levels below the minimum requirements for survival mainly due to high population pressure (**demographic theory**: the relationship between population growth and food availability) and climate change/variability (**climatic theory**: in rain-fed agricultural areas, drought or flood causes crop failure and can lead to famine) (Eshetu and Guye, 2021; Moroda *et al*., 2018; Sewnet, 2015).

The food availability decline theory is the most influential and the oldest approach still today (Burchi and Muro, 2016) and is also called as the Malthusian approach which focused on the disequilibrium between the rate of population growth and per capita food availability (Burchi and Muro, 2012; Eshetu and Guye, 2021). Still, today, demographically related theories are widespread in the debates on famine and food insecurity and the most understood demographic theories are the Malthusian, and Neo-Malthusian principles (Engler *et al*., 2014).

The Malthusian theory: Robert Thomas Malthus wrote a book in 1798 entitled "An Essay on the Principle of Population" and his theory stated that, "*the power of the population is indefinitely greater than the power of the earth to produce subsistence for man and when unchecked, the population will increase in a geometrical ratio while subsistence (food production) increases only in an arithmetical ratio*" (Malthus, 1798 as cited in Engler *et al*., 2014, p.5; Sewnet, 2015, p.124). However, the assumptions of Malthus did not consider the possibility of advancement in science and technology and the far-reaching improvement in agriculture (Engler *et al*., 2014; Sewnet, 2015). The Neo-Malthusian theory also accepted the basic principle of Malthus's exponential growth of population resulting in a shortage of food supply, even though they consider the impact of science and technology on food production.

Climatic theory: The climatic theory is mainly related to a substantial change in the average climatic condition or its variability on all spatial and temporal scales resulting from the periodic occurrence of El Niño and La Niña events (Rojas *et al*., 2014) persisting for an extended period causing drought (marked by the prolonged absence of precipitation) and flooding (Moroda *et al*., 2018; WHO, 2016) and such kinds of recurrent climatic change results crop failures which in turn causes food shortage or food insecurity in the meantime. Research studies indicated that climatic change is expected to have an impact on agricultural production in several ways mainly through the intensity and frequency of extreme weather events, increased variability in rainfall, temperature, changes in the patterns of water and rainfall availability (Abebe, 2018; FAO *et al*., 2017; Goshme, 2019; Niles and Salerno, 2018). Consequently, the vulnerability and inability of the farmers to cope with such adverse effects of extreme climatic change affects their planting of various crops and decreases the productivity of the agricultural sector (Hanson, 2013; Rojas *et al*., 2014).

Agricultural systems in general and crop production, are very sensitive to climate variability and the adaptive capacity of the rural farmers to climate change and the degree of exposure to climatic hazards (Niles and Salerno, 2018). Natural disasters and climatic hazards (such as droughts, floods, and hurricanes) and food insecurity are also directly interrelated to each other adversely affecting farm production, food processing, livestock production and fishing which in turn interrupt access to market and supply of food that erodes the livelihoods of the exposed people (FAO *et al*., 2015; Rojas *et al*., 2014; Moroda *et al*., 2018; Sewnet, 2015). Thus, climatic change and its variability can jeopardize food availability, accessibility, and food supply stability over time (Mkandawire *et al*., 2014) and even cause severe food insecurity. Hence, the impact of climate change on the sustainability of the food supply is one of the priority areas that need special attention (Gustafson *et al*., 2016) and now a day's sustainability of food is dominated by the impact of climate change (Lang and Barling, 2013).

2.6.1.2. Food Entitlement Decline Theory

There is a debate for a long time on hunger and famine as heavily dependent on the food availability approach (Malthus thought) (Burchi and Muro, 2012) and the debate was shifted from national food supply to access at the household and individual level with the development of new paradigm within food security theories in the 1980s mainly resulted from the publication of Sen’s book on poverty and famine (Bazezew, 2013; Burchi and Muro, 2016). The food entitlement decline theory differs from the food availability decline theory in its approach shifting the focus from international and national food availability to the ability of the individual’s or households, food entitlement or access to food (Eshetu and Guye, 2021; Engler *et al*., 2014; Sewnet, 2015). Thus, the food entitlement decline theory emphasizes on people’s relationship to food (access to food) and food distribution rather than solely on food availability (Engler *et al*., 2014). The main argument of food entitlement theory is that the mere availability of food in each country or in the market does not entitle a person to consume it and thus starvation can set in without any noticeable decline in aggregate food availability. Hence, regardless of food availability at the global or national levels, people who do not have enough food due to exchange failures can be affected by famine and become food insecure (Burchi and Muro, 2012; Engler *et al*., 2014; Sewnet, 2015). This indicated that the entitlement approach is based on personal endowments (access to productive resources such as land and livestock) and commodities that a person can obtain through their own production and trade (Burchi and Muro, 2012).

According to Sen as cited in (Burchi and Muro, 2016) the entitlement failure can take different forms like the exchange failure entitlement approach (a drop in the food exchange rate causes a reduction in food production for consumption), production-based entitlement failure (lack of access to assets; land and livestock to produce food)), trade-based entitlement failure (due to market price fluctuations, inability to access or purchase food), labour-based entitlement failure (lack of employment opportunities or access to work) and transfer-based entitlement failure (lack of strong social networks).

2.6.2. Political Economy Theory

Food security at the household or individual level is mainly obtained from own production, exchange for food (efficient market institutions and trading system), or through food transfers (food aid) and each of these means of access to food was influenced or limited by a number of factors including socio-political systems and conflicts (Verwimp, 2012; Deaton and Lipka, 2015). The concept of the political economy approach mainly focuses on the distribution of wealth and power between different groups and individuals and the processes that transform and sustain these relationships over time (Collinson cited in Bazezew, 2013). Thus, the political economy theory includes issues related to lack of transparency, accountability, good governance, and land tenure insecurity. The political economy theory has been associated with the complex interaction of food insecurity and war/conflicts (Lecoutere *et al*., 2009) and argued that food insecurity can also be caused by political powerlessness despite food availability at the national level and well-functioning market systems. Thus, the political economy theory suggests an intervention on accountability, transparency, good governance and state construction rather than merely focusing on people's access to food and food availability as the only means of the factor causing famine and food insecurity (Bazezew, 2013; Eshetu and Guye, 2021). This is since political instability would exacerbate the problem of food insecurity, resulting in chronic infant malnutrition and significantly altering overall patterns of food production and consumption (Lecoutere *et al*., 2009; Simmons, 2013).

Political instability and civil unrest (Mkandawire *et al*., 2014) in each country can also reduce or limit the level of investment and thereby diminishes the development of the non-agricultural sector (manufacturing sector) and the associated income earnings that might enable the purchase of food when home production is limited (Verwimp, 2012; Deaton and Lipka, 2015). Hence, chronic violence, civil unrest, conflict, political mismanagement, and political instability distort the available assets and significantly disrupt/damage the overall livelihood activities/systems of people which reshape the existing mechanisms of food production and access to food resulting in undernutrition, hunger, or food insecurity (Lecoutere *et al*., 2009; Simmons, 2013; Engler *et al*., 2014).

2.6.3. Vulnerability Theory

The food entitlement decline theory was again not comprehensive enough in describing the factors (natural disasters, socio-economic and political crisis) that cause famine and food insecurity and thus resulted in the development of a new conceptual framework for the understanding vulnerability of an individual or a household to food insecurity (Bazezew, 2013). The concept of vulnerability theory refers to the exposure of some people or groups of households to certain negative external risks, shocks, stress or natural hazards like drought that can cause famine and food insecurity and the inability to cope with those risks (FAO *et al.*, 2021; Pieters *et al*., 2013).

Furthermore, combined with different natural and environmental disasters, economic, demographic, social and political factors can also further aggravate drought and famine that limited the access and utilisation of food by people and result in vulnerability to food insecurity. The degree of a household and an individual vulnerability depends on the level of livelihood strategies, access and resource endowment and their ability to cope with the risk (Moroda *et al*., 2018; Pieters *et al*., 2013). Thus, vulnerability to food insecurity is the result of an algorithmic procedure that includes current socioeconomic characteristics as well as risk exposure (shocks, stresses, trends, and seasonality) that determine a household's future characteristics and potential risk management capacity. Hence, vulnerability is caused by multiple stressors: low wealth, access to natural resources, economic and social isolation, cultural factors, institutional failure, political instability, and environmental change (Eshetu and Guye, 2021; Engler *et al*., 2014).

2.6.4. Territorial and Multi-Dimensional Approach

Despite there is significant progress in eradicating hunger over the last decade, about 813 million people were still facing severe food insecurity (FAO *et al*., 2021) and the majority of the world's hungry and food-insecure people live in developing countries particularly in the poor rural areas mostly dependent on agriculture (FAO *et al*., 2021; Goshme, 2019); Woldie *et al*., 2020). Geographically, there are significant regional disparities (between countries, within countries and rural-urban) in income inequality and food insecurity with the most vulnerable, poor and food-insecure people living in the rural areas (Cistulli *et al*., 2013; Cistulli, 2015; FAO *et al*., 2021). Disparities and inequalities exist because each territory or locality has a set of natural, physical, financial, human, institutional and cultural resources that are often unique to a particular geographic area (FAO, 2013; Cistulli, 2015). Thus, the potential economic development and success of the food security policy depend on these asset endowments and the context of the geographic socio-economic conditions. This resulted in a shift from a narrow agricultural (specific) sector approach to a broader territorial approach (place-based) or multi-sectoral and integrated approach to food security, nutrition, and rural development.

To date, food security and nutrition policies are principally focused on the food availability dimension (Cistulli *et al*., 2013) or food supply and food self-sufficiency (Cistulli, 2015) that has been developed mainly through traditional, "top-down", "one-size-fits-all" or one-dimensional and "sectoral" approach (designed and implemented at the national level) that has been unable to deliver the appropriate sustainable and long-term response to the problem of food insecurity (Organization for Economic Co-operation and Development [OECD], FAO and United Nations Capital Development Fund [UNCDF], 2016). This resulted in the development of a new approach or paradigm shift named as territorial approach to food and nutrition security that embraces multi-dimensional, multi-sectoral, bottom-up and place-based innervations (FAO, 2013; OECD *et al*., 2016) which addresses all the dimensions of food security (availability, accessibility, nutritional quality, and stability) (Cistulli *et al*., 2013). Hence, the territorial approach proposes a systematic, more holistic, and alternative approach aimed to fill some of the gaps and the multidimensionality and complexity of poverty and food insecurity (Cistulli, 2015).

Table 2.1: Comparative overview of food security theory and approach

Theory Groups	Theories and Concepts	Market Situation
Socio-Economic Theory	➢ Food Availability Decline • Demographic theory - Malthusian theory - Neo-Malthusian theory • Climatic theory - Drought (El Niño) - Flooding (La Niña) ➢ Food Entitlement Decline ➢ Market Failure	• Food supply • Food supply • Food supply • Food supply • Food supply • Food demand • Both food supply and food demand
Political Economy Theory	➢ Political instability and civil war ➢ Political mismanagement	• Both food supply and food demand • Both food supply and food demand
Vulnerability Theory	Exposure to external risk, shocks, stress or natural hazards like drought	• Both food supply and food demand
Multi-Dimensional and Territorial Approach	➢ Multi-sectoral and integrated approach ➢ Regional disparities (Geographic socio-economic conditions)	• Both food supply and food demand • Both food supply and food demand

2.7. Indicators of Food Security and Sustainability

Berry *et al*. (2015) stated that food security is a problem from the individual to the global level and it is basically an individual issue, though its measurement is best at the household level and policies mostly deal with it at the national level (Figure 2.3). The indicators of food security range from the prevalence of undernourishment to the average consumption of various nutrients by the source of food acquisition (Moltedo *et al*., 2014).

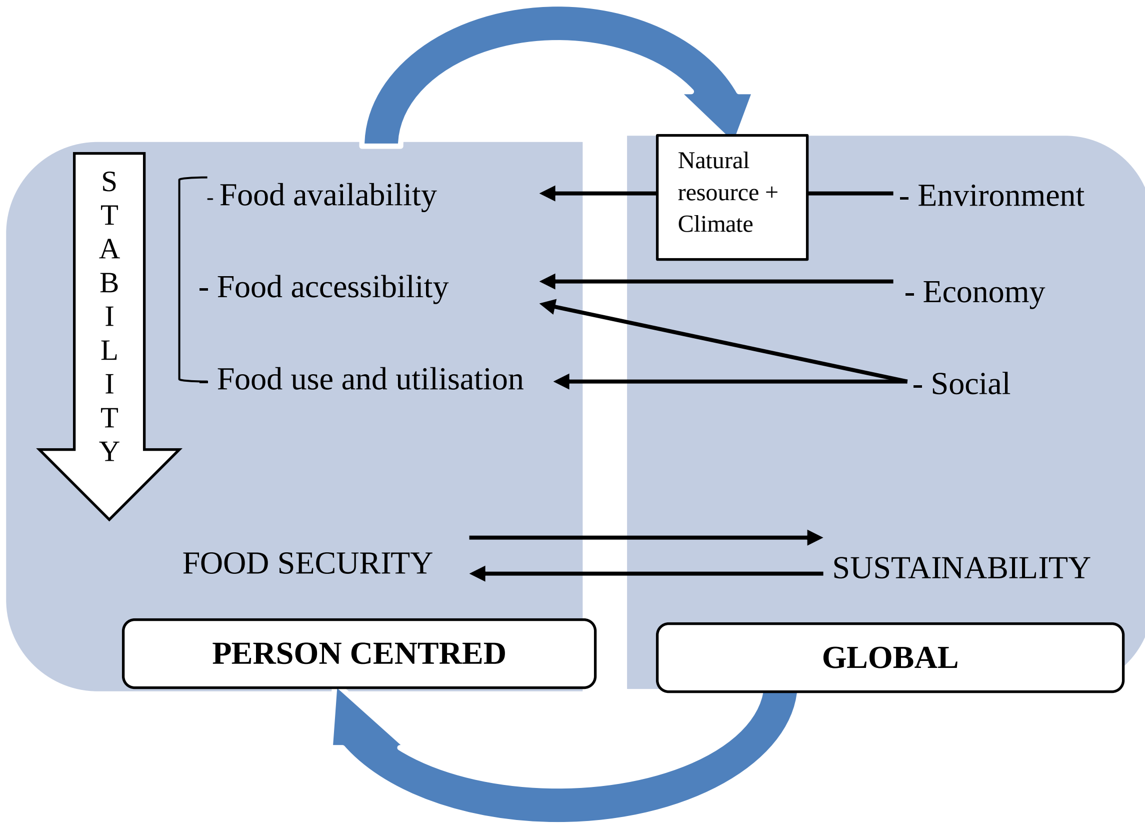

Figure 2.3: The interrelationships between food security and pillars of sustainability (Berry *et al*., 2015)

Despite the significant economic, social, and environmental costs of meeting the world's growing food demand in the face of climate change, water scarcity, ecosystem degradation, declining resource availability, and pressure from a growing human population, sustainability considerations have been largely absent from most food security assessments conducted to date (Gustafson *et al*., 2016). The Sustainable Development Commission (SDC) as cited in Lang and Barling (2013) proposed a multi-dimensional approach for food sustainability: quality (taste, seasonality, cosmetic and authenticity); health (safety, nutrition, equal access, availability, social status/affordability, information and education); social values (pleasure, identity, trust, choice, equality and justice, and animal welfare); economy (food security and resilience, affordability/price, efficiency, true competition and fair returns, jobs and decent working conditions, fully internalized costs); governance (transparency, democratic accountability, ethical values/fairness, science and technology evidence base, international aid and development) and environment (climate change, water, soil, land use, energy use, biodiversity and waste reduction).

Gustafson *et al*. (2016) also identified seven metrics of sustainable food and nutrition security as: (1) food nutrient adequacy; (2) ecosystem stability; (3) food affordability and availability; (4) socio-cultural well-being; (5) resilience; (6) food safety; and (7) waste and loss reduction. Each of these metrics consists of several indicators, and they are used to gauge the overall health of the food system as well as its effects on social, economic, and environmental sustainability. All these elements revolve around the four main dimensions of sustainability, which are economic, social, institutional, and environmental concerns. Generally, the indicators of sustainable food security revolve around the four pillars or dimensions of food security (availability, access, utilisation, and stability) (Aborisade and Bach, 2014; Berry *et al*., 2015; FAO *et al*., 2013; Vandevelde and Swinnin, 2019).

2.8. Food Security Situations and Policies in Ethiopia

With an estimated total population of over 120 million (UN, 2022), Ethiopia is the second-most populous country on the African continent and one of the fastest-growing economies in the world (Ahmed, 2019; FAO, 2018; FAO *et al*., 2020; Mekore and Yaekob, 2018). The agricultural sector is the country's foundation and source of overall economic growth, which could employ nearly 80% of the population and play a leading role in terms of contribution to gross domestic product and foreign currency earning (Ahmed, 2019; Alemu and Mengistu, 2019; FAO, 2018; Mohamed, 2017; Woldie *et al*., 2020). The country is endowed with numerous natural resources and diverse agro-climatic zones for the growing of a variety of crops and the rearing of animals (Aragie and Genanu, 2017). The country's agricultural sector primarily depends on rain-fed practices and producing crops and rearing livestock, it is a basic source of income and means of subsistence for most people. (Abebe, 2018; Adem *et al*., 2018; Alemu and Mengistu, 2019; Tsegaye *et al*., 2018; Woldie *et al*., 2020). Despite Ethiopia having the largest potential for the development of the agricultural sector in terms of vast suitable land and availability of freshwater resources for irrigation purposes, its agricultural sector is characterized by small-scale subsistence production systems where its productivity is low

(Ahmed, 2019). Furthermore, the Ethiopian economy's great vulnerability to rainfall variability and recurrent drought has long been recognized as a critical development concern.

Moreover, although agriculture is the mainstay of the Ethiopian economy and well progressed in production and productivity (Adem *et al*., 2018; Desalegn and Ali, 2018), it has not been productive enough to sustainably ensure farm household food security as it suffers from adverse climate-related shocks (prolonged drought and unreliable rainfall), pest infection and technologically limited farming practices (Gemechu *et al*., 2016; Tsegaye *et al*., 2018) that severely affected food production and livelihoods. Furthermore, in Ethiopia, food insecurity is one of the characteristics of rural poverty mainly amongst the rural population of smallholder farmers, moisture deficit and some pastoral areas and poverty remains a major challenge in the country (Ahmed, 2019). Food security evidence in Ethiopia shows that there is a high prevalence of food insecurity, with substantial individual and geographic characteristics. Food insecurity and poverty, especially in rural areas, remain a major challenge, and the country continues to have one of the highest malnutrition rates in Sub-Saharan Africa and many people may not have access to the food they need to live an active and healthy lifestyle (FAO *et al*., 2020; UNDP, 2020). Besides, the number of severely food insecure people in Ethiopia increased from 14.7 million in the years 2014-16 to 15.4 million in 2017-19 (FAO *et al*., 2020) and increased to 18.4 million in 2018-20 (FAO *et al*., 2021). Furthermore, according to the UNDP (2020), roughly 23.5% of Ethiopians live below the national poverty line, with 61.5% experiencing severe multidimensional poverty and the remaining 8.9% becoming vulnerable to multidimensional poverty.

Empirical evidence showed that food insecurity has become a severe and growing problem in many sections of the country due to a combination of natural and man-made reasons. The immediate causes of food insecurity and widespread poverty in the country include rapid population growth, erratic rainfall patterns and frequently recurring droughts, poor rural infrastructure, land degradation, the low levels of technology employed in agriculture and the resulting low productivity of the sector. Additionally, high population growth, high rate of natural degradation, low level of farm technology, production fluctuations, regional fragmentation of markets, low non-farm employment, low income, poor health and sanitation, high illiteracy and inadequate quality of basic education, inter-state and intra-state military conflicts and wars and poor governance are all contributing factors to the country's current state of food insecurity and poverty (Ahmed, 2019; Aragie and Genanu, 2017; Assefa, 2019; Endalew *et al*., 2015; FAO, 2018; Feyisa, 2018; Fikire and Zegeye, 2022; Goshme, 2019; Mohamed, 2017; Welteji *et al*., 2017).

To address and deal with the food insecurity problem, the Ethiopian government developed a food security strategy in 1996 for the first time and launched a Food Security Program (FSP) in 1998 (Assefa, 2019) with the goal of enhancing household food security and putting them on a path of asset accumulation and stabilization (Aragie and Genanu, 2017; Asenso-Okyere *et al*., 2013). The program has four components: 1) Voluntarily Resettlement Program (VRP) 2) Complementary Community-based Infrastructure Program (CCI) 3) Household Asset Building Program (HABP) and Productive Safety Net Program (PSNP). PSNP and HABP capacity-building programs are funded by donors, whilst HABP, CCI, and VRP are funded by the government as part of the FSP. To implement the food security program, PSNP and HABP capacity-building programs were financed by donor support, whereas VRP and CCI, HABP receive government funding. PSNP was launched in 2005 by the government of Ethiopia and its development partners with donor support in response to the recurrent food insecurity in rural areas (Abay *et al*., 2020; Asenso-Okyere *et al*., 2013; Welteji *et al*., 2017). Productive Safety Net Program as a component of the Ethiopian government Food Security Program was essentially targeted toward chronically food insecure *woreda*s and household members (Mohamed, 2017) and aimed to address food insecurity and vulnerability to shocks while also enabling households to build assets that may enable them to escape from poverty (Abay *et al*., 2020; Asenso-Okyere *et al*., 2013). Moreover, many pro-poor policies were funded by the government, notably the PSNP, which was dedicated to reducing food insecurity. With a population growth rate of 2.5%, which implies a doubling of the population in less than 30 years, sustainable food security will be increasingly difficult to achieve while maintaining internal stability and avoiding drought and other related disasters (Mohamed, 2017).

2.9. Conceptual Framework of Sustainable Food Security

The analysis of food insecurity is difficult because of the complexity and multi-dimensionality of the concepts (Sandhu, 2014; Berry *et al*., 2015) and the unpredictability of many shocks that cause food insecurity. As shown in Figure 2.4, the conceptual framework for sustainable food security in this study integrates resilience assessment and a livelihood approach to address the underlying causes of vulnerability. "*The livelihood approach emphasizes the importance of access to different productive assets (land ownership, livestock and oxen ownership, availability and use of agricultural input such as improved seeds, fertilizer), access to market, institutional structures and processes, and the livelihood strategies pursued by households*" (Frankenberger *et al*., 2012, p.3). The concept of livelihood asset consists of physical capital, natural capital, financial capital, human capital, and social capital (Kamaruddin and Samsudin, 2014; Ndhlovu, 2018; Sati and Vangchhia, 2016; Serrat, 2017) which influences the availability, accessibility, and utilisation of food. Livelihood assets are assumed to be influenced by biophysical vulnerability and household demographic characteristics while livelihood assets in turn influence food availability. The analysis also incorporates variables that adversely affect food availability, access, utilisation, and stability. Access to food is partly determined by food availability whereas food utilisation is partly determined by access to food. Under non-farm ventures: off-farm income, rural credit, market and saving potential are assumed to influence household purchasing powers. Finally, under food utilisation household feeding practices, health and sanitation, and storage systems are analysed.

Moreover, a sustainable food security system has also been influenced by exposure to various external shocks and stresses (Ecker and Breisinger, 2012) at global, national, household, and individual levels. These external shocks include global food price increase, natural disasters (climate change/droughts and floods) and civil conflicts or political instability that affects the food security status from global to individual levels (Ecker and Breisinger, 2012). "*The extent and nature of community and household responses to these shocks and stresses will result either in increased vulnerability or increased adaptive capacity and resilience over time. Households that are not able to use their adaptive capacity to manage the shocks or stresses caused by external shocks/disturbances are sensitive and are likely vulnerable to food insecurity while households that can use their coping mechanisms/adaptive capacity to manage the shocks or stresses that they are exposed to and incrementally reduce their vulnerability*" (Frankenberger *et al*., 2012, p.3 & 5) and they are on a resilience pathway which contributes to the sustainability of food security.

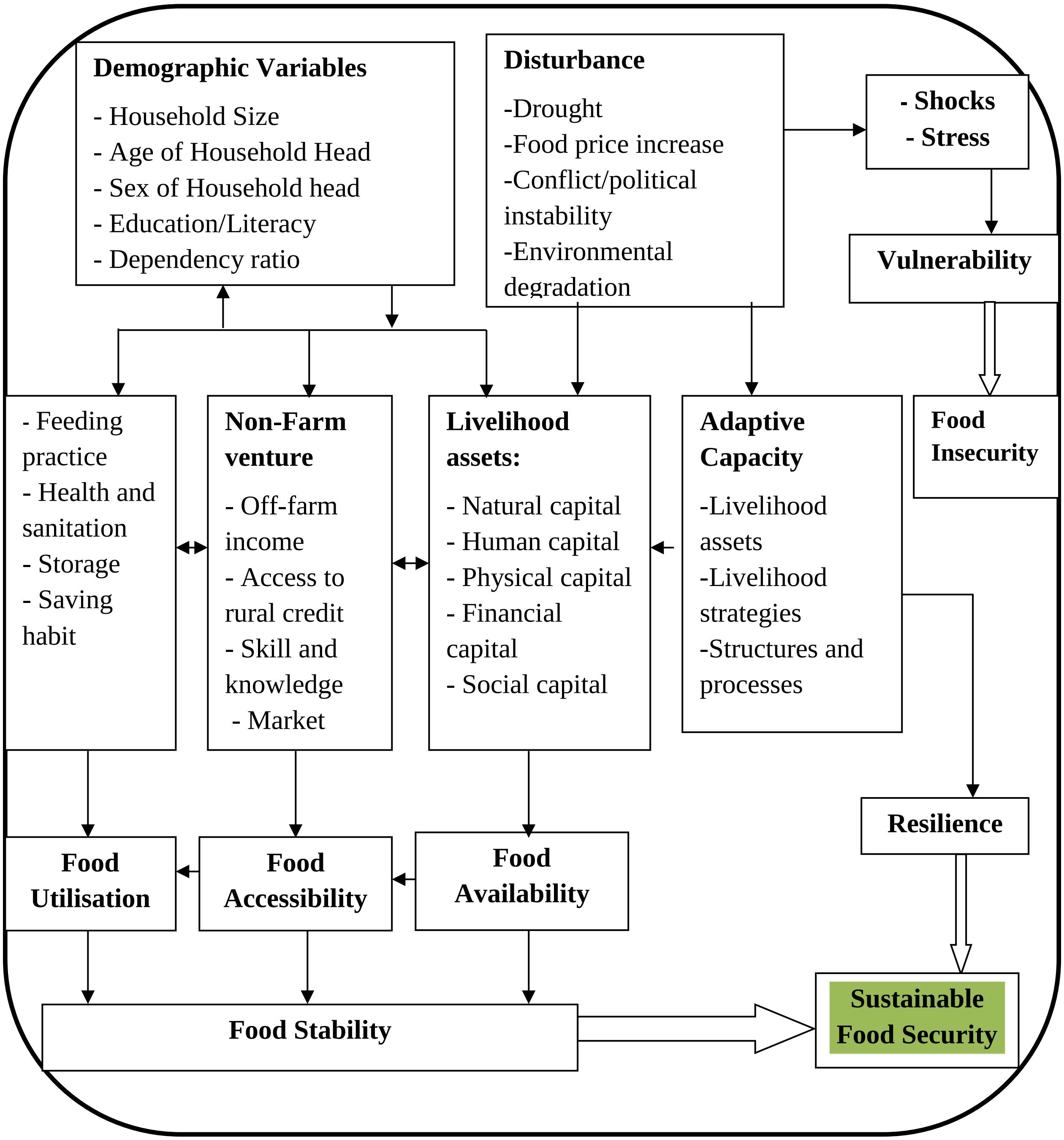

Figure 2.4: Schematic illustration of the interactions between sustainability of food security and determinant factors (Source: Compiled by the researcher)

CHAPTER THREE

PHYSICAL AND SOCIO-ECONOMIC SETTINGS OF THE STUDY AREA

3.1. Introduction

Kurfa Chele *woreda* is one among the 20 *woredas* in East Haraghe zone (Ethiopia) frequently affected by recurrent drought, erratic rainfall and vulnerable to food insecurity problems. Most of the farmers in the *woreda* have a very small land size and use traditional crop cultivation methods, and they are unable to produce the food they need for their family members. Additionally, despite its diverse agro-ecological zones and potential to produce various agricultural activities, Kurfa Chele *woreda* is still vulnerable to food insecurity, owing to reliance on rain-fed agriculture which is highly sensitive to climate-related shocks, high population pressures, extensive land degradation, and deterioration of other natural resources and use of traditional production systems.

Furthermore, several food security and productive safety net programs have been introduced and implemented in the *woreda* since 2005 to reverse this situation, yet food insecurity and vulnerability to food insecurity persists in questioning the sustainability of food security in the area. Hence, the purpose of this chapter is to provide background information on the physical, demographic, and socio-economic set-up of the study *woreda*, which could serve as a basis for the understanding of the vulnerability of the study area to food security problems and its un/sustainability. In line with this, the chapter intended to give a summary picture of the physical and socio-economic background of the study area which mainly focuses on issues like location, topography, agro-climatic zone, land use pattern, climate change and drainage systems. Moreover, the chapter also gives the highlights of some demographic and socio-economic aspects such as population characteristics, educational services, availability of safe water, and major economic activities carried out in the study area such as major types of livestock and crop production. Finally, the chapter documents about the food security status of the rural farm households, PSNP and emergency relief in the study *woreda*.

3.2. Eastern Hararghe Zone

Eastern Hararghe is one of the 23 zones of Oromia region located in the eastern part of the region. There are four towns and 20 rural *woredas* in the zone of which five *woredas* are pastoralist and agro-pastoralist areas. The estimated total population of the zone is 3,493,680 (1,781,315 are males and 1,712, 365 are females). The total area of the zone is 23,525 km^2 with a population density of 148.5 persons per kilometre square. The altitude of the zone ranges from 500 to 3405 meters above sea level (Berhane *et al*., 2020). Eastern Hararghe zone consists of three agro-climatic zones: *dega* (highland) 7.7%, *woina-dega* (midland) 24.5% and *kolla* (lowland) 67.7% (Zeleke *et al*., 2021). The zone receives relatively low/erratic amount of annual rainfall having bimodal rainfall seasons namely *belg*[10]/spring and *meher*[11]/summer. Normally, the *belg* rain extends from *Yekatit* (February) 15 to *Ginbot* (May) 30 and while the *meher* rain extends from *Sene* (June) 15 to *Meskerem* (September) 30. The average annual rainfall of the zone ranges from 400 to 1200 mm and the average minimum and maximum temperature of the zone ranges from 13^0C to 28^0C (Eastern Hararghe Zone Agricultural and Rural Development Office [ARDO, 2018] and Disaster Prevention and Preparedness Office [DPPO, 2017).

The livelihood of the Eastern Hararghe zone is mainly relayed on crop cultivation and livestock rearing; petty trade, daily labourer and collection of firewood and charcoal are alternative livelihood activities in the zone. The agro-ecology of the zone is favourable to produce cereal crops, pulses, oil crops, vegetables, and fruits. The major crops grown in the zone are maize, sorghum, wheat, barley, and groundnut. Sorghum and maize are used as a staple food in most of the areas of Eastern Hararghe Zone. In addition, cash crops like chat and coffee as well as livestock production are widely practised in the area. The major types of livestock produced in the zone include cattle, sheep, goats, camels, donkeys, and poultry**.** Even though the area receives two seasonal rainfalls and is favourable for all types of crops and livestock production, the zone is suffering from natural hazards, like drought and flood, landslides, crop pests and hailstorms, man-made hazards like conflict and land degradation (Eastern Hararghe Zone ARDO, 2018 and DPPO, 2017; Sileshi *et al*., 2019). Furthermore, east Hararghe zone is one of many areas in Ethiopia that are frequently affected by recurring drought, irregular rainfall, and

[10] An expression for the short rainy season in Ethiopia also named as spring

[11] An expression for long (main) rainy season in Ethiopia also called as summer

severe land degradation. Many smallholder farmers in the zone have extremely small plots of land and cultivate crops using traditional methods. Shortage of farmland, scarcity of surface and groundwater, and shortage of grazing land, coupled with recurrent drought and variability of climatic conditions challenged smallholder farmers' livelihood resulting vulnerable to the problem of food insecurity (Alemaw and Hailu, 2019; Zeleke *et al*., 2021)

3.3. The Study *Woreda*: Kurfa Chele

3.3.1. Location and Topography

The study was conducted in Kurfa Chele *woreda* of Eastern Hararghe zone, Oromia regional state of Ethiopia. The *woreda* was named after its administrative centre, Kurfa Chele which is located at 57km to the west of Harar town the capital of eastern Hararghe zone and 537km to the east of Addis Ababa. Astronomically, the *woreda* is situated between $9^{o}06'30''$ to $9^{o}18'45''$ North latitude and $41^{0}\,44'00''$ to $42^{o}00'00''$ East longitude.

Kurfa Chele *woreda* is bounded by Bedeno *woreda* in the west, Girawa *woreda* in the south, Fedis *woreda* in the southeast, Haromaya *woreda* in the east and northeast and Kersa *woreda* in the northwest. The *woreda* covers a total land area of 301.77 square kilometres and it has 18 rural *kebeles* and two urban *kebeles* namely Kurfa Chele 01 and Dawe 02 (Kurfa Chele *Woreda* Agriculture and Rural Development Office, 2018). According to Kurfa Chele *woreda* Agricultural and Rural Development Office, the altitude of the *woreda* approximately ranges from 1100 meters to 3381 meters above sea level and mountain Gara Muleta, Dedero and Gebiba are amongst the highest points in the area.

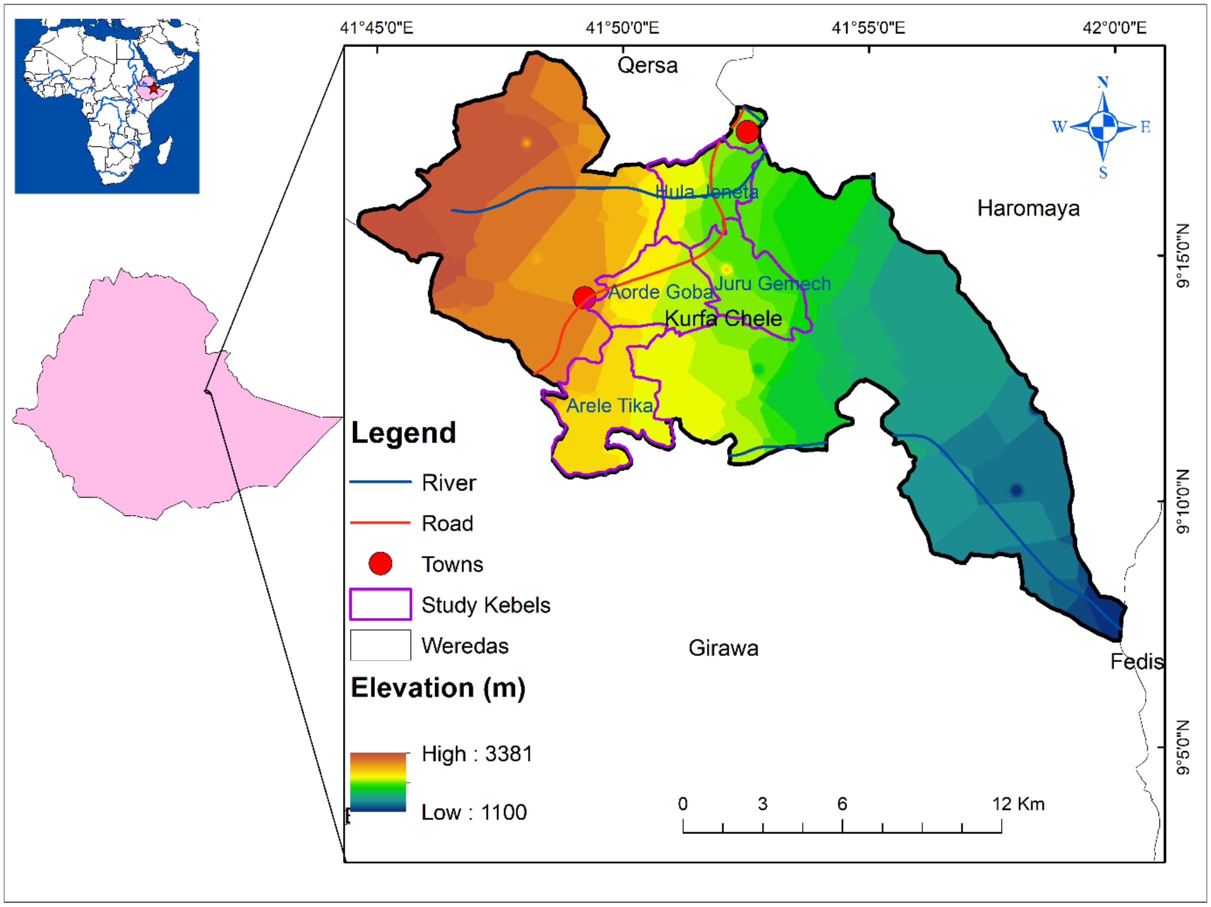

Figure 3.1: Map of the study area (Kurfa Chele *woreda*) (source: Ethio-GIS, 2021)

3.3.2. Biophysical Characteristics of the Woreda

3.3.2.1. Agro-ecology and Land Use Pattern

Based on altitude, three major agro-climatic zones are identified in the study *woreda* namely *dega (highland)*, *woina-dega (midland)* and *kolla (lowland)* which constitutes 36%, 13% and 51% of the total land area of the *woreda*, respectively (Figure 3.2). The percentage of people living in *dega*, *woina-dega* and *kolla* agro-climatic zone approximately accounts for 44.4%, 8.2% and 47.4% of the total population of the *woreda*, respectively (Kurfa Chele *Woreda* Agriculture and Rural Development Office, 2018).

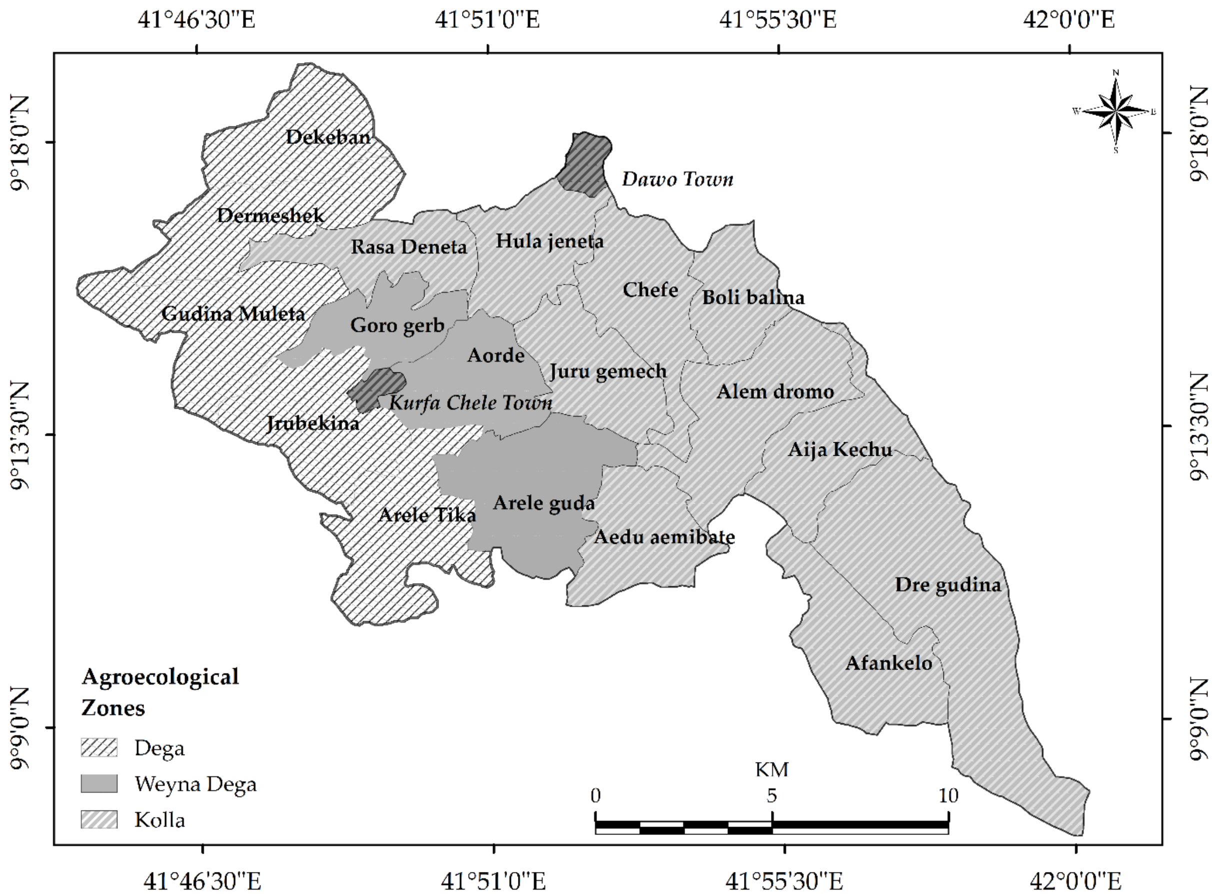

Figure 3.2: Map of agro-climatic zone of Kurfa Chele *woreda*) (source: Ethio-GIS, 2021)

The *woreda* covers a total land area of 301.77 square kilometres and it has 18 rural and two urban *kebeles*. As it is shown in Figure 3.3, the land use pattern of Kurfa Chele *woreda* is dominated by arable or cultivable land which constitutes 11,899 hectares (39.43%) of the total land area. Forest land accounts for 6,746 hectares (22.35%) and the remaining 3, 047 hectares (10.09%); 3,653 hectares (12.11%); 2,905 hectares (9.63%) and 1,927 (6.38%) of land area in the *woreda* is considered as pasture or grazing land; land used for social service (built-up land); shrubs and bushland; and stony, hilly, and degraded land respectively (Kurfa Chele *Woreda* Agriculture and Rural Development Office, 2018).

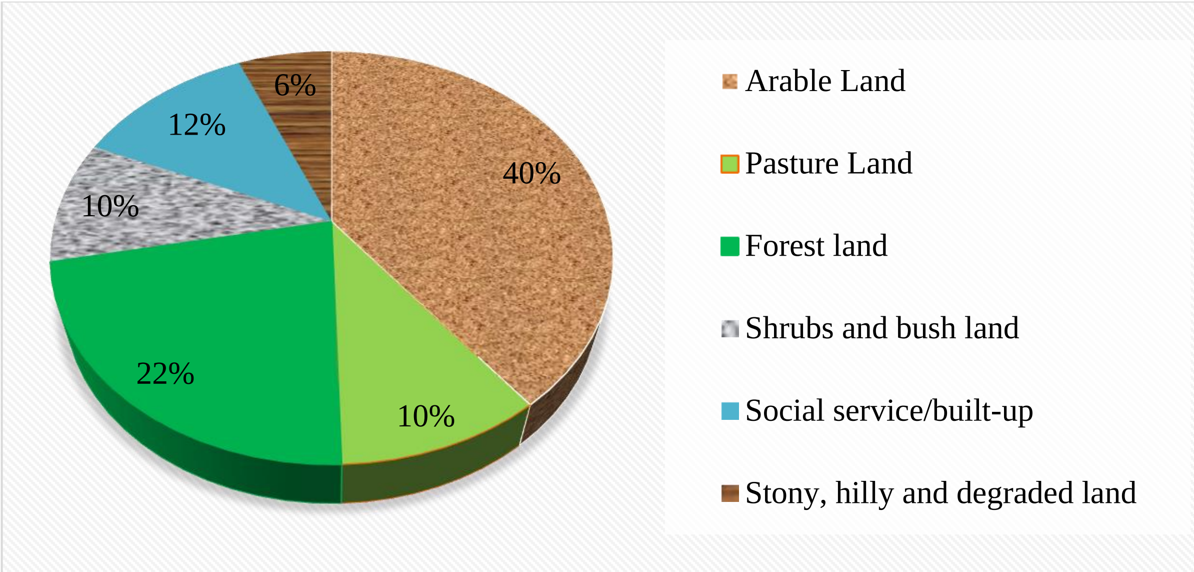

Figure 3.3: Land use pattern of Kurfa Chele *woreda*

Source: Kurfa Chele woreda Agricultural and Rural Development Office

3.3.2.2. Climate and Drainage Systems

Rivers and streams in the *woreda* include the Dawe, Gefra Gelana and Gefra and their discharging system is towards the east and southeast of Kurfa Chele. These are small rivers and streams which extremely fluctuated in the amount of water they carried and depends on the seasonal rainfall. The historical monthly climatic data such as minimum and maximum rainfall and temperature observed and recorded in the study area were obtained from the Ethiopian National Metrological Agency and Kurfa Chele *woreda* Agricultural and Rural Development Office. Data obtained from the *woreda* showed that the annual mean minimum and maximum temperature of the study area were estimated at 12^0C and 27^0C respectively.

As shown in Figure 3.4, the study area receives bimodal rainfall seasons namely short *belg*/spring rains (which extend from March to May) mainly used for land preparation and planting of long cycle crops such as sorghum and maize and *meher*/Summer the main rainy season (extends from June 15 to September). Data in Figure 3.4 displayed that the summer seasonal rainfall is the main rainy season and contributed to most of the annual rainfall amount in the study area. The highest rainfall amount was also recorded in the month of August with mean monthly rainfall of 173mm.

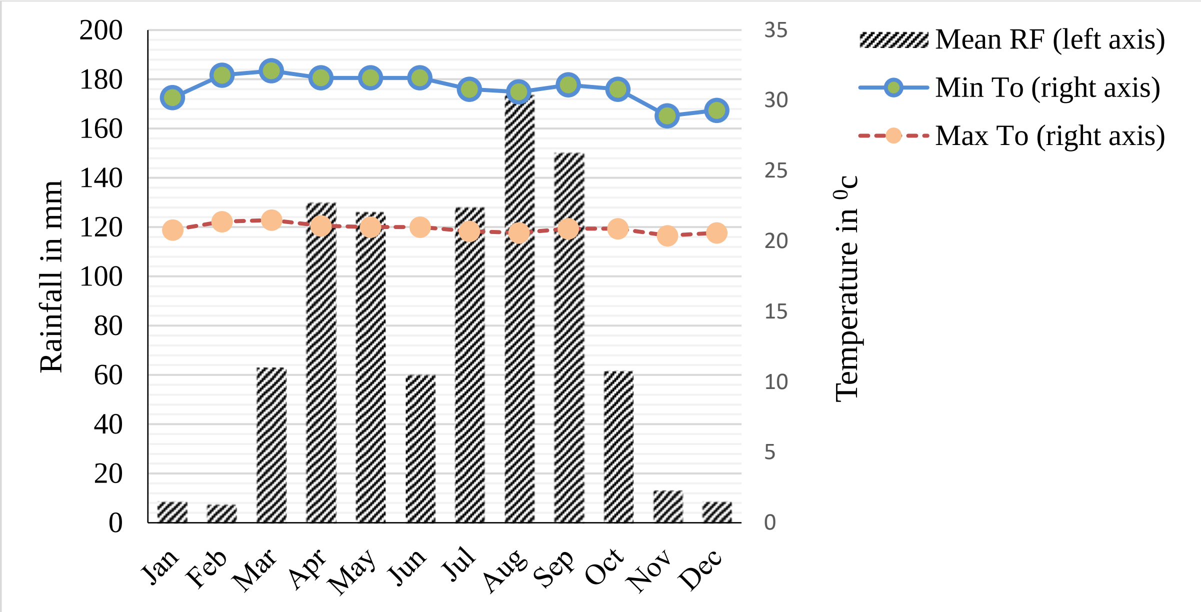

Figure 3.4: Seasonal distribution of rainfall and temperature of Kurfa Chele *woreda* (1999-2016)

Source: National Meteorological Agency of Ethiopia

The annual rainfall time series analysis of Kurfa Chele *woreda* was shown in Figure 3.5 and the rainfall anomaly over the study area indicated that it is moderately slightly variable from year to year for the last two decades. Accordingly, the annual rainfall amount in the study area approximately varies between 750mm and 1200mm with a mean annual rainfall of 973mm. The annual rainfall trend shows both positive and negative rainfall anomalies for the last 18 years (1999-2016). Data in Figure 3.5 displayed that the upward bar indicates positive anomalies showing the rainfall was above the mean value and the downward bar indicates negative anomalies showing the rainfall was normally below the mean value over the study area in the year 1999-2016.

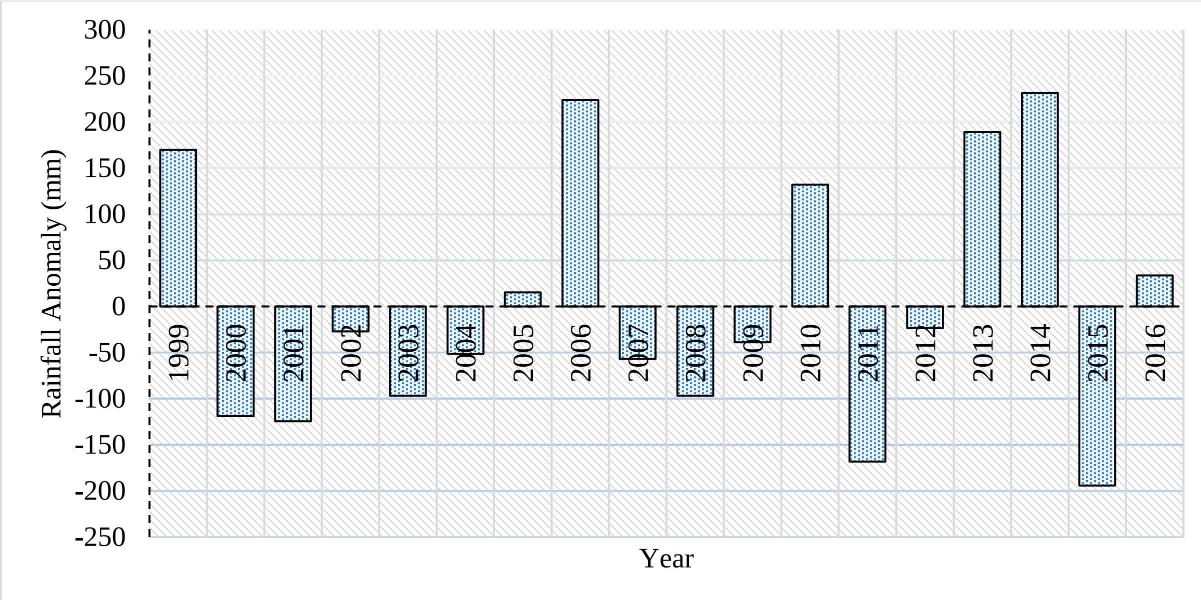

Figure 3.5: Annual rainfall anomaly in Kurfa Chele *woreda* (1999-2016)

Source: National Meteorological Agency of Ethiopia

3.3.3. Demographic Characteristics of the Study *Woreda*

According to the 2007 population and housing census report, the total population of Kurfa Chele *woreda* was estimated at 58,701, of whom about 29,675 (50.55%) were men and 29,026 (49.45%) were female. Out of the total population of the *woreda* about 52,937 (90.18%) were residing in the rural areas and 5,764 (9.82%) were urban dwellers. Most of the inhabitants of the *woreda* are followers of the Muslim religion, which accounts for 96.44% and 3.27% of the population are practising Ethiopian Orthodox Christianity. The largest ethnic group in Kurfa Chele is Oromo, which accounts for 94.25% of the population of the *woreda* and is followed by Amhara which makes up 5.69%. According to *woreda* report of 2016, the total population of Kurfa Chele were estimated and reached 75,418 (Kurfa Chele *Woreda* Agricultural and Rural Development Office, 2018).

3.3.4. Socio-Economic Characteristics of the Study *Woreda*

3.3.4.1. Education and Health Service

In the year 2016/17, there were a total number of 47 schools in the *woreda* of which one is kindergarten (private), 43 schools were from grades 1-8 and two schools are from grades 9-10.

Moreover, there is also one preparatory school (grade 11-12) that is giving educational services in the *woreda* starting from 2014/15. The total number of students enrolled in the *woreda* has increased from year to year (Figure 3.6) with educational coverage in the area reached approximately 96.7% and the number of enrolled students also reached over 25,000 in the year 2016/17 (Kurfa Chele *Woreda* Education Office, 2018).

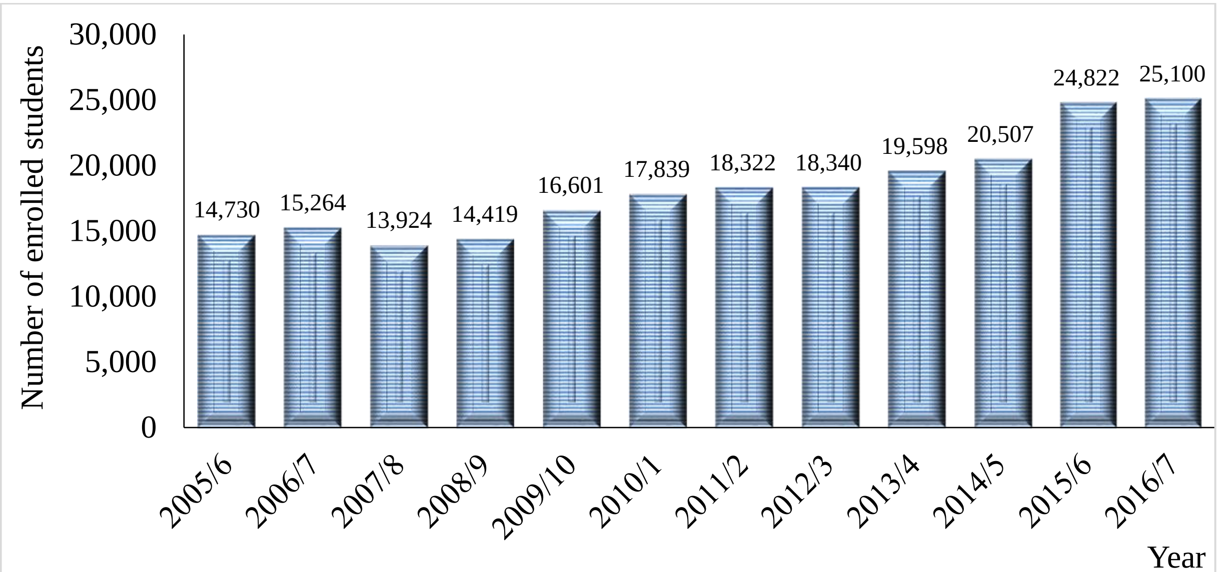

Figure 3.6: Total number of enrolled students in Kurfa Chele *woreda* (2005/06-2016/17) (Source: Kurfa Chele woreda Education Office, 2018)

Concerning to health facilities, the *woreda's* health institutions consists of four health centres (Kurfa Chele 01, Dawe 02, Dire Gudina and Wakijira Health Centre) and 18 health posts with a total of 38 health extension workers. However, there is no hospital in the *woreda*. Over the last 15 years, information on woreda health-care service coverage has shown an increasing general trend.

3.3.4.2. Availability of Safe Water

As of 2015/16, the number of water supply schemes spring with distribution in the *woreda* accounts for 13 and the number of schemes on spot was four and that of schemes with roof catchment was three (Kurfa Chele *Woreda* Agriculture and Rural Development Office, 2018). The water supply in the *woreda* is seasonal and not sustainable throughout the year mainly dependent on the weather conditions. For instance, in the year 2015/16, from the total of 54 water schemes in the *woreda*, about 30 of them were dried up because of the severe drought or shortage of and unreliable rainfall that happened in the area and the country. Reports of the Kurfa Chele *Woreda* Agriculture and Rural Development Office (2018) showed that the percentage of safe water supply in Kurfa Chele *woreda* was better and increased (except for the year 2014-2016) because of a shift in the use of potable water between urban and rural areas. For instance, one of the water schemes (Ganda Manago Scheme) constructed by CARE in Jiru Balina *kebele* was used by the rural population during the daytime and it was used by Kurfa Chele 01 town population during night-time. This increased the potable water supply coverage in the study area.

Table 3.1: Total population and potable water supply coverage in Kurfa Chele *woreda*

Year	Total population			Potable water supply coverage (%)		
	Rural	Urban	Total	Rural	Urban	Total
2012/13	63,725	5,832	69,557	49.50	83.25	54.17
2013/14	65,255	6,065	71,320	53.03	83.25	55.60
2014/15	66,803	6285	73,088	56.48	83.27	56.48
2015/16	67,051	8,367	75,418	36.73	27.20	35.68

Source: Kurfa Chele *Woreda* Agriculture and Rural Development Office, 2018

As shown in Table 3.1 the potable water supply coverage in Kurfa Chele *woreda* in the year 2012/13, 2013/14 and 2014/15 accounts for 54.17%, 55.60% and 56.48%, respectively. The data in the table show that there is evidence of progress in potable and safe water supply coverage in urban, rural, and woreda areas in general. However, in the year 2015/16, the potable water supply coverage of the *woreda* declined and accounted for only 35.68% indicating there was a decline in the supply of safe drinking water compared to the previous two/three years. This was due to the severe and prolonged drought and shortage of rainfall that prevailed in the area. People in the area also travelled for a long distance to fetch water and some people even have drunk river water without any treatment. For instance, the people in Dawe 02 *kebele* have no safe drinking water and they usually have drunk river Dawe which mainly results in the flourish of cholera in the *kebele*, hence the *woreda* tried to distribute water treatment mechanisms such as, Wuha Agar (Bishan Gari) and Aquatabs which has been supplied and donated by a different non-governmental organization. Moreover, WASH was under development in Arele Tika *kebele*.

3.3.4.3. Crop Production and Rainfall Trends in the Study Woreda

The major livelihood activities of the people in the study area heavily depend on subsistence mixed agriculture which most dominantly depends on seasonal rainfall performance. Agriculture is the major economic activity of the study *woreda* and the most dominant source of food and income for the people to lead their livelihoods. Approximately 94.6 per cent of the *woreda's* population is engaged in agricultural production activities. The area is well known to produce long-cycle crops like sorghum and maize (the most dominantly produced and common source of staple food in the area) which account for over 70% of the total crops produced in the *woreda* (see Figure 3.7). The four major crop types most dominantly cultivated in the *woreda* are sorghum, maize, wheat, and barley. Other crops like *teff*, haricot bean, groundnut, oats, horse bean, field pea, chickpea, lentil, linseed, and fenugreek are also produced in small quantities (Kurfa Chele *Woreda* Agricultural and Rural Development Office, 2018).

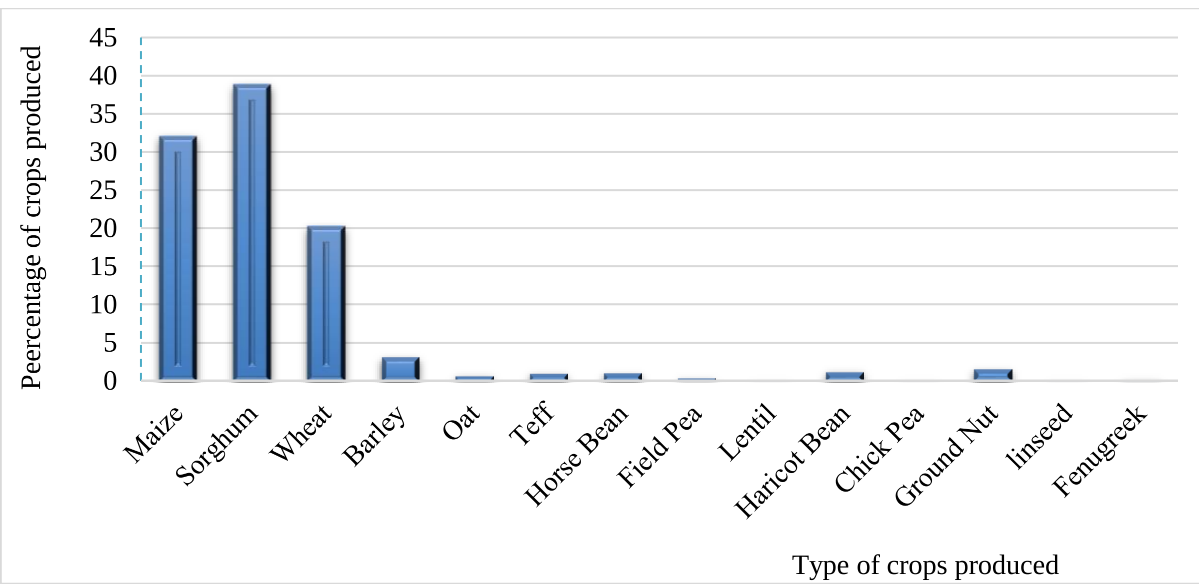

Figure 3.7: Percentage of crops produced in Kurfa Chele *woreda* (2009/10-2016/17)

Source: Kurfa Chele *Woreda* Agricultural and Rural Development Office, 2018

Farmers in the study *woreda* also cultivate and produced some stimulant cash crops like *khat (Catha edulis,* widely chewed as a stimulant*)* and coffee, which is the main source of income.

These cash crops are predominantly produced in Rasa Jeneta and Hula Jeneta *kebeles* where the availability of water was somewhat better compared to the rest of *kebeles*. The other major source of income for farm households in the *woreda* is the production of short-cycle vegetables (mostly produced using irrigation) like potatoes, onion, and garlic. Peppercorn is also produced in small amounts in Hula Jeneta *kebele*. These short-cycle crops are mainly produced using irrigation where irrigation facilities are available. Most of the farmers in the study area also practice intercropping of sorghum and maize with *khat* which is the most common method of farming in the study area (see Figure 3.8)

Figure 3.8: Photograph showing intercropping of sorghum with khat in the study area (Orde Goba) (Photograph were taken by the researcher, April 2018)

Rainfall trends over time in the study area showed that there is a direct relationship between the amount of rainfall received in the area and the total amount of crops produced by the farmers. Figure 3.9 reveals that there is a declining trend of crop production in the year 2011/12 and 2015/16 as of rainfall distribution. The 2015/16 year is one of the severe and prolonged shortages of annual rainfall ever seen over the last 20 years putting the total crop production of the area at 7,353 quintals resulting in over 90% of the population of the area under emergency relief food assistance (Kurfa Chele Agricultural and Rural Development Office, 2018).

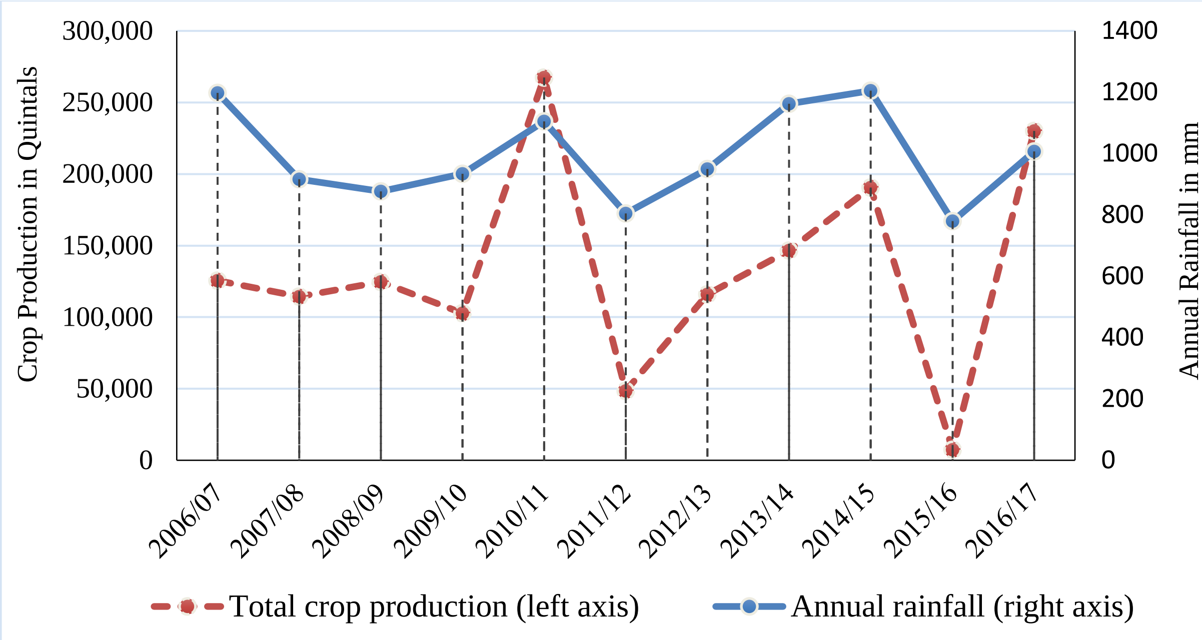

Figure 3.9: Rainfall trend and crop production in Kurfa Chele *woreda* (2006/07-2016/17)

3.3.4.4. Livestock Production

Livestock production is another important economic activity and the second-largest source of livelihood for the study *woreda's* population, providing essential sources of food and income. Moreover, livestock resource also plays an immense role in the well-functioning of the farming system in the study area. Cattle, goat, sheep, donkey, camel, and poultry are among the main types of livestock reared in the area. Additionally, a small number of horses and mules are also reared in the *woreda*. According to the *woreda* Agriculture and Rural Development Office report document, livestock in the study area were used for draught power for agricultural operations, as a security reserve in the event of crop failure, as a source of income, and as a mode of transportation. The production of livestock in the study area was increased over time apart from a slight decrease in 2015/16 because of the severe and prolonged droughts and shortage of rainfall that occurred in the area (Figure 3.10). The major livestock diseases in kurfa Chele *woreda* are infectious diseases such as blackleg, pasteurellosis, anthrax, newcastle, salmonella, mastitis; and non-infectious diseases like blotting, grain engorgement, GIT parasite, ectoparasite and urethral blockage.

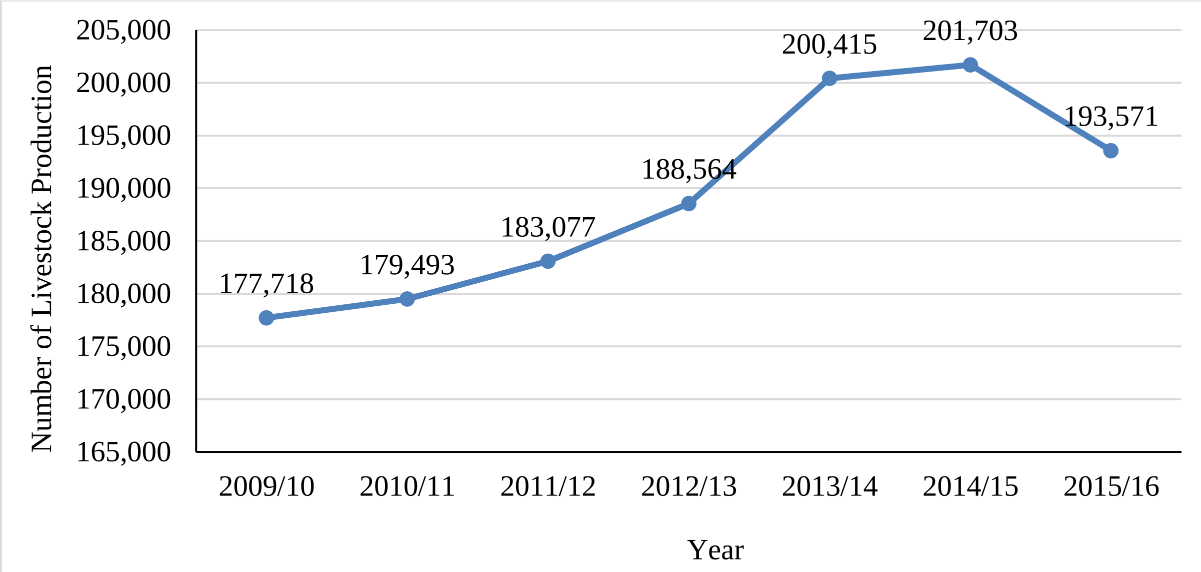

Figure 3.10: Livestock Production in Kurfa Chele *woreda* from 2009/10 – 2015/16

Source: Kurfa Chele *woreda* Livestock Production and Fishery Office, 2018

3.3.4. Food Security, PSNP and Emergency Relief in Kurfa Chele *Woreda*

Kurfa Chele *woreda* is one of the most frequently and severely affected areas by drought and food insecurity problems in the Eastern Hararghe zone. The *woreda* is one of the food insecure, PSNP targeted and hotspot *woredas* of Eastern Hararghe zone. According to Kurfa Chele *woreda* Disaster and Risk Management (DRM) office report, the most drought-prone and food insecure areas in the *woreda* are the lowland region. In the year 2015/16, all the rural *kebeles* of Kurfa Chele *woreda* were affected by drought and most of the households in these *kebeles* were assisted by emergency food relief (Figure 3.11).

The *woreda* is characterized by high population pressure, unreliable rainfall, and poor asset ownership. In the year 2016, Kurfa Chele *woreda* produced and harvested only 5% of the total planted and planned crop production and over 90% of the population of the *woreda* were unable to produce their yearly minimum kilocalorie consumption from their own production and this forced them to be dependent on food aid which was provided by a government and non-government organizations.

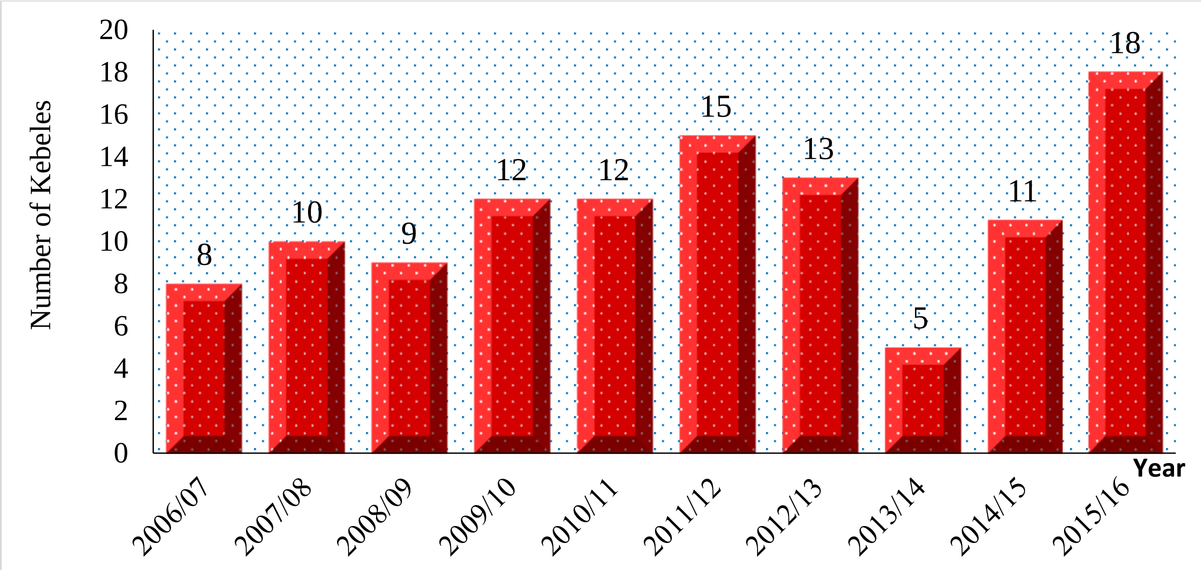

Figure 3.11: Number of *kebeles* affected by drought in Kurfa Chele *woreda*

In Kurfa Chele *woreda, the* productive safety net program (PSNP) was launched in 2006 after one year it was introduced in the country to assist and provide transfers to the chronically food-insecure households. Since then, the PSNP has been implemented in twelve food-insecure rural *kebeles* of Kurfa Chele *woreda* until 2015. However, because of the severe and prolonged drought that occurred in the year 2015/16 in Ethiopia and the study area, in particular, the total number of beneficiary *kebeles* of PSNP in the *woreda* were increased to fourteen *kebeles.* Accordingly, all *kebeles* (11) in the *kolla* agro-climatic zone, two *kebeles* (namely Orde Goba and Goro Gerbi) in the *woina-dega* agroclimatic zone and one *kebele* (namely Arele Tika) in the *dega* agroclimatic zone were included under the beneficiary of the PSNP. This showed that about 77.78% of the rural *kebeles* in Kurfa Chele *woreda* were under PSNP. Furthermore, in 2015/16, a total of 65,832 rural people, representing 92.56 per cent of the *woreda's* rural population, were unable to provide enough food to feed their family members and were assisted by the government in collaboration with various donor partners. Of these, 24 per cent (17,079) of chronically food-insecure households were identified and included as PSNP beneficiaries, while 68.5 per cent (48,753) of rural residents received emergency relief assistance. However, in the year 2016/17, the total number of populations of PSNP beneficiaries and emergency relief assistance was reduced to 35,362 people, which accounted for 46.8% of the population of the woreda (Figure 3.12).

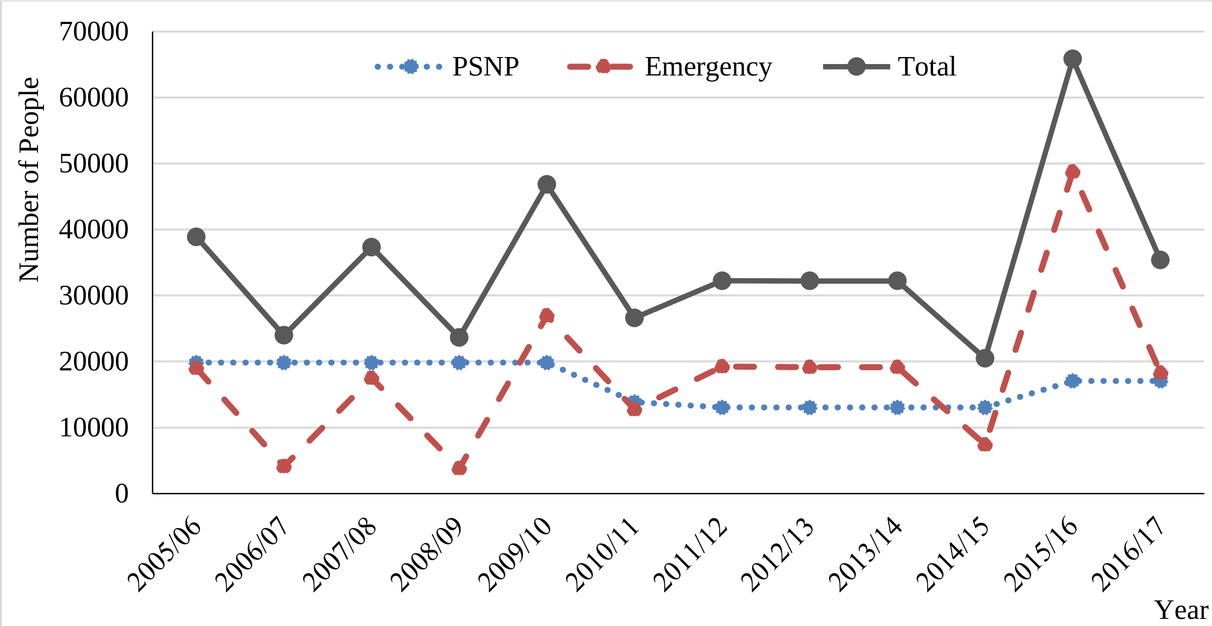

Figure 3.12: Number of population under PSNP and Emergency Relief in Kurfa Chele *woreda*

3.4. Summary

The study was conducted in Kurfa Chele *woreda*, one among the 20 *woredas* in East Hararghe zone (Ethiopia) covering a total land area of 301.77 square kilometres with 18 rural and two urban *kebeles*. Regarding the land use pattern of Kurfa Chele *woreda*, arable or cultivable land constitutes nearly 40% of the total land area followed by forest land (22%), land used for social service (built-up land) (12% and grazing land (10%). The altitude of the *woreda* approximately ranges from 1100 meters to 3381 meters above sea level with mountain Gara Muleta, the highest point in the area. Of the three major agro-climatic zones identified in the area, *kolla* covers half (51%) of the total land area of the *woreda* followed by *dega* (36%). The largest proportion of the population resides in *kolla* (47.4%) and *dega* (44.4%) agro-climatic zone. Concerning the weather condition of the *woreda*, the annual mean minimum and maximum temperature were estimated at 12^{0}C and 27^{0}C respectively and the annual rainfall amount in the study area approximately varies between 750mm and 1200mm with a mean annual rainfall of 973mm.

The major livelihood activities of the people in the woreda heavily depend on subsistence mixed agriculture which most dominantly depends on seasonal rainfall performance. Agriculture production activities accounting for nearly 95% of the population of the study *woreda* is the most dominant economic activity and the major source of food and income for the people to lead their livelihoods. The area is well known to produce long-cycle crops like sorghum and maize (the most dominantly produced and common source of staple food in the area) which account for over 70% of the total crops produced in the *woreda*. Moreover, crops such as wheat, barley, *teff*, haricot bean, groundnut, oats, horse bean, field pea, chickpea, lentil, linseed, and fenugreek are also produced in small quantities. Additionally, farmers in the study *woreda* also cultivate and produced some stimulant cash crops like *khat (Catha edulis*, widely chewed as a stimulant*)* and coffee, which is the main source of income. Besides, livestock production is another important economic activity and the second-largest livelihood base that provides important sources of income and food for the population of the study *woreda*. Livestock resource also plays an immense role in the well-functioning of the farming system in the study area. Cattle, goat, sheep, donkey, camel, and poultry are among the main types of livestock reared in the area.

Kurfa Chele *woreda* is one of the 20 *woredas* in East Haraghe zone most frequently and severely affected areas by recurrent drought, erratic rainfall, and vulnerability to food insecurity problems. Furthermore, Kurfa Chele *woreda* is one of the food insecure, PSNP targeted and hotspot *woredas* of Eastern Hararghe zone. Accordingly, all *kebeles* (11) in the *kolla* agro-climatic zone, two *kebeles* in the *woina-dega* agro-climatic zone and one *kebele* in the *dega* agro-climatic zone were supported by the Productive Safety Net Program (PSNP) indicating slightly more than three-fourths of the rural *kebeles* in Kurfa Chele *woreda* are under PSNP. Additionally, the largest proportion of the *woreda* population was assisted by emergency relief during crisis, though the number varies from year to year. This indicated that if the current prevalence of environmental problems and food insecurity problems persist, ensuring sustainable food security and achieving the sustainable development goals of ending poverty and zero hunger will be the main challenging in the study area. In connection, the next chapter will focus on descriptive analysis of the data that were generated from the sampled household respondents on socio-demographic characteristics, and farmers' access to economic and productive resources in the study area.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1. Introduction

This chapter presents the procedures that were used in conducting this research study. The chapter is organized into the following sub-headings: research approach and design; source of data and data collection methods; sample size determination and sampling procedures; description of the variables of the study, measurement, and hypothesis formulation; statistical methods of data analysis and analytical model specification. Finally, the chapter looks at ethical considerations, and how ethical clearance and consent was obtained to collect data.

4.2. Research Approach and Design

For this study, an extensive (descriptive) survey research design was employed, because it aimed to examine the current status or prevailing situations of the magnitude and problems (phenomenon) under investigation (of food security) and it enables the researcher to scratch a wide area of the problem in the study area. Descriptive research attempts to describe the phenomenon or situation or relationships among the variables being studied (Christensen *et al*., 2015). Moreover, a descriptive survey design provides a quantitative description of trends and associations and relationships among the variables under study (Creswell W. and Creswell, 2018) on the data obtained from the sample respondents. Moreover a survey design helps to answer three types of questions: descriptive questions, questions about the relationships between variables and questions about predictive relationships between variables (Creswell W. and Creswell, 2018). Additionally, a cross-sectional study was also applied/used to collect data from all research participants at the specified single time.

The combination of quantitative and qualitative research methods was also applied as a general approach in the study though it is more of a non-experimental quantitative approach. The quantitative approach involves the collection of quantitative and numerical data which could be put to rigorous quantitative analysis including inferential statistics (Christensen *et al*., 2015). Moreover, the quantitative methods or approach used mathematical modelling and statistical techniques to understand the phenomena under study (Clifford *et al*., 2010). Accordingly, this method helped to collect data concerning farm crop production, livestock production, landholding size, farm income, consumption patterns and dietary diversity, and months of adequate household food provisioning. Meanwhile, the qualitative approach is a non-quantitative form of data that uses the subjective assessment of the insights, attitudes, and opinions (Christensen *et al*., 2015) of the sample respondents on the phenomena under study. In the process, the two approaches are combined in the research design resulting in a mixed research approach (Clifford *et al*., 2010). Hence, a mixed research approach was used in this research study by triangulating information obtained from various sources, which helped to increase the validity of the outcomes and the conclusion of this research (Christensen *et al*., 2015).

Finally, both probability and non-probability sampling techniques were used to select the household survey respondents, key informant interviewees, focus group discussion participants and samples from the study area. Furthermore, a household food balance model (HFBM) which is used to measure household food grain availability were triangulated with other food-related information such as months of adequate household food provisioning (MAHFP) and household dietary diversity score (used as a measure of rural household food access) to contribute towards providing a holistic picture of the food security status and its sustainable in the study area.

4.3. Sample Size Determination and Sampling Procedures

The study area is in Eastern Hararghe Zone, Oromia region, which consisted of 20 *woredas*. Almost all *woredas* in the Eastern Hararghe zone are chronically food insecure, relying on relief programs, and a Productive Safety Net Program is being implemented in all *woredas* in the zone (Alemaw and Hailu, 2019; Berhane *et al*., 2020; Zeleke *et al*., 2021). Hence, from these 20 *woredas* in the zone, the researcher purposively selected Kurfa Chele *woreda* as the target area of the study based on accessibility and the possibility of getting data from the area. Kurfa Chele *woreda* consists of two towns (Kurfa Chele 01 and Dawe 02) and 18 rural *kebeles*. The study was based on multi-stage sampling procedures in which all the *kebeles* of the study area were stratified into three agro-climatic zones: *kolla (*occupies 51%*), dega* (36%) and *woina-dega* (13% of the area). These three agro-climatic zones consist of eleven, five, and two *kebeles* respectively, and the researcher randomly selected four rural *kebeles*: two from *kolla* (Hula

Jeneta and Jiru Gemechu) since it covers 51% of the area, and one each from *dega* (Arele Tika) and *woina-dega* (Orde Goba) agro-climatic zone proportional to their size.

The selected sample rural *kebeles* have a total population of 14,982 and 3,121 rural household heads of which 2,774 were male-headed households and 347 were female-headed households. Then, the rural household heads of these four selected *kebeles* of Kurfa Chele *woreda* were taken as the planned sample (sample frame) of the study from which the actual sample respondents were selected. First, the household heads in the four *kebeles* were stratified as male household heads and female household heads. Then, from the 3,121 rural household heads in the four *kebeles*, 255 sample respondents consisting of 226 male household heads and 29 female household heads were selected using a systematic random sampling method based on the list obtained from their respective *kebele* administration. To determine the sample size Cochran (1977) formula of calculating a sample for proportion (to generate a representative sample) at 95% level of confidence and 5% level of precision were employed. Finally, each kebele's sample size was proportionally assigned to its total population size.

$$n = \frac{z^2 p(1-p)}{e^2}$$

Where *n* is the desired sample size; *Z* is the value of standard normal distribution corresponding to the desired confidence level (for 95% confidence level, z = 1.96); *p* is the expected true proportion of an attribute that is present in the population (the proportion of the household heads to its total population in the selected sample *kebeles* which equals: $p = \frac{3{,}121}{14{,}982} = 0.21$) and *e* is the desired level of precision or allowable sampling error which is set at ±5% (0.05).

Hence, $n = \frac{z^2 p(1-p)}{e^2} = \frac{(1.96)^2 0.21(1-0.21)}{0.05^2} = \frac{(3.8416)(0.1659)}{0.0025} = \frac{0.637}{0.0025} \approx 255$

Table 3.1: Agroecology, sample kebele, HH head and sample size distribution

Agro-climatic zone	Sample *kebele*	Total population	Household Head			Sample size		
			Male	Female	Total	Male	Female	Total
Dega	Arele Tika	6,343	1,169	152	1,321	95	13	108
Woina-dega	Orde Goba	2,774	517	61	578	42	5	47
Kolla	Hula Jeneta	3,039	560	73	633	46	6	52
	Jiru Gemechu	2,826	528	61	589	43	5	48
Total		14,982	2,774	347	3,121	226	29	255

4.4. Data Sources and Types

In order to achieve the study's objectives and properly address the research questions, data were collected from both primary and secondary sources. The primary data was collected through the household survey questionnaire, focus group discussion and key informant interviews. The secondary sources of information were obtained from published and unpublished works, journals, books, and articles that are related to factors that determine the sustainability of rural household food security. These pieces of literature were collected from national, regional, zonal and *woreda* offices and are even available on worldwide websites. These sources of information were used to supplement data obtained through primary data sources and helped to understand the geographical setting and socio-economic conditions and population characteristics of the study area. Accordingly, data on the population size and structures, crop production and livestock rearing, topography, land use pattern, drainage systems of the study area, about food security and PSNP beneficiaries of the farm households were collected from the Kurfa Chele *woreda* and eastern Hararghe zone offices. Moreover, secondary data on the climatic condition of the study area (rainfall and temperature data), were also collected from National Meteorology Agency (NMA) Eastern Hararghe Agricultural and Rural Development Offices.

4.5. Instrument of Data Collection

Questionnaire (Appendix III): A pre-tested household survey questionnaire that was organized and developed from literature and different related research already conducted on the topics related to the present study was employed to generate data to achieve the intended objective of this research. This is mainly to become aware of which questions are more applicable in the context of the study sites and facilitates ensuring the predetermined questions were well understood by the farmers although there were some differences among the participants in their level of understanding some concepts. Accordingly, the actual data collection was started after some modifications were made based on the results obtained. The household survey questionnaire was employed to generate quantitative data on variables related to the demographic, institutional, economic, and social characteristics of the sample respondents, resource endowment, agricultural input utilisation, crop production, household food consumption pattern and their coping and adaptive strategies for the food insecurity problem. In view of this, the household survey questionnaire covers and responds to all specific objectives of the study. For this purpose, the questionnaire was designed comprised of both close-ended and open response questions. Then, the questionnaires that had been prepared were translated into the local language 'Afan Oromo' for the convenience of data collection and its use as the medium of communication with the research participants. Hence, four development agents, one in each of the sample *kebeles* were recruited and trained to collect the data from the selected sample respondents under the supervision of the research investigator. Then the recruited data collectors administered the questionnaire to the selected household heads through face-to-face interviews.

Key informant interview and focus group discussion (Appendix IV): Besides the household survey questionnaire, key informant interviews and focus group discussions were also carried out to supplement, triangulate and validate data obtained through the household survey questionnaire and to gain maximum knowledge or information on the communities' access to resources, social services and agricultural input, land resource change, climatic variability (drought) and its influence on crop production and food availability, nutritious food consumption, household food security status and its sustainability, adaptive and coping strategies used by the households to minimize the problem of food insecurity. Hence, focus group discussions and key informant interviews had been used to enrich the quantitative data gathered via household survey questionnaires, which could have a general idea of all specific objectives of the study. The key informant participants were drawn from experienced local community elders, development agents, local government officials and *kebele* administrators.

Likewise, four focus group discussions consisting of six members one in each sample *kebeles* (involving participants from rural farm household heads in various age group and from both sexes) were also conducted to gain additional information about the problem of food insecurity and its sustainability in the study area. Concerning the selection of focus group discussions and key informant interviews, the non-probability sampling method was used whereby the purposive sampling method had been used. The checklists were prepared both for key informant interviews and for focus group discussions in English and translated to Afan Oromo to conduct the interviews and group discussions with participants. These checklists were used to guide the discussions and allow the participants to state their experiences. Both the key informants and group discussion participants were informed to openly and freely describe their ideas, views, and suggestions towards issues related to the sustainability of food security in their study area. Finally, key informant interviews and focus group discussions were undertaken by the research investigator with the coordination and facilitation of the data collectors recruited for the survey part.

4.6. Methods of Data Analysis and Data presentation

4.6.1. Statistical Methods of Data Analysis and Presentation of Data

The data collected from various sources using various instruments were classified, organized, and interpreted using a combination of both quantitative and qualitative analysis in line with the objective of the research though it was more of quantitative methods. Hence, the information generated from key informant interviews and focus group discussions were analysed qualitatively to gain deeper insights and substantiate data obtained through a household survey on the sustainability of rural farm households' food security status. Generally, qualitative data were analysed textually with help of narrations and descriptions in words to validate the statistical results from quantitative data. Whereas, data gathered from household survey questionnaires were coded, tabulated t and entered into a computer specifically using SPSS stands for Statistical Product and Service Solutions (George and Mallery, 2019) version 24 and analysed quantitatively by applying both descriptive statistics (frequency distribution, percentage, mean, and standard deviation, standard error, mean difference) and inferential statistics (chi-square test, ANOVA, independent sample t-test, multivariate logistic regression model. Moreover, Microsoft excel sheet 2016 was also employed to present the data using figures and diagrams.

Descriptive statistics: Descriptive statistics were used to summarize, and describe the information and data obtained from the sample respondents and used to visualize the patterns and variations in the distribution of the variables under study (Hanneman *et al*., 2013). Moreover, the summarized and organized information and data obtained from the study participants were presented by using different types of graphs and diagrams, which helps to display the patterns and trends with the data among the analysed variables. In addition, tables were also used to present results by showing the exact values and reporting numerous statistical models in a summary way (Clifford *et al*., 2010; Hanneman *et al*., 2013).

Inferential statistics: The Pearson chi-squared test was used to determine whether the dependent and explanatory variables had a statistically significant relationship. Moreover, an independent sample t-test and One-way ANOVA was computed to compare whether there is a statistically significant mean difference among the study variables such as the mean age of the respondents, household size (AE), dependency ratio, per capita kcal available, the number of livestock (TLU), per capita income (Birr) and farmland size between the food secure and food insecure rural households.

Furthermore, multivariate logistic regression was used because the independent variables assumed to influence the food security status of rural farm households were numerous. As a result, logistic regression estimates probabilities using a logistic function, which is the cumulative logistic distribution, to assess the relationship between the dichotomous dependent variable and the multiple independent variables. The logistic regression procedure is a useful tool for predicting the value of a categorical response variable with two possible outcomes. It was also computed to identify and screen out the most significant variables that best correlate with the dependent variable. Additionally, the odds in the logistic regression were also determined from probabilities and its value ranges between zero and infinity. Odds are the probability of a household being food secure versus food insecure, and odds ratios in logistic regression are the effect of one unit of change in each explanatory variable on the predicted dependent variable with all other variables in the model held constant.

Testing the Goodness-of-fit of the Model

Goodness-of-fit statistics helps to determine whether the model adequately describes the data. The binary logistic regression produce reports of the Hosmer-lemeshew goodness-of-fit statistic of the model. The Hosmer-lemeshow chi-square test of goodness-of-fit statistics indicate the model adequately fits the data, if the the significance value is greater than 0.05 and the chi-square value is small. Moreover, the Hosmer-Lemeshow's goodness of fit test statistics indicates the predicted frequency and observed frequency should match closly, the more closely they match, the best fit it yields. Additionally, -2 log likelihood ratio was also computed to describe wether the models best fits the data or not.

Checking for Multicollinearity

Multicollinearity is the inter-correlation of the independent variables. Before running the logistic regression analysis, all the expected predictor variables entered in the model were checked for the existence of multicollinearity problems to identify variables included in the final regression analysis. Accordingly, Variance Inflation Factor (VIF) was computed to detect the multicollinearity problem for continuous variables and the contingency coefficient were used to detect a high degree of association for qualitative (dummy) explanatory variables. The variance inflation factor has computed using the formula:

$$VIF(X_i) = \frac{1}{1- {R_i}^2}$$

Where, R^2 is the coefficient of determination which indicates the extent to which a predictor can explain the change in the response variable. Variables with a variance inflation factor (VIF) of greater than 5 indicate the presence of a multicollinearity problem and should be scrutinized before being included in a regression analysis (George and Mallery, 2019; Cheteni *et al*., 2020). However, it is acceptable for the VIF to lie between 1-10 (Cheteni *et al*., 2020). In addition to VIF, contingency coefficients (C) were computed for each pair of qualitative (categorical) variables and computed as follows:

$$C = \sqrt{\frac{x^2}{n+ x^2}}$$

Where, C is the contingency coefficient, x^2 is a chi-square random variable and n = is the total sample size. The value of the contingency coefficient ranges between 0 and 1, and an absolute correlation coefficient value of greater than 0.70 among two or more predictor variables where indicates a strong association of the variables and the presence of a multicollinearity problem.

4.6.2. Analytical Model Specification and Econometric Analysis

The concept of food security is extremely broad and multidimensional (Berry *et al*., 2015; Faridi and Sulphey, 2019; Adjimoti and Kwadzo, 2018) which encompasses the analysis of economic, socio-demographic, environmental and institutional issues ranging from global to national, regional, household and individual levels. A good indicator should then consider all aspects and generate a multidimensional index that encompasses the most significant factors from each dimension of food security (Adjimoti and Kwadzo, 2018). However, despite the variety of food security indicators that exist in the literature, there is no single method of all-encompassing indicator of food security that incorporates more than one dimension and most of the research done to date were based on one or a single indicator of food security analysis. The most commonly identified food security indicators are the FAO method (using Food Balance Sheets and calories available per capita), Household Income and Expenditure Survey (HIES), Household Food Insecurity Access Scale (HFIAS), Household Food Consumption score (HFC)**,** Household Dietary Diversity Score (HDD), Months of Adequate Household Food Provisioning (MAHFP), Copying Strategy Index (CSI) and experience-based food insecurity measurement scales (Berlie, 2015; Carletto *et al*., 2013; Cordero-Ahiman *et al.,* 2018; Devereur and Tavener-smith, 2019; De Cock *et al.,* 2013; FAO *et al*., 2017; Maxwell *et al*., 2014; Moltedo *et al*., 2014; Ogundari, 2017). All these food insecurity measurement techniques have their own advantages and limitations which are used by different countries based on the availability of data and their applicability to a particular area.

In this research, attempts were made to harmonize three measures of food insecurity indicators such as the FAO Food Balance sheet model (HFBM), months of adequate household food provisioning (MAHFP) and household dietary diversity score (HDDS) to analyse and estimate the food security status quo of the surveyed households and to capture the various food security dimensions in the study area. Additionally, the Foster-Greer-Thorbecke model (FGT) was used to estimate the incidence, depth and severity of rural household food insecurity.

3.6.2.1. Household Food Balance Model (HFBM)

Among the economic, financial, population, political, agricultural, and environmental factors affecting food security, the world population consuming food and annual agricultural production determines food supplies and demand and results in a food security problem or no problems (Kogan, 2019). Hence, annual agricultural production from agriculture (food supply) and annual food consumption (food demand) can be considered as the principal contributors to food security assessments. Agricultural production is multidimensional, which includes crops, vegetables, fruits, and animals. From all these variables, grain is the principal product used by the entire world for both food and feed. Therefore, the amount of grain produced annually by the farm household can be considered as an indicator of household food supply and used to assess the food security status of the surveyed sample respondents. Furthermore, since vegetables, fruits and animal products are rarely consumed by farming households in the study area, the analysis of food security was mostly based on the measurement of grain food availability (measured as average dietary energy supply adequacy) at the household level which is expressed as dietary energy supply (Devereux, 2018; Faridi and Sulphey, 2019).

Dietary energy supply is defined as the food that is available for human consumption, expressed in kilocalories per person per day (Devereux, 2018; FAO *et al*., 2017). Hence, a modified form of the equation named as Household Food Balance Model (expressed as dietary energy supply) from the FAO Regional Food Balance Model (Devereux, 2018; FAO *et al*., 2017; Moltedo *et al*., 2014), which was used by Agidew and Singh (2018), Bazezew (2012), Ferede and Wolde-Tsadik (2018), Shimeles *et al*. (2011), and Tora *et al*. (2021) was used to quantify food availability at the household level and to assess the food security situations of the rural sample households in the study area. Food security (daily per capita food availability for each household), a dependent variable in this study were measured in four steps. Firstly, food grain availability at the household level from own production and net transactions was calculated by compiling a Food Balance model which can be expressed in the form of an equation as:

$$HHFA = (P + B + O) - (L + R + S + G) \quad \text{------} (1)$$

Where HHFA = Household Food Available/year/household

P = Total own production/year/household (+)

B = Total food bought/year/household (+)

O = Total grain obtained through another means /year/household (+)

L = Post-harvest losses/year (-)

R = Amount of grain reserved for seed/year/household (-)

S = Amount of grain sold/year/household (-)

G = Amount of grain given to others within a year (-)

All the data needed for the model, except for post-harvest losses were obtained through a household survey. Post-harvest crop loss was estimated at 5% of the total harvest for each crop. The data for the other variables were based on the inventory for the 12 months between November 2016 and 2017. The sum of all grains computed here will give the net total food grains available for consumption of each household in the year under study.

Secondly, the net food available in kilograms at the household level calculated in step one was used to calculate the calories available per person per day for each household. In order to convert the food grain available in kilograms into equivalent calories, conversion factors were utilised for all crops and each type of crop is converted into kilocalories using Platt (1985) and USAID (2016) table of the number of kilocalories available for 1000gm (1kg) of the grain of each crop (Appendix V). The resulting figure depicts the total amount of food energy available to the household over the reference period. Then, the per capita kilocalorie available for the household per adult equivalent[12] per day was calculated by dividing this figure by the number of adult equivalents in each household and the number of days in a year (365).

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[12] In this study, the coefficient of an adult equivalent is estimated to be 0.65 (it is estimated that children's consumption needs (under 14 years) are 65 percent of adult consumption needs). The following formula is used for estimating the number of adult equivalent household members in the household levels Mushegh (2007):

$$AE = N + 0.65C$$

Where, AE = is the number of adult equivalent members

N = is the number of household members above 14 years

C = is the number of household members below 14 years

Mathematically, it is written as:

$$y_i = \frac{\sum_{i=1}^{n} NFA_{ij} x E_j}{AE_i} / 365 \text{ ---(2)}$$

Where, y_i is total grain food energy (kilocalorie) available for household i per adult equivalent per day; n is the number of sample households; NFA is net grain food available in kg at the household level for food item j; E is the number of kilocalories (energy content) for food item j and AE_i is adult equivalent for each household.

Thirdly, the medically recommended levels of kilocalories per adult equivalent were used to determine calorie demand for each household. That is, 2100 kilocalories per person per day was used as a measure of calories required to enable an adult to live a healthy and moderately active life (Agidew and Singh, 2018; Aragie and Genanu, 2017; Awoke *et al*., 2022; Ferede and Wolde-Tsadik, 2018; Melese and Alemu, 2021; Melese *et al*., 2021; Million and Muche, 2020; Sani and Kemaw, 2019; Tora *et al*., 2021; Weldearegay and Tedla, 2018; Wondimagegnhu and Bogale, 2020). Then, a comparison between the available (supply) and required (demand) grain food was made. Finally, a household's food security status was determined by the difference between calorie availability and calorie demand. Households with a per capita available calorie greater than their per capita calorie demand were considered food secure and given a value of 1, while those with a calorie deficit were considered food insecure and given a value of 0. As a result, the dependent variable, the i^{th} household's food security status, was measured as a binary variable:

$$y_i = \begin{cases} 1, \text{if the } i^{th} \text{ household is food secure} \\ 0, \text{otherwise} \end{cases} .$$

Where, y_i is daily per capita calorie available (supply) and i = 1, 2, 3, ..., 255

The calculated food energy available for each household per adult equivalent estimated in equation (2) is in turn used to compute the food security ratio. The food security ratio (FSR) is measured as the total available food energy divided by the total energy requirements by the households and the value of FSR greater than one (FSR>1) means the household meets its food energy requirements and has access to surplus energy (Silvestri *et al.*, 2015). Mathematically, it is expressed as:

$$FSR_i = y_i/ER \text{ --(3)}$$

Where FSR_i is the food security ratio for household i and *ER* is energy requirement (the minimum recommended kcal i.e. 2100).

Due to the dichotomous nature of the dependent variable (food secure or insecure households), a binary logistic regression was used, with estimated probabilities ranging from logical limit 0 to 1. Hence, the logistic regression function for household food security status is explained by the following model:

$$P(x) = E\left(y = {}^{1}\!/_{x}\right) = \frac{e^y}{e^y+1} = \frac{1}{1+e^{-y}} \text{ --- (4)}$$

where P(x) is a probability that households being food secure ranging from 0 to 1, *y* is the observed food security status of the household, *x* is the factor determining the food security status of the household and *e* is the base of natural logarithm which approximately equal to 2.71828. Assuming that, y is a linear function of explanatory variable x, mathematically it is expressed as:

$$y = \beta_0 + \beta_i X_i \text{ -- (5)}$$

Since the independent variable in this research study is large in number, then y*i* is a linear combination function of multiple explanatory variables X_i which is written as:

$$y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_n X_n \text{ -- (6)}$$

where β_0 is an intercept from the regression equation (the value of the dependent variable when the predictor is equal to zero), β_i is the slope of the equation in the model/logit parameters or regression coefficient (the relative effect of a particular explanatory variable on food security) and X_i is explanatory variables. Hence, the logistic regression function in equation (4) can now be written as:

$P(x) = {}^{1}/_{1 + e^{-(\beta 0 + \beta ixi)}}$ --- (7)

In other words, the probability that households being food insecure 1-P(x) can be expressed as:

$1 - P(x) = 1 - {}^{1}/_{1 + e^{-yi}} = {}^{e^{-yi}}/_{1 + e^{-yi}}$ --- (8)

Then, the expression $\frac{\mathrm{P(x)}}{1-\mathrm{P(x)}}$ represents the odds ratio in favour of food security which is written as:

$\frac{\mathrm{P(x)}}{1-\mathrm{P(x)}} = {}^{1}/_{1 + e^{-yi}} / {}^{e^{-yi}}/_{1 + e^{-yi}} = {}^{1}/_{1 + e^{-yi}}\ x\ {}^{1 + e^{-yi}}/_{e^{-yi}} = {}^{1}/_{e^{-yi}}$ -------- (9)

Hence, the odds ratio is the ratio of the probability that a household being food secure (Px) to the probability that being food insecure (1-Px). Lastly, taking the natural logarithm of equation (9) gives

$Li = ln\left(\frac{Px}{1-Px}\right) = y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n = \beta_0 + \sum_{i=1}^{n} \beta_i x_i + \mathcal{E}_i$ ----------(10)

Where, *Li* is the logit model (log of the odds ratio) which is linear in x_i and the parameters; *ln* is the natural logarithm, n is the number of sample households and $\mathcal{E}_i$ is the disturbance (error) term introduced by the standard logistic distribution.

3.6.2.2. Months of Adequate Household Food Provisioning (MAHFP)

To supplement the household food balance model and household dietary diversity score, the months of adequate household food provisioning (MAHFP) index were also computed for the surveyed rural farm households. MAHFP was developed by Africare's food security programs in late 1990 as a tool for identifying vulnerable groups and used to measure for how months of the past year a household was unable to provide itself with enough food. The MAHFP measures household food accessibility throughout the past year, which also captures the sustainability dimension (De Cock *et al.*, 2013) and reflects the seasonality aspect of food security. This indicates the sustainability issues of food security are partly captured by months of adequate household food provisioning index. Hence, the sampled household respondents were asked how many months in the previous year they did not have enough food to meet their household's needs. A MAHFP score ranges from 0 to 12 and the logical categorization of low food access or most food insecure (food access of < 9 months); moderate food access or moderately food insecure (food access of 10-11 months) and high food access or least food insecure (12 months of food access) (Cordero-Ahiman *et al*., 2018; Leah *et al*., 2012) was used to assess farm households' level of food security status. This means that a lower score indicates that a household has less food access, while a higher score (12) indicates that a household has more sustained food access throughout the year.

3.6.2.3. Household Dietary Diversity Score (HDDS)

In addition to the months of adequate household food provisioning (MAHFP) index, the household dietary diversity score was also computed for the surveyed households in the study area to supplement the household food balance model in determining the food security status of the sampled rural farm households. Household dietary diversity is a measure of the diversity of food consumption (adequacy of the diet) and one of the indicators of household food security (Bazezew, 2012; FAO *et al*., 2020; Mango *et al*., 2014) and widely used proxy measure of household food access or individual food quality and food consumption patterns and provides a holistic picture of the food and nutritional diversity security in the community (Carletto *et al*., 2013; Mango *et al*., 2014). The HDDS measures the food access dimension of food security by reflecting the number of different food groups that households consume (Maxwell *et al*., 2014). It is measured by summing the number of food groups that households consume over a reference period (for 24 hours, 7 days and so on).

Different food groups for measuring HDDS were developed by FAO and WFP (FAO, FANTA, USAID) and in this study, HDDS is composed of 12 food groups. The score is calculated by counting the number of food groups consumed at the household level. Each food group is given a weight of one (Mango *et al*., 2014) and the potential score of HDD hence ranges from 0-12. In this study, the sample households were asked to recall the food item consumed pertaining to one of the 12 predefined food groups at least once in the last 24 hours. The response to the question is either yes (score = 1) or no (score = 0). The 12 food groups are FG_1, cereals; FG_2, pulses, legumes, and nuts; FG_3, vegetables; FG_4, Fruits; FG_5, meat; FG_6, eggs; FG_7, fish; FG_8, milk and milk products; FG_9, oils and fats; FG_{10}, sweets; FG_{11}, tubers and roots; FG_{12}, spices, condiments, and beverages. Hence, HDDS is calculated as follows:

$$HDDS = FG_1+FG_2+FG_3+FG_4+FG_5+FG_6+FG_7+FG_8+FG_9+FG_{10}+FG_{11}+FG_{12} \text{-----------------} (15)$$

With FG_1 to FG_{12} being 0 or 1 depending on whether the households consumed the food group or not in the last 24 hours.

Table 3.3: An overview of different food groups used for the computation of HDDS adopted from (WFP, FAO and FANATA)

No	Food staff or Food Group	Example
1	Cereals	Grain such as teff, maize, barley, sorghum, &Starchy food (injera, porridge, bread, pasta, rice, macaroni)
2	Pulses, legumes and nuts	Includes any food made from beans, peas, lentils, nuts, chickpea, faba bean, horse bean, field bean, lentil, pea, peanut (groundnut), soybean
3	Vegetables	Includes carrot, sweet potato, fenugreek greens, lettuce, cabbage, garlic, green pepper, onion, tomato
4	Fruits	Mango, avocados, banana, orange, lemon, mandarin
5	Meat	Beef, goat, sheep, chicken
6	Eggs	Chicken eggs
7	Fish	Fresh or dried fish
8	Milk and milk products	Includes food items made from dairy except for butter due to its high-fat content (cheese, yoghurt, whole milk, skimmed milk)
9	Oils and Fats	Butter, ghee, mayonnaise, vegetable/nut oils
10	Sweets	Food items with a high content of different sweetening agents (Sugar, honey, candies)
11	Tubers and roots	white potatoes, cassava, yams, or other foods made from roots
12	Spices, condiments, and beverages	Incudes items commonly used in small quantities and mainly used to enhance the flavour of the dish. (Spices, tea, coffee, salt, Beer, wine, hard spirits, ketchup, chillies)

3.6.2.4. Foster-Greer-Thorbecke Model (FGT)

After calculating household food availability and kilocalorie intake for each household, the Foster-Greer-Thorbecke index (FGT) was used (employed) to estimate the incidence, depth, and severity of household food insecurity (Shimeles *et al*., 2011; Muche *et al*., 2014 and Tafesse *et al*., 2015). The formula is written as follows:

$$\mathrm{FGT}_{\alpha} = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{m-yi}{m}\right]^{\alpha} \text{--}(11)$$

Where: FGT is the index; q is the number of food-insecure households (those with kcal of below *m*); *m* is the minimum kcal requirements per day per adult equivalent (2100 kcal/day/AE); y_i is food calorie intake of per adult equivalent of each household; α is the weight attached to the severity of food insecurity and *n* is the total number of sample households. Thus, in the model, a household is food secure when $y_i > m$.

Three commonly used indices were computed within FGT index: headcount ratio, food insecurity gap index, and squared food insecurity gap (Hoddinott cited in Muche *et al*., 2014; Tafesse *et al*., 2015). The headcount ratio is the incidence of food security which shows the number of sampled households with caloric intake falls below the minimum requirements (the predetermined 2100 kcal level). Hence, the food count ratio measures the proportion of the households that live below the minimum calorie requirements. Concerning the weight of α, giving no weight to the severity of food insecurity is equivalent to assuming α = 0 and hence, the formula of the FGT index is reduced to the headcount ratio and mathematically written as:

$$\mathrm{FGT}_{0} = \frac{\mathrm{q}}{\mathrm{n}} \text{--}(12)$$

The food insecurity gap index, on the other hand, referred to the depth of food insecurity and is used to determine how far food insecure households fall below the minimum calorie requirements on average. Giving equal weight to the severity of food insecurity among food-insecure households is equivalent to assuming that α = 1 and in this case, the formula of the food insecurity gap index is written as:

$$\mathrm{FGT}_{1} = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{m-yi}{m}\right] \text{--}(13)$$

Lastly, the squared food insecurity gap index is the most common and widely used measure of FGT specific index which is a measure closely related to the severity of the food insecurity gap but gives those farther away from the minimum level a higher weight in aggregation than those closer to the subsistence level. Mathematically, the squared food insecurity gap index ($\alpha = 2$) is measured as:

$$FGT_2 = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{m-yi}{m}\right]^2 \text{---} (14)$$

4.7. Variables of the Study, Measurement and Hypothesis

In this study, the dependent variable (Y) is household food security status, which is expressed as daily per capita food availability expressed as dietary energy supply for each household estimated using the Household Food Balance Model which is expressed as:

$Y = X_1 + X_2 + X_3 + X_3 + X_4 + X_5 + \ldots\ldots\ldots + X_n$ (see Table 3.2).

In addition to dietary energy supply measure from grain food availability using Household Food Balance Model (HFBM), Months of Adequate Household Food Provisioning (MAHFP) and Household's Dietary Diversity Score (HDDS) were also considered as dependent variables used to measure household food security status to supplement HFBM. Based on the literature reviewed from different sources, some of the most common potential predictors that could affect the sustainability of food security in rural households have been selected and categorized into demographic, socio-economic, institutional, and environmental variables. Therefore, the independent variables that are hypothesized to affect the sustainability of household food security in the study area include demographic variables, educational level of the household head, farming systems, asset ownership, the use of improved agricultural inputs, the use of fertilizer, infrastructural endowment level, access to financial credit and agricultural extension service, access to road and market centre or town, access to health service and access to information and so on (Table 3.2).

Table 3.2: Variables assumed to influence sustainability of rural household food security

Variables	Description and measurement
Age of household head	Number of years of age
Gender of household head	0 = Female and 1 = Male
Household size	Number of household members
Educational level of household head	0 = Illiterate and 1 = Literate
Dependency ratio	Number (continuous)
Size of cultivated land	Land area measured in hectares
Total number of livestock ownership	TLU in number (continuous)
Use of chemical fertilizer	0 = non-user and 1 = user
Use of manure	0 = non-user and 1 = user
Use of improved seed	0 = non-user and 1 = user
Use of herbicide	0 = non-user and 1 = user
Access to agricultural extension service	0 = no and 1 = Yes
Access to financial credit	0 = no and 1 = Yes
Access to the nearest market	Walking hours from the nearest mkt
Access to road infrastructure	Walking hours from the nearest road
Access to information (radio, mobile phone)	0 = No and 1 = Yes
Soil and water conservation practice	0 = No and 1 = Yes
Per capita income	Birr[13] (continuous)
Per capita off-farm income	Birr (continuous)
Access to Irrigation	0 = No and 1 = Yes
Drought (Unreliable rainfall)	0 = No and 1 = Yes
Production Diversity	Number of crops produced
Dietary diversity	Number of food groups
PSNP beneficiary	0 = No and 1 = Yes

Age of household head: Age is a continuous explanatory variable measured in years. The elderly has a comparatively richer experience of the social and physical environment, and they are expected to have greater experience in farming activities, a stable economy in farming and better access to land than the younger household heads (Alpízar *et al*., 2020; Awoke *et al*., 2022;

[13] Birr is the basic unit of money in Ethiopian (Ethiopian currency) used as means of exchange

Fikire and Zegeye, 2022; Silvestri *et al*., 2015; Wiranthi *et al*., 2014). Hence, it is hypothesized that the age of the rural farm household heads is positively correlated with the sustainability of household food security.

Gender of household head: The gender of the household respondents is a dummy variable, which is anticipated to influence the food security status. According to the reviewed literature, compared to male-headed households, female-headed households are at higher risk of food insecurity due to their limited access to livelihood assets and agricultural technologies and lack of labour force (Beyene and Muche, 2010; Zakari *et al*., 2014; Tibesigwa and Visser, 2015). Thus, in this study, it is hypothesized that the sex of the household heads is expected to be positively correlated with household food security status and male-headed households are more likely to be food secure than their counterparts.

Household size: Household size is also a continuous explanatory variable that refers to the total number of persons living in the household and is expected to have negatively correlated with the sustainability of household food security. For most of farm households with limited access to land and limited finance to purchase agricultural inputs, an increase in the size of households tends to exert greater pressure on consumption than on the workforce it contributes to production (Eshetu and Guye, 2021, Ferede and Wolde-Tsadik, 2018, Million and Muche, 2020). Hence, in this study, it is hypothesized that the number of household size is expected to be negatively associated with the food security status of the household as food requirements increase with the number of persons in a household.

Educational status of the household head: Education is a dummy variable that assumes the value of one if a household head is literate and zeroes if a household head is illiterate. Education is critical to improving household livelihoods and food security. Hence, educated household heads are expected to have a better chance of managing their farmland by adopting soil and water conservation measures, their capacity to innovate and adopt new skills and adopt timely technology which in turn increases the total crop production (Adjimoti and Kwadzo, 2018; Ahmed, 2016; Alemaw and Hailu, 2019; Alpízar *et al*., 2020, Fikire and Zegeye, 2022; Ferede and Wolde-Tsadik, 2018; Henri-Ukoha *et al*., 2013; Mulugeta *et al*., 2018; Wiranthi *et al*., 2014). Furthermore, household literacy is expected to have an impact on livestock and crop production, application of agricultural inputs and food security. Thus, it is hypothesized that there is a positive relationship between the household head's educational level and their food security status.

Dependency ratio: It is also a continuous explanatory variable measured as the total number of economically dependent individuals in the rural farm household (whose age is less than 15 and greater than 64 years) divided by the number of individuals in the working-age group of the household (whose age is between 15 and 64). According to the reviewed literature, an increase in the number of non-working members of the household, which implies an increase in the dependency ratio put more pressure on consumption than production and decreases the food security level of the households (Beyene and Muche, 2010; Gemechu *et al*., 2016; Muche *et al*., 2014; Shimeles *et al*., 2011). Hence, it is expected that the dependency ratio and sustainability of rural farm household food security status are correlated negatively.

Land size: Farmland size is a continuous explanatory variable, which refers to the total available land owned by the household and measured in hectares. Studies conducted by different researchers indicated that farm size was statistically significant and positively correlated with the level of household food security status (Bimerew and Beyene, 2014; Dagne, 2016; Ferede and Wolde-Tsadik, 2018; Henri-Ukoha *et al*., 2013; Moroda *et al*., 2018). Thus, in this research, it is hypothesized that households with larger farmland sizes are more likely to be food secure than households with smaller farmland sizes and the sustainability of household food security is positively correlated with the size of farmland.

Number of livestock owned: It is a continuous explanatory variable measured by the number of Tropical Livestock Units **(**TLU). As per the reviewed literature, livestock ownership is one of the prominent strategic household’s assets because it is the main source of wealth and cash income for rural households, means of transportation, source of meat and milk products and supply manure to improve soil fertility (Adjimoti and Kwadzo, 2018; Asmelash, 2014; Frelat *et al*., 2016; Maziya *et al*., 2017; Silvestri *et al*., 2015). Hence, household respondents with relatively large number of livestock sizes are expected to be less vulnerable to food insecurity and it is hypothesized that livestock ownership is significantly and positively correlated with the sustainability of household food security.

Use of fertilizer: The use of chemical fertilizers is a dummy variable that assumes the value of one if the farm household uses it and zero if the household is not using fertilizer. The literature reviewed from various sources indicated that other things being constant, the household food security status is highly determined by the level of households' capability to use agricultural inputs like fertilizer and the use of chemical fertilizer increases the productivity of crops per unit of farm area which would enhance the total crop production per farm household and hence, improve the availability of food for farmers (Abafita and Kim, 2014; Dagne, 2016; Goshu *et al*., 2013). Thus, in this research, it is hypothesized that the use of chemical fertilizer is positively and significantly correlated with the sustainability of household food security.

Use of manure/compost: The use of manure is also a dummy variable that assumes the value of one if the farm household uses it and zero otherwise. For most smallholder farming systems where there is little access to chemical fertilizer, manure is the main source of fertilizer. Hence, like that of chemical fertilizers, it is hypothesized that the use of manure is expected to have a significant positive relationship with household food security status.

Improved seed use: It is a dummy variable and like fertilizer, the application of improved seed is also an important agricultural input assumed to enhance crop production and boost agricultural productivity and thereby increasing the probability of household food security status (Dagne, 2016). Therefore, the use of improved seeds is hypothesized to have a positive effect on the sustainability of household food security.

Herbicides: also play a significant role in farming by killing weeds that compete with crops for water and nutrient sources in the soil and farmers use this input to reduce weeds in their crops to boost the productivity of agriculture. Hence, the use of herbicides is also expected to have a significant and positive relationship with the food security status of rural households.

Access to agricultural extension service: It is a dichotomous independent variable that assumes the value of one if the farm household has access to agricultural extension services and zero otherwise. Agricultural extension service is essentially an educational process whereby farmers are taught (given training) about the use of improved seeds, application of chemical fertilizers, soil and water conservation management practices, adoption of improved practices of crop production and livestock rearing to increase agricultural productivity, improve rural livelihoods and increase food security and thereby raise the living standards of the rural people. It is one of the strategies for transforming traditional agricultural practices into more progressive and modern one by changing farmers' attitudes, knowledge, and skills to enhance the farmers' capacity to produce more yields and impacts their living standards (Kipkurgat and Tuigong, 2015). Hence, farmers' access to agricultural extension services will enhance their access to better crop production techniques and are expected to have a significant positive correlation with the sustainability of household food security.

Credit service: It is a dummy variable that assumes the value of one if the farm household has access to credit service and zero if not. The availability of institutional credit services which contributes to sustainable rural development is also one of the vital elements for the sustainability of rural farm household's food security; because it enables households to diversify their livelihood and helps to purchase modern agricultural inputs such as fertilizer, improved seeds, herbicides, and pesticides that improves the productivity of farm households (Pieters *et al*., 2013; Tafesse *et al*., 2015). Thus, the availability and the use of credit services are hypothesized to be positively and directly correlated with the sustainability of farm household food security status.

Distance from the market centre is also a continuous explanatory variable measured by the number of hours travelled. Households that are found closer and access to the market centre have a better opportunity for livelihood diversification, selling of farm products, access to additional sources of income via off-farm activity, and purchase of other food items (Moroda *et al*., 2018; Pieters *et al*., 2013). Thus, proximity to the market centre is assumed to increase the probability of sustaining livelihood and positively correlated with the sustainability of household food security.

Distance from the road: It is a continuous explanatory variable measured by the number of hours travelled Households that are found closer to the main road have better access to information and farm inputs such as fertilizers, seeds, herbicides, pesticides, and so on. Farm households, on the other hand, may be unable to access these inputs on time if the distance to the source is great and the infrastructure is inadequate. As a result, it is expected that distance from the input source will have a negative impact on household food security.

Access to information: Farmers' accessibility to up-to-date information about the market price of the product can help the farmers decide on when to sell their products and it empowers the farmers to bargain for better prices. The dissemination and efficient transmission of information about new modern agricultural technologies, market prices, climate change and weather conditions increase the confidence of the farmers and supports rural livelihood diversification and plays a key role in enhancing the sustainability of food security. Hence, in this research study, it is hypothesized that farmers accessibility to different means of obtaining information (access to radio, mobile phones) are positively correlated with the sustainability of food security.

Soil and water conservation: it is a dummy variable that assumes the value of one if the farm household is practising soil and water conservation measures on their farmland and zero if not. In mountainous countries like Ethiopia, soil erosion and land degradation are the main constraints that hinder agricultural productivity and food production because of the unsustainable management of soils which in turn affects household food security (Beyene and Muche, 2010). Therefore, in this research, it is hypothesized that household practices of any kind of soil and water conservation measures are positively and directly associated with the sustainability of household food security.

Off-farm income: Off-farm income is a continuous explanatory variable that is measured in Birr, and it is one of the factors that influence household food security. Participation of farmers in various types of off-farm activities will ease capital constraints to buy foods and agricultural inputs leading to higher food production and better access to food (Abegaz, 2017; Awoke *et al*., 2022; Dagne, 2016; Mulugeta *et al*. (2018). Hence, access to off-farm income is positively and significantly correlated with the sustainability of household food security.

Drought (Unreliable rainfall): It is a dichotomous variable that assumes the value of one if the farm household perceived that food insecurity is caused by drought and zero otherwise. The reviewed literature indicates that drought (severe climate change) resulting in unreliable and erratic rainfall (spatial and temporal variability) is one of the major environmental crises that decreases agricultural production and causing severe food shortages (FAO *et al*., 2015; Moroda *et al*., 2018; Tafesse *et al*., 2015; WHO, 2016) which in turn influences the sustainability of food security. Hence, in this research, it is hypothesized that drought or unreliable rainfall is negatively and significantly correlated with the sustainability of household food security.

Access to irrigation is a dummy variable that assumes a value of one if the farmers are access to and utilise irrigation and zero otherwise. Access to irrigation water enables rural farm households to produce and harvest twice or three times per year, diversify the cropping systems, increase their income and consumption levels, improve nutrition outcomes, which influences the sustainability of rural household food insecurity (Ahmed, 2019; Dagne, 2016; Eshetu and Guye, 2021; Ferede and Wolde-Tsadik, 2018; Moroda *et al*., 2018). Thus, in this research, it is hypothesized that access to and utilisation of irrigation is positively and significantly associated with the sustainability of farm household food security.

4.8. Validity and Reliability of the Study

Validity refers to whether the designed questionnaire actually measured the concept that the researcher thinks to measure (Gomez and Jones III, 2010). To enhance the validity of this study the surveyed sample respondents were selected from the three different agro-climatic zones of the *woreda*, the literature was examined to identify variables to be included and pre-testing of the data collection instruments was done with 20 respondents who did not participate in the main study. Furthermore, the study applied a mixed research approach; qualitative (focus group discussion and interview) and quantitative (household survey) with the intent to obtain and triangulate information obtained from various sources, which will help to increase the validity of the outcomes and the conclusion of this research. Additionally, the sample respondents were also selected from the different agro-climatic zone, and this will also enhance the validity of the result.

The measure or measurement device's reliability refers to whether it measures the attribute the same way for each observation or the same way each time or place it is used (Gomez and Jones III, 2010). In another way, reliability is the degree of consistency with which a research instrument measures the attributes it is designed to measure. Hence, in this research, the reliability of the study was enhanced using a pilot test (pre-tested questions) and the actual data collection was started after the pre-test was conducted and modifications were made. Additionally, to ensure the reliability of the data collectors was trained, and the researcher instructs them to ask questions exactly as appeared in the questionnaire and to consistently record the response of all sample respondents.

4.9. Ethical Considerations

First, pertinent government administrative chains of command were contacted, and the concerned bodies were briefed about the purpose of the study and how this study is planned to be carried out. Secondly, the sample households were informed about the objectives and procedures of the study, the confidentiality of their response and the strict use of their responses only to the objective of this study. Thirdly, they were also informed that they have the full right not to participate in the study at all or not to respond to any of the questions. Thus, household heads participated voluntarily in the study and the questionnaires were administered to them based on their verbal consent. Ethical approval for the study was obtained from the College of Agriculture and Environmental Science, University of South Africa Ethical Committee Reference number 2016/CAES/021 (Appendix I). In accordance with institutional requirements, the final thesis was subjected to similarity software, and the similarity counts fall within acceptable norms (Appendix II).

CHAPTER FIVE

DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS OF THE SAMPLE HOUSEHOLD RESPONDENTS

5.1. Introduction

The purpose of this chapter is to provide background information about the characteristics of the surveyed sample household respondents for the succeeding chapters with respect to their overall livelihood strategies in general and access to productive resources. This is mainly since farmers' socio-demographic, access to different economic and agriculturally productive resources and availability of rural infrastructure could have significant implications and influence the food security status of rural farm households. Hence, this chapter mainly presents information on the demographic and socio-economic background characteristics of the sample household respondents in the study area. Specifically, the age and sex composition of the sample household heads, household size, marital and educational status were explored in detail under the sub-heading of socio-demographic characteristics of the sampled households. Furthermore, the sample household respondents' landholding size and its dynamics, land fragmentation and livestock possession were also discussed in detail under the farmers' access to economic and productive assets sub-heading. Finally, farmers' access to agricultural extension services, utilisation of modern agricultural inputs, access to market and availability of roads in the study area were also discussed.

5.2. Socio-demographic Characteristics of Sample Households Respondents

5.2.1. Age and Gender Composition of the Households

Table 5.1 shows the age and sex composition of sample households included in this study. As indicated in the Table, many household heads are in the age group of 39 to 45 years, which accounts for 42.7% of the sample households followed by the age group of 46 to 52 years accounting for 24.3%. Those who are in the age group of 32 to 38 years and 53 to 59 years old constitute 14.9% and 8.6% of the sample household heads respectively, while the number of respondents at the two extreme age groups was insignificant. The minimum and maximum age of the sampled household respondent is 25 years and 80 years, respectively with a mean age of

44.75 years and a standard deviation of 8.40 years. The average age of the sampled respondents in the study area was slightly higher than the average age for those reported by Aragie and Genanu (2017) (43.46 years), Aweke *et al*. (2020) (38 years), Fikire and Zegeye (2022) (43.14 years), Million and Muche (2020) (43 years), Sileshi *et al*. (2019) (40.19 years), Tantu *et al*. (2017) (43.03 years) and Welteji *et al*. (2017) (44.04), but found to be lower than the average age of 51.5 years reported by Menghistu *et al*. (2018), 45.24 years reported by Mitiku and Legesse (2014) and 46 years by Tora *et al*. (2021). The elderly has a comparatively richer experience of the social and physical environment, and they are expected to have greater experience in farming activities, a stable economy in farming and better access to land than the younger household heads (Alpízar *et al*., 2020; Awoke *et al*., 2022; Fikire and Zegeye, 2022; Silvestri *et al*., 2015) and hence, the age of the rural farm household heads could have impact on the sustainability of the household food security.

Table 5.1 Age and sex profile of the surveyed sample household heads

Variables	Category	Frequency	Percentage	Total	%
	25-31	9	3.5		
Age of HH heads	32-38	38	14.9		
	39-45	109	42.7		
	46-52	62	24.3	255	100
	53-59	22	8.6		
	60-66	7	2.7		
	67-73	6	2.4		
	74-80	2	.8		
Gender of HH heads	Male	226	88.6	255	100
	Female	29	11.4		

Source: Household survey data, 2018

The gender of the household heads is the other aspect of determining the demographic characteristics of the surveyed respondents. Accordingly, as depicted in Table 5.1, about 88.6% of the surveyed household heads are male and the rest 11.4% of them were female household heads. The result indicates the majority of the surveyed rural farm households in the study area was headed by a male and a few households were led by female due to the death of their husbands or other reasons. Compared with this study, the percentage of female household heads who participated in those studies conducted in other areas accounts for 20% (Agidew and Singh, 2018), 11.64% (Aragie and Genanu, 2017), 10.3% (Aweke *et al*., 2020), 9.92% (Fikire and Zegeye, 2022), 20% (Gemechu *et al*., 2016), 12.5% (Menghistu *et al*., 2018), 11.75% (Mengistu *et al*., 2021), 25% (Million and Muche, 2020), 10.87% (Sani and Kemaw, 2019), 13% (Sileshi *et al*., 2019), 19.9% (Tantu *et al*., 2017) and 25% (Workicho *et al*., 2016) indicating that the number households headed by the female are by far less in all parts of the country. Compared to male-headed households, female-headed households are at higher risk of food insecurity due to their limited access to livelihood assets and agricultural technologies and lack of labour force (Zakari *et al*., 2014; Tibesigwa and Visser, 2015) and thus, the gender of the household heads is expected to be positively correlated with household food security status.

5.2.2. Household Size and Marital Status of the Households

Table 5.2 shows the members of household size and the marital status of the surveyed household respondents in the study area. Accordingly, as indicated in Table 5.2, more than half of the sample households (54.1%) had between 7 and 9 household members and 34.5% of them had between four and six household members. This shows that 88.6% of the sample respondents in the study area had between four and nine household members. On the other hand, those households who had between one and three and 10 to 12 household members constituted 5.5% and 5.9% of the sample respondents, respectively. Moreover, about 60% of the surveyed respondents in the study area had between 7 and 12 household members. The average household size of the sample respondents is 6.75 with a standard deviation of 1.81. The finding revealed that there is a high population concentration and large household members in the study area, which could have an impact on the availability of food supply. Furthermore, for most of farm households with limited access to land and limited finance to purchase agricultural inputs, an increase in the size of households tends to exert greater pressure on consumption than on the workforce it contributes to production (Eshetu and Guye, 2021, Ferede and Wolde-Tsadik, 2018, Million and Muche, 2020).

Table 5.2: Household size and marital status of the sample households

Variables	Category	Frequency	Percentage	Total	%
HH size	1-3	14	5.5	255	100
	4-6	88	34.5		
	7-9	138	54.1		
	10-12	15	5.9		
Marital status	Single	-	-	255	100
	Married	225	88.2		
	Divorced	5	2.0		
	Widowed	25	9.8		

Source: Household survey data, 2018

In contrast to the results of this study, Aragie and Genanu (2017), Aweke *et al*. (2020), Ferede and Wolde-Tsadik (2018), Fikire and zegeye (2022), Gebrehiwot and van der Veen (2015) and Robaa and Tolossa (2016) reported on average a lower household size of 6.44, 5.01, 5.50, 5.30, 4.98, and 6.38, respectively. Furthermore, a study conducted by Workicho *et al*. (2016) reported over half (52.2) of the respondents had more than four household members. However, studies conducted by Gemechu *et al*. (2016), Mengistu *et al*. (2021), Mitiku and Legesse (2014), Robaa and Tolossa (2016) and Welteji *et al*. (2017), respectively reported an average family size of 6.88, 7.06, 7.13, and 7.17 persons, which is slightly higher than the finding of the study area. With respect to marital status, about 88.2% of the sample household heads are in a marital union during survey time and the remaining 2% and 9.8% have been divorced and widowed, respectively.

Table 5.3 shows the dependency ratio of the surveyed households which is expressed in terms of the agro-ecological zone. Dependency ratio is measured as the total number of household members in an economically inactive age group (older than 64 and younger than 15 years) divided by the total household members in the economically active age group (15-64). The higher the dependency ratio indicates, the more people each potential worker should have to support and the lower human capital development.

Table 5.3: Dependency ratio of the surveyed sample respondents by *kebeles*

Agro-ecological zone		Household members				
		<15	15-64	>64	Total	Dependency Ratio
Kolla	%	47.80	51.57	0.63	100	93.90
Woina-dega	%	50.00	49.32	0.68	100	102.76
Dega	%	44.44	53.79	1.77	100	85.92
Total	%	46.63	52.21	1.16	100	91.55
	F	803	899	20	1722	

Source: Household survey data, 2018

According to the survey result presented in Table 5.3, the *woina-dega* agro-ecological zone had the highest dependency ratio (50%) for the younger population and *dega* had the highest dependency ratio for the older population (1.77%). In addition, *woina-dega* agro-ecological zone had the highest total dependency ratio (102.76%) indicating that about 100 economically active populations should have to support approximately 103 economically dependent people for their survival. Moreover, on average, about 46.63% of the members of the sample households in the study area are under the age of 15 years, 52.21% are the economically active population (15-64 years) and the remaining 1.16% are above the age of 64 years old. Accordingly, the overall dependency ratio for the surveyed households in the study area is 91.55%. Hence, about 100 economically active people in the study area should have to support approximately 92 economically inactive household members for survival (see Table 5.3). The household survey results as depicted in Table 5.2 also revealed that there is a total of 1722 household members of the sample respondents of which 848 (49.25%) are males and 874 (50.75%) are females. In comparison to the result of this research, studies conducted by Gebrehiwot and van der Veen (2015), Gemechu *et al*. (2016), and Sileshi *et al*., (2019) reported a very high average dependency ratio of 1.28 (128%), 1.93 (193%) and 1.29 (129%), respectively. Moreover, a study conducted by (Aragie and Genanu, 2017) reported an average dependency ratio of 1.008 (100.8%).

5.2.3. Educational Status of the Households

Data on the educational status of sample respondents was collected by categorizing the household heads into literate and illiterate. The literate category includes those households who at least can read and write, who had a grade one to four, grade five to eight and grade 9-10.

Table 5.4: Educational status of the surveyed households in Kurfa Chele *woreda*

Variables	Category	Frequency	Percentage
Educational status	Illiterate	174	68.2
	Literate	81	31.8
	- Can read & write	34	13.3
	- Grade 1-4	30	11.8
	- Grade 5-8	13	5.1
	- Grade 9-10	4	1.6

Source: Household survey data, 2018

Concerning the educational status of the sampled household respondents, results presented in Table 5.4 revealed that the majority (68.2%) of the farm household heads are illiterate with only 31.8% of them being literate. Among the literate household heads, 13.3% can read and write[14] but had no formal schooling and and 1.6% of them had attended grade 9 to 10. Consistent with the results of this study, research findings conducted in other parts of Ethiopia by Agidew and Singh (2018), Asenso-Okyere *et al*. (2013), Aweke *et al*. (2020), Gemechu *et al*. (2016), Menghistu *et al*. (2018), Mengistu *et al*. (2021) and Workicho *et al*. (2016), respectively reported that 72.6%, 77%, 59.5%, 57.6%, 63.75%, 82.8% and 60.3% of the sampled respondents are illiterate who cannot read and write indicating a high level of illiteracy rate in the country. Additionally, a study conducted by Robaa and Tolossa (2016) also reported nearly half (49.2%) of the sample respondents are illiterate. Education is critical to improving household livelihoods and food security. Educated household heads are expected to have a better chance of managing their farmland by adopting soil and water conservation measures, their capacity to innovate and adopt new skills and adopt timely technology which in turn increases the total crop production (Adjimoti and Kwadzo, 2018; Alemaw and Hailu, 2019;

[14] Refers to those household who had no formal schooling but had adult literacy education

Alpízar *et al*., 2020, Fikire and Zegeye, 2022; Ferede and Wolde-Tsadik, 2018). In contrast, the finding of this study revealed that the majority of the farm household heads are illiterate which could have a negative impact on their food security status.

5.2.4. Access to Safe Drinking Water

The surveyed sample household respondents in the study area were asked to describe the main sources of their current drinking water and whether they have access to clean and safe drinking water supply for their home consumption. According to the survey result and key informant interviewees, the sources of drinking water supply in kurfa Chele *woreda* and the study area were greatly varied across *kebeles* and most of the *kebeles* in the *woreda* severely faced shortage of safe water supply and even they were travelling a long distance to fetch water for their domestic consumption. For instance, the focus group discussion participants of Orde Goba confirmed that they were travelling up to one and half hours (7.5km) in order to fetch water. Accordingly, Table 5.5 shows the percentage distribution of the surveyed households in terms of their access to safe drinking water supply in the study area.

Table 5.5: Farm households' access to clean and safe drinking water supply

	Do you have access to clean and safe drinking water?					
	Jiru Gemechu	Hula Jeneta	Orde Goba	Arele Tika	Total	
Response	%	%	%	%	F	%
Yes	95.8	-	29.8	96.3	164	64.3
No	4.2	100	70.2	3.7	91	35.7
Total	100	100	100	100	255	100

Source: Household survey data, 2018

As depicted in Table 5.5 about 64.3% of the surveyed sample households reported that they were getting access to clean and safe drinking water and the remaining 35.7% of them were not getting access to safe water for their home consumption. According to the survey result, most of the surveyed households who had access to clean and safe drinking water supply in the study area were located in Jiru Gemechu (95.8%) and Arele Tika (96.3%). An interview with the key informants (interviewees) and focus group discussion participants in both *kebeles* showed that their *kebeles* had got better access to safe water because Water, Sanitation and Hygiene

(WASH) constructed in their *kebeles* by CARE and PSNP sponsored by the USAID and provide them communal tap though it is few and somewhat far apart from each other. Contrary to this, all the surveyed households in Hula Jeneta and about 70.2% of the sample respondents in Orde Goba *kebele* reported that they are not getting access to clean water supply, and hence, they were using unsafe water for their home consumption. Furthermore, of those sample respondents who were not getting access to clean and safe drinking water for their home consumption about 64.84% of the surveyed household reported that they were treating their water using water guards like aqua tabs and Wuha Agar (Bishan Gari) which was donated by non-governmental organizations and distributed through the *woreda* water resource and management office.

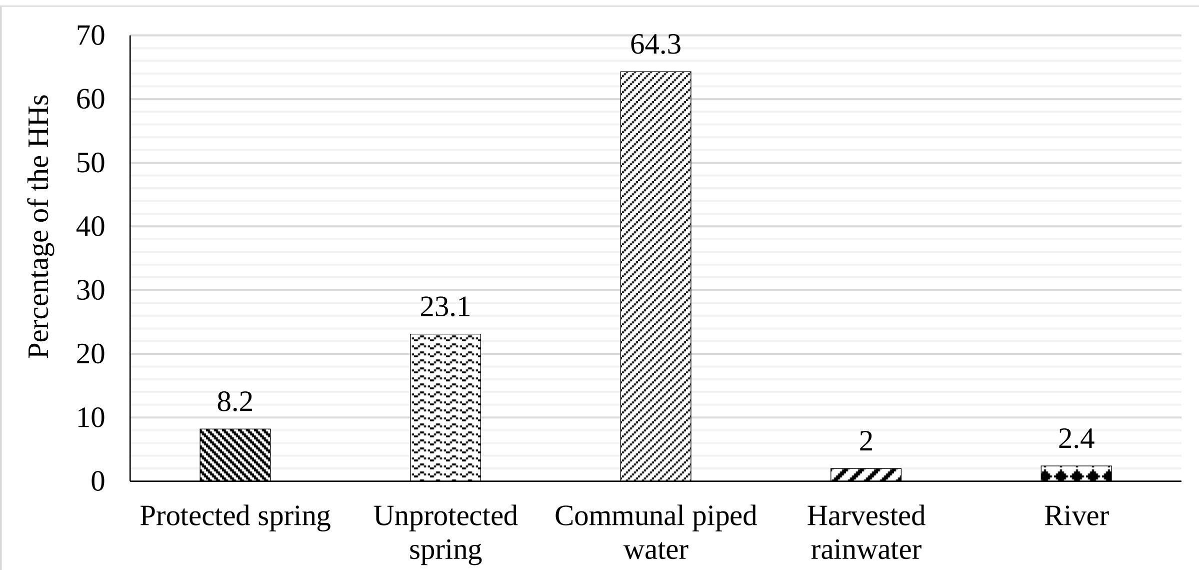

Figure 5.1: The main sources of the sample respondents' current home water consumption
Source: Household survey data, 2018

Figure 5.1 shows the percentage distribution of the surveyed sample households by the main current source of water for their home consumption. Accordingly, the results presented in the Figure revealed that most of the surveyed households (64.3%) in the study area were using communal piped water *(bono)* of which 28% in Jiru Gemechu and 63.4% were located in Arele Tika. On the other hand, about 23.1% of the surveyed households reported that they were using unprotected springs of which 52.5% in Orde Goba and 44.1% in Hula Jeneta. Furthermore, about 8.2%, 2.4% and 2.0% of the surveyed sample respondents in the study area were using protected springs, rivers, and harvested rainwater, respectively for their home consumption.

5.3. Farmers Access to Economic and Productive Assets

5.3.1. Landholding Size and its Dynamics

Land is an important economic resource in countries like Ethiopia where approximately 80% of its population is rural residents and depends on rain-fed agriculture (Alemu and Mengistu, 2019; FAO, 2018; Mengistu *et al*., 2021; Mohamed, 2017; Woldie *et al*., 2020). Similarly, in Kurfa Chele *woreda* about 92% of the households were living in the rural areas depending on subsistence agricultural production and land is the main source that determines their food availability. For this reason, besides other factors, both the size and fertility of the landholding play a key role in determining the amount of agricultural production and the food availability status of rural farm households.

As in many parts of Ethiopia, many rural households in the study area were unable to produce sufficient food because of poor access to landholding and its unequal distribution besides other factors like climatic conditions. Hence, landholding size is recognized as a significant production variable in determining what crops are grown and how much crop is harvested. Furthermore, the availability of pastoral land is also a critical issue for livestock production. Consequently, under subsistence agriculture, landholding size is one of the factors that are expected to play a significant role in influencing rural farm households' food security status and its sustainability. Accordingly, in this survey research, farmers' landholding size was asked assuming that farmers' estimation errors and data unreliability could be minimized.

Table 5.6 presents eight categories of landholding sizes and the proportion of rural farmers that fall under each category. As indicated in the Table, most rural farm households (41.57%) in the study area held 0.25 hectares to 0.50 hectares of land and almost half of the households (50.20%) held less than or equal to 0.50 hectares of land. Moreover, about 95.69 % of the sample respondents held less than or equal to one hectare of land and only 4.3% of them held greater than one hectare of land. The average landholding size per household for the entire sample in the study area was 0.63 hectares with a standard deviation of 0.92 hectares and the minimum and maximum holding sizes were 0.13 hectares and 2.0 hectares, respectively.

Table 5.6: Percentage distribution of farmers by landholding size

Landholding size in (Ha)	Frequency	Percentage	< Cumulative %
0- 0.25	22	8.63	8.63
0.25-0.50	106	41.57	50.20
0.50-0.75	82	32.16	82.36
0.75-1.00	34	13.33	95.69
1.00-1.25	5	1.96	97.65
1.25-1.50	2	0.78	98.43
1.50-1.75	2	0.78	99.21
1.75-2.00	2	0.78	100
Total	255	100	
Average land holding size = 0.63ha; Std. deviation = 0.92ha			

Source: Household survey data, 2018

The average farmland size of the surveyed rural farm households respondents was less than the national average small farmers holding of 0.8 hectares (FAO, 2018; Gedefaw *et al*., 2019) and the regional average holding of 1.15 hectares per household (Headey *et al*., 2014 as cited in Leta *et al*., 2021). Moreover, in comparison with other areas, the average farmland size of the sample respondents (0.63 hectares) in the study area was found to be lower than 3.56 hectares reported by Asenso-Okyere *et al*. (2013), 1.14 hectares reported by Aweke *et al*. (2020), 1.58 hectares reported by Fikire and Zegeye (2022), 0.96 hectares reported by Gebrehiwot and van der Veen (2015), 1.96 hectares reported by Gemechu *et al*. (2016), 2.99 hectares reported by Mengistu *et al*. (2021), 0.77 hectares reported by Mitiku and Legesse (2014), 1.5 hectares reported by Million and Muche (2020), but higher than 0.47 hectare reported by Aragie and Genanu (2017), 0.49 hectares reported by Robaa and Tolossa (2016).

Landholding variations in terms of the age of the surveyed farm household heads in the study area were also presented in Figure 5.2. Accordingly, results in the Figure indicated that households in the younger age group have smaller landholding sizes compared to the older household heads. For instance, households in the age group of 45-52 have held land on averagely of 0.66 hectares and households in the age group of 53-59 held 0.733 hectares of land. In addition, households in the age group of 60-66, 67-73 and 74-80 years held land of 0.973, 0.792 and 0.565 hectares, respectively. This result indicates the landholding size of the last two age groups (older ager groups declined mainly because they shared their land with their children.

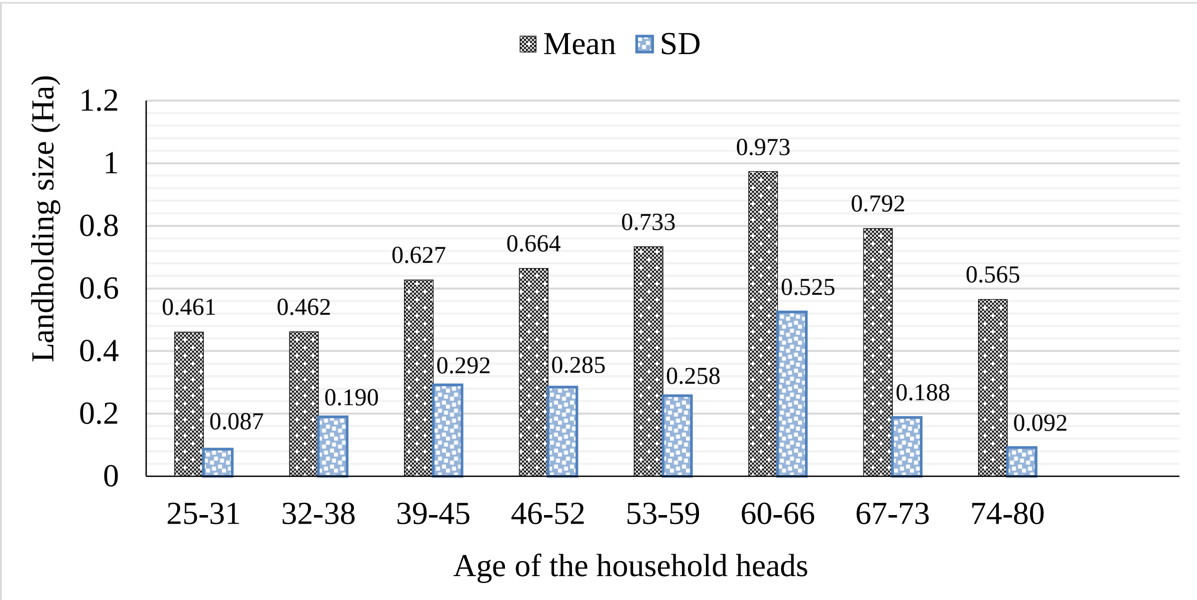

Figure 5.2: The relationship between age of the household and landholding size
Source: Household survey data, 2018

In line with this, to test the hypothesis a one-way ANOVA was computed on the landholding size for the surveyed rural farm households to see whether there is a statistically significant mean difference in landholding size among the different households' age groups. Levene's test for homogeneity of variance with a significant value of .015 indicates variances for farmland size for each of the age groups do indeed differ significantly. For the surveyed sample respondents in the study area farmland holding size vary between a narrow variance for the age group of 25-31 of 0.087^2 (= 0.0076) to a much wider variance for the age group 60-66 of 0.525^2 (= 0.2756) (Figure 5.2). Results presented in Table 5.7 indicate that there was a statistically significant mean difference in farmers' landholding size among the age groups of the surveyed household heads at a 1% significant level; $F(7, 247) = 4.916$, $P < .000$.

Table 5.7: One-way ANOVA summary for respondent age and landholding size

Source of variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.616	7	0.374	4.916	.000
Within Groups	18.777	247	0.076		
Total	21.394	254			

Source: Household survey data, 2018

Furthermore, in order to know between which age groups, the difference lies (groups that are statistically different from one another) a post hoc multiple comparisons tests using the Tukey HSD[15] were conducted and results for those age groups statistically significant were presented in Table 5.8.

Table 5.8: Multiple comparisons of respondents' ages and average landholding size

	HH age group (I)	HH age group (J)	Mean Difference (I-J)	Std. Error	Sig*.
Tukey HSD	25-31	60-66	-0.51175	0.13895	.007
	32-38	39-45	-0.16433	0.05194	.037
		46-52	-0.20166	0.05680	.011
		53-59	-0.27036	0.07387	.007
		60-66	-0.51049	0.11341	.000
	39-45	32-38	-0.16433	0.05194	.037
		60-66	-0.34616	0.10751	.031
	46-52	32-38	-0.20166	0.05680	.011
	53-59	32-38	-0.27036	0.07387	.007
	60-66	25-31	-0.51175	0.13895	.007
		32-38	-0.51049	0.11341	.000
		39-45	-0.34616	0.10751	.031

*. The mean difference is significant at the 0.05 level for all groups

A post hoc comparison using the Tukey HSD test depicted in Table 5.8 indicated that the mean landholding size of the household falls within the age group of 25-31 (M = 0.461) was

[15] HSD: denotes Honestly Significant differences

statistically significantly different from the mean landholding size of the household heads that belong to the age group of 60-66 years (M = 0.973). In addition, the mean landholding size for the household heads that belong to the age group of 32-38 years (M = 0.462) was also significantly different from the mean landholding size of the household heads belonging to the age group of 39-45 years (M = 0.627), 46-52 years (M = 0.664), 53-59 years (M = 0.733) and 60-66 years (M = 0.973). This result indicates that the mean landholding size of the older age group is higher than that of the mean landholding size of their younger age counterparts.

Survey results regarding how the sample farmer households had access to land were depicted in Table 5.9. The main mechanisms of access to cropland that were most frequently reported by the studied farmer households are land redistribution and inheritance from their parents. As it is indicated in the Table, land redistribution has been one of the major means of farmers' access to land; this was reported by 51.76% of the survey respondents. Inheritance from parents is also another most common means of getting access to farmlands in the study area as it was reported by 60.78% of the sample respondents. Land renting and sharecropping were seldom practised by the surveyed farm household respondents in the study area, and it is accounted for only 2.35% of the respondents.

Table 5.9: Means of getting access to land by sample household respondents

Means of getting access to land	Frequency*	Percentage
Land redistribution	132	51.76
Inheritance	155	60.78
Sharecropping	2	0.78
Rental	4	1.57

Source: Household survey data, 2018 (*multiple responses)

In addition to means of getting access to farmland, the surveyed sample household respondents were also asked about the changes that happened to their landholding size over the last 20 years. Hence, about 22.7%, 41.2% and 35.3% of the surveyed households have confirmed that there is an increase, a decrease and no change in their landholding size, respectively (Table 5.10). This revealed that a decrease in landholding size had happened for most of the sample households under investigation. The main reason for the decline in their landholding size is due to the land being overtaken by their children and shared among family members.

Table 5.10: Change in landholding size of the sample household over the last 20 years

Change	Lowland		Midland		Highland		Total	Percent
	F	%	F	%	F	%		
Increased	20	20	10	21.3	28	25.9	58	22.7
Decreased	52	52	13	23.7	40	37	105	41.2
No change	28	28	24	51.1	38	35.2	90	35.3
Don't know	-	-	-	-	2	1.9	2	0.8
Total	100	100	47	100	108	100	255	100

Source: Household survey data, 2018

5.3.2. Land Fragmentation and Quality of the Soil

As it is dominated by smallholder farming, Ethiopian agriculture is characterized by fragmentation and scattering of farmlands where a single farmer consists of numerous discrete parcels of land often dispersed over a wide area. The field survey data revealed that there is no considerable variation concerning the number of plots of land belonging to the studied sample households as per Table 5.11.

Table 5.11: Farm household percentage distribution by number of land plots

Plot of land	Frequency	Percentage	< Cumulative %	Mean	Std. Deviation
1	15	5.9	5.9		
2	82	32.2	38.0		
3	111	43.5	81.6		
4	41	16.1	97.6		
5	5	2.0	99.6		
6	1	0.4	100		
Total	255	100		2.77	0.89

Source: Household survey data, 2018

As indicated in Table 5.11, the number of farm plots among the sample household respondents in the study area ranges between one and six plots of land. Accordingly, about 43.5% of the sample respondents have three plots of land and almost all (97.6%) of the sample households have less than five plots of land and only the remaining 2.4% of them has more than four plots of land. Furthermore, the average plot of land for the total sampled household respondents was 2.77 with a standard deviation of 0.89. The findings revealed that farmland fragmentation was slightly lower in the study area compared to the average number of plots for Ethiopian household farmers, which is four plots (FAO, 2018; Gedefaw *et al*., 2019), and in other parts of the country, owing to the small landholding of farm households on average and high population concentration.

Results presented in Figure 5.3 showed the perception of the surveyed farmers on the quality and fertility status of their agricultural land. Soil fertility is examined based on the local and indigenous knowledge and perception of the households whether they consider their lands could be infertile, moderately fertile, and fertile. Accordingly, most of the sample farm households perceived that the fertility status of their soil was poor and reported as infertile (48.6%) while 45.1% of the respondents perceived it as moderately fertile. Only about 6.3% of the surveyed farmers perceived that their farmlands were fertile.

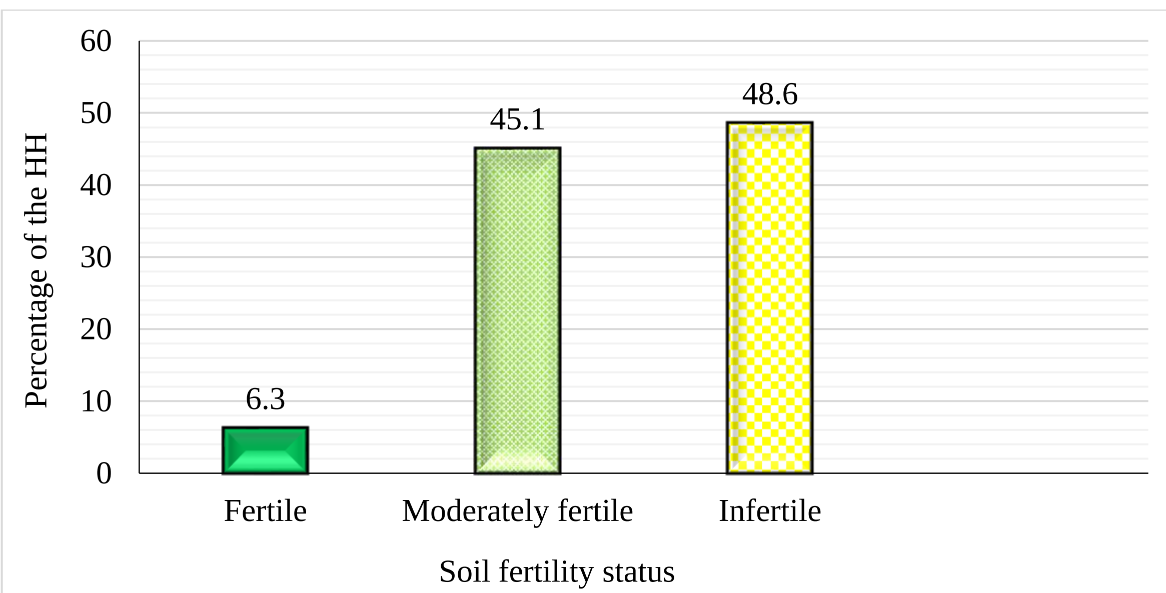

Figure 5.3: Fertility status of the farmland

Source: Household survey data, 2018

5.3.3. Livestock Possession

Animal husbandry is one of the most important sources of livelihood for rural farm households and prominent strategic household's assets including for the farmers in the study area. Moreover, livestock production can contribute to the farm households' economy in many ways mainly as a source of food and pulling power, source of wealth and cash income, means of transportation, source of dung fuel and organic fertilizer (manure) (Adjimoti and Kwadzo, 2018; Frelat *et al*., 2016; Maziya *et al*., 2017; Silvestri *et al*., 2015) which could have direct implication on the sustainability of rural farm household food security. Thus, the surveyed households in the study area were asked to list the types and the total number of livestock they owned during the survey period. Accordingly, the total number of livestock counted during the survey in the rural farm households was converted into Tropical Livestock Unit (TLU) and presented in Table 5.12. A tropical livestock unit is equivalent to a livestock weight of 250kg, and the conversion factors vary according to the types of livestock (see Appendix V-1).

Table 5.12: Distribution of livestock ownership among sample households

TLU	Frequency	Percentage	< Cumulative %	Mean	Std. Deviation
0	15	5.89	5.89		
0-1.5	14	5.50	11.39		
1.5-3.0	64	25.10	36.49		
3.0-4.5	73	28.63	65.12	3.88	2.11
4.5-6.0	52	20.39	85.51		
6.0-7.5	23	9.02	94.53		
>7.5	14	5.50	100		
Total	255	100			

Source: Household survey data, 2018

Table 5.12 provides the average number of livestock availability in terms of TLU per the sampled farm households in the study area. As showed in the Table, livestock availability for the sample households in terms of tropical livestock units was found to be 3.88 TLU on average with a standard deviation of 2.11 TLU. The average livestock holdings in the study area are relatively higher than the national average livestock keeping of 2.4 TLU (FAO, 2018) and the findings in other areas by Aragie and Genanu (2017) who reported 2.02 TLU, Aweke *et al*.

(2020) reported 3.5 TLU, Gebrehiwot and van der Veen (2015) reported 2.35 TLU and Sileshi *et al*. (2019) reported 1.78 TLU but, lower than 5.33 TLU reported by Asenso-Okyere *et al*. (2013), 6.26 TLU reported by Fikire and zegeye (2022), 4.95 TLU reported by Gemechu *et al*. (2016), 7.5 TLU reported by Mengistu *et al*. (2021) and 5.84 TLU reported by Mitiku and Legesse (2014). The minimum number of livestock holding is zero (5.89% of the surveyed households) and the maximum available livestock for the surveyed households in the study area was 11.21 TLU. This demonstrates that the availability of livestock varies greatly among the sampled rural farm households in the study area. Results in the table reveal that about 11.39% of the sample households owned livestock less than or equal to 1.5 TLU and 65.12% of them were owned less than or equal to 4.5 TLU. Moreover, 14.52% of the surveyed respondents in the study area were owned greater than 6 TLU and only 5.50% of them owned livestock greater than 7.5 TLU.

5.3.4. Participation in Income Generating Activities (Financial Capital)

Farmer's participation in different types of on-farm and off-farm income-generating activities are the major determinants of rural farm household per capita expenditure, access to food and their food security status (Ojeleye *et al.,* 2014) and enable them to smoothen their food consumption pattern (Sileshi *et al*., 2019). Participation of farmers in various types of off-farm activities will ease capital constraints to buy foods and agricultural inputs leading to higher food production and better access to food (Abegaz, 2017; Awoke *et al*., 2022; Dagne, 2016; Mulugeta *et al*. (2018). Accordingly, the surveyed rural farm households were asked to identify in which types of off-farms and on-farm income-generating activities they were engaged in to diversify their livelihoods (Figure 5.4).

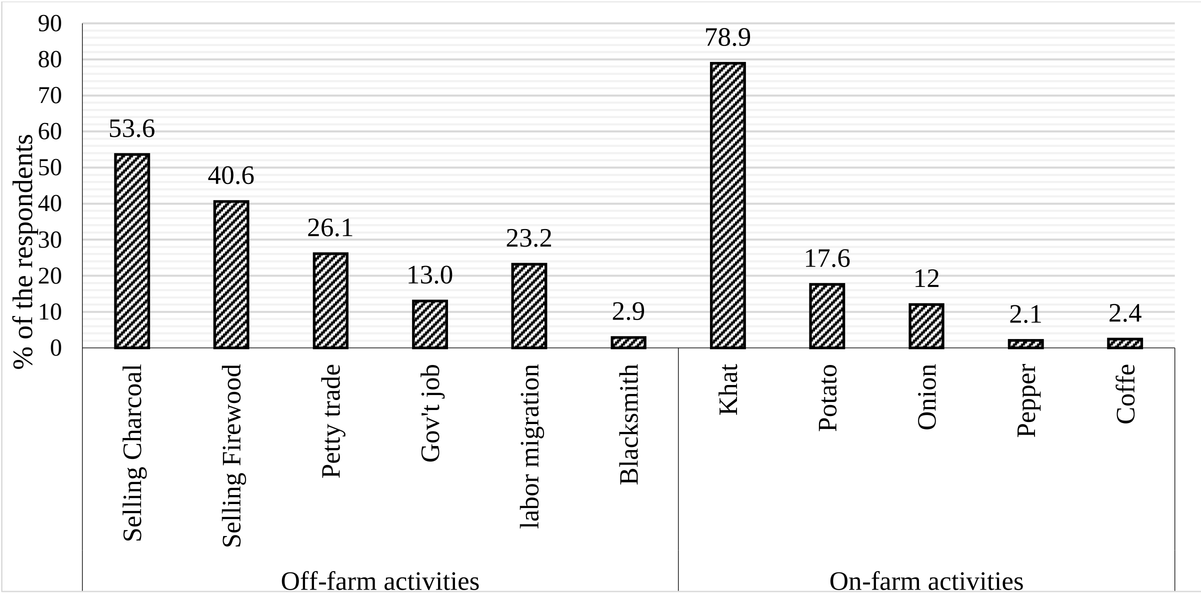

Figure 5.4: Sample households' participation in on-farm and off-farm activities

Moreover, the results presented in Figure 5.4 showed that 78.9% of the surveyed households planted cash crops mainly Khat and a few sample respondents (2.5%) were also reported to produce coffee. Some of the rural farm household respondents in the study area also grew garden vegetables such as potatoes (17.6%), onions (12%) and pepper (2.1%). The result revealed that the main sources of on-farm income-generating activities for the surveyed farm households in the study area are the selling of Khat and followed potatoes. Similarly, studies conducted by Gemechu *et al*. (2016), Sani and Kemaw (2019) and Sileshi *et al*. (2019), respectively reported that about 56.4%, 37.3% and 465 of the sampled households participated and earned positive income from on-farm and off-farm activities.

Figure 5.5: Photographs showing participation in selling firewood and charcoal (Photograph were taken by the researcher, April 2018)

The surveyed farm households in the study area were asked to estimate the total income that they earned from on-farm activities (income earned from sales of on-farm activities like khat, coffee, potato, and onion) and off-farm activities (income earned from the sale of off-farm activities such as sales of firewood and charcoal, petty trade, employment income, and remittance) per month. Then, the estimated income was multiplied by 12 and transformed to annual income and per capita annual income value by dividing the estimated income by the number of adult equivalent household members. Accordingly, the result in Figure 5.6 revealed that the overall average per capita annual income for the surveyed sample households in the study area was 1,405 birr/year/person and 8,974 Birr/year/households. Among the surveyed households at the *woreda* level, households in Arele Tika had recorded higher annual income than households in the other surveyed *kebeles*, with an average of 1,521 Birr/year/adult equivalent and 10,630 Birr/year/households. On the other hand, the surveyed households in Jiru Gemechu, Hula Jeneta and Orde Goba were earned an average annual income of 1,577 Birr, 1,420 Birr and 947 Birr/year/adult equivalent and 9,251 Birr, 8,782 Birr and 5,098 Birr/year/households, respectively.

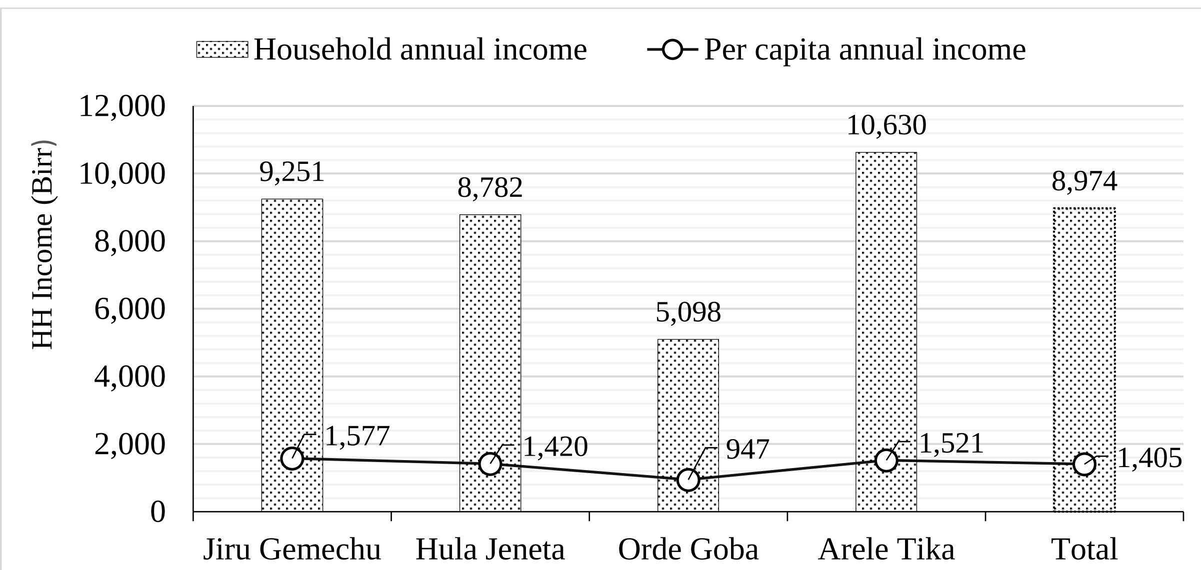

Figure 5.6: Estimated annual income of the sample households by *kebele*

Source: Household survey data, 2018

5.4. Agricultural Extension Services and Utilisation of Modern Agricultural Inputs

5.4.1. Access to Extension Services, Farm Credit and Utilisation of Irrigation

In a country like Ethiopia, where most farm households are illiterate, agricultural extension services would play an important role in assisting them to identify and analyse production problems, as well as making them aware of opportunities for improvement, resulting in the adoption of modern agricultural technologies. Hence, the effectiveness of the utilisation of modern agricultural inputs in their production process partly relies upon the availability of sound agricultural extension services at the community level. Moreover, access to agricultural information plays a vital role as it allows the rural farm households to use varied improved farming technologies (Nyikahadzoi *et al*., 2012). Accordingly, the surveyed farmer sample households in the study area were asked whether they got advice and training on their agricultural activities from extension services. As it is shown in Table 5.13, about 81.2% of the surveyed households in the study area identified themselves as the beneficiaries of the extension service program and the remaining 18.8% had no access to extension services. In line with the finding of this research, Aragie and Genanu (2017), Aweke *et al*. (2020) and Mengistu *et al*., (2021) reported the largest proportion of the sampled household respondents (95%, 87.5% and 95.05%, respectively) had access to agricultural extension services while a study conducted by Gemechu *et al*. (2016) reported 59.3% of the respondents had access to contact with agricultural development agents.

Table 5.13: Farmer's access to irrigation, extension, and credit services, SWC practices

Do you have access to these services?	Frequency		Percentage	
	Yes	No	Yes	No
Extension services	207	48	81.2	18.8
Farm credit	49	206	19.2	80.8
Irrigation	31	224	12.2	87.8
Soil and water conservation (SWC) practices	243	12	95.3	4.7

Source: Household survey data, 2018

Information obtained from the interviewees indicated that the development agents provided the farmers with information regarding the utilisation of inputs such as fertilizers, improved seeds, the way how farmers prepare manure/compost, construction of toilets, tillage of the land, how do they manage their farmland and so on. In line with this, the surveyed sample households in the study area were also asked what type of activities they got advice from the extension workers. As depicted in Table 5.14 it was found that about 95.2% and 93.7% of the survey respondents reported that they were getting advice on the utilisation of improved seeds and chemical fertilizer, respectively. Similarly, of those sample respondents who had access to agricultural extension services in the study area about 84.5% and 77.8% confirm that they were getting advice on crop production and soil and water conservation practices.

Table 5.14: Agricultural extension workers' advice types received by sample respondents

		F	% of Cases
Extension Services obtained*	Crop production	175	84.5%
	Animal husbandry	125	60.4%
	Use of fertilizer	194	93.7%
	Use of herbicide	20	9.7%
	Use of improved seeds	197	95.2%
	Soil and water conservation	161	77.8%

* Multiple responses are possible

Source: Household survey data, 2018

In addition to agricultural extension services, an attempt was also made to identify the number of the sample households which had benefited from farm credit services in the study area. This is since agricultural financial/credit services are an important component of small farm development programs and the use of modern agricultural inputs for subsistence farmers who have had little or no cash to spend on their farms. According to the survey results presented in Table 5.13, around 19.2 per cent of the sampled respondents had access to credit services, while 80.8 per cent did not, meaning that most of the households did not have access to any sort of credit. Similarly, studies conducted by Aweke *et al*. (2020), Fikire and Zegeye (2022), Robaa and Tolossa (2016), Mengistu *et al*., (2021) and Sani and Kemaw (2019), respectively reported that 79%, 53.39%, 66.7%, 87.5% and 80.79% of the sampled respondents had no access to credit services mainly due to various reasons. On the other hand, studies conducted by Agidew and Singh (2018) in south Wollo zone of Ethiopia and Gemechu *et al*. (2016) in west Hararghe zone of Ethiopia, reported a high level of access to credit with only 22.8% and 38.6% of the sampled respondents had no access to credit services respectively.

Regarding access to irrigation, the finding of the study indicated that only 12.2% of the surveyed household respondents in the study area were reported to utilise irrigation and the majority (87.8%) were not (Table 5.14). Of the total surveyed households in the study area who had access to irrigation facilities, the majority (54.8%) of them were in Hula Jenata *kebele* mainly because they are situated near Dawe River and 25.8% were in Jiru Gemechu *kebele*. In contrast to the finding of this study, Sani and Kemaw (2019) reported that 56.16% of the sampled households had access to irrigation and beneficiaries of irrigation water while Sileshi *et al*. (2019) reported that 35% of the respondent's used irrigation. Furthermore, about 95.3% of the surveyed respondents confirm that they are practising soil and water conservation mechanisms on their farmland and only 4.7% were reported not practising. Unfortunately, the study area is well known in the practice and management of soil and water conservation mechanisms by using different strategies.

5.4.2. Utilisation of Modern Agricultural Inputs

Various studies conducted in Ethiopia and elsewhere in the world (Dagne, 2016; Eshetu and Guye, 2021; Ferede and Wolde-Tsadik, 2018; Kipkurgat and Tuigong, 2015; Tafesse *et al*., 2015) have demonstrated that the application and utilisation of appropriate modern agricultural inputs like improved seeds, chemical fertilizers, and herbicides can increase crop output and agricultural productivity of rural farmers. The importance of these agricultural inputs becomes more important particularly in highly vulnerable environments and eroded soils to improve land productivity and overall farm production. Hence, the surveyed sample households in the study area were asked whether they utilise modern agricultural inputs such as chemical fertilizers, manure, improved seeds, and herbicides to increase their yields. As it is indicated in Figure 5.7, although varied across inputs, the proportion of the surveyed sample households applying modern agricultural inputs was found to be somewhat high in the study area for chemical fertilizer and improved seeds unlike that of herbicides.

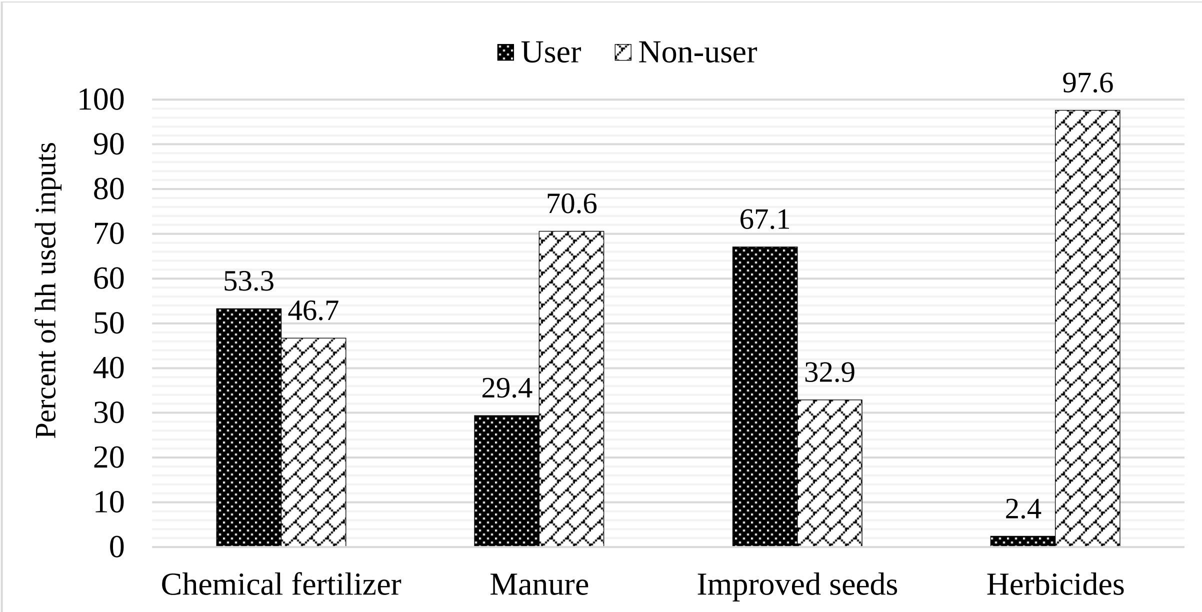

Figure 5.7: Percentage distribution of sample HHs utilised modern agricultural inputs

Source: Household survey data, 2018

Results in Figure 5.7 show that more than half (53.3%) of the surveyed sample respondents applied chemical fertilizers on their farmlands during the survey period and the remaining 46.7% of the sample respondents did not use it. Additionally, the result also indicated that about 70.6% of the sample households applied manure on their farmland to boost the soil fertility status. On the other hand, about 67.1% of the sample respondents confirm that they were utilised improved seeds and the rest 32.9% did not. As stated by focus group discussants, and key informant participants most of the sampled farm households in the study area have had access to the improved seeds through emergency seed assistance which is provided by USAID and CARE Ethiopia. In comparison to the results of this study, Aragie and Genanu (2017) and Sileshi *et al*. (2019) reported about 51.64% and 65.37%, and 54% and 51% of the household respondents had used fertilizers and improved seeds, respectively. Moreover, a study conducted by Gemechu *et al*. (2016) reported that 42.1% of the sampled respondents had access to improved seeds.

The utilisation of herbicides also plays a significant role in agricultural production by killing weeds that compete with crops for water and nutrient sources in the soil and thereby boosting the productivity of agriculture. However, according to the survey respondents, the utilisation of herbicides in the study area was found to be quite too low were with only 2.4% of sample households reported to use it as per Figure 5.7. This shows that most of the surveyed respondents were removed weeds from their farmland manually rather than spraying herbicides. Information provided by the key informant interview and focus group discussion participants also confirmed the same result.

5.5. Access to Market and Road Availability

Table 5.15 revealed that the surveyed sample household respondents' estimation of distance from the market centre. Data in the table shows that there is substantial variation between the studied *kebeles* in terms of the farm households' access to the market centre. The surveyed sample households found in Orde Goba and Hula Jeneta are more accessible to the centre of the market than farm households found in Jiru Gemechu and Arele Tika. In total, about 32.55% and 40% of the surveyed households have travelled 30-60 minutes and 60-90 minutes to reach the nearest market centre in their area.

Table 5.15: Distribution of the sample household heads by distance from market centre

The time required (minute)	Distance from market centre				Total		
	Jiru Gemechu	Hula Jeneta	Orde Goba	Arele Tika			
	%	%	%	%	F	%	<Cum%
< 30	-	7.69	40.43	-	23	9.02	9.02
30-60	18.75	67.31	38.30	19.44	83	32.55	41.57
60-90	33.33	21.15	14.89	62.96	102	40.00	81.57
90-120	25.00	3.85	6.38	17.59	36	14.12	95.69
120-150	22.92	-	-	-	11	4.31	100
Total	100	100	100	100	255	100	
Mean = 107 minutes, SD = 45 minutes							

Source: Household survey data, 2018

Additionally, 14.12% of the survey households have also travelled 90-120 minutes and the remaining 4.31% of the households were travelled more than two hours (120 minutes) to reach the nearest market centre in their area. Furthermore, rural farm households in the study area travelled an average of 107 minutes, with a standard deviation of 45 minutes, to the market centre. The finding revealed that the majority of the farm households travelled more than one hour to get the nearest market centre and would have a negative impact on sustaining their livelihood and sustainability of household food security. In contrast to the findings of this study, Gebrehiwot and van der Veen (2015) reported that the sampled households travelled 43 minutes on average to reach the market centre.

In addition to the distance to the market centres, farm households in the study area were also asked to estimate the distance that they had travelled from the main road (all-weather road) in their area. Consequently, Figure 5.8 and Table 5.16 showed the means of the transportation facilities and access to road transportation in the study area. Rural road access is one of the essential infrastructures for the households in the area to transport and market their crop and livestock products to buy essential consumer goods and agricultural inputs. Households that are found closer to the main road have better access to information and farm inputs such as fertilizers, seeds, herbicides, pesticides, and so on which could have an implication on household food security. The main road access in Kurfa Chele *woreda* was the all-weather road and in some villages, there was a rural road constructed of gravel which is used only in the dry season. The area was also mostly not accessible to buses and other safe transportation services. The most used means of transportation service in the area was an Isuzu car as can be seen from Figure 5.8 where passengers are loaded over the commodities.

Figure 5.8: One of the most widely used means of transportation in kurfa chele *woreda* (Photograph were taken by the researcher, January 2017)

Most of the farmer households in the study area had less access to roads particularly households in Arele Tika and Jiru Gemechu. According to the survey result, about 68.75%, 63.46% and 87.23% of the sample respondents in Jiru Gemechu, Hula Jeneta, and Orde Goba *kebele*, respectively, confirmed that they travel up to 30 minutes walking to reach the main road (all-weather road). On the other hand, more than half (60.19%) of the surveyed farm households in Arele Tika were travelling about 60-90 minutes to reach the all-weather road.

Furthermore, the cumulative percentage distribution as indicated in Table 5.16 shows that about 66.27% of the surveyed households were travelling up to one hour and 7.06% of the sample respondents were travelling more than one and a half hours walk to reach the main road. The result revealed that farm households in Hula Jeneta and Orde Goba are more accessible to the road mainly because the all-weather road in the *woreda* were across through their *kebeles*. Moreover, rural farm households in the study area travelled an average of 63 minutes to the nearest all-weather road, with a standard deviation of 50 minutes (motorable road). In comparison to the findings of this study, Gebrehiwot and van der Veen (2015) reported that the sampled households spent 35 minutes on average travelling to the nearest all-weather road.

Table 5.16: Distribution of the sample household heads by distance from the main road

Time required (minute)	Distance from main Road (all-weather road)				Total		
	Jiru Gem.	Hula Jen.	Orde Goba	Arele Tika			
	%	%	%	%	F	%	<Cum%
≤ 30	68.75	63.46	87.23	0.93	108	42.35	42.35
30-60	29.17	34.62	10.64	22.22	61	23.92	66.27
60-90	2.08	1.92	2.13	60.19	68	26.67	92.94
90-120	-	-	-	16.67	18	7.06	100
Total	100	100	100	100	255	100	
Mean = 63 minutes; SD = 50 minutes							

Source: Household survey data, 2018

5.6. Access to Information/Media (Radio, Mobile Phones)

Farmers' accessibility to up-to-date information about the market price of agricultural products can help the farmers decide on when to sell their products and it empowers the farmers to bargain for better prices. The dissemination and efficient transmission of information about new modern agricultural technologies, market prices, climate change, and weather conditions increase the confidence of the farmers and supports rural livelihood diversification and plays an important role in improving the sustainability of food security. Accordingly, as presented in Table 5.17, of the surveyed rural farmer households in the study area only 22% of them had radio and access to information while more than three-fourths (78%) had no access to means of getting access to media (radio). Additionally, about 25% of the respondents had access to a mobile phone while the remaining majority (75%) of the sampled households had no access to mobile phones. The finding of the study showed that the proportion of the sampled households who had access to mobile phones is relatively higher than those who had access to radios. The finding from the data revealed that access to media or information in the study area is limited and only a few households relatively got better information.

Table 5. 17: Farmers access to information (radio and mobile phone)

Do you have access to information?	Radio		Mobile phone	
	Frequency	Percentage	Frequency	Percentage
No	199	78.0	191	74.9
Yes	56	22.0	64	25.1
Total	255	100	255	100

Source: Household survey data, 2018

5.7. Participation in Productive Safety Net Program (PSNP)

The recurrent food crises and famines that occurred in Ethiopia resulted in many of the rural farm households being supported by emergency food-based interventions. Hence, the Productive Safety Net Program (PSNP) is designed to provide transfers to chronically food-insecure households that could prevent asset depletion at the household level and creates assets at the community level (Agidew and Singh, 2018). Kurfe Chele *woreda* is one of the chronically food-insecure areas where PSNP has actively been implemented in the area since 2005 to change the livelihood of the households (Kurfa Chele Disaster and Risk Management Office, 2016). In line with this, the surveyed farm household respondents in the study area were asked whether they are the beneficiaries of the PSNP or not. Accordingly, the result in Figure 5.9 revealed that about 30.2% of the surveyed households were beneficiaries of the productive safety net program and the remaining 69.8% were non-beneficiary of the productive safety net program. The vast majority of PSNP clients are from *kolla* and *woina-dega* agro-climatic zone, which accounts for 49% and 42.6% of the total sample household respondents, respectively. On the other hand, of the total surveyed sample respondents from *dega* agro-climatic zone, only 7.4% of them were beneficiaries of PSNP. This indicates that most of the food insecure farm households are located in *kolla* agro-climatic zone. In comparison to the finding in other areas, the proportion of sampled household respondents supported by PSNP (30.2%) in this study is slightly higher than 21.8% reported by Agidew and Singh (2018) and 23.8% reported by Aweke *et al*. (2020) but found to be lower than 57.1% reported by Gemechu *et al*. (2016).

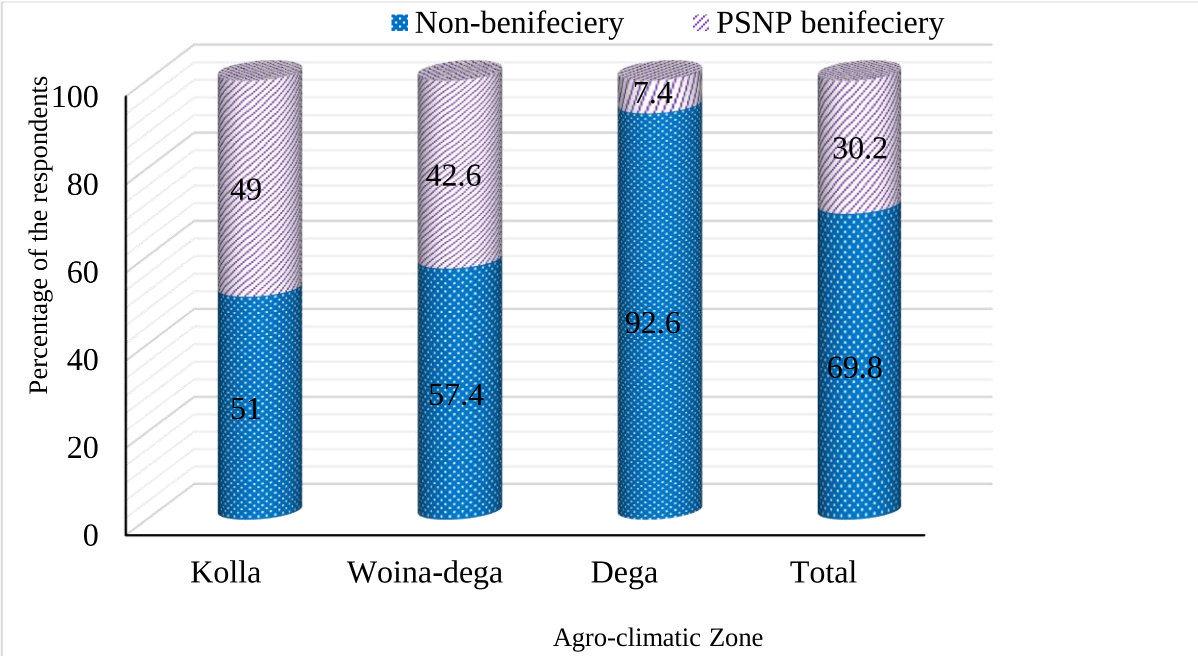

Figure 5.9: PSNP beneficiaries and non-beneficiaries in Kurfa Chele *woreda*

Source: Household survey data, 2018

A productive safety net programme has two components: public work (PW), for those able to perform labour-intensive work and a direct support (DS) component for those unable to participate in public works. Beneficiaries of PSNP received the transfers either in the form of food, in the form of cash, or the combination of both food and cash. Data from the surveyed farm households presented in Figure 5.10 indicated that over half (55.8%) of the beneficiaries were received the transfer in the form of food for public work followed by cash for public work which accounts for 28.6%. Additionally, about 10.4% and 5.2% of the PSNP beneficiaries received the transfer in the form of direct support as food or grain and cash transfer, respectively. The finding reveals that the majority of the PSNP beneficiaries received a transfer for participating in different types of public works. Concerning the types of work engaged for those who participated in public work, the majority (37.8%) of the PSNP beneficiaries have participated in soil and water conservation followed by hillside terracing which accounts for 27%. Moreover, 18.2% and 16.9% of the beneficiaries have participated in tree planting and construction of rural feeder roads in their villages, respectively.

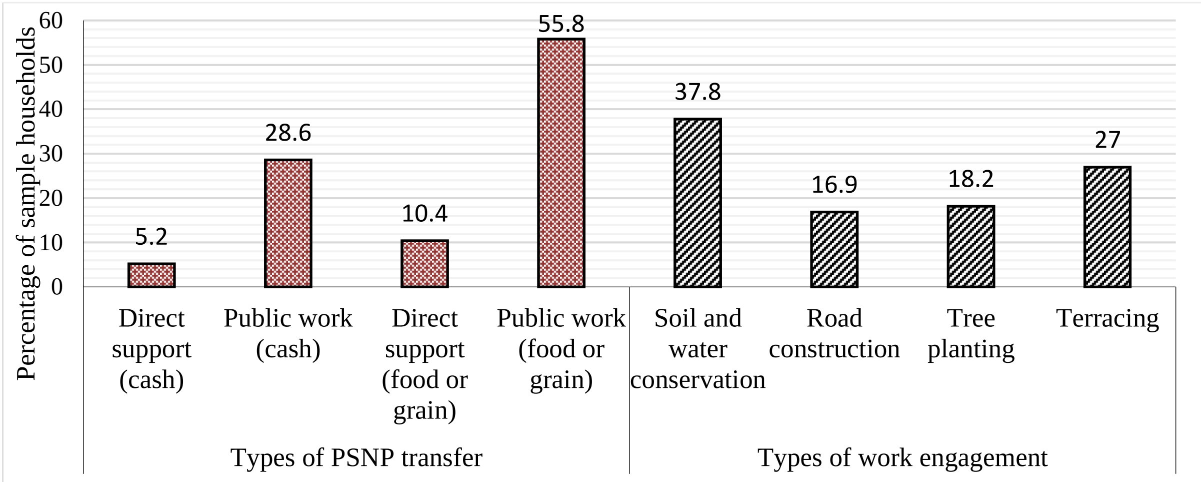

Figure 5.10: Types of PSNP transfer and work engagement

Source: Household survey data, 2018

5.8. Summary

The chapter presented background information about the characteristics of the surveyed sampled household respondents for the succeeding chapters with respect to the overall livelihood strategies in general and access to productive resources, which could have significant implications and impacts on the sustainability of rural farm households' food security status. This is mainly since farmers' demographic, socio-economic and access to various types of economic and agricultural productive resources as well as the availability of rural infrastructure could have significant implications and influence on the food security status of rural farm households. More specifically, in the chapter, description of some demographic and socio-economic characteristics of the sampled households (age and sex composition, household size and educational status of the households) as well as accessibility to productive resources like land, livestock, agricultural inputs and extension services) were described. Accordingly, the study found that the mean age of the sample respondents was 44.75 years and the majority (42.7%) of them are within the age groups of 39-45 years. Additionally, the study showed that most (88.6%) of the surveyed households were male respondents. Furthermore, more than half of the sample households (54.1%) had between 7 and 9 household members with an average household size of 6.75; this likely could have had implications on food security status.

The study finds that only 31.8% of the sampled respondents are literate indicating that the literacy rate is very low. Moreover, about 64.4% of the respondents had got access to clean and safe drinking water for their home consumption. The average landholding size per household for the entire sampled respondents in the study area was 0.63 hectares and about 95.69 % of the sampled respondents owned less than or equal to one hectare of land and this had its own implications for food production and availability. Farm households in the study area participated in different on-farm and off-farm income diversification activities such as Khat, potato, onions, selling of firewood and charcoal, labour migration, so on to generate income and diversify their livelihoods. The finding showed that most of the sampled respondents travelled long distances to reach the nearest all-weather road and market centres in their area. Moreover, the study revealed that only a few sample respondents have had access to credit services, irrigation and utilising herbicides while, more than half of the respondents reported themselves as the beneficiaries of extension service programs, chemical fertilizers, improved seeds and animal manure.

As to distance to the nearest market centres, about 33% and 40% of surveyed household respondents had travelled 30-60 minutes and 60-90 minutes, respectively. Moreover, nearly 18.8% of the sampled households travelled more than one and half hours while around 4% of them travelled more than two hours to reach the nearest market centres in the area. Regarding the distance to the nearest all-weather road, about 42% of the sampled households reported travelling less than 30 minutes while nearly one third (33%) and 7% of the respondents reported travelling more than one and half hours and more than two hours. The finding of the study also indicated that about 22% of the surveyed rural farmer household respondents in the study area had radio and access to information while nearly quarters of the sampled respondents had access to mobile phones. Moreover, the finding of the study showed that about 30% of the sampled household respondents were supported by PSNP in the form of public work for those able to perform labour-intensive work and direct support component for those unable to participate in public works. Data from the surveyed sampled farm households indicated that over half (55%) of the PSNP beneficiaries had received the transfer in the form of food for public work followed by cash for public work which accounts for 28%. Regarding the type of work engaged for those who participated in public work, the majority (37.8%) of the PSNP beneficiaries participated in soil and water conservation followed by hillside terracing which accounts for 27%.

Finally, based on the results presented in this chapter, it is possible to conclude that achieving sustainable food security and meeting the SDGs of ending poverty and zero hunger will be difficult in the study area if the current demographic, socioeconomic, institutional, and rural infrastructure factors persist. This is primarily due to the fact that the majority of rural farmers in the study area lack sufficient land size for agricultural production to sustain the food required by their family members, more than two-thirds of the sampled respondents are illiterate (unable to read and write), nearly four-fifths do not have access to credit services to invest in agriculture, and nearly nine-tenths do not have access to irrigation water to diversify their means of subsistence. Furthermore, the majority of respondents have less access to markets and all-weather roads to sell their products and buy agricultural inputs, less access to information, a large household size, and insufficient livestock possession. Additionally, around 30% of the sampled household respondents are chronically food insecure and supported by productive safety net program. With all these interlinked factors and complex tensions between agricultural production and environmental variability inherent in the study area, making smallholder rural farm households more vulnerable to poverty and food insecurity, achieving sustainable food security and the SDGs is profoundly challenging.

CHAPTER SIX

FARM PRODUCTION, FOOD SECURITY STATUS QUO AND ITS SUSTAINABILITY

6.1. Introduction

In Ethiopia, nearly 80% of the population are rural dwellers primarily depending on rain-fed agriculture producing varieties of crops and rearing livestock and for an overwhelming majority of the people, agriculture is a basic means of livelihood and source of income. Although agriculture is the mainstay of the Ethiopian economy and well progressed in production and productivity over time, it has not been productive enough to sustainably ensure rural farm household food security as it suffers from adverse climate-related shocks and technologically limited farming practices that severely affected food production and livelihoods. Furthermore, food insecurity is one of the main features of rural poverty and a serious problem in the country, mainly among the rural smallholder farmers, moisture deficit and some pastoral areas. Thus, this chapter aims to address the first objective of the research paper, which is mainly concerned with analysing the food security status quo of the surveyed rural farm households in the study area and its (un)sustainability. Hence, this chapter describes the characteristics of agricultural production of sampled rural farm households in terms of major crop production, livestock rearing, production diversity, and trends of agricultural production as well as factors affecting the performance of agricultural production. Moreover, the chapter highlights the econometric analysis of the food security status of the sampled respondents such as the household food balance model (HFBM), months of adequate household food provisioning (MAHFP), household dietary diversity score (HDDS) and Foster-Greer-Thorbecke index used to estimate the status, incidence, depth, and severity of food insecurity among the sample farm households in the study area. Finally, the perceived causes of food shortage and factors threatening the sustainability of food security in the study area were also examined.

6.2. Household Crop and Livestock Production

Consonant to the statement that most rural farm households in Ethiopia (Sibhatu and Qaim, 2017), the majority of farm households in Kurfa Chele *woreda* are also involved in small-scale farming, producing different varieties of crop and livestock species partly for subsistence purposes and partly for sale at the market. Though it is difficult to assess the true contribution of own production as household faces difficulty in the recall of crop production in their backyards, an attempt was made to estimate the number of different crops they cultivated (Table 6.1). The result revealed that almost all (99%) of the surveyed households were involved in the production of a few varieties of food crops such as sorghum, maize, wheat, barley, oats, horse beans, haricot beans, linseed, and fenugreek. Among these, sorghum (99.22%) and maize (96.86%) were the two main crops (stable foods) being most frequently reported and produced by the surveyed households followed by wheat (54.51%), barley (35.29%) and haricot bean (20.78%). However, farm production in the study area mostly depends on the two rainfall seasons, mainly summer (*meher*) and spring (*belg*) rains which are constrained by the onset, duration, and cessation of these rainfall seasons.

Table 6.1: Rural farm household crop production in Kurfa Chele *woreda* 2016/2017

Crop production	Total (in Quintal[16])	Mean	SD	F	% HH
Sorghum	1524.08	6.02	3.05	253	99.22
Maize	964.60	3.91	2.50	247	96.86
Wheat	300.10	2.16	1.14	139	54.51
Barley	160.7	1.79	0.95	90	35.29
Oat	8.06	1.34	0.73	6	2.35
Horse bean	11.45	1.04	0.68	11	4.31
Haricot bean	83.88	1.58	0.77	53	20.78
Linseed	27.70	0.74	0.33	37	14.51
Fenugreek	21.45	0.67	0.39	32	12.55
Agro-ecology					
Dega	1565	14.49	3.90	108	100
Woina-dega	542	11.53	3.01	47	100
Kolla	1037	10.37	5.40	98	98
Total	3112	12.33	4.80	253	99.22

Source: Household survey data, 2018

[16] One quintal equals 100 kilograms

Regarding the amount of crop production, on average, the surveyed farm households in the study area produced 12.33 quintals with a standard deviation of 4.80 (Table 6.1). Finally, with an average overall crop production of 14.49 quintals, farm households in *dega* agro-climatic zone produced relatively higher yield than farm households in *woina-dega* (11.53 quintals) and *kolla* (10.37 quintals) agro-climatic zones.

A one-way ANOVA was also computed to see whether there is a significant mean difference in the amount of crop production among the three agro-climatic zones. Levene's test for homogeneity of variance with a significant value of less than .001 indicates variances for crop production for each of the agro-climatic zones do indeed differ significantly. For the surveyed sample respondents in the study area the amount of crop production varies between a narrow variance for the *woina-dega* agro-climatic zone of 3.01^2 (= 9.06) to a much wider variance for the *kolla* agro-climatic zone of 5.40^2 (= 29.16). Moreover, results in Table 6.2 also portrayed that there was statistically significant mean difference in the amount of crop production among the three agro-climatic zones at 1% significant level; $F(2, 252) = 22.492$, $P < .000$.

Table 6.2: Summary of one-way ANOVA for crop production by agro-climatic zone

Source of variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8908208.563	2	4454104.281	22.492	.000
Within Groups	49903571.770	252	198030.047		
Total	58811780.340	254			

Source: Household survey data, 2018

A post hoc comparison using the Tukey HSD test in Table 6.3, indicated that the mean amount of crop production of the farm household in the *kolla* agro-climatic zone (M = 10.37, SD = 5.40) was found to be a statistically significant difference from the mean amount of crop production of the farm the household in *dega* agro-climatic zone (M = 14.49, SD = 3.90). Likewise, the mean crop production of farm household heads belongs to *woina-dega* agro-climatic zone (M = 11.53, SD = 3.01) was also significantly different from the mean crop production of farm households belongs to *dega* agro-climatic zone (M = 14.49, SD = 3.90).

Table 6.3: Multiple comparisons of farm crop production in terms of agro-climatic zone

	Agro-climatic zone (I)	Agro-climatic zone (J)	Mean Difference (I-J)	Std. Error	Sig.
Tukey HSD	*Kolla*	*Woina-dega*	-1.162	.782	.299
		Dega	-4.121*	.614	.000
	Woina-dega	*Kolla*	1.162	.782	.299
		Dega	-2.959*	.773	.000
	Dega	*Kola*	4.121*	.614	.000
		Woina-dega	2.959*	.773	.000

*. The mean difference is significant at the 0.05 level.

Source: Household survey data, 2018

Conversely, for the farm household in *kolla* and *woina-dega* agro-climatic zone, comparison of mean crop productions was found not significantly different from one another (P > .05) though the average crop production of the farm household heads of *woina-dega* agro-climatic zone (11.53) was greater than that of *kolla* (10.37).

Next to crop production-related questions, the surveyed households were asked if they have had engaged in livestock rearing. Accordingly, about 94.1% of the respondents reported they have had livestock while 5.9% of the respondents reported they had no livestock. (Figure 6.1). In the *dega* agro-climatic zone almost all the farm households (99.1%) had livestock whereas in *woina-dega* and *kolla* zone about 97.9% and 87% of the farm households reported they had livestock, respectively. The finding showed that most of the sample respondents with not having livestock were found in the *kolla* agro-climatic zones. Generally, the result showed that most of the surveyed households in the study area usually produce various kinds of livestock, which is an important source of capital and traction power for the rural farm household. In comparison to the findings of this study, studies conducted by Aragie and Genanu (2017) and Workicho *et al*. (2016) reported that approximately 11.34 percent and 25 percent of the sampled respondents, respectively, do not own livestock.

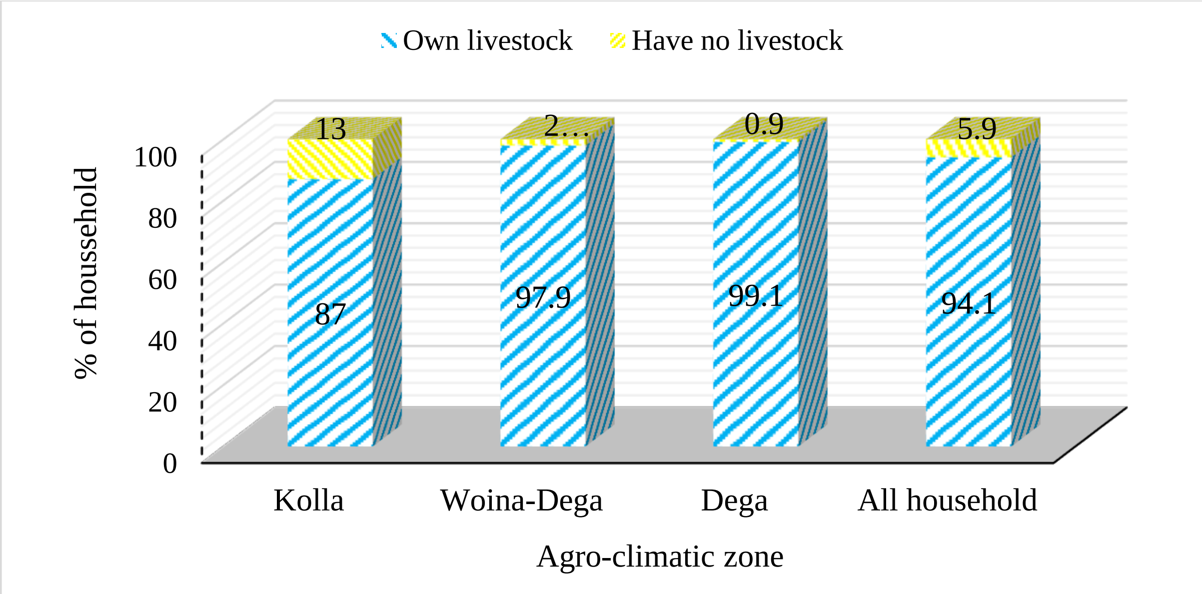

Figure 6.1: Livestock rearing and ownership in Kurfa Chele *woreda*

Source: Household survey data, 2018

Concerning the type of livestock owned by the sampled respondents, results recorded in Table 6.4 revealed that about 91% of the surveyed households reported they have had cattle, 76.1% of them had poultry, 69.8% had goats and 48.6% had sheep. In terms of animal numbers, the most common livestock owned by the majority of farm households surveyed were poultry, cattle, goats, sheep, and donkeys.

Table 6.4: Types of livestock reared by sample households in Kurfa Chele *woreda*

Livestock type	Total count	Mean	SD	F	% HH
Cattle	778	3.4	1.68	232	91.0
Sheep	343	2.8	1.67	124	48.6
Goat	692	3.9	2.63	178	69.8
Donkey	146	1.1	0.62	129	50.6
Camel	13	3.3	2.50	4	1.6
Poultry	1069	5.5	3.40	194	76.1

Source: Household survey data, 2018

Households that owned poultry had on average 6 chickens, while households that owned cattle had on average 3 heads and households that owned goats and sheep had on average 4 and 3 heads, respectively (Table 6.4). This indicated that although rural farmer households in the study area rear animals which serve as a source of household capital (insurance for the households in case of crop production failure) and input in the farm operation (traction power), the average amount of animals owned by the surveyed household was typically less than the average livestock owned by rural farm household in other parts of the country (Fikire and zegeye, 2022; Gemechu *et al*., 2016; Mengistu *et al*., 2021; Mitiku and Legesse, 2014). The main reason for this might be due to the shortage of grazing land (pastureland).

6.3. Farm Production Diversity

Farm production diversity refers to the combined species count of both crop and livestock exercised by rural farmers' households in the study area. Crop diversity is referring to the types of different crop species produced, and livestock diversity is the types of livestock species reared by the selected sample respondents in the study area. Results portrayed in Figure 6.2 shows the different agro-climatic zones and agricultural production diversity of the surveyed rural sample farm households in the study area.

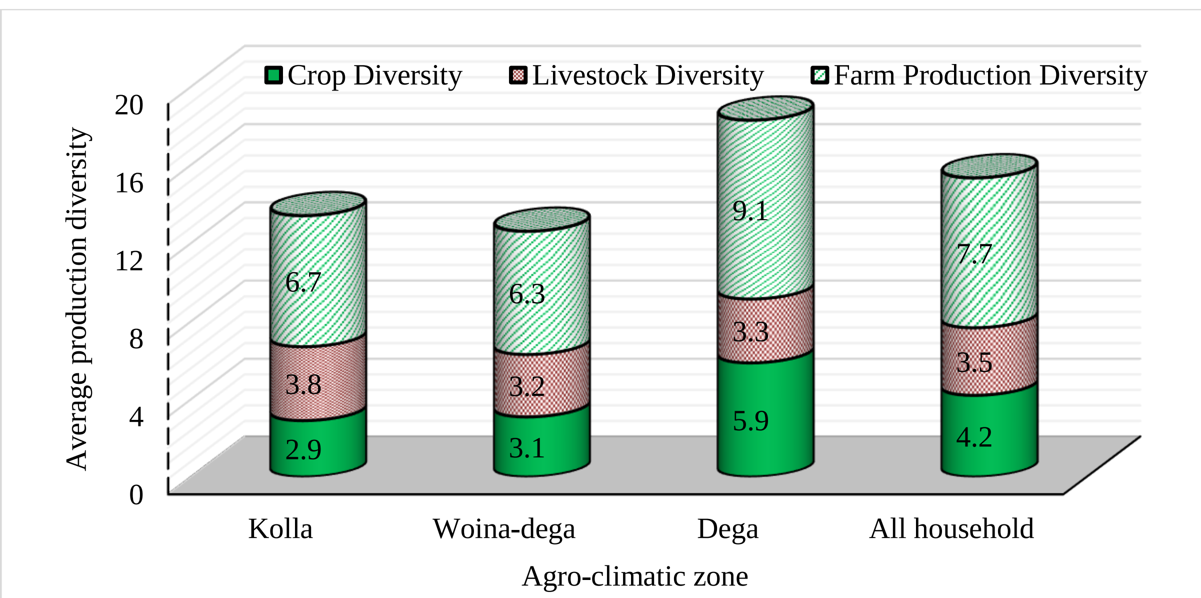

Figure 6.2: Farm household agricultural production diversity in Kurfa Chele *woreda*

Source: Household survey data, 2018

The finding showed that on average farmers in *kolla* agro-climatic zones produced 2.9 crop species and reared about 3.6 different livestock species. On the other hand, farmers in the *dega* agro-climatic zone practised 5.9 different crop species on their farmland and 3.3 livestock species. Farm households in the study area on average produced 4.2 different crop species and reared 3.5 livestock. The overall average farm production diversity for the selected rural farmer households was 7.7 indicating that low production diversity is noted among the farm households in the study area compared to other smallholder farmer households in the country with mean production diversity of 10.2 (Sibhatu *et al*., 2015). Furthermore, in comparison to this finding, studies conducted by Aweke *et al*. (2020) and Sileshi *et al*. (2019) showed that on average farmers grew 3.3 and 2.46 different varieties of crop production, respectively.

Furthermore, a one-way ANOVA was computed on agricultural production diversity for the surveyed farm household to see whether there is a statistically significant mean difference in production activity among the three agro-climatic zones. Accordingly, results in Table 6.5 revealed that there was a significant mean difference in crop diversity, livestock diversity and overall farm diversity among the three agro-climatic zones in the study area. Additionally, a post hoc multiple comparisons using the Tukey HSD test (equal variances of the level of the variable is assumed) was also computed to see which agro-climatic zone differed significantly in mean crop diversity, livestock diversity and overall farm production diversity.

Table 6.5: One-way ANOVA analysis of agricultural diversity by agro-climatic zone

		Sum of Squares	df	Mean Square	F	Sig.
Crop diversity	Between Groups	528.740	2	264.370	376.721	.000
	Within Groups	176.845	252	.702		
	Total	705.584	254			
Livestock diversity	Between Groups	14.749	2	7.374	4.019	.019
	Within Groups	462.388	252	1.835		
	Total	477.137	254			
Farm production diversity	Between Groups	412.867	2	206.433	77.168	.000
	Within Groups	674.129	252	2.675		
	Total	1086.996	254			

A post hoc comparison using the Tukey HSD test in Table 6.6 indicated that the mean crop production diversity of the farm household in the *kolla* agro-climatic zone (M = 2.9) was found to be a statistically significant difference from the mean amount of crop production of the farm the household in *dega* agro-climatic zone (M = 5.9) (Figure 6.2). Similarly, the mean crop production diversity of farm household heads belongs to *woina-dega* agro-climatic zone (M = 3.1) was also significantly different from the mean crop production diversity of farm households that belonged to *dega* agro-climatic zone (M = 5.9). This shows that crop production diversity in the *dega* agro-climatic zone was higher than crop production diversities undertaken in the *kolla* and *woina-dega* agro-climatic zones.

Table 6.6: Multiple comparisons of agricultural diversity and agro-climatic zones

Tukey HSD	Agro-climatic zone (I)	Agro-climatic zone (J)	Mean Difference (I-J)	Std. Error
Crop Diversity	*Dega*	*Kolla*	2.970***	.116
		Woina-dega	2.785***	.146
Livestock Diversity	*Kolla*	*Woina-dega*	0.516*	0.240
		Dega	0.481**	.188
Farm Production Diversity	*Dega*	*Kolla*	2.439***	.227
		Woina-dega	2.820***	.286

*, ** and *** refer to the mean difference is significant at 0.1, 0.05 and 0.01 level respectively.

Source: Household survey data, 2018

The post hoc comparison results presented in Table 6.6 revealed that the average livestock production diversity of the surveyed farm households in the *kolla* agro-climatic zone (M = 3.8) was found to be significantly different from the average livestock production diversity in the *dega* (M = 3.3) and *woina-dega* (3.2) agro-climatic zones, indicating that there was higher livestock diversity in the *kolla* area. Nonetheless, there was no statistically significant mean difference in livestock diversity between the *dega* and *woina-dega* agro-climatic zones in the study area. Additionally, the average farm production diversity (crop and livestock diversity) of the farm household heads in the *dega* agro-climatic zone (9.1) was higher and found to be significantly different from the average farm production diversity of the sample respondents in the *kolla* (6.7) and *woina-dega* agroclimatic zones (6.3). The finding portrayed that, lower crop diversity is observed in *kolla* agro-climatic zone, while a higher crop diversity is observed in *dega* agro-climatic zone, which is inverted for livestock diversity.

6.4. Trends and Challenges of Agricultural Production

Under this sub-heading, the trend of agricultural production and factors attributed to the declining or variation of agricultural production of the surveyed farm household were presented. Accordingly, the perception of surveyed farm households in the study area was asked about the trend of their agricultural production over the last 15 years and a review of secondary data was also described for the last ten years. As indicated in Figure 6.3, data obtained from the *woreda* agricultural office on the total crop production revealed that there is great variability in the amount of yield with a mean of 133,638 quintals and a standard deviation of 70,655 over the last ten years. Furthermore, the data revealed that the overall crop production varied by 53% from year to year over the last ten years which could be attributed to different factors.

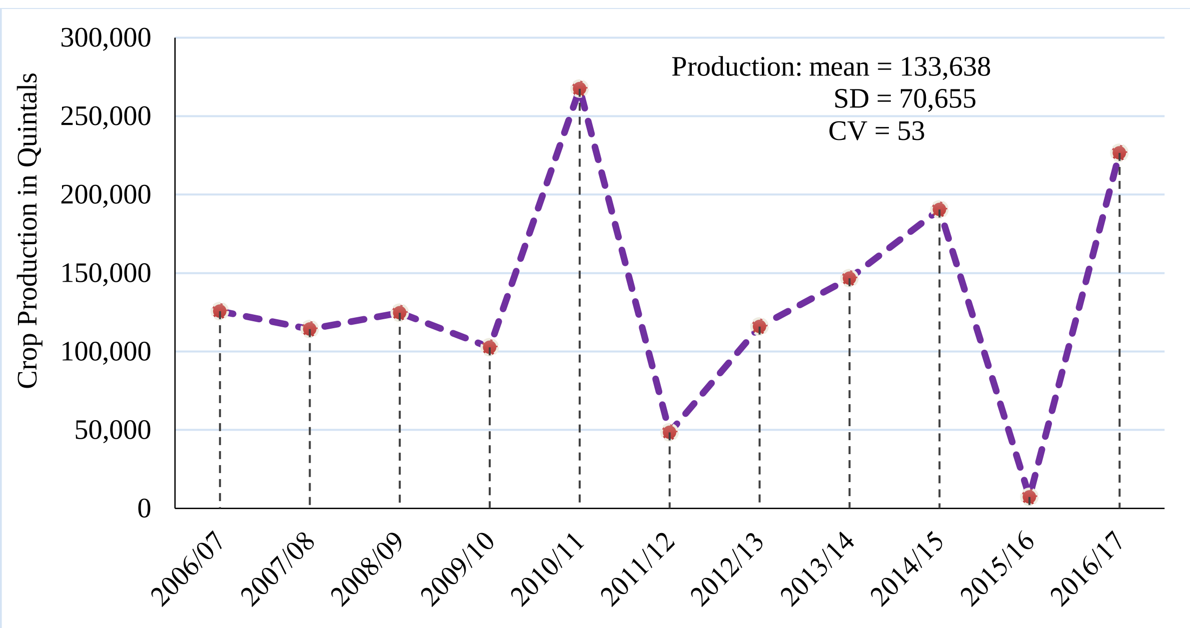

Figure 6.3: Total crop production in Kurfa Chele *woreda* 2006/7 to 2016/17

Source: Kurfa Chele *woreda* agricultural and rural development office

Concerning the perception of farm households on trends in farm production, results presented in Table 6.7 showed that most of the surveyed respondents (42.4%) reported the amount of their agricultural production got worsened/deteriorated (showed a declining trend) over time. On the other hand, 19.6% of the sample respondents reported that their agricultural production got better and showed improvement over the last 15 years. Moreover, 36.1% of the respondents argued their agricultural production showed variation from year-to-year, which was attributed to climatic variability, while 2% of the sample households reported that their production did not show significant change over the last 15 years. The majority of sample respondents who reported that their production has shown declining trends (get worsened) were belong to *kolla* (65%) and *dega* (34.3%) agro-climatic zones. In addition, three fourth (74.5%) of the surveyed farm households from *woina-dega* and 36.1% of the respondents from the *dega* agro-climatic zones were argued that their products showed variation from year to year over time.

Table 6.7: Perceived crop production trends in Kurfa Chele *woreda* over the last 15 years

Trend of crop production	*Kolla*	*Woina-dega*	*Dega*	N	Percent
Get better	14	10.6	28.7	50	19.6
Get worse	65	12.8	34.3	108	42.4
Vary from year to year	18	74.5	36.1	92	36.1
Unchanged	3	2.1	0.9	5	2.0
Total	100	100	100	255	100.0

Source: Household survey data, 2018

Besides the trend of agricultural production, the surveyed rural farm households in the study area were also asked to indicate the main causes for the declining trends and variations in crop production over time. As a result, multiple response questions were developed for those sample respondents who reported a decrease in production and variation from year to year. As depicted in Figure 6.4, the variability and decline in the trends of agricultural production in the study area were attributed to various factors such as drought, poor soil quality, small landholding, land degradation, pest and crop disease.

Most of the surveyed respondents (95%) perceived that the main factors that contributed to the declining trend of their agricultural production were attributed to drought or erratic and seasonal fluctuation of rainfall (Figure 6.4). The other most frequently reported factors causing variation and decline in crop production in the study area were poor soil quality and small landholding size, which is stated by 75.5% and 50.5% of the sample respondents, respectively. Moreover, information obtained from the key informant and focus group discussion participants also conveyed that frequent occurrence of drought, irregular rainfall (delayed onset of *Belg* rainfall and early cessation of summer rainfall), hailstorm, insufficient landholding and land fragmentation were among the factors that contributed to deteriorating the productivity of agriculture in the study area.

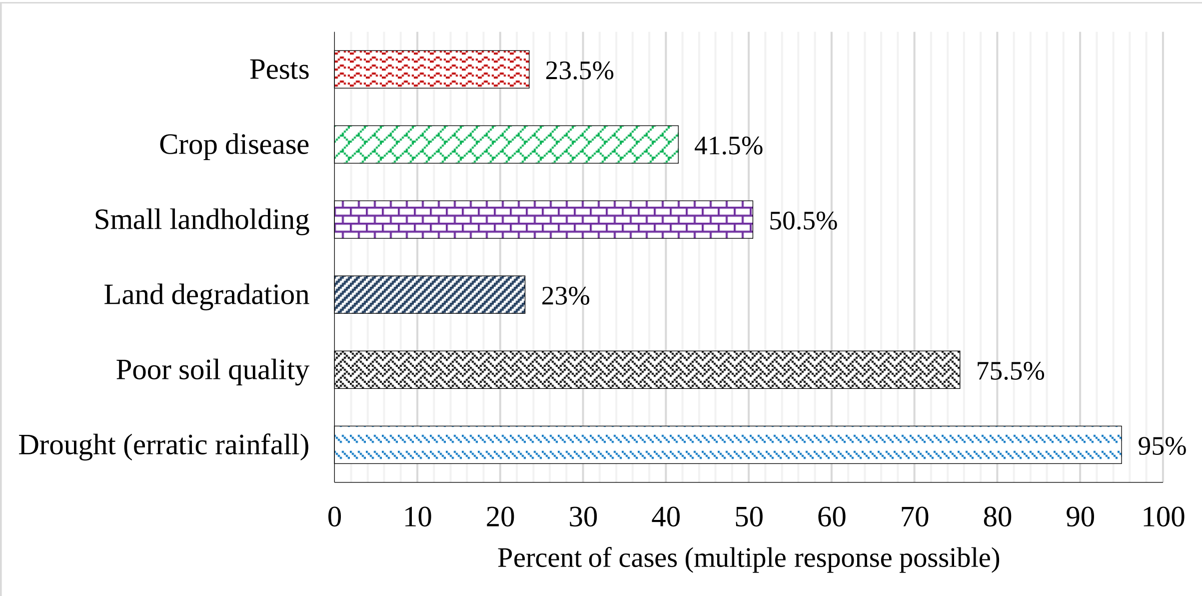

Figure 6.4: Perceived causes of declining trends (variation) in agricultural production

Source: Household survey data, 2018

6.5. Econometric Analysis of Food Security Status Quo in Kurfa Chele *Woreda*

6.5.1. Analysis of Household Food Balance Model (HFBM)

To determine the per capita adult equivalent calorie availability of the surveyed households in the study area, a modified form of equation termed as 'Household Food Balance Model' adopted from FAO Regional Food Balance Sheet were used to quantify food availability at the household level and to assess the food security situations of the rural sample households in the study area. The model has been employed to estimate per capita calorie consumption from grain food availability at the household level. By considering the minimum recommended per capita kilocalorie requirements of 2,100 kcal per adult equivalent per day (Melese and Alemu, 2021; Melese *et al.*, 2021; Million and Muche, 2020; Sani and Kemaw, 2019; Tora *et al.*, 2021; Weldearegay and Tedla, 2018; Wondimagegnhu and Bogale, 2020) an attempt was made to assess the food security status of the surveyed farm households in the study area. Hence, households whose per capita available kilocalorie per day per adult equivalent is found to be greater than the minimum recommended kcal of 2,100 were regarded as food secure and households experiencing less than 2,100 kcal per adult equivalent per day was set to be food insecure. Consequently, Table 6.8 shows the distribution of the surveyed households in the study area in terms of their ability to cover a different percentage of the minimum recommended amount of food availability in kilocalories per adult equivalent.

Table 6.8: Daily per capita food availability of the surveyed households

Food security status	Households with per capita calories of	No. of HH	Percentage	Cumulative percentage
Food insecure	<50% of MRA*	12	4.7	4.7
	50-80% of MRA	154	60.4	65.1
	81% - 2,100	29	11.4	**76.5**
Food secure	Over 2,100	60	**23.5**	100
Total		255	100	
Mean kcal = 1,704		Minimum kcal = 615		
SD = 509		Maximum kcal = 4,065		

* MRA- Minimum Recommended Allowance (2100Kcal)

Source: Household survey data, 2018

The results of the computation of the model presented in Table 6.8 portrayed that, of the total surveyed farm households in the study area, about 23.5% of the farm households could attain the minimum recommended allowance. However, about 76.5% of the sampled households were in a state of food insecurity during the year under investigation and consumed below the minimum recommended daily per adult equivalent kilocalorie allowance and these figures indicate the prevalence of critical food shortage facing the rural farm households in the study area. Moreover, households with daily per capita kilocalories of less than 50% of the minimum recommended allowance were constituted 4.7% and 60.4% of the surveyed households had lower than 80% of the minimum recommended allowance. The finding of the study implied that more than three-quarters of the sampled households in the study area were food insecure indicating the high prevalence of food scarcity and unsustainable nature of food security.

In comparison with other areas, the prevalence of food insecurity (76%) in the study area is higher than 61.79% reported for rural Ethiopia (Abegaz, 2017), 62% reported for the central and northern Gonder zone in Ethiopia (Awoke *et al*., 2022), 71.8% reported for Belo-jiganfoy district of Benishangul-gumuz region in Ethiopia (Ferede and Wolde-Tsadik, 2018), 60.55% reported for north Shewa zone of Amahara region in Ethiopia (Fikire and Zegeye, 2022), 42.5% reported for Jimma Zone in Ethiopia (Million and Muche (2020), 42.9% reported for south-west Ethiopia (Muche *et al*., 2014), 74.2% reported for southern Ethiopia (Robaa and Tolossa, 2016), 53.62% reported for western Ethiopia (Sani and Kemaw, 2019), 64% reported for Eastern Ethiopia (Tafesse *et al*., 2016), 37.6% reported for Wolaita Sodo town in Ethiopia (Tantu *et al*., 2017). However, the prevalence of food insecurity is lower than 77% reported for Bule-Hora district, Borona zone Oromia region of Ethiopia (Abdulla, 2015), 77% reported for Dodota district in Oromia region of Ethiopia (Dagne, 2016), 79.1 % reported for south Wollo zone of Ethiopia (Agidew and Singh, 2018) and 80% (Bazezew, 2012).

The mean per capita kilocalorie available to the surveyed households per adult equivalent per day for the entire sample household is found to be 1,704 kcal accounting for 81.1% of the minimum recommended allowance of 2,100 kcal with a standard deviation of 509 kcal (Table 6.8). In addition, the range of daily per capita food availability per adult equivalent was 3,415 kcal with the minimum daily per capita per adult equivalent kilocalorie being 615 and the maximum being 4,065 kcal. The result is consistent with the finding of Agidew and Singh (2018), Gemechu *et al*. (2016), Ferede and Wolde-Tsadik (2018) and Sani and Kemaw (2019) who reported the mean calories intake of the sampled household was lower than the minimum calorie (2100 kcal) required for a healthy and productive life. However, finding appear contrary to those of Aragie and Genu (2017) and Million and Muche (2020), who reported the average calorie intake among sampled households in rural Ethiopia to be higher than the minimum recommended intake level.

Table 6.9 shows the mean daily per capita kcal per adult equivalent of the surveyed households in the study area and their food security status. As depicted in the Table, an independent sample t-test was computed to see whether there is statistically significant difference in mean per capita kcal per adult equivalent per day between the food secure and food-insecure households in the study area. Accordingly, it was found that the mean per capita kcal per adult equivalent per day for the food secure households is 2408.40 with a standard deviation of 414.20 and the mean per capita kcal per adult equivalent per day for the food insecure households was 1486.85 with a standard deviation of 292.902. The t-test value presented in Table 6.9 revealed that there was a statistically significant difference in the mean per capita kcal per adult equivalent per day between the food secure and food-insecure households in the study area [$t(253) = 16.044$, $P < .001$]. This indicates that the mean per capita kcal per adult equivalent per day for the food secure households in the study area is by far greater than (921 Kcal) that of the mean per capita kcal per adult equivalent per day for the food insecure farm households. Similarly, a study conducted by Million and Muche (2020), and Zemedu and Mesfin (2014) confirmed that there is a statistically significant mean difference in per capita kcal consumption between food secure and food-insecure households.

Table 6.9: Mean per capita Kcal per adult equivalent per day and HH food security status

		Household food security status		T-test for equality of means		
Variable		Food Secure (n=60)	Food Insecure (n=195)	t-value	Sig. (2-tailed)	df
Kcal	Mean	2408.40	1486.85	16.044	.000	253
	SD	414.20	292.901			

Source: Household survey data, 2018

6.5.2. Analysis of Months of Adequate Household Food Provisioning (MAHFP)

Months of adequate household food provisioning (MAHFP) which addresses the reliability and regularity dimension of food security is another indicator of household food access used (Cordero-Ahiman *et al.*, 2018) in this study alongside HFBM and the HDDS. MAHFP measures a household's access to food over the course of the previous 12 months and ensures the household's ability to regularly supply food throughout the year. Food access depends on the ability of a household to obtain food from its own production, purchases, stocks, or through food transfers from donors, government, the community, or relatives. Farm household's access and ability to meet their food needs can vary over the year and depends on several factors such as availability of resources, inadequate crop production by the households mainly due to poor soil quality, inadequate income to purchase agricultural input, natural disasters (drought, flooding, and landslide) as well as social obligations (Bilinsky and Swindale, 2010).

In line with this, an attempt was made to assess and determine the months of adequate household food supply and the length of the food deficit period in the study area and households were asked to identify the number of months they faced food shortages over the last 12 months. The food gap here is defined as the number of months in the past 12 months that a household reported having trouble in meeting their food requirements. Unfortunately, the survey period (2015/2016) coincided with the severe drought year and the worst seasonal food insecurity in the study area under investigation. Hence, according to the survey result presented in Table 6.10, about 94.5% of the sample households reported that they failed to meet the all-year-round food requirements for their household members from their own productions and they were supported by food aid and emergency assistance. This indicates the majority of the surveyed farm households do not regularly produce sufficient food from their own crop production to cover their consumption requirement of all-year-round and could hardly feed their household members until the next harvest season.

Based on the data obtained from the households' self-assessment of food access and their food security levels using the indicator of MAHFP, the surveyed households were classified into three categories. *Category 1: least food insecure (high food access)* includes households that reported being able to satisfy their household food supply for all months (MAHFP = 12) and did not anticipate experiencing any period of food insecurity. *Category 2*: *moderately food insecure (moderate food access)* includes households that can satisfy their food needs for nine months of the year and food insecure only up to three months of the year. C*ategory 3: most food insecure (low food access)* includes households that were food-insecure for more than three months (MAHFP $\leq$ 9) during the previous year (Cordero-Ahiman *et al*., 2018).

Subsequently, results in Table 6.10 revealed that the level of food access as measured by MAHFP was relatively low as 80.4% of the surveyed rural farm households reported difficulties in obtaining adequate food to meet their household needs for three months or more in the past 12 months (MAHFP score of $\leq$ 9; categorized as the most food-insecure households). In addition, about 14.1% of the surveyed farm households have moderate access to food and are classified as moderately food insecure as per the result of MAHFP model analysis. On the other hand, only 5.5% of the surveyed sample households did not experience difficulties (least food insecure) in accessing and obtaining food for their household needs in the past 12 months (MAHFP score of 12). The mean value of MAHFP was also 6.5, which indicates on average, the surveyed rural farm household in the study area has low access to food. In contrast to the findings of this study, Smith and Frankenberger (2018) reported a mean number of months of adequate food as 11 in Bangladesh, indicating that the majority of people have adequate months of food access. Furthermore, according to a study conducted by Cordero-Ahiman *et al*. (2018), the sampled households have an average of 7.83 months of food access.

Table 6.10: Food access measured by months of adequate household food provisioning

MAHFP category (%)	Agro-climatic zone			All household
	Kolla	*Woina-dega*	*Dega*	
Least food insecure	5.0	4.3	6.5	5.5
Moderately food insecure	13.0	12.8	15.7	14.1
Most food insecure	82.0	83.0	77.8	80.4
Mean	6.0	5.9	7.2	6.5
Std. Deviation	2.7	2.7	2.1	2.5

Source: Household survey data, 2018

The model analysis also showed that a significant number of the surveyed households in all of the three agro-climatic zones reported that they had experienced several months of insufficient food provisioning as much as 82% in *kolla*, 83% in *woina-dega* and 77.8% in *dega* agro-climatic zone has low access to food and classified as the most food-insecure farm households. Comparatively, the surveyed farm households in *dega* agro-climatic zone have reported the highest number of months of adequate food provisioning indicating better access to food. However, contrary to expectations, farm households in the woina-dega agro-climatic zone have relatively higher months of insufficient food provisioning, although the difference is insignificant. Results presented in Figure 6.5 showed the kernel density estimation of the distribution of MAHFP for the surveyed sample respondents. As indicated in the Figure, the kernel density estimation of the distribution of the estimated months of adequate household food provisioning for the surveyed farm household is more skewed to the right, indicating that the majority of the sampled household respondents suffered some form of food deprivation and experienced food scarcity. The data revealed that about 59.6% of the surveyed rural farm households had MAHFP of less than the mean (6.5) and the rest 40.4% had MAHFP of greater than the average for the whole sampled respondents, which indicates the majority of the sample households failed to produce sufficient food required for their family and faced the highest number of months of food shortage.

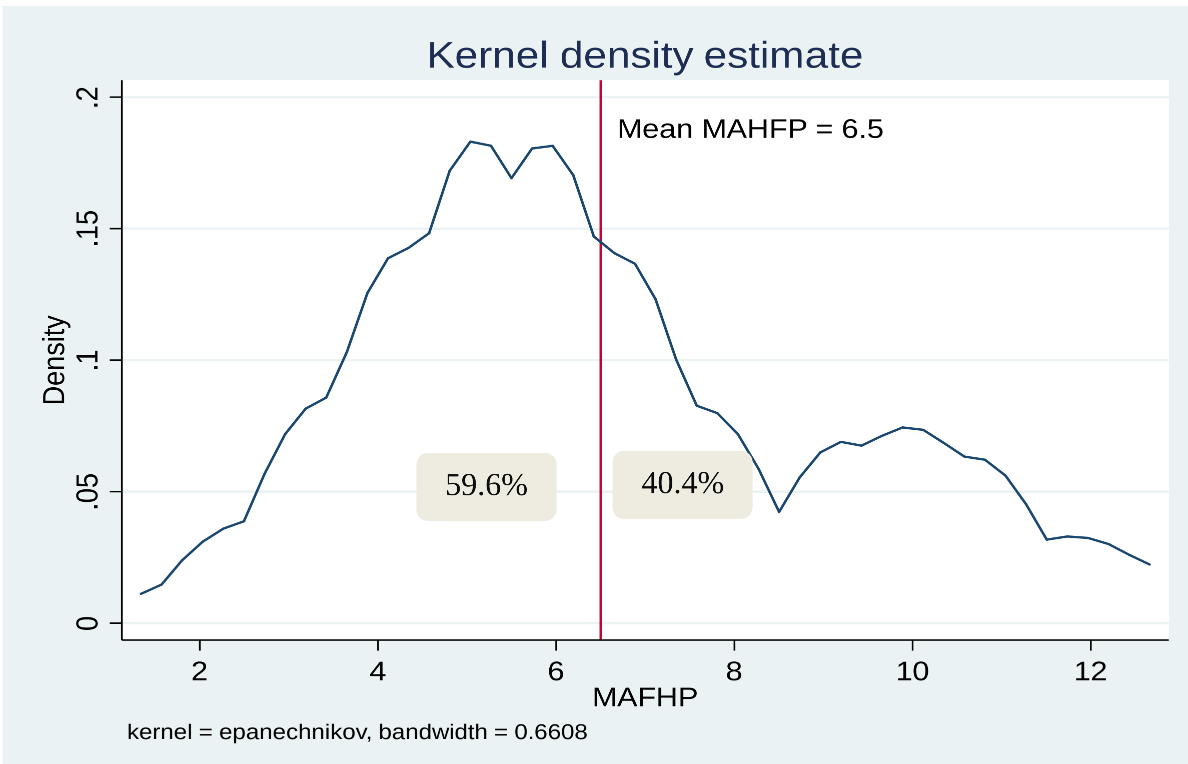

Figure 6.5: Kernel density estimation of months of adequate food provisioning

According to the key informant interviewees and focus group discussion participants most of farm households faced food shortages and seasonal food insecurity even under normal circumstances, mainly because farmers relied on the single harvest of the summer (*meher*) season per year and other related factors. The key informant interviewees and focus group discussants also confirmed that planting and pre-harvest periods (especially, July, August, September, and October) are generally the times when the majority of the households encounter a severe food shortage while harvest and immediately post-harvest periods are the times when food supply is adequate under normal circumstances.

Determinants of Months of Adequate Household Food Provisioning

Results presented in Table 6.11 showed the relationship between the MAHFP scores and continuous variables assumed to determine household food access as measured by MAHFP. As indicated in the Table, the most food-insecure households (category 3) have the lowest average daily per capita kcal intake, a relatively lowest average age of household heads, highest average household size, lowest average land size, the lowest average amount of livestock units (TLU), lowest average HDDS, lowest average production diversity, lowest average per capita income and per capita off-farm income.

As indicated in Table 6.11, variables that are related to better food access of the surveyed households include daily per adult equivalent kcal consumption (P = .000), household size of the surveyed respondents (P = 0.017), land size (P = 0.002), livestock unit (P = .000), household dietary diversity score (P = .016), per capita income (P = .000) and per capita off-farm income (P = .000). The data revealed that the more the farm households diversify their farm production the higher the months of household adequate food provisioning will be. The mean farm production diversity of the least food-insecure household is significantly different from (higher than) the mean farm production diversity of moderately food insecure and most food-insecure households. Moreover, households with higher per capita and off-farm income were found to be more access to food (more months of adequate household food provisioning. Hence, these variables are identified as the factors determining the sustainability of food availability and food security status of the surveyed farm households in the study area.

Table 6.11: Bivariate associations between MAHFP food access and continuous variables

Indicators		MAHFP score category Category 1: Least food insecure	 Category 2: Moderately food insecure	 Category 3: Most food insecure	ANOVA *P*-value
Kcal	Mean	2487.21	2224.79	1558.66	.000***
	SD	397.44	529.09	391.07	
Age	Mean	49.21	45.75	44.27	.076*
	SD	13.70	9.8	7.60	
Household size	Mean	5.86	6.22	6.91	.017**
	SD	1.88	1.59	1.81	
Dependency ratio	Mean	130.99	102.78	109.23	.502
	SD	83.07	63.44	78.17	
Land size	Mean	0.79	0.74	0.60	.002**
	SD	0.46	0.32	0.26	
TLU	Mean	6.02	5.21	3.50	.000***
	SD	2.67	2.14	1.87	
Distance from mkt	Mean	1.14	1.13	1.06	.605
	SD	.55	.53	.45	
Distance from road	Mean	.68	.67	.62	.775
	SD	.58	.53	.49	
HDDS	Mean	4.64	4.47	3.99	.016**
	SD	1.01	1.18	1.18	
Production diversity	Mean	9.64	8.14	7.44	.000***
	SD	1.91	1.62	2.07	
Per capita income	Mean	6038.99	2547.06	888.35	.000***
	SD	5096.14	1266.36	942.44	
Off-farm income	Mean	1323.94	718.58	103.84	.000***
	SD	1296.70	994.37	258.23	

**P* < 0.1; ** *P* < 0.05; ** *P* < 0.01.*

Source: Household survey data, 2018

Results in Table 6.12 indicate the bivariate relationship between the MAHFP score and some of the categorical variables. The results revealed that utilisation of irrigation scheme (*P* = .000), fertilizer (*P* = 0.011), improved seeds (*P* = .012), utilisation of animal manure (P = .072) access to extension services (P = .072), access to credit services (P = .001) and beneficiaries of Productive Safety Net Program (*P* = .007) significantly associated with MAHFP and hence determining the sustainability of food security status in the study area. Conversely, the result portrayed that gender of the surveyed household heads, educational status of the HH, utilisation of herbicides, soil and water conservation practices and agro-climatic zones did not significantly associate with MAHFP.

Table 6.12: Bivariate associations between MAHFP food access and categorical variables

Indicators		MAHFP score category: Category 1: Least food insecure	Category 2: Moderately food insecure	Category 3: Most food insecure	X^2 *P*-value
Gender	Male	5.8	14.6	79.6	.699
	Female	3.4	10.3	86.2	
Educational status	Literate	4.9	19.8	75.3	.210
	Illiterate	5.7	11.5	82.8	
Access to irrigation	Yes	16.1	45.2	38.7	.000***
	No	4.0	9.8	86.2	
Fertilizer	Yes	8.1	18.4	73.5	.011**
	No	2.5	9.2	88.2	
Manure	Yes	5.8	16.4	77.8	.072*
	No	4.2	4.2	91.7	
Improved seeds	Yes	7.6	17.0	75.4	.012**
	No	1.2	8.3	90.5	
Herbicide	Yes	0.0	33.3	66.7	.352
	No	5.6	13.7	80.7	
Credit	Yes	2.0	30.6	67.3	.001***
	No	6.3	10.2	83.5	
Extension service	Yes	5.8	16.4	77.8	.072*
	No	4.2	4.2	91.7	
SWC	Yes	5.3	14.8	79.8	.339
	No	8.3	0.0	91.7	
PSNP beneficiary	Yes	1.3	6.5	92.2	.007***
	No	7.3	17.4	75.3	
Agro-climatic zone	*Dega*	6.5	15.7	77.8	.927
	Woina-dega	4.3	12.8	83.0	
	Kolla	5.0	13.0	82.0	

Association was statistically significant: * $P < 0.1$, ** $P < 0.05$, *** $P < 0.01$.

Source: Household survey data, 2018

Consistent with the finding of this research, a study conducted by Nyikahadzoi *et al*. (2012) revealed that household size, access to credit and utilisation of fertilizers had a statistically significant association with MAHFP reporting the lower the household size, the more access to credit, and chemical fertilizer, the higher months of adequate household food provision. Moreover, a study done by Leah *et al*. (2012) reported that the age of the household and access to irrigation had significantly associated with food access of the households (MAHFP) indicating that the older the age of the household and the more irrigated land area, the higher months of adequate household provisioning.

6.5.3. Analysis of Household Dietary Diversity Score (HDDS)

The Household Dietary Diversity Score (HDDS) refers to the different variety of food groups consumed by households (Jones *et al*., 2013) and it was developed to measure the diversity of food consumption; household food access and an indicator of the adequacy of the diet, one of the pillars of food security (Vellema *et al*., 2016, FAO *et al*., 2020). An increase in the average number of different food groups consumed (higher HDDS) provides a quantifiable measure of improved household access to food and reflects an improvement in the household's diet (Mango *et al*., 2014; Venkatesh *et al*., 2016) which might be used as a household level indicator of the sustainability of rural farm household food security. The dietary diversity score is also one method of measuring dietary quality (Dillon *et al*., 2015) and implies dietary quantity (Vellema *et al*., 2016). Hence, beyond calorie consumption and months of adequate food provisioning, attempts were made to measure the degree of dietary diversity and the quality of diet for the rural farm households in Kurfa Chele *woreda* one of the important factors influencing nutritional outcomes (Sibhatu and Qaim, 2017).

Accordingly, results presented in Figure 6.6 revealed that the surveyed households had an average HDDS of 4.09 out of the twelve food groups indicating that, on average, rural farm households in the study area consumed around four different food groups which are lower than the average food groups (six) consumed by farm households in Ethiopia (Sibhatu and Qaim, 2017). On the other hand, studies conducted by Mengistu *et al*. (2021), Moroda *et al*. (2018) and Workicho *et al*. (2016), respectively reported that household respondents on average consumed 5.73, 6 and 5 variety of food groups. Of the total surveyed sample households, approximately only 17% had consumed greater than six different food groups in contrast to 43%

and 40% had HDDS of three or less and between four to six different food groups, respectively (Figure 6.6). Furthermore, most of the food secure sample respondents (53.3%) fell in the medium dietary diversity category consuming four to five different food groups while almost greater than half (51.3%) of the food insecure households consumed three or less than three different food groups and classified as the lowest HDDS groups. The model also reveals that the proportion of households that consumed less than the mean of the surveyed sample household (4 food groups) is 65.1% while 34.9% consumed greater than the mean of the surveyed households. The survey results revealed that the majority of the households (65.1%) in the study area lack the varieties of dietary diversity reasoned as a pre-condition for a decent healthy life. The average dietary diversity score of the food secure and food insecure sampled farm household in the study area is 4.75 and 3.89, respectively. Hence, the result revealed that the food secure households had by far better food dietary diversity than the food insecure households. This showed that farm households' food security status and DDS are strongly correlated, and their measurements could be substantiated by each other.

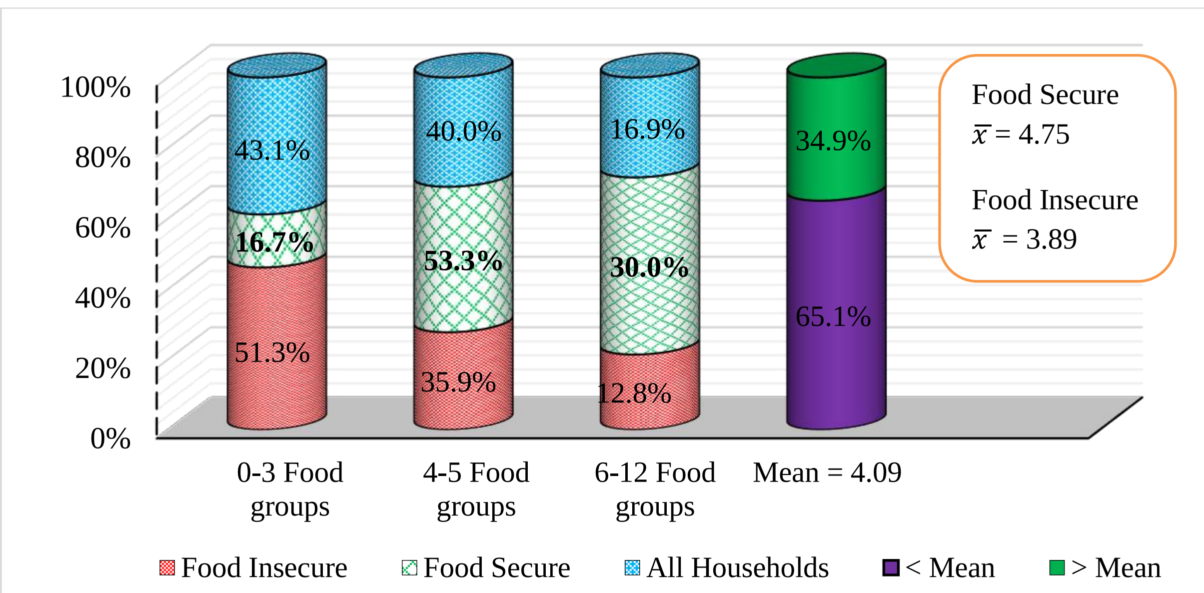

Figure 6.6: Household dietary diversity scores (HDDS) (FAO (2010) cut-offs)

Source: Household survey data, 2018

Using FAO (2010) cut-offs almost 43% of the surveyed farm households had low dietary diversity scores (0-3 food groups) and they were categorized as severely food insecure households, compared to 83% and 65% of the respondents using Chakona and Shackleton

(2018) cut-offs (0-5 food groups) and terciles thresholds (0-4 food groups), respectively (Table, 6.13). Moreover, about 40% of the sample households had moderate dietary diversity scores (4-5 food groups) and were classified as moderately food insecure using FAO (2010) cut-offs compared to 16.9% and 34.9% of the sample respondents being classified at the same level using Chakona and Shackleton (2018) cut-offs and terciles threshold levels. On the other hand, about 16.9% of the surveyed rural farm households reported to have a high level of dietary diversity score and categorized as food secure using FAO (2010) cut-offs while none of the surveyed respondents had been classified as having a high dietary diversity score using both the Chakona and Shackleton (2018) cut-offs and terciles threshold level.

Table 6.13: Proportion of households with different categories of dietary diversity score

Categories of HDDS	FAO (2010) Cut-offs	Chakona and Shackleton (2018) Cut-offs	*HDDS terciles threshold*
	%	%	%
Low HDDS[a,d,g]	43.1	83.1	65.1
Moderate HDDS[b,e,h]	40.0	16.9	34.9
High HDDS[c,f,i]	16.9	-	-

Source: Household survey data, 2018

Note: FAO (2010) cut-offs are [a]0-3, [b]4-5, [c]6-12, Chakona and Shackleton (2018) cut-offs are [d]0-5, [e]6-7, [f]8-12 and Terciles cut-offs are [g]0-4, [h]5-8, [i]9-12.

In terms of agroclimatic analysis, results presented in Table 6.14 revealed that in the *dega* agroclimatic zone, about 47.2% of the households had HDDS of 4 to 5 and 13.9% had a HDDS of 0 to 3. The equivalent figures were 48.9% and 51.1% in *woina-dega* and 28% and 71% in *kolla* agro-climatic zone. Furthermore, about 38.9% of the respondents in *dega* agro-climatic zone had a dietary diversity score of greater than six food groups and only 1% and none of the respondents from *kolla* and *woina-dega* agro-climatic zones had greater than six food groups, respectively. This reveals that households in *dega* agro-climatic zone had a higher dietary diversity score than households in the *woina-dega* and *kolla* agroclimatic zone. For instance, households in *dega* agro-climatic zone consume on average 1.53 and 1.64 more food groups than households in the *woina-dega* and *kolla* agro-climatic zones, respectively.

Table 6.14: Distribution of HDDS by agro-climatic zone in Kurfa Chele *woreda*

Agro-climatic zone	Proportion (%) of households with HDDS 0-3	4-5	6-12	Mean	Std. Deviation
Kolla	71.0	28.0	1.0	3.38	0.722
Woina-dega	51.1	48.9	-	3.49	0.585
Dega	13.9	47.2	38.9	5.02	1.111
Total	43.1	40.0	16.9	4.09	1.190

Source: Household survey data, 2018

Moreover, a significant majority of the households in *woina-dega* and *kolla* agro-climatic zone score a dietary diversity below the average of the surveyed households. These effects are mainly determined by the higher farm production diversity in the *dega* agro-climatic zone than *woina-dega* and *kolla*. The result of one-way ANOVA (Table 6.15) also reveals that there was a statistically significant mean difference in the mean HDDS among the three agro-climatic zones; $F(2, 252) = 101.47$, $P < .000$.

Table 6.15: One-way ANOVA analysis of HDDS by agro-climatic zones

Source of variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	160.47	2	80.237	101.47	.000
Within Groups	199.27	252	.791		
Total	359.74	254			

Source: Household survey data, 2018

Determinants of the Household Dietary Diversity Score

Analysis was also carried out to elucidate potential mechanisms underlying the relationship between household dietary diversity scores and continuous variables presented in Table 6.16. The result in the Table indicated that amount of kcal consumption, household size, landholding size, per capita income, per capita off-farm income, and farm production diversity have had statistically significant relationships with household dietary diversity score. This implies that households with higher farmland, higher per capita income and off-farm income were those households more diversified diet, better access to food and hence thereby improve the food security status of the households. Furthermore, the finding also indicates that HDDS appears positively correlated with crop diversity and farm production diversity implying that, those farm households diversify their crop and farm production, household diversify their diet. Hence, these significant variables were expected to increase the sustainability of rural farm household food security status.

Table 6.16: Analysis of one-way ANOVA for HDDS and continuous variables

		HDDS category				
Indicators		Lower HDDS (0-3)	Moderate HDDS (4-5)	Higher HDDS (6-12)	ANOVA value	*P*-value
Amount of Kcal	Mean	1583.9	1784.1	1819.3	5.633	.004**
	SD	455.3	555.5	467.0		
Age HH	Mean	44.6	44.0	47.0	2.080	.127
	SD	9.3	7,2	8.4		
Household size	Mean	6.5	6.8	7.3	2.841	.060*
	SD	1.9	1.7	1.7		
Dependency ratio	Mean	109.9	115.7	93.7	1.255	.287
	SD	83.1	75.6	57.8		
Total Land Size	Mean	0.59	0.63	0.71	2.448	.089*
	SD	0.31	0.27	0.28		
TLU	Mean	3.8	4.0	3.7	.453	.637
	SD	2.4	2.1	1.5		
MAHFP	Mean	5.5	7.2	7.4	18.516	.000***
	SD	2.3	2.4	2.4		
Per capita income	Mean	807.4	1968.3	1599.2	10.213	.000***
	SD	1147.9	2674.2	951.9		
Per capita off-farm	Mean	161.8	343.2	299.7	2.388	.094*
Income	SD	512.1	774.9	420.1		
Crop diversity	Mean	3.3	4.5	5.9	58.775	.000***
	SD	1.1	1.7	1.2		
Livestock diversity	Mean	3.3	3.6	3.4	1.604	.203
	SD	1.5	1.3	1.0		
Farm production	Mean	6.6	8.1	9.4	39.592	.000***
diversity	SD	1.8	1.9	1.3		

*$P < 0.1$; ** $P < 0.05$; *** $P < 0.01$.*

Source: Household survey data, 2018

Analysis of independent sample t-test for HDDS and some of the categorical variables were also made to see whether there is a statistically significant relationship between dietary diversity and these variables. Accordingly, a significant household dietary diversity relationship was found for the food security status of the household, educational status of the household heads, beneficiaries of PSNP and utilisation of animal manure (Table 6.17). The results indicated that households with food security were more likely to have a diverse diet than their counterparts.

Table 6.17: Analysis of t-test score for HDDS and the categorical variables

Variable		HH Dietary Diversity Score		T-test for equality of means		
		Mean	SD	t-value	Sig. (2-tailed)	df
Food Security	Secure	4.75	1.216	5.118	.000*	253
	Insecure	3.89	1.109			
Education	Literate	4.44	1.285	3.268	.001*	253
	Illiterate	3.93	1.110			
PSNP	Yes	3.49	0.941	-5.609	.000*	253
	No	4.35	1.195			
Gender	Male	4.12	1.192	0.949	.343	253
	Female	3.90	1.175			
Irrigation	Yes	3.97	.836	-0.630	.529	253
	No	4.11	1.232			
Fertilizer	Yes	4.18	1.210	1.182	.238	
	No	4.00	1.164			
Manure	Yes	4.37	1.136	2.442	0.015*	253
	No	3.98	1.196			
Improved Seeds	Yes	4.14	1.200	0.885	.377	253
	No	4.00	1.172			
Credit	Yes	4.08	1.288	-0.082	.935	253
	No	4.10	1.169			
Extension service	Yes	4.14	1.217	1.283	.201	253
	No	3.90	1.057			
SWC	Yes	4.11	1.198	0.777	.438	253
	No	3.83	1.030			

Households with educated household heads were more likely to consume a diverse diet while beneficiaries of the productive safety net program household heads were related to a less diverse diet (Table 6.17). Furthermore, the finding also portrayed that those farm households which are utilised animal manure on their farmlands were found to consume a more diversified diet than that of their counterparts. On the other hand, the result suggests that gender of the household heads, access to irrigation, application of chemical fertilizers, access to improved seeds, credit and extension services do not exhibit any significant impact on the households' dietary score in the study area.

Consistent with the finding of this research Dillon *et al*. (2015) also reported that educational status and production diversity are positively and significantly correlated with HDDS indicating that households with better-educated heads and those who diversified their production, had a more diverse diet than their counterparts. Similarly, a study conducted by Jones *et al*. (2014) in Malawi, confirmed that household size, educational level of the household head, cultivated land area and income from non-agricultural activities are identified as significant variables that influenced dietary diversity. Furthermore, in India, Venkatesh *et al*. (2016) reported that those households with higher production diversity, higher per capita income and higher literacy rates consume more diversified foods than others.

In their study in Mudzi district of Zimbabwe, Mango *et al*. (2014) stated that the educational level of the household heads has a positive influence on dietary diversity indicating households with literate household heads were more likely to be food secure than their counterparts. They also confirmed that livestock wealth had a positive influence on dietary diversity and the food security status of the households. Additionally, Sibhatu *et al*. (2015) in their study on production diversity and dietary diversity in smallholder farm households, reported that farm production diversity and off-farm employment have a positive and significant effect on household’s dietary diversity arguing that more diversified farms and access to off-farm income sources, tends to increase more access to diversified diets and household’s ability to buy diverse foods from the market. Moreover, a study done by Workicho *et al*. (2016) reported that household head's literacy status, livestock ownership and higher months of food access had been found to be significantly and positively associated with higher-level household dietary diversity scores. Likewise, Singh *et al*. (2020) confirmed that dietary diversity was strongly and positively closely linked with food security status, reporting households with lower diversity scores being more likely to be food insecure than households with higher dietary diversity scores.

Correlation between Household Food Balance Model (Kcal), HDDS and MAHFP

Person product-moment correlation coefficients were calculated to examine the associations between the three indicators (Kcal intake, HDDS and MAHFP) of food security status used in this research. Survey results presented in Table 6.18 revealed that household dietary diversity, per capita kilocalorie intake and months of adequate household food provisioning was found positively and significantly correlated with each other. This implied that households with a more diversified diet (higher HDDS) are those households with adequate intakes of Kcal and adequate months of household food provisioning. The result also portrayed that HDDS score is more correlated with MAHFP than Kcal intake (dietary energy supply) while, MAHFP was found to be more strongly correlated with Kcal than HDDS. Furthermore, the finding portrayed that based on the household food balance model (dietary energy supply expressed as Kcal), the finding suggests that about 76.5% of the sample households were regarded as food insecure. On the other hand, the results showed that about 80.4% and 83.1% of the surveyed respondents were regarded as food insecure based on MAHFP and HDDS thresholds, respectively.

Table 6.18: Pearson's correlation coefficient between HDDS, Kcal intake and MAHFP

Food security indicators	Correlation			Food security status	
	HDDS	Kcal	MAHFP	Food secure (%)	Food insecure (%)
HDDS	1.00			16.9	83.1
Kcal Intake (HFBM)	.21*	1.00		23.5	76.5
MAHFP	.33*	.58*	1.00	19.6	80.4

Note: * Significant at 5%

Source: Household survey data, 2018

The finding also revealed that HDDS indicators of food security analysis estimated a relatively higher level of food insecurity among the surveyed farm households than MAHFP and dietary energy supply (Kcal) indicators indicating a higher prevalence of food shortage in the study. On the other hand, HFBM (dietary energy supply in Kcal) estimated a relatively low prevalence of food insecurity (76.5%) as compared to MHAFP (80.4%) and DDDS (83.1%) in the surveyed farm households. Generally, all the three methods of household food security indicators used in this research showed that more than three-quarters of the sampled household respondents are food insecure, indicating the unsustainability of food security status in the study area due to several interrelated factors.

6.6. Extent of Food Insecurity: Incidence, Depth and Severity

To determine the extent of food insecurity among the surveyed households in the study area, Foster-Greer-Thorbecke (FGT) index was employed (Foster *et al*., 1984 cited in Tafesse *et al*, 2015). The Foster-Greer-Thorbecke index is the most used method to estimate the incidence, depth and severity of household food insecurity (Muche *et al*., 2014; Shimeles *et al*., 2011; Tafesse *et al*., 2015). Consequently, the results in Table 6.19, showed the association between some explanatory variables by comparing the incidence, depth and severity of food insecurity among the surveyed households with different characteristics based on the calorie intake approach (HFBM) of the food security indicator. The incidence of food insecurity among the surveyed households in the study area was found to be 76.5% (0.765), indicating that only one-fourth of the sampled households met the minimum recommended daily per capita kcal for subsistence. In comparison with other areas, the food insecurity incidence (0.76) in the study area is higher than 0.58 reported for South-west Nigeria (Akerele *et al*., 2013), 0.68 reported for southern Ethiopia (Eshetu and Guye, 2021), 0.42 reported for south-west Ethiopia (Muche *et al*., 2014) but, lower than 0.77 and 0.79 found in Dodota district in Oromia region of Ethiopia (Dagne, 2016), and south Wollo zone of Ethiopia (Agidew and Singh, 2018), respectively.

The food insecurity gap index (depth) showed that on average 22.7% of the surveyed households consumed less than the recommended minimum caloric intake for an active and healthy life. Hence, the extent of the calorie deficiency gap for the surveyed households in the study area was 476.7 kcal per adult equivalent per day. This indicated that on average a minimum of 477 kcal per adult equivalent per day would be required to get out of the households from and eliminate the food insecurity problem at least in theory. The depth of food insecurity in the study area is higher than 14.21% reported by Aragie and Genanu (2017), 14.76% reported by Mitiku and Legesse (2014), 4.4% reported by Muche *et al*. (2014), and 16.84% reported by Sani and Kemaw (2019) but lower than 31% reported by Eshetu and Guye (202) for southern Ethiopia, 48% reported by Ferede and Wolde-Tsadik (2018) for western part of Ethiopia

(Benishangul-gumuz region). Furthermore, the finding portrayed that the severity of food insecurity (squired food insecurity gap) in the study area was 0.0848 (Table 6.19) indicating that approximately 8.5% of the surveyed farm households in the study area are the most food insecure groups in the sample respondents. In comparison, studies conducted by Aragie and Genanu (2017), Eshetu and Guye (2021), Mitiku and Legesse (2014) and Sani and Kemaw (2019, respectively reported 7.15%, 18%, 7.26% and 7.32% of the severity of food insecurity.

Table 6.19: Incidence, depth and severity of food insecurity in the study area

Variables		Incidence of food insecure	Depth of food insecure	Severity of food insecurity
Agro-climatic zone	*Dega*	72.22	0.2101	0.0691
	Woina-dega	74.45	0.2611	0.1070
	Kolla	82.00	0.2196	0.07902
Household size	1-3	42.86	0.0744	0.0180
	4-6	68.18	0.1659	0.0542
	7-9	83.33	0.2595	0.0962
	10-12	100.00	0.3649	0.1398
Average landholding	>Average	67.74	0.2016	0.0705
	<Average	81.50	0.2357	0.0854
Average TLU (3.88)	>Average	83.33	0.2335	0.0825
	<Average	88.89	0.2661	0.0961
PSNP beneficiary	Non-beneficiary	71.91	0.2101	0.0726
	Beneficiary	87.01	0.2538	0.0971
Educational status	Literate	64.20	0.1664	0.0551
	Illiterate	82.18	0.2497	0.0916
Average		0.7647	0.2272	0.0848

Source: Household survey data, 2018

More specifically, the prevalence of food insecurity was found to be positively correlated with the household size indicating that, the incidence of food insecurity was 2.3 times and 1.5 times higher in households with 10-12 household sizes than in households with 1-3 and 4-6 household size respectively. Moreover, the incidence of food insecurity was 1.9 times higher in households of 7-9 household sizes than in households with 1-3 household sizes (Table 6.19). Generally, the finding showed that the incidence, depth, and severity of food insecurity increased with greater household size as was also reported by Akerele *et al*. (2013).

According to the study's findings (shown in Table 6.19), the incidence of food insecurity increased as the proportion of landholding size and TLU in the household decreased. Furthermore, the prevalence of food insecurity was also found to be higher among the beneficiary of PSNP (87.01%) compared to their counterparts (71.90%). Additionally, the incidence of food insecurity was higher in *kolla* (82%) and lower in *dega* agro-climatic zone (72.2%). However, in the case of depth and severity of food insecurity, it was higher in *woina-dega* than *dega* and *kolla* agro-climatic zone. Concerning the educational status, the incidence of food insecurity for illiterate household heads was 1.3 times higher than the literate household heads. Likewise, the depth and severity of food insecurity were also higher in illiterate household heads than in literate households.

Consistent with the finding of Akerele *et al*. (2013) in Nigeria, the severity and depth of food insecurity were higher among household heads with a low level of education (illiterate), suggesting that education is a critical factor in a household's food security status. This is mainly since education leads to improvement in human capital and impacts labour productivity and wages.

6.7. Perceived Causes of Food Shortage and Factors Affecting Sustainability of Food Security

Under this sub-heading, the perception of the surveyed household's self-assessment of the sustainability of their food security status, the causes of food shortage and the main reasons for the unsustainability of food security in the study area were presented. Although it is highly subjective in nature and perhaps too easy to manipulate in programmatic contexts, several self-assessment food insecurity measures have been introduced in recent years (Headey cited in Maxwell *et al*., 2014). These include self-assessments of current food security status in a recent recall period and the change in livelihood status over a long period of time. Accordingly, the surveyed farm households in the study were asked about the sustainability of their food security status and 98% of the surveyed respondents reported that their food security status was not sustainable over the last 15 years. Furthermore, an attempt was made to identify the main bottlenecks affecting the households' agricultural productivity and food insecurity.

Farmer households may face seasonal food shortages because of their inability to produce adequate food which can be attributed to multiple factors. These factors are related to several perceived environmental, economic, socio-demographic and institutional constraints. Hence, since all these factors cannot have an equal magnitude of influence upon every farm household, the household survey instrument was designed in such a way that, the surveyed households responded with their perceptions of each variable by rating either as 'highest effect', 'medium effect', low effect' and 'no effect' on their food production and sustainability of food security. Then, point score analysis was employed to analyse the data and in identifying the main perceived causes of food shortage and factors affecting the sustainability of their food security status.

Based on the survey result depicted in Table 6.20 it appears that among the listed constraints forwarded for inquiry as a possible cause of food shortage that influence the sustainability of food security status of the surveyed respondents, the environmental and economic factors were accounts for the largest share. About 96.8% and 61.6% of the survey respondents identified and reported drought/unreliability of rainfall and poor soil fertility, respectively, are among the environmental factors that were perceived as a medium and highest effect on agricultural productivity causing food shortage and influencing the sustainability of the rural households' food security status. Inability to produce ample grains and inability to access nutritious foods are among the economic factors that were identified and reported by 94.8% and 93.85% of the surveyed sample respondents as a medium and the highest effect on their food security status. Moreover, about 85.9%, 85.2% and 84.4% of the surveyed households in the study area also reported that shortage of farmland, failure to utilise irrigation and inability to rear livestock, respectively, as a medium and highest effects perceived to cause food shortage and affects the sustainability of their food security status. In addition, large household size (high population pressure) and poor access to social infrastructure are among the socio-demographic factors that were reported by 61.9% and 33.3% of the surveyed households, respectively, perceived to cause food shortage and affect their food security status.

Table 6.20: Perceived causes of food shortage and unsustainability of food security

Reason for unsustainability of food security	Level of effect (%)				
	Highest effect	Medium effect	Low effect	No effect	Applicability (%)
Environmental Factors					
Drought (Unreliable rainfall)	90.1	6.7	3.2	0	96.8
Poor soil fertility	6.3	55.3	37.3	1.2	61.6
Pest and diseases	-	14.5	70.2	15.3	14.5
Weed	-	5.1	56.1	38.8	5.1
Economic factors					
Inability to produce sufficient grains	60.5	34.3	5.2	0	94.8
Shortage of farmland	60.4	25.5	14.1	0	85.9
Inability to rear livestock	22	62.4	15.7	0	84.4
Poor farming technology	4.3	72.9	22.7	0	77.2
Inadequate income from non-farm activities	3.1	66.3	28.6	2	69.4
Inability to access nutritious food	26.3	67.5	5.9	0.4	93.8
Failure to utilise irrigation	43.1	42.1	13.7	0	85.2
Lack of access to appropriate technologies	2.4	56.1	41.6	0	58.5
Socio-demographic Factors					
Large household size	18.8	63.1	14.5	3.5	81.9
Poor access to social infrastructure	0.8	32.5	56.9	9.8	33.3
Group member participation	0	1.6	58.8	39.6	1.6
Poor social and communication network	0	12.2	56.5	31.4	12.2
Institutional Factors					
Inadequate extension services	0	44.3	54.9	0.8	44.3
Lack of access to credit	0.4	60.0	37.6	2.0	60.4
Poor storage	0	1.6	45.1	53.3	1.6
Lack of training and skills	0	44.3	52.9	2.7	44.3
Poor access to market	0	29.4	59.2	11.4	29.4
Poor access to media	0	0	31.0	69.9	-
Poor access to mobile phone	0	0	22.0	78.0	-

Note: *I. The scores given to the responses were: 0 for no effect, 1 for low effect, 2 for medium effect and 3 for high effect. Response values were then multiplied by the number of respondents in the table and summed up to get total scores.*

II. Percent of applicability refers to the sum of the percentage of farmers that reported the factor to be severe (highest effect) and moderate (medium effect).

Source: Household survey data, 2018

On the other hand, lack of access to credit, inadequate extension services and lack of training and skills are among the institutional services/factors that were reported by 60.4%, 44.3% and 44.3% of the surveyed household respondents, respectively, perceived to cause food shortage and thereby impact the sustainability of their food security status. Drought or unreliable and shortage of rainfall, inability to produce sufficient grain, inability to access nutritious food, shortage of farmland, failure to utilise irrigation and inability to rear livestock are among the factors that were reported as the main perceived cause of food shortage that influences the sustainability of the rural farm household food security status. In contrast, weed, access to media, access to mobile phones, group member participation and poor storage facility are among the factors that were reported to have an insignificant impact on the food security status of the surveyed households. Key informant interview and focus group discussion participants also confirm that drought, unreliable and shortage of rainfall, shortage of farmland, and rapid population growth are among the main factors causing food shortage and influencing the sustainability of food security status in the study area.

6.8. Summary

The chapter presented findings related to the first objective of the research paper, concerned with the food security status quo of the surveyed rural farm households in the study area and its (un)sustainability. In doing so, the chapter highlights the characteristics of agricultural production of sampled rural farm households and econometric analysis of the food security status of the sample respondents such as household food balance model, months of adequate household food provisioning, household dietary diversity score and Foster-Greer-Thorbecke index that were used to estimate the status, incidence, depth and severity of food insecurity among the sample farm households in the study area.

More specifically, the chapter presents the results of the study obtained from the surveyed rural farm households in the study area on crop and livestock production, production diversity, trends, and challenges of agricultural production. The study highlights that sorghum and maize account for the highest share of crop production followed by wheat and barley. With an average of 14.49 quintals, farm households in *dega* agro-climatic zone produced relatively higher crops than farm households in *woina-dega* and *kolla* agro-climatic zones while the *kolla* agro-climatic zone relatively produces more livestock than others. The finding also showed that drought and erratic rainfall (delayed onset and early cessation of rainfall), poor soil quality, and small landholding are among the major factors perceived, identified, and frequently reported by the rural farmers causing the variation and declining trends in crop production and productivity in the area.

The finding portrayed that about 76.5% of the sample households are regarded as food insecure based on HFBM (Kcal) while, about 80.4% and 83.1% of respondents are regarded as food insecure based on MAHFP and HDDS thresholds, respectively. The overall incidence of food insecurity was 76.5 % while the depth of food insecurity expressed as the average per cent increase in calories required to meet the recommended daily requirement was 22.3 % as per HFBM. The surveyed farm household's self-assessment results also portrayed that for about 98% of the respondents their food security status was not sustainable over the last 15 years mainly attributing to different environmental, economic, socio-demographic, and institutional factors. This implies that smallholder rural farm households in the study area are vulnerable to poverty and food insecurity due to recurrent occurrence of drought and unreliable rainfall patterns, poor soil fertility, shortage of farmland, lack of access to credit, inadequate extension services, poor access to social and rural infrastructure, large household size, inability to produce sufficient grains and rear livestock, shortage of water and lack of access to irrigation infrastructure and their dependency on rain-fed agriculture. To sum up, the overall finding of the result implied that food security is not sustainable in the study area as each of the three parametric methods used to measure the level of food security revealed more than three-quarters (75%) of the sample households have been food insecure. Furthermore, if the current trend of poverty and food insecurity persist, achieving sustainable food security and ending poverty in all its form in the study area is profoundly challenging putting the country significantly off-track in achieving the zero-hunger target (SDG 2) in 2030.

CHAPTER SEVEN

BIVARIATE ANALYSIS OF FOOD SECURITY STATUS QUO, FARMERS ACCESS TO PRODUCTIVE ASSETS AND SUSTAINABILITY OF FOOD SECURITY

7.1 Introduction

Most rural farmers in Ethiopia, in general, and those in the study area in particular are dependent on rain-fed agriculture as a source of food and income. Nevertheless, the agricultural systems in the country as a whole and the study area were characterized by small-scale subsistence farming, low level of production and productivity and highly sensitive to weather-related shocks. As a result, the smallholder rural farmers are failed to produce sufficient food required for their family members and are found to become food insecure in many parts of the country. Moreover, food insecurity is a real and serious challenge to the life and livelihood of most of the rural farmers in Ethiopia. The problem of food insecurity in Ethiopia is caused by several interrelated factors mainly due to insufficient supply of food, rapid population growth, lack of access to resources, climate change, political instability, deforestation, land degradation, and among others demographic, and socio-economic factors.

Consequently, this chapter intended to address the second objective of the study, which mostly describes the level of rural farmers' access to different productive assets in view of their implication on the sustainability of food security status of the surveyed household respondents. More specifically, the chapter explores the bivariate relationship between the various demographic, socio-economic and institutional variables, and the food security status of the sample households in the study area. Hence, under this chapter, the separate effect of each independent variable (categorized under household socio-demographic characteristics, resource endowment and asset possession, agricultural extension services and input utilisation, market, and road availability) on the dependent variable (household food security status or daily per capita kcal availability) has been computed using different descriptive and inferential statistics as presented below. The association between each explanatory variable and household food security status is examined by cross-tabulating (using the chi-square test) each predictor variable against the dependent variable to see whether there is a statistically significant relationship between the two variables. Moreover, an independent t-test and a one-way ANOVA were also computed for some variables to examine whether there is a statistically significant mean difference among the surveyed households in terms of their food security status.

7.2. Household Socio-demographic Characteristics and Food Security Status

7.2.1. Age of the Household Heads and Sustainability of Food Security

Age of the household heads is one of the important demographic explanatory variables expected to positively influence the sustainability of the surveyed rural farm household food security status. Hence, the older household heads are expected to be more likely food secure than the younger household heads and as a result, their per capita kcal availability per adult equivalent per day is higher than that of the younger age household heads. This is mainly due to the older household heads have a relatively richer experience of the social and physical environments and they are expected to have greater experience in farming activities, a stable economy in farming and better access to land than the younger household heads (Shimeles *et al*., 2011; Wiranthi *et al*., 2014). In line with this, to test the hypothesis a one-way ANOVA was computed on the per capita kilocalorie availability per adult equivalent per day for the surveyed households to see whether it is a statistically significant mean kcal difference among the different households' age groups.

As it is shown in Table 7.1, the older household age groups appear with a greater mean per capita kilocalorie per adult equivalent per day than the younger household age groups. In addition, the results (Table 7.1) also reveal that the mean per capita kilocalorie per adult equivalent per day available for the two extreme household age groups was found to be greater than that of the households in the middle age groups. This happens mainly because households in the two extreme age groups have lower household sizes than their counterparts which in turn, has an impact on the per capita kilocalorie available for the households.

Table 7.1: Per capita Kcal available for the surveyed household by age groups

Age groups	F	Kilocalorie per adult equivalent per day		
		Mean	SD	Std. Error
25-31	9	1937.54	501.65	167.65
32-38	38	1661.95	401.89	65.20
39-45	109	1684.71	508.54	48.71
46-52	62	1617.02	373.30	47.41
53-59	22	1472.70	402.60	85.84
60-66	7	2317.82	751.54	284.06
67-73	6	2654.11	642.29	262.21
74-80	2	2704.93	392.10	277.26
Total	255	1703.68	508.71	31.86

Source: Household survey data, 2018

As can be seen from Table 7.2, the F statistic of the one-way ANOVA procedure has been computed for further explanation of these apparent differences. Levene's test of homogeneity of variance assumed statistically significant indicating that the selected variables are suitable for analysis. Results presented in Table 7.2 indicated that there was statistically a significant mean difference in the per capita kilocalorie available per adult equivalent per day among the eight age groups of the surveyed household heads at a 1% significance level; $F(7, 247) = 8.124$, $P < .000$. A post hoc multiple comparisons using the Tukey HSD test (equal variances of the level of the variable are assumed) was also computed to see which age groups differed significantly in mean daily per capita kilocalories available.

Table 7.2: Summary of one-way ANOVA for daily per capita Kcal by age groups

Source of variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12302079.65	7	1757439.950	8.124	.000
Within Groups	53429815.50	247	216315.043		
Total	65731895.15	254			

Source: Household survey data, 2018

The result of Tukey test in Table 7.3, indicated that the mean daily per capita kcal of the household heads belongs to the age group of 32-38 years (M = 1661.95, SD = 401.89) was statistically significantly different from the mean daily per capita kcal of the household heads belongs to the age groups 60-66 years (M = 2317.82, SD = 752.54), 67-73 years (M = 2654.11, SD = 642.29) and 74-80 years (M = 2704.93, SD = 392.10).

Table 7.3: Multiple comparisons of the household age groups and daily per capita Kcal

	HH age group (I)	HH age group (J)	Mean Difference (I-J)	Std. Error
Tukey HSD	32-38	60-66	-655.866*	191.297
		67-73	-992.165**	204.316
		74-80	-1042.979*	337.417
	39-45	60-66	-633.107*	181.347
		67-73	-969.406**	195.031
		74-80	-1020.220*	331.877
	46-52	60-66	-700.795*	185.448
		67-73	-1037.094**	198.850
		74-80	-1087.908*	334.135
	53-59	60-66	-845.116*	201.828
		67-73	-1181.415**	214.208
		74-80	-1232.229*	343.497

* and ** refers to the mean difference is significant at the 0.05 and 0.01 levels respectively.

Source: Household survey data, 2018

Moreover, the mean daily per capita kcal available for the household heads belongs to the age groups of 39-45 years (M = 1684.71, SD = 508.54), 46-52 years (M = 1617.02, SD = 373.30) and 53-59 years (M = 1472.70, SD = 402.60) was also statistically significantly different from the mean daily per capita kcal of the household heads belongs to the age groups of 60-66, 67-73 and 74-80 years. However, for the other household heads' age groups, comparisons of mean daily per capita kcal were not significantly different from one another ($P > .05$).

Additionally, as it is hypothesized in chapter four of this thesis, the t-test value (Table 7.4) also confirm that there was statistically a significant difference in the mean age between the food secure (M = 47.48, SD = 11.58) and food-insecure household heads (M = 43.91, SD = 6.97); [t(253) = 2.926, $P < .01$]. These results suggested that the age of the household heads does have an impact on the food security status of the households, and it indicates the mean age of the food secure household heads is relatively greater than the mean age of the food insecure household heads. Similarly, studies conducted in different parts of Ethiopia by Mitiku *et al*. (2012) and Bimerew and Beyene (2014) also found a statistically significant relationship between the age of the household heads and their food security status. The mean age of food-insecure household heads is less than the mean age of food-secure household heads. Moreover, studies conducted by Wiranthi *et al*. (2014) and Silvestri *et al*. (2015) also revealed that there is statistically a significant mean difference between the mean age of food secure and food insecure household heads indicating that older households tend to be relatively more food secure than the younger household heads. However, contrary to these results, studies conducted by Muche *et al*. (2014), Million and Muche (2020), Tefera T. and Tefera (2014) did not find a significant mean age difference between the food secure and food-insecure households.

Table 7.4: The surveyed sample household heads age by the status of food security

		Household food security status		T-test for equality of means		
Variable		Food Secure (n=60)	Food Insecure (n=195)	t-value	Sig. (2-tailed)	df
HH age	Mean	47.48	43.91	2.926	.004	253
	SD	11.58	6.97			

Source: Household survey data, 2018

7.2.2. Gender of the Household Heads and Sustainability of Food Security

Gender of the household head is also a demographic variable, which is expected to have an impact on the food security status of the surveyed farm households in the study area. In line with this, the chi-square test of association was computed to see whether there is a statistically significant difference in food security status among male and female-headed households in the study area. Accordingly, the study result presented in Table 7.5 revealed that of the total male-headed households about 23.5% of them were food secure and the rest 76.5% were food insecure. On the other hand, out of the total female-headed household sampled respondents, about 24.1% of them were food secure and the remaining 75.9% were food insecure. This finding suggested that there is a relatively higher food security status among female-headed households than male-headed households in the study area. However, contrary to expectations, this study did not find a significant difference in food security status between male-headed and female-headed households in the study area. This indicates that statistically there is no association between the gender of the sample respondents and their food security status. A possible explanation for this might be since female-headed households in the study area engaged in different types of non-farm activities such as firewood selling, charcoal selling, petty trading and khat trading, which may offer an alternative opportunity to enlarge their income to purchase food. Another possible alternative explanation of this finding might be due to the fact the number of female-headed households that participated in this research is by far less than the number of male-headed households as sampling was based on their proportion. This finding is consistent with that of Muche *et al*. (2014); Zemedu and Mesfin (2014); Gemechu *et al*. (2016) who also find out there is no statistically significant association between food security status and the gender of the sample respondents

Table 7.5: Household food security status by gender of the sample respondents

Gender of the household heads	Food secure		Food insecure		χ^2-square test of association		
	F	%	F	%	df	χ^2	*P*-value
Male HHH	53	23.5	173	76.5	1	.007	.935
Female HHH	7	24.1	22	75.9			

Source: Household survey data, 2018

Contrary to the finding of this research, a study conducted by Tibesigwa and Visser (2015) in South Africa indicated that male-headed households were observed relatively higher food security status than female-headed counterparts. Furthermore, studies conducted by Mitiku *et al*. (2012) and Zakari *et al*. (2014) also suggested that female-headed households were found to be more vulnerable to food insecurity compared to male-headed households.

7.2.3. Household Size, Dependency Ratio and Sustainability of Food Security

Household size is another demographic explanatory variable with implications for household food security, and it is mentioned as one of the main predicting variables for the food security status of rural households in most literature. For most of rural farm households with limited access to farmland and limited finance to purchase modern agricultural inputs, an increase in household size tends to exert more pressure on consumption than on the labour force it contributes to production (Goshu *et al*., 2013).

Consequently, households with smaller household members are expected to be more likely food secure than households with larger household members and thereby their daily per capita kcal available per adult equivalent is higher than that of households with larger household members. Hence, the total number of persons living in the household is expected to be negatively correlated with the sustainability of household food security status as food requirements increases in relation to the number of persons in a household. In line with this, a one-way ANOVA was computed to see whether there is statistically a significant mean daily per capita kilocalorie availability per adult equivalent between the different household size groups. Accordingly, the description of the mean daily per capita kilocalorie available per adult equivalent for the household size categorized into different groups was presented in Table 7.6. Levene's test statistics for homogeneity of variance with a significant value of less than .001 showed variances for daily per capita Kcal per adult equivalent for each of the household size groups do indeed differ significantly. For the surveyed sampled respondents in the study area, the amount of daily per capita Kcal per adult equivalent varies between a narrow variance for the household size group of 10-12 of 176.46^2 (= 31,138.13) to a much wider variance for the household size group 1-3 of 620.39^2 (= 384,883.75).

Table 7.6: Daily per capita Kcal available for the surveyed respondents by household size

HH size	F	Kilocalorie per adult equivalent per day		
		Mean	SD	Std. Error
1-3	14	2337.06	620.39	165.81
4-6	88	1872.74	555.78	59.25
7-9	138	1571.83	389.99	33.20
10-12	15	1333.72	176.46	45.56
Total	255	1703.68	508.71	31.86

Source: Household survey data, 2018

As it is depicted in Table 7.6, households having smaller household sizes appear with a greater mean per capita kilocalorie per adult equivalent per day than the households with larger household sizes. For instance, households having one up to three household sizes have a daily per adult equivalent mean per capita kilocalorie of 2337 while households with four up to six, seven up to nine and 10-12 household sizes have a daily per adult equivalent mean per capita kilocalorie of 1872, 1571 and 1333, respectively. This data reveals that the daily mean per capita kilocalorie per adult equivalent available for the household decreases with an increase in household size. As it is shown in Table 7.7, the F statistic of the one-way ANOVA procedure has been computed for further explanation of these apparent differences.

Table 7.7: Summary of one-way ANOVA for daily per capita available Kcal and HH size

Source of variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12583589.06	3	4194529.688	19.809	.000
Within Groups	53148306.08	251	211746.239		
Total	65731895.15	254			

Source: Household survey data, 2018

Results presented in Table 7.7 indicate that there was statistically a significant difference in the mean per capita kilocalorie available per adult equivalent per day between the four household size groups of the surveyed respondents at 1% significance level; $F(3, 251) = 19.809$, $P < .001$. Post hoc comparisons using the Tukey HSD test (Table 7.8) indicated that the mean kcal for households with one to three household sizes (M = 2337.06, SD = 620.39) was significantly different than the households with four to six (M = 1872.74, SD = 555.78), seven to nine (M = 1571.83, SD = 389.99) and 10 -12 household sizes (M = 1333.72, SD = 174.46). However, there was no statistically significant difference in mean daily per capita kcal between households having seven to nine and 10-12 household size groups ($P = .229$). Taken together, these results suggest that a high number of household sizes really do have an effect on the availability of daily per capita kilocalories.

Table 7.8: Multiple comparisons of the household size and available daily per capita Kcal

	HH size group (I)	HH size group (J)	Mean Difference (I-J)	Std. Error
Tukey HSD	1-3	4-6	464.311*	132.404
		7-9	765.223*	129.070
		10-12	1003.334*	171.000
	4-6	1-3	-464.311*	132.404
		7-9	300.912*	62.774
		10-12	539.023*	128.540
	7-9	1-3	-765.223*	129.070
		4-6	-300.912*	62.774
		10-12	238.111	125.103
	10-12	1-3	-1003.334	171.000
		4-6	-539.023*	128.540
		7-9	-238.111	125.103

*. The mean difference is significant at the 0.05 level

Source: Household survey data, 2018

In addition to the one-way ANOVA analysis, an independent-sample t-test was also conducted to see whether there is statistically a significant mean difference in the average household size and dependency ratio between the food secure and food insecure sample respondents. Consequently, as it is shown in Table 7.9 the computation of the t-test value confirm that there was statistically a significant difference in the mean household size between food secure household respondents (M = 5.83, SD = 1.72) and food-insecure household heads (M = 7.04, SD = 1.74); [t(253) = 4.690, *P* < .001]. This indicates that farm household with larger family size tends to be more food insecure than their counterparts. Consistent with the result of this study, Muche *et al*. (2014) disclosed that there is statistically significant inverse relationship between household size and food security status of the households mainly because most of the family members are in the economically inactive age group creating more pressure on the household's food security status as they have no contribution to production. Moreover, studies conducted by Bimerew and Beyene (2014), Million and Muche (2020), Zemedu and Mesfin (2014) and Silvestri *et al*. (2015) also showed a statistically significant relationship between household size and their food security status indicating the food insecure households tend to have larger family size compared with the food secure households. The finding is also consistent with those of Gemechu et al. (2016) and Silvestri et al. (2015), who found that the average household size was smaller in food secure households than in food insecure households, indicating that larger household sizes have a negative impact on food (calorie) availability.

Table 7.9: Sample household size and dependency ratio by the status of food security

Variables		Household food security status: Food Secure (n=60)	Household food security status: Food Insecure (n=195)	T-test for equality of means: t-value	Sig. (2-tailed)	df
HH Size	Mean	5.83	7.04	-4.690	.000	253
	SD	1.72	1.74			
Dependency ratio	Mean	106.59	110.41	-0.338	.736	253
	SD	72.12	77.92			

Source: Household survey data, 2018

The dependency ratio, which is measured as the total number of economically inactive members of the households divided by the number of individuals in working-age groups supporting these households, was also hypothesized to influence the food security status of the farm households. However, though the average dependency ratio of food insecure sample household in the study area was a little bit greater than that of the food secure sample household respondents, the independent-sample t-test result reveals that there was no statistically significant mean difference in the dependency ratio between the food insecure ($M = 110.41$, $SD = 77.92$) and food secure households ($M = 106.59$, $SD = 72.12$); [$t(253) = .338$, $P = .736$]. The finding of this research was similar to studies conducted by Aragie and Genanu (2017) and Tefera T. and Tefera (2014). Contrary to the finding of this research studies conducted by Muche *et al*. (2014) and Gemechu *et al*. (2016) where showed there was statistically a significant difference in the mean dependency ratio between the food secure and food insecure sample respondents indicating that the number of dependent individuals was higher among food-insecure households than their counterparts.

7.2.4. Educational Status of the Household Heads and Sustainability of Food Security

Educational attainment of the household head is one of the explanatory human capital variables which refers to the knowledge, skills, and ability of the household to engage in different work to pursue their livelihood strategies and achieve the desired livelihood objectives (Adjimoti and Kwadzo, 2018; Ahmed, 2016; Alemaw and Hailu, 2019; Alpízar *et al*., 2020; Davidson *et al*., 2014; Fikire and Zegeye, 2022; Ferede and Wolde-Tsadik, 2018). Hence, education is a key to the improvement of household livelihoods and food security since educated household heads are expected to have a better chance of managing their farmland by adopting soil and water conservation measures, their capacity to innovate and adopt new skills and adopt timely technology which in turn increases the total crop production (Abafita and Kim, 2014; Alpízar *et al*., 2020; Henri-Ukoha *et al*., 2013; Wiranthi *et al*., 2014). It could also lead to awareness of the possible advantages of modernizing agriculture and can have a positive contribution toward food security and better living standard for rural households. Moreover, an educated household is assumed to be a better adopter of new technologies, such as the use of modern chemical fertilizers, improved seeds, herbicides, and so on, which increases the productivity of farmer households and their level of food security. Subsequently, the Pearson chi-square test of association was computed to test whether there is statistically a significant relationship between the educational status of the surveyed household heads and their food security status (Table 7.10).

Table 7.10: Chi-square test relationship between the educational status and food security

Educational Status	Food Secure		Food Insecure		χ^2-square test of association		
	F	%	F	%	df	χ^2	*P*-value
Illiterate	31	17.8	143	82.2	1	9.937	.002
Literate	29	35.8	52	64.2			
Total	60	23.5	195	76.5			

Source: Household survey data, 2018

Results in Table 7.10 revealed that from the total surveyed literate farm household heads in the study area, about 35.8% were food secure and the remaining 64.2% were food insecure. Similarly, of the total illiterate sampled household heads of the study participants, about 17.8%

were food secure and the rest 82.2% were food insecure. Moreover, the results of the Pearson chi-square test of association revealed that (Table 7.10) there is statistically a significant association between the educational status of the surveyed household heads and their food security status [χ^2 (1) = 9.937, p < .005] at 5% significance level, indicating that the literate and illiterate household heads were not the same regarding their food security status. In addition, this evidence in turn pointed out that food security status was strongly associated with the educational status of the surveyed household heads.

The finding of this research is similar to studies conducted by Henri-Ukoha *et al*. (2013), Abafita and Kim (2014), Bimerew and Beyene (2014), Muche *et al*. (2014) and Wiranthi *et al*. (2014) which stated that the educational status of the household heads is positively and significantly related to the food security status and finally an increase in the educational level of the household heads would increase the probability of the households to become food secure. On the other hand, household heads headed by illiterate farm households were more likely exposed to the risk of food insecurity than literate household heads because of the differences in the level of awareness to apply modern agricultural technologies and livelihood diversification. However, contrary to this finding, studies done by Gemechu *et al.* (2016), Million and Muche (2020) and Zemedu and Mesfin (2014) showed that there is no statistically significant relationship between the educational status of the farm household heads and their food security status.

7.3. Resource Endowment, Asset Possession, and Sustainability of Food Security

7.3.1. Livestock Availability and Sustainability of Food Security

The availability of livestock in many countries of the world was often used as an indicator of the wealth status of the farm households and it also plays an important role in determining the sustainability and food security status of the rural households. Additionally, livestock ownership is one of the prominent strategic household assets as it is the main source of wealth and cash income for rural households, means of transportation, source of traction power, supplementary food, source of meat and milk products, supply manure to improve soil fertility and a reserve asset that can be utilised whenever farmers face food shortage caused by crop failure (Abafita and Kim, 2014; Silvestri *et al*., 2015). Hence, livestock ownership significantly and positively correlated with the sustainability of the rural farm household's food security status indicating that a household with a relatively large livestock size was found to be less likely vulnerable to food insecurity and it is hypothesized that the food secure households have larger livestock possession than the food insecure households.

For more elaboration and test of the hypothesis, an independent-sample t-test was computed to see whether there is a statistically significant difference in mean livestock holding in terms of tropical livestock units between the food secure and food-insecure farm households. Consequently, the results depicted in Table 7.11 revealed that the test was statistically significant and the mean livestock holding for the food secure and food insecure farm households were 5.19 TLU and 3.47 TLU with a standard deviation of 2.08 TLU and 1.95 TLU, respectively; t(253) = 5.886), $P < 0.001$. This result indicated that consistent with the literature, farm households with a relatively larger number of livestock were found to be more likely food secure than farm households with a smaller number of livestock.

Table 7.11: Livestock holding and food security among farm households

		Household food security status		T-test for equality of means		
Variable		Food Secure (n=60)	Food Insecure (n=195)	t-value	Sig. (2-tailed)	df
TLU	Mean	5.19	3.47	5.886	.000	253
	SD	2.08	1.95			

Source: Household survey data, 2018

The result of this finding is consistent with that of Mitiku *et al*. (2012), Tefera T. and Tefera (2014) and Zemedu and Mesfin (2014) who reported that TLU has a positive and significant relationship with the food security status of the households. Furthermore, Gemechu *et al*. (2016) also reported that the food secure households had relatively large livestock expressed in TLU than the food insecure households and they reported there is statistically significant mean difference in TLU between the two groups.

7.3.2. Farmland Size and Sustainability of Food Security

The availability of and accessibility to farmland is one of the natural capitals (Li *et al.*, 2020; Sati and Vangchhia, 2016) and an explanatory variable which has an impact on the livelihood diversification of the rural farm households and the sustainability of their food security status. Access to an adequate amount of farmland is one of the most important determinants of rural household productivity and food security status. Hence, land is one of the basic inputs in farming and the most fundamental factor in determining the diversification of crop and animal production in the rural economy, which is essentially related to the sustainability of the rural households' food security status, and it is an important variable in mitigating the risk of food insecurity problem (Shimeles *et al*., 2011). Moreover, the presence of sufficient farmland size in the farm household also encourages them to adopt and use new agricultural technologies such as the application of chemical fertilizers, improved seeds, pesticides, herbicides and so on which boosts the productivity of their agricultural yields and in turn have an implication on their food security status. Thus, households with large farmland sizes are expected to be more likely food secure than households with smaller farmland sizes. In line with this, an analysis was conducted to determine whether there is statistically significant mean difference in landholding size between the food-secure and food-insecure farm households in the study area (Table 7.12).

Table 7.12: Farmland size of the surveyed households by the status of food security

		Household food security status		T-test for equality of means		
Variable		Food Secure (n=60)	Food Insecure (n=195)	t-value	Sig. (2-tailed)	df
Land size	Mean	0.76	0.59	4.028	.000	253
	SD	0.36	0.25			

Source: Household survey data, 2018

Results depicted in Table 7.12 indicated that the mean farmland holding size of the surveyed households in the study area for the food secure and food insecure households was 0.76 and 0.59 hectares with a standard deviation of 0.36 and 0.25 hectares, respectively. Moreover, the results of an independent-sample t-test showed that there was statistically a significant mean difference in farmland holding size between the food secure and food insecure farm households at 1% significance level; $t(253) = 4.028$), $P < 0.001$. This result suggests that landholding size does have an impact on the food security status of the rural households indicating that the food secure households have relatively larger farmland sizes than the food insecure households. Similarly, studies conducted by different researchers such as Shimeles *et al*. (2011), Goshu *et* *al*. (2013), Henri-Ukoha *et al*. (2013) and Bimerew and Beyene (2014) also confirmed that farmland size was positively and statistically significantly correlated with the food security status of the households. However, contrary to the finding of this research studies conducted by Million and Muche (2020), Muche *et al*. (2014) and Tefera T. and Tefera (2014) reported farmland size has no significant effect on food security status.

7.4. Income Diversification and Sustainability of food security

Most of the farmers in developing countries were engaged in off-farm income diversification activities to increase family income, as the income generated from farming alone cannot guarantee and provide sufficient livelihood for the rural farm households. Furthermore, on-farm production activities and off-farm income diversification are one of the important strategies used in reducing farm household income variability and risk related to agriculture. Hence, diversification of farm households into other on-farm and off-farm activities results in livelihoods' diversification and thereby raises the level of rural farm income which will have an impact on welfare and the sustainability of household food security status (Osarfo *et al.*, 2016).

Off-farm income diversification is one of the rural farm household strategies to deal with income fluctuations or to stabilize household income and reduce farm household income risk. Moreover, participation of farmers in different types of off-farm activities will ease capital constraints to buy foods and agricultural inputs leading to higher food production and better access to food (Abegaz, 2017; Awoke *et al*., 2022 Mulugeta *et al*., 2018; Ojeleye *et al*., 2014). The amount of income generated from off-farm and on-farm activities are a continuous explanatory variable measured in Birr and one of the important factors that is expected to affect household food security. Hence, participation of farmers in diverse types of income-generating off-farm and on-farm activities will diversify their livelihood strategies and are hypothesized to positively and significantly correlate with the sustainability of rural farm household food security. Accordingly, the amount of income earned from several types of on-farm and off-farm activities are estimated and their relationship with the food security status of the surveyed farm households was analysed. Subsequently, Table 7.13 presents the results obtained from the analysis of the independent sample T-test on the mean per capita on-farm and off-farm income difference between the food secure and food-insecure households. As can be seen from the table, the result shows there is a significant mean difference in off-farm per capita and total per capita income between the food secure and food insecure sample households; t(253) = 6.557), $P < 0.001$ and t(253) = 7.556), $P < 0.001$, respectively. This reveals that the mean per capita off-farm income (684.58) and total per capita income (2919.58) of the food secure farm household is by far greater than that of the mean per capita off-farm income (126.24) and total per capita income (939.37) of the food insecure farm household.

Table 7.13: Farm households' income diversification and food security status

		Food security status		T-test for equality of means		
Variable		Food secure	Food insecure	t-value	Sig. (2-tailed)	df
PCOI	Mean	684.58	126.24	6.557	.000	253
	SD	1036.50	327.40			
TPCI	Mean	2919.58	939.37	7.556	.000	253
	SD	3131.31	1062.08			

Source: Household survey data, 2018

Note: PCOI refers per capita off-farm income and TPCI is total per capita income

Consistent with the result of this finding, a study conducted by Osarfo *et al.* (2016) on the impact of nonfarm activities on rural farm household income and food security in the Upper East and Upper West Regions of Ghana showed that participation in non-farm activities would boost the income and welfare of the households and thereby improved the food security status compared to households that do not participate in non-farm activities. Furthermore, Abegaz (2017) and Frelat *et al*. (2016), noted that off-farm income was strongly correlated with the degree of food availability and one of the key options for achieving food security which is an important source of livelihood diversification for the poorest farmers. Additionally, studies in Ethiopia by Gemechu *et al*. (2016) and Muche *et al*. (2014) also portrayed that household access to and higher per-capita off-farm income was found to be relatively more food secure than their counterparts.

7.5. Agricultural Input Utilisation, Extension Services and Sustainability of Food Security

7.5.1. Utilisation of Modern Agricultural Inputs and Sustainability of Food Security

The rural farm households employing modern agricultural inputs and access to agricultural extension services are expected to be equipped with a better farm management system, crop production techniques and productivity of their agriculture. Hence, appropriate application of modern farm inputs (improved agricultural practices) such as the utilisation of modern chemical fertilizers, high-yielding improved seeds, irrigation, herbicides, pesticides and so on are expected to improve the productive agricultural land and increase the overall crop yield/production of the rural farm households. Thus, the utilisation of different varieties of modern farm inputs is anticipated to enhance agricultural production and thereby positively correlated with the sustainability and food security status of the farm households. Accordingly, farm households in the study area were asked about the utilisation of agricultural inputs and statistical analysis was made to discover whether the application of these agricultural inputs have a significant impact on the food security status of the surveyed households in the study area (Figure 7.1 and Table 7.14).

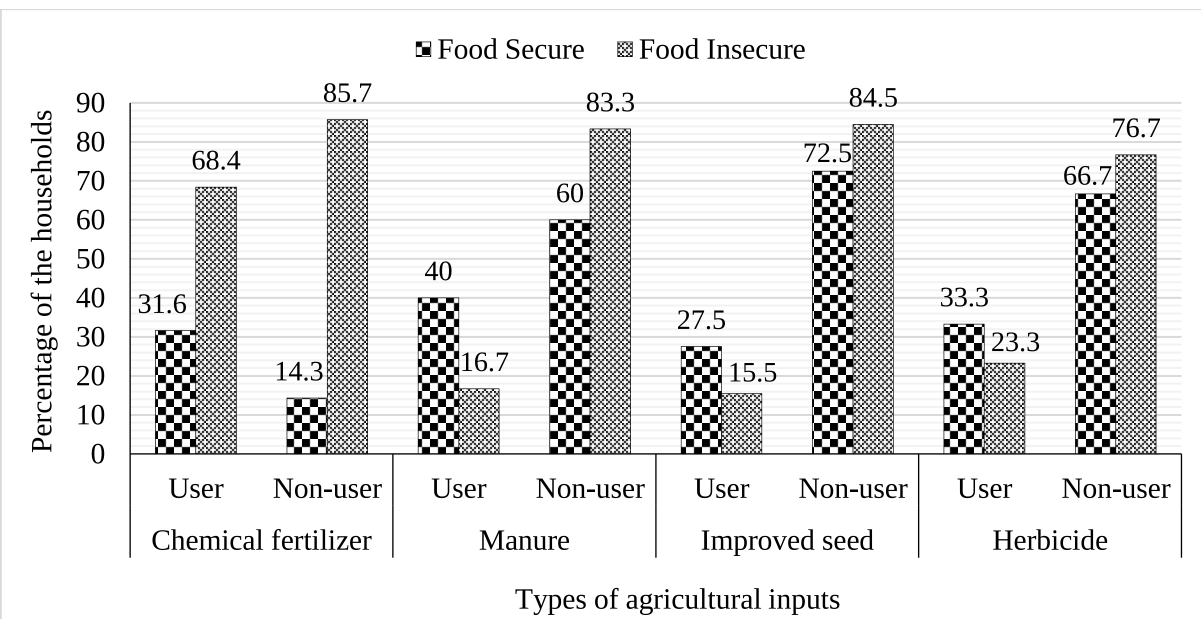

Figure 7.1: Percentages distribution of the households that utilised modern agricultural inputs
Source: Household survey data, 2018

The application of chemical fertilizer for crop production is essential to farmers productivity and their food supply. In line with this, statistical analysis was performed to determine whether there is a significant relationship between the application of chemical fertilizers and the food security status of the surveyed households in the study area. As shown in Figure 7.1 it was found that of the total chemical fertilizer user surveyed households about 31.6% were food secure and the remaining 68.4% were food insecure households. In a similar fashion, of the total non-fertilizer user farm households in the study area about 14.3% were found to be food secure and the rest 85.7% were food insecure households. The result of the Pearson chi-square test of association revealed that there was statistically a significant relationship between the food security status of the surveyed households and their application of chemical fertilizers at 1% significance level; $\chi^2(1) = 10.596$, $P < .01$ (see Table 7.14). This result showed that those farm households who utilised chemical fertilizer might get better opportunities to increase their production and productivity and become more likely food secure as compared to their counterparts. Studies conducted so far in different parts of the world also reveal the same results. For instance, a study conducted by Goshu *et al*. (2013) in the rural part of Ethiopia shows that the quantity of chemical fertilizer used by the farm households increased their food security status by 12%. Similarly, a study conducted by Dagne (2016) on the determinants of food security in farm household drought prone area of Oromia region also reveals that the use of chemical fertilizers has a significant and positive impact on the food security status of the households. However, contrary to this, a study conducted by Abafita and Kim (2014) on determinants of household food security in rural Ethiopia indicated that food security and fertilizer use had a significant negative relationship.

Table 7.14: Chi-square test of association b/n agricultural inputs and food security status

	χ^2-square test of association		
Variables	df	χ^2	*P*-value
Fertilizers	1	10.596	.001***
Manure	1	16.019	.000***
Improved seeds	1	4.515	.034**
Herbicides	1	.328	.567

***,** Significant at p<0.01 and p<0.05 respectively (Source: Household survey data, 2018)

Like that of chemical fertilizer, the utilisation of manure or compost by the farmers also plays a positive role in boosting agricultural production and productivity. In line with this view, statistical analysis was performed to examine whether there is statistically a significant association between manure users and non-manure users' households with respect to their food security status. Accordingly, results depicted in Figure 7.1 show that from the total surveyed manure user households in the study area, about 40% were found to be food secure and 60% of them were food insecure households. Similarly, of the manure user sampled households in the study area, about 16.7% were food secure and 83.3% were found to be food insecure. The Pearson chi-square test of association also indicates that there was statistically a significant association between the food security status of the surveyed households and their application of manure on their farmlands at 1% significance level; $\chi^2(1) = 16.019$, $P < .001$ (Table 7.14). This result reveals that the application of manure on farmland does have an impact on the productivity and food security status of the rural farm households indicating that those households who utilised manure on their agricultural land were found to be more likely food secure than that of their counterparts.

Like the application of other agricultural inputs, the utilisation of improved new hybrid seeds also supplements crop production resulting in a high yield per cultivated land and thereby minimising the risk of food shortage among rural households. Hence, the application of new hybrid improved seeds is one of an essential agricultural input assumed to enhance crop production and boost the productivity of agriculture and thus expected to increase the probability of the sustainability of rural household food security status. For more elaboration, a statistical test was carried out to discover whether there is a significant relationship between the application of improved seeds and the food security status of the surveyed households in the study area. As is shown in Table 7.14, among the surveyed households that utilised improved seeds, about 27.5% were found to be food secure and the rest 72.5% of them were food insecure. On the other hand, of the surveyed rural households in the study area who were not utilised improved seeds, 15.5% were food secure and 84.5% were found to be food insecure households. Moreover, the computation of the Pearson chi-square test of association reveals that there was statistically a significant relationship between the use of improved seeds and the food security status of the surveyed farm households in the study area at a 5% significance level; $\chi^2(1) = 4.515$, $P < .05$. In agreement with the finding of this research, studies were done by Bimerew and Beyene (2014) and Gemechu *et al*. (2016) also portrayed that the application of improved seeds had significantly associated with the food security status of the households implying that households who are using improved seeds are found to be more likely food secure than those households who do not.

Regarding the utilisation of herbicides in the study area, only a small number of the surveyed rural farm households (2.67%) had used them. As pointed out in Table 7.14 the Pearson chi-square test of association indicates that there is no statistically significant relationship between the use of herbicides and the food security status of the surveyed households in the study area ($P > .05$). This might be due to partly a very small proportion of herbicide user households in the study area.

7.5.2. Access to Extension, Credit, Irrigation Services and Sustainability of Food Security

In a country like Ethiopia, where many farm households are illiterate, agricultural extension services would play a significant role in assisting them by making them aware of opportunities for improvement and enhancing better access to crop production techniques. Agricultural extension serves as a channel for the dissemination of information, knowledge, new and improved practices in agriculture thereby increasing productivity. Moreover, the effectiveness of the use of other agricultural inputs in production partly relies upon the availability of sound agricultural extension services at community levels. Hence, the coefficient of extension contact was expected to be positively correlated with the food security status of farm households. Accordingly, the surveyed farm households in the study area were asked whether they have access to agricultural extension services or not.

As indicated in Table 7.15, about 24.6% of the farm households that have had access to extension services were found to be food secure and 18.8% who do not have access to extension services were food secure. On the other hand, about 81.2% of the farm households who do not have access to agricultural extension services were found to be food insecure while 75.4% who have access to extension services were found to be food secure. The finding showed that the percentage of food-secure households is higher among those households who are access to agricultural extension services and vice versa. However, the Pearson $\chi2$-square test of association result presented in Table 7.15, finding of this study showed that there was no statistically significant relationship between access to agricultural extension services and household food security status mainly because of a large proportion of the farm households are access to agricultural extension services in the study area.

Table 7.15: Rural farmers' access to agricultural services and food security status

Have access to:	Responses	Food Secure F	Food Secure %	Food Insecure F	Food Insecure %	χ^2-square test of association df	χ^2	P-value
Extension service	Yes	51	24.6	156	75.4	1	0.751	.386
	No	9	18.8	39	81.2			
Irrigation	Yes	16	51.6	15	48.4	1	15.469	.000***
	No	44	19.6	180	80.4			
Farm credit	Yes	16	32.7	33	67.3	1	2.806	.094**
	No	44	21.4	162	78.6			
SWC * practice	Yes	58	23.9	185	76.1	1	0.330	.566
	No	2	16.7	10	83.3			

***, ** indicates significant at less than 1% and 10% respectively

Source: Household survey data, 2018

On the other hand, of the total surveyed farm households using irrigation schemes more than half (51.6%) were food secure. However, from the sampled rural farm household not using irrigation schemes about 80.4% were food insecure and only 19.6% were found to be food secure. Moreover, the Pearson $\chi 2$-square test of association result of the study revealed that the use of irrigation scheme was found to be positively and significantly related to the household food security status; $\chi 2(1) = 15.469$, $p < .001$. Likewise, a study conducted by Bimerew and Beyene (2014) in East Hararghe zone, Ethiopia, on factors influencing rural household food insecurity also showed that the use of irrigation schemes was found to be negatively and significantly correlated with households' food insecurity problem, indicating that when the households continual use irrigation, the likelihood of the household to be food secure will increase.

Concerning the credit services, as indicated in Table 7.15, from the total households who have had access to credit services about 32.7% were food secure and 67.3% of them were food insecure households. In a similar fashion, of the non-credit user households, 21.4% were found to be food secure and the remaining 78.6% of them were found to be food insecure households indicating that the level of food insecurity is higher among non-credit users' sample respondents. Furthermore, the Pearson $\chi 2$-square test of association also showed that there is statistically significant association between the food security status of households and farmers' access to credit services at 10% significant level: $\chi 2(1) = 2.806$, $p < .1$.

As to soil and water conservation practices, results presented in Table 7.15 revealed that about 23.9% of the sample respondents who were exercising SWC practices on their farmland was found to be food secure and 83.3% of the surveyed sample household who were not practising SWC were found to be food insecure, implying that the level of food insecurity is higher among those farmers who have been not exercising soil and water conservation practices on their farmland. However, the Pearson $\chi 2$-square test of association portrayed that there is no statistically significant relationship between SWC practices and the surveyed farm household food security status in the study area; $\chi 2(1) = 0.330$, $p = .566$.

7.6. Market, Road Availability and Sustainability of Food Security

Distance from road and market centres is among the physical capitals that influence the livelihood of rural farm households in general and their food security status. This meant that the distance that farmers travel to sell their agricultural products, buy other food items, and access to market information is one of the most important determinants of the farm households' food security status. Hence, households' that are found closer and access to the market centre have better opportunities for livelihood diversification, selling of farm products, access to additional income via off-farm activity, and purchase of other food items (Moroda *et al*., 2018; Pieters *et al*., 2013). Thus, the accessibility of the market has been anticipated to have a positive correlation with the food security status of rural farm households. Consequently, an independent-sample t-test was computed to see whether there is statistically a significant mean difference in the average distance the farmer travels from their home to the market centre between the food secure and food-insecure households in the study area (Table 7.16).

Table 7.16: Market and road accessibility of farm households by food security status

Variables		Food Secure (n=60)	Food Insecure (n=195)	t-test for equality of means		
				t-test	Sig.(2-tailed)	df
Market accessibility in minute	Mean	60.07	60.08	0.049	.961	253
	SD	49.58	46.26			
Motorable road distance in minute	Mean	67.48	61.50	-0.808	.420	253
	SD	53.66	49.08			

Source: Household survey data, 2018

As it is shown in Table 7.16 on average it takes about 60.07 minutes walking distance to reach the nearest market centre for both the food secure and food insecure farm households. Similarly, the independent t-test analysis revealed that there is no statistically significant mean difference in the distance the farmers travel from their homes to reach the nearest market centre by the food secure and food-insecure households. Contrary to the findings of this research studies conducted by Zakari *et al*. (2014), Zemedu and Mesfin (2014) and Gemechu *et al*. (2016) shows a statistically significant relationship between the distance of the households from the market and their food security status indicating that households near to the centre of the market tend to be more food secure than households located far away from the market. This is primarily since households located closer to the market centre have a better chance of selling surplus products and can buy agricultural inputs and food for their families at any time.

Like that of the market, access to the motorable road is also another important explanatory variable with implications for the food security status of the rural farm households. As is depicted in Table 7.16 comparisons of the mean distance in terms of minutes that the surveyed households travelled to reach the main road were made. Accordingly, on average the food secure surveyed households located at 67.48 minutes walking distance away from the main road and it takes 61.50 minutes for the food secure households. The independent t-test result revealed that like that of market there is no statistically significant mean difference in the distance travelled (in terms of minutes) by the food secure and food insecure households to reach the main road: [t(253) = -0.808, P = .420

7.7. Farm Production Diversity, HDDS and Sustainability of Food Security

Results portrayed in Table 7.17 showed the relationship between agricultural production diversity, HDDS and the food security status of the surveyed rural farm households in the study area. As indicated in the Table, the mean crop diversity, livestock diversity, and overall production diversity of the food secure farm household was 4.63, 4.12 and 8.75, respectively, which is greater than the mean crop diversity (4.06), livestock diversity (3.25), and overall production diversity (7.33) of the food insecure farm households in the study area. The independent sample t-test for equality of means also portrayed that there is a positive and statistically significant mean difference in all cases between the food secure and food-insecure households of the sample respondents at a 1% significant level. This could be elucidated by the fact that an increase in farm production diversity, increases Kcal intake which enhances the food security status of the rural farm households. Hence, farm production diversity is found to be positively related with the sustainability of the rural farm household food security status. This is accompanied by the fact that failure in the production of one crop mainly due to different factors such as drought, crop diseases, pests, and livestock disease (assuming a different degree of resistance) can be partly compensated by the returns obtained in the farm production of other crops.

Table 7.17: Agricultural production diversity and food security status of farm households

Variables		Household food security status		T-test for equality of means		
		Food Secure (n=60)	Food Insecure (n=195)	t-value	Sig. (2-tailed)	df
Crop Diversity	Mean	4.63	4.06	2.366	.019	253
	SD	1.804	1.603			
Livestock Diversity	Mean	4.12	3.25	4.459	.000	253
	SD	1.106	1.381			
Production diversity	Mean	8.75	7.33	4.858	.000	253
	SD	2.064	1.957			
HDDS	Mean	4.75	3.89	5.118	.000	253
	SD	1.216	1.109			

Source: Household survey data, 2018

The finding of this research agrees with the work of Adjimoti and Kwadzo (2018), Makate *et al*. (2016) and Silvestri *et al*. (2015) who reported that production diversification is positively and significantly related to the food security status of the farmers indicating the higher production diversity the more farm households found to be food secure. This is mainly due to the diversification of farm production activity could increase farm income, improve soil fertility, increase resilience, diversify farmers' livelihoods, and finally allow them to cope with food shortages and problems of food insecurity.

Results presented in Table 7.17 showed that the mean household dietary diversity score (HDDS) of the surveyed farm households in the study area for the food secure and food insecure households was 4.75 and 3.89 with a standard deviation of 1.216 and 1.109, respectively. An independent sample t-test revealed that there was statistically a significant mean difference in household dietary diversity score (HDDS) between the food secure and food insecure households at a 1% significance level; $t(253) = 5.118$), $P < 0.001$. This result suggested that dietary diversity had an impact on Kcal intake and the food security status of the rural households indicating that the food secure households have relatively higher dietary diversity scores than the food insecure households. The finding is consistent with studies conducted by Chakona and Shackleton (2018), Leroy *et al*. (2015), Maxwell *et al*. (2014) and Mulugeta *et al*. (2018) who noted that dietary diversity is positively and significantly correlated with the food security status. The finding evidenced that those households who have consumed more diverse food groups were found to be more likely food secure than their counterparts as dietary diversity significantly improves energy availability.

7.8. Agro-climatic Zones and Sustainability of Food Security

Results presented in Figure 7.2 shows the daily per capita per adult equivalent kilocalorie of the different agro-climatic zone in the study area. Accordingly, the result of the study displayed that the mean daily per adult equivalent kilocalorie available for the surveyed households in *dega* agro-climatic zone is 1,726 with a standard deviation of 457 is greater than that of the mean daily per adult equivalent kilocalorie available for the households in *woina-dega* (1672) and *kolla* (1695) agro-climatic zone.

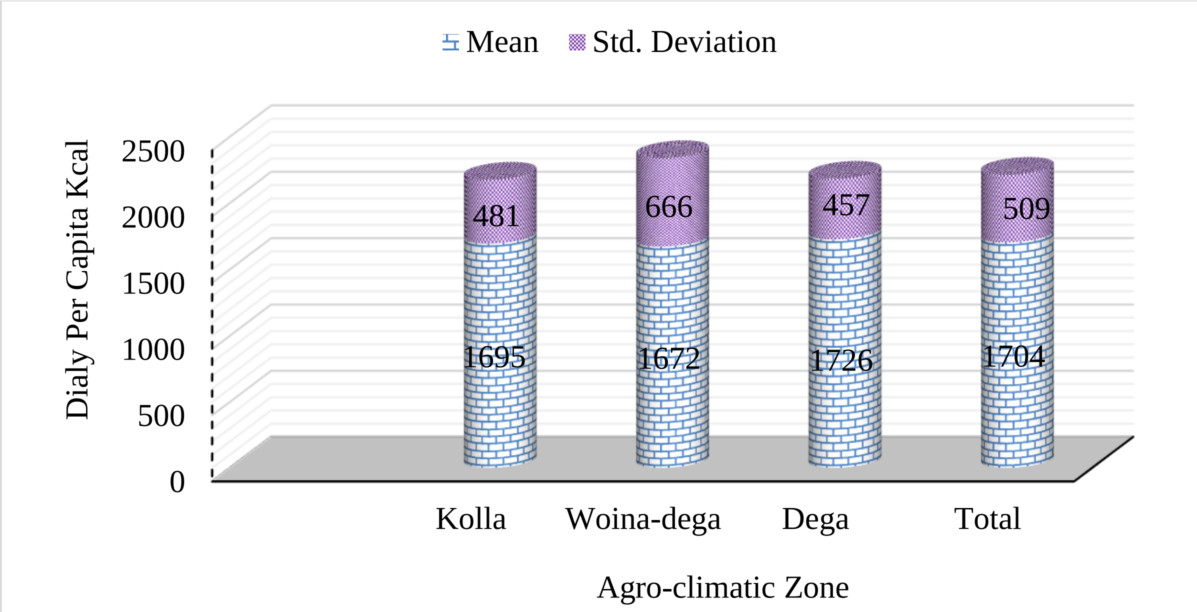

Figure 7.2: Mean daily per capita Kcal/AE in terms of Agro-climatic zone

Source: Household survey data, 2018

To test if there would be a significant association between the food security status of the surveyed farm households in the different agro-climatic zone of the study area, a chi-square test was computed. As depicted in Table 7.18 of all the surveyed households in the *dega* agro-climatic zone about 27.5% of them were food secure while the rest 72.2% of them were found to be food insecure. In addition, about 25.5% and 18% of the surveyed households in *woina-dega* and *kolla* agro-climatic zone, respectively, were food secure. Thus, the result of the study reveals that households in *dega* agro-climatic zone were more likely food secure than those households in *woina-dega* and *kolla* agro-climatic zone. This may imply the largest percentage of food-insecure households in the study area have also resided in *kolla* (82%) followed by *woina-dega* (74.5%) agro-climatic zone. Unfortunately, unlike studies conducted by Tafesse *et al*. (2015), the computation of the chi-square test for this study revealed that statistically there is no significant relationship between the food security status of the surveyed farm households and the different agro-climatic zone in the study area [$\chi2$ (2) = 2.887, $P > .05$].

Table 7.18: Association b/n farm household food security status and agro-climatic zone

Agro-climatic zone	Food Secure		Food Insecure		df	χ^2	*P*-value
	F	%	F	%			
Dega	30	27.8	78	72.2	2	2.887	.236
Woina-dega	12	25.5	35	74.5			
Kolla	18	18.0	82	82.0			
Total	60	23.5	195	76.5			

Source: Household survey data, 2018

7.9. Participation in PSNP and Sustainability of Food Security

Results presented in Table 7.19 showed that about 13% of the farm households who were the beneficiaries of the productive safety net program (PSNP) were found food secure and the remaining 87% were food insecure. On the other hand, about 71.9% of the farm households who were not beneficiaries of the productive safety net program (PSNP) were found food insecure and only the rest 28.1% who benefited from PSNP were food secure. The finding showed that the proportion of food security is higher among the non PSNP beneficiary than the PSNP beneficiaries. This implied that the food insecure households are more dependent and beneficiary of PSNP than their counterparts. Furthermore, the Pearson χ2-square test of association result also portrayed that there is a statistically significant relationship between PSNP beneficiaries and farm household food security status in the study area at 5% significant level; $\chi^2(1) = 6.814$, $p < .05$.

Table 7.19: Participation in PSNP and HHs food security status

Are you PSNP beneficiaries?	Food Secure		Food Insecure		χ^2-square test of association		
	F	%	F	%	df	χ^2	*P*-value
Yes	10	13.0	67	87.0	1	6.814	.009
No	50	28.1	128	71.9			

Source: Household survey data, 2018

The findings revealed that households who benefited from the safety nets program are still more likely to be food insecure in the study area. The result of this research is consistent with the work of Bazezew (2013), who reported that participation of the households in the productive safety nets program has positively and significantly associated with food insecurity implying that the PSNP beneficiaries are the most food-insecure groups. Moreover, a study conducted by Zeleke *et al*. (2021) revealed that beneficiaries of the PSNP were more vulnerable to climate change and become more likely food insecure than their counterparts. Contrary to the finding of this research a study conducted by Agidew and Singh (2018) and Gemechu *et al*. (2016) showed there is no significant difference in food security status between the beneficiaries and non-beneficiaries of productive safety net programs.

7.10. Exposure to Media and Sustainability of Food Security

Results in Table 7.20 showed that about 32.1% of the sample respondents who has exposure to media were found to be food secure and the remaining 67.9% were food insecure. On the other hand, of the sample respondents who have no access to media (mainly radio), about 21.1% are found to be food secure and the rest 78.9% of them were food insecure. The finding depicted that the farm households who had access to media (radio) were found to be more likely food secure than their counterparts. Additionally, the Pearson $\chi 2$-square test of association result also revealed that access to media exposure was found to be positively and significantly associated with the food security status of the surveyed farm households in the study area at 10% significant level; $\chi 2(1) = 2959.469$, $p < .1$. The finding of this research is supported by the work of Isernia and Marcolin (2019) who reported that media plays an important role as it creates awareness among the farmers concerning the choices, decisions and perceptions on food security and consumption, food crisis events, risk events and impact of climate change on food sustainability.

Table 7.20: Access to media (radio), mobile phone and food security status

Variables	Responses	Food Secure		Food Insecure		χ^2-square test of association		
		F	%	F	%	df	χ^2	*P*-value
Access to media	Yes	18	32.1	38	67.9	1	2.959	.085
	No	42	21.1	157	78.9			
Access to Mobile	Yes	16	25.0	48	75.0	1	0.103	.749
	No	44	23.0	147	77.0			

Source: Household survey data, 2018

As portrayed in Table 7.20, the find of the study showed that about 25% of the sample respondents who had mobile phones were found to be food secure and the remaining 75% were food insecure. In contrast, of the sample respondents who had no mobile phone, about 23% are found to be food secure and the remaining 77% were found to be food insecure implying that households who had access to mobile phones were more food secure than those households with no access to mobile phone. However, the Pearson $\chi 2$-square test of association revealed that statistically there is no significant relationship between the food security status of the surveyed farm households and their access to mobile phones.

7.11. The implication of the Findings

The findings presented in this chapter addressed the second objective of the study, which mostly describes about the level of rural farmers' access to different productive assets in view of their implication on the sustainability of food security status of the surveyed household respondents. Moreover, the chapter presented the separate effect of each of the independent variables mainly categorized under household socio-demographic characteristics, resource endowment and asset possession, agricultural extension services and input utilisation, market, and road availability, on the dependent variable, farm household food security status. The finding implied that access to irrigation, credit services, information, utilisation of fertilizers, improved seeds and manure, and on-farm and off-farm income positively affected the extent and sustainability of food security. Moreover, age of the household heads, small household size, literacy level, access to sufficient farmland size, livestock production, and farm production diversity are also among the principal variables positively and significantly related to the extent and sustainability of rural farm household's food security status.

Working on these significant variables by local authorities, development agents and practitioners and other stakeholders may have expected to improve the food security status of rural farmers in the study area, contributing to the achievement of sustainable food security and SDGs in general. Hence, in terms of policy implication, these findings suggest that more attention is needed to improve the livelihoods of the most vulnerable smallholder farmers in terms of access to various social, economic, infrastructural and institutional services to boost their agricultural production and productivity so that they could sustain and produce sufficient food for their family members. More specifically, the study calls for awareness creation on effective family planning and the impact of large family size on ensuring sustainable food security with the available shortage of resources including farmland. Furthermore, attention is needed to improve the educational status of the rural farmers and their technical skills mainly through adult education as being literate enhances household's access to information and receptiveness of new ideas, which may have a positive impact on their production activities to improve farmers' food security status.

Besides, the study result implies there is also a need to enhance farm households' income-earning opportunities and access to credit services as it enables them to purchase various agricultural inputs and diversify their livelihoods and thereby improving agricultural production and productivity. Moreover, the study calls for actions concerning the harvesting of rainwater and construction of irrigation schemes, as access to irrigation water enables farmers to produce more than once a year by reducing dependency on the vulnerable rain-fed agriculture and crop failure and thereby helps them to reduce food insecurity. Additionally, there is also a need to sufficiently provide agricultural inputs such as fertilizers and improved seeds timely and training on the management of the rural farmers' agricultural production. To sum up, the finding of the study implied that there is a need to work in collaboration among the various sectors, stakeholders and development practitioners to improve the livelihoods of the rural poor farmers and the local area's ability in achieving sustainable food security and SDGs.

7.12. Summary

This chapter presented the findings of the study on socio-demographic, level of farmer's access to productive assets such as land, livestock ownership, access to and use of agricultural inputs, financial capital and extension services in view of their impact on food security status at the household level and sustainability of rural household food security. Accordingly, the finding portrayed that the older household heads had higher per capita kcal per adult equivalent per day than that of the younger age household heads and were found to be more likely food secure than their counterparts. This is mainly because the older household heads have a relatively richer experience of the social and physical environments and they are expected to have greater experience of farming activities, a stable economy in farming and better access to land than the younger household heads. On the other hand, the gender segregation analysis of rural farm household food security status in the study area was showed no significant differential between male-headed and female-headed households. The finding also showed that households with small members had higher per capita kcal than households with larger family members found to be more food secure. Furthermore, the study portrayed that household heads headed by illiterate farm households are more likely exposed to the risk of food insecurity than literate household heads because of the differences in the level of awareness to apply modern agricultural technologies and livelihood diversification.

The finding on resource endowment indicated that households with larger farmland sizes and the larger number of livestock expressed in TLU are found to be more food secure than households than their counterparts as they have an impact on livelihood diversification for the rural farm households which in turn impacts the sustainability of their food security status. The finding of this research also depicted that the participation of farmers in diverse types of income-generating off-farm and on-farm activities had a positive and significant relationship with the food security status of the farm households implying that diversification of rural farm income helps to diversify livelihood strategies which could stabilize household income and reduce farm household income risk and in turn, enhances the sustainability of rural farmers' food security status. The study also showed that farm households who had applied modern farm inputs such as the utilisation of modern chemical fertilizers, high yielding improved seeds, and application of animal manure are more food secure than households who do not use these inputs as the application of these modern farm inputs are expected to improve the productivity of agricultural land and increased the overall crop yield/production of the rural farm households. Additionally, the use of irrigation schemes by farm households, the more farm production diversity and the higher the dietary diversity score had also positively correlated with the food security status of the farm households. To sum up, the findings presented in this chapter indicated that demographic, socioeconomic, and institutional services determined the sustainability of food security in the study area, as most of the variables associated with these domains have a significant relationship with the food security status of the surveyed sample household respondents. The next chapter presents the research findings and analysis on the factors determining and influencing sing regression model analysis in line with the research objectives of the study.

CHAPTER EIGHT

FACTORS DETERMINING THE SUSTAINABILITY OF RURAL FARM HOUSEHOLD FOOD SECURITY STATUS

8.1. Introduction

Food insecurity and poverty are serious and ongoing problems for most Ethiopians and the study area. Besides, Ethiopia is one of the most food-insecure countries in the world, with famine impacting the majority of the population, which has been affected by chronic and transitory food insecurity, living rural farm households to become temporarily rely on emergency food aid and relief food assistance. Furthermore, rural households in Ethiopia commonly experience food security issues due to a variety of reasons including socioeconomic, agro-climatic, cultural, and demographic characteristics. Food insecurity in the country is primarily caused by reliance on rain-fed agriculture, which is highly vulnerable to climate change, unreliable and erratic rainfall, recurring drought, poor infrastructural development, land degradation, large family size, limited access to productive assets, and insufficient and fragmented landholding, among other factors.

Thus, this chapter is an extension of the previous chapter (chapter 7) and anticipated to address the third objective of the study and intended to examine the main demographic, socio-economic, institutional, and environmental variables most significantly contributed to (un)sustainability of food security in the study area using econometric analysis (regression model). Hence, the chapter focuses on the identification of the main factors that were responsible for the sustainability of the rural farm household's food security in view of meeting SDGs. Furthermore, the chapter also elaborates on climatic variability and its implication on rural farm household agricultural production and sustainability of farm household food security status.

8.2. Logistic Regression Analysis of Rural Household Demographic, Socio-Economic and Sustainability of Food Security

The dependent variable in this study, food security, is dichotomized and measured as food insecure or food secure. In the forgoing bivariate analysis of the relationship between the dependent variable (food security status or daily per capita kcal availability) and explanatory variables, about 17 potential predictor variables were found to be significant (Table 8.1).

Table 8.1: Variables included in the logistic regression analysis

Variables included in the regression model		Measurement
	Food Security status (Dependent Variable)	1 = Food secure 0 = Food insecure
X_1	Age of the HH (X_1) *	Number of age in years
X_2	Household size (X_2) *	Number of HH members
X_3	Dependency ratio (X_3)	In number
X_4	Farmland size (X_4) *	Measured in a hectare
X_5	Livestock TLU (X_5) *	TLU in number
X_6	Market distance from home (X_6)	Walking hours
X_7	Main road distance from home (X_7)	Walking hours
X_8	Per capita income (X_8) *	Birr
X_9	Per capita off-farm income (X_9) *	Birr
X_{10}	Household dietary diversity score (X_{10}) *	In number
X_{11}	Farm production diversity (X_{11}) *	In number
X_{12}	Gender (X_{12})	(1=male and 0= female)
X_{13}	Educational status (X_{13}) *	(1= literate, 0= illiterate)
X_{14}	Practice SWC (X_{14})	(1 = Yes, 0 = No)
X_{15}	Access to irrigation (X_{15}) *	(1 = Yes, 0 = No)
X_{16}	Fertilizer (X_{16}) *	(1 = User, 0 = Non-user)
X_{17}	Manure (X_{17}) *	(1 = User, 0 = Non-user)
X_{18}	Improved seeds (X_{18}) *	(1 = User, 0 = Non-user)
X_{19}	Access to credit (X_{19}) *	(1 = Yes, 0 = No)
X_{20}	PSNP beneficiary (X_{20}) *	(1 = Yes, 0 = No)
X_{21}	Access extension (X_{21}	(1 = Yes, 0 = No)
X_{22}	Access to media (X_{22}) *	(1 = Yes, 0 = No)
X_{23}	Drought (X_{23}) *	(1 = Yes, 0 = No)

* Significant variables in the bivariate analysis (chapter seven)

It is of interest in this study to further discern the combined effects of these explanatory variables on the sustainability of rural household food security status (the dependent variable) using multivariate logistic regression models. A regression method brings out the relationships between variables whose relation is imperfect. To determine the explanatory variables that are better predictors of the food security status of the surveyed rural farm households, the multivariate logistic regression model was used to estimate the maximum likelihood estimation method. Subsequently, about 23 potential explanatory variables (Table 8.1) that were assumed to be determinants of the sustainability of food security status of the surveyed sample respondents in the study area were entered into computation of multivariate logistic regression analysis.

Before running the logistic regression model, all the expected explanatory variables entered in the model were checked for the existence of multicollinearity problems to identify variables included in the final regression analysis. Accordingly, Variance Inflation Factor (VIF) was computed to detect the multicollinearity problem for continuous variables and the contingency coefficient were used to detect a high degree of association for qualitative (dummy) explanatory variables (Table 8.2 and 8.3). Results from the computation revealed that VIF values for those continuous explanatory variables entered the model were found to be small (VIF value was less than 5 with a mean of 1.662) indicating that none of these variables exhibited any multicollinearity problem (Table 8.2).

The result of the contingency coefficient presented in Table 8.3 also discloses a small degree of association among the qualitative explanatory variables. The maximum correlation value is 0.544 which is less than 0.70, indicating the absence of severe multicollinearity problem (less degree of association) among the potential dummy variables entered in the model. Subsequently, the assumptions of non-collinearity were satisfied, and the regression model was then estimated.

Table 8.2: Variance inflation factor (VIF) test for continuous variables

Variables	Collinearity Statistics	
	VIF	Tolerance (1/VIF)
Age of the household head (X_1)	1.332	0.751
Household size (X_2)	1.258	0.795
Dependency ratio (X_3)	1.260	0.794
Farmland size (X_4)	1.313	0.762
TLU (X_5)	1.637	0.611
Market distance from home (X_6)	1.425	0.702
Main road distance from home (X_7)	2.547	0.393
Per capita income (X_8)	1.807	0.553
Per capita off-farm income (X_9)	1.675	0.597
Household dietary diversity score (X_{10})	1.764	0.567
Farm production diversity (X_{11})	2.262	0.442
Mean VIF	1.662	

Source: Household survey data, 2018 (Model output)

Table 8.3: Contingency coefficient test for discrete variables

	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}	X_{23}
Gender (X_{12})	1.000											
Educ (X_{13})	.163	1.000										
SWC (X_{14})	.207	.047	1.000									
Irrigation (X_{15})	.095	.030	.031	1.000								
Fertilize r(X_{16})	.086	.147	.052	.107	1.000							
Manure (X_{17})	.041	.015	.102	.252	.086	1.000						
Impseeds (X_{18})	.015	.066	.038	.082	.544	.086	1.000					
Credit (X_{19})	.013	.055	.108	.032	.057	.009	.039	1.000				
PSNP (X_{20})	.087	.045	.135	.164	.170	.124	.084	.069	1.000			
Extension (X_{21}	.393	.112	.175	.087	.112	.112	.110	.082	.055	1.000		
Media (X_{22})	.041	.045	.073	.231	.022	.094	.009	.030	.121	.086	1.000	
Drought (X_{23})	.042	.032	.057	.052	.015	.046	.009	.003	.099	.042	.019	1.000

Source: Household survey data, 2018 (Model output)

The model result from the model diagnostics and model fitting (-2 log-likelihood = 102.881) revealed that the likelihood ratio for all independent variables is different from zero displaying a model good-fit (Table 8.4). The omnibus test of the model coefficient analysis presented in Table 8.4 portrayed that the chi-square of the regression is 175.373 ($\chi^2 = 175.373$; $P < .001$) indicating the model was found to be statistically significant at 1% when all the 23 predictor variables were considered together, and the model fits the data very well. Overall, the model predicted correctly at 93.3% of the sample respondents. Additionally, the independent variables entered the model were better at predicting who would be food insecure (95.9% correct) than at who would be food secure (85% correct) implying the high predictive power of the model (Hanneman *et al*., 2013) in which the model predicts both groups accurately. The Hosmer-Lemeshow chi-square test of goodness-of-fit statistics revealed the model is a good fit and adequately describes the data (p-value > 0.05), which suggests that there is no difference between the predicted and observed model values of the dependent variable. The pseudo-R-square (Nagelkerke R square value of 0.749) indicates that about 75% of the variation in the dependent variable (food security status) can be explained by the combined effect of all the predictor variables included in the model.

The result of the multivariate logistic regression model presented in Table 8.4 shows that about 10 explanatory variables out of the 23 variables which thought to influence the dependent variable were found to be statistically significant in determining the food security status of the surveyed rural farm households in the study area while the remaining 13 variables were not significant in explaining the variations in the dependent variable. Those variables that are found to be significant coefficients in the logistic regression model include household size (at 1% significant level), age of the household heads, educational status, TLU, access to irrigation water, drought, per capita off-farm income, HDDS, farm production diversity (at 5% significant level) and farmland size (at 10% significant level). The finding implied that these variables are the most substantial factors in determining and influencing the un/sustainability of rural farm household food security status in the study area. The detailed interpretation and discussion of these significant explanatory variables in the model were presented hereunder as follows.

Table 8.4: Logistic regression of factors affecting the sustainability of food security

Explanatory variables		B Coefficient	S.E.	Wald	Exp(B) Odds ratio
	Constant	-10.939	3.409	10.298	
Socio-demographic variables	Sex of the Household Head	-.529	.962	.303	.589
	Age of the Household Head	.115**	.043	7.216	1.122
	Household Size	-1.146***	.242	22.384	.318
	Dependency Ratio	.001	.004	.111	1.001
	Educational status	1.785**	.701	6.482	5.959
Resource endowments	Farmland Size	2.245*	1.176	3.646	9.441
	TLU	.443**	.213	4.342	1.558
Institutional services	Access to irrigation water	2.071**	1.049	3.900	7.937
	Market distance from home	-1.215	.878	1.915	.297
Geographic variables (road)	Main road distance from home	.823	1.016	.655	2.277
	Use of modern fertilizer	.602	.854	.497	1.826
	Use of manure	.060	.677	.008	1.061
	Use of Improved seeds	-.275	.954	.083	.759
	Extension Service	-.337	.809	.174	.714
	Access to credit	.445	.719	.383	1.561
	Access to Media	.551	.697	.625	1.735
HH income and production (Economic Variables)	Beneficiaries of PSNP	.529	.792	.446	1.698
	Per capita income	.000	.000	2.129	1.000
	Per capita off-farm Income	.001**	.001	4.815	1.001
	HDDS	.792**	.335	5.585	2.207
	Farm production diversity	.502**	.211	5.679	1.653
Environmental variables	Drought	-1.832**	.914	4.013	.160
	SWC Practices	1.388	1.240	1.253	4.007

Model diagnostics:	
-2 Log likelihood =	102.881
Cox & Snell R Square	.497
Nagelkerke R Square	.749
Omnibus test of the model	(χ^2) = 175.373; P = 000
Correct prediction of food secure HH (%)	85.0
Correct prediction of food insecure HH (%)	95.9
Overall prediction of all samples (%)	93.3
Hosmer and Lemeshow Test	(χ^2) = 14.871; p = .062;

Note: p-values: *** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$

Source: Household survey data model output, 2018

Age of the household head: the age of the household heads is one of the determining factors of the food security status of the surveyed sample farm household in the study area. The regression model in Table8.4 indicates that the age of the sample farm household has a positive and significant impact on the food security status of the sample households with a beta coefficient of 0.115. This shows that holding other variables constant, a one-year increase in the age of the sample respondents had increased the probability of food security by 11.5% in the study area. Moreover, the model reveals that older farm household heads are 1.12 times more likely food secure than the younger household heads (odds ratio = 1.122).

In agreement with the result of this research, studies conducted by Magaña-Lemus *et al*. (2016) in Mexico and Abdullah *et al*. (2019) in the rural northern hinterland of Pakistan also reported that there is a positive and statistically significant relationship between the age of the household head and food security. In both studies, household heads of younger age were found to be more likely food insecure and the older household heads were found to be more food secure. For instance, Magaña-Lemus *et al*. (2016) found that households aged greater than 61 years old were found to be 10.8% more likely food secure than those household heads younger than 30 years old. In addition, Abdullah *et al*. (2019) found that older households are 2.65 more likely food secure than younger household heads and their finding also revealed that holding other variables remain unchanged, a one-year increase in the age of the household had increased the probability of food security by 97.7% (beta coefficient = 0.977). The result of this finding was also supported by a study conducted by Ahmed (2016) in Haramaya *woreda* of East Hararghe zone of Ethiopia, Alpízar *et al*. (2020) in Central America, Awoke *et al*. (2022) in the central and northern zone in Ethiopia and Fikire and Zegeye (2022) in north Shewa zone of Amhara region in Ethiopia who reported the older household had more experience of farming, mostly intensify and diversify their production activities than the younger household heads which rises their income and in turn, helps to improve their food security status. Moreover, a previous study conducted by De Cock *et al*. (2013) in the rural areas of the Limpopo province in South Africa was also reported that the age of the household head had a negatively significant relationship with food insecurity, which indicates as the age of the household increases the probability of being food secure had decreased and vice versa.

However, contrary to the finding of this research a study conducted by Bedeke (2012) in Kersa district of East Hararghe zone of Ethiopia was find out that there is a negative significant relationship between the age of the household heads and food security status reporting an increase in the age of the household head decreased the likelihood for the households to be food secure. On the other hand, various studies conducted by Bogale (2012) in Eastern Ethiopia, Mitiku *et al.* (2012) in Southern Ethiopia, Asmelash (2014) in the Tigray region of Ethiopia, Bimerew and Beyene (2014) in the Eastern Hararghe zone of Ethiopia, Muche *et al*. (2014) in Southwest of Ethiopia, Ojeleye *et al*. (2014) in Nigeria, Habyarimana (2015) in Rwanda and Ahmed *et al*. (2017) in Pakistan were found out there was statistically no significant relationship between age of the household head and food security.

Household size: the model results presented in Table 8.4 revealed that household size was significantly and negatively correlated with the food security status of the surveyed farm households at a 1% significant level in the study area. The finding indicated that the probability of being food secure computed for the surveyed farm household increases with a decrease in household size. The beta coefficient for household size was -1.146 indicating that, keeping other factors constant the probability of the surveyed farm household's food security status had decreased by 114.6% as their household size increased by one additional member. In addition, the odds ratio of the model also revealed that sample respondents with smaller household sizes are 0.32 times more likely food secure than those sample respondents with larger household sizes (odds ratio = .318). The possible explanation is that an increase in household size may exert more pressure on food consumption as the additional household member shares the limited food resources available in the study area.

Consistent with the finding of this research, a study conducted by Asmelash (2014) Tigray region of Ethiopia confirmed that household size has a negative and significant relationship with the probability of food security. He reported that each additional member of the household increases the probability of being food insecure by about 115% due to limited productive resources. Similarly, a study conducted by Ahmed *et al*. (2017) revealed that one additional household member decreases the likelihood of being food secure by 39.5%, putting more burden on the limited available resources. Besides, a study conducted by Ferede and Wolde-Tsadik (2018) in western part of Ethiopia (Benishangul-gumuz region) also reported that family size was positively and significantly related to food insecurity implying a unit increase in household size increases the probability of being food insecure by 45%. Furthermore, this result agrees with the findings of other studies conducted by Abafita and Kim (2014), Agidew and Singh (2018), Alpízar *et al*. (2020), Awoke *et al*. (2022), Dagne (2016), Fikire and Zegeye (2022), Gemechu *et al*. (2016), Goshu *et al*. (2013), Maziya *et al*. (2017) Muche *et al*. (2014), Zemedu and Mesfin (2014) and Sani and Kemaw (2019) who reported that household size and their food security status are negatively and significantly related to each other indicating that households with larger members more likely experiences recurrent food shortages than smaller households. In addition, Frelat *et al*. (2016) confirmed that household size explained a substantial part of food availability variation, reporting an increased household size decreased food availability which needs more land and livestock to feed the family. Finally, it is possible to conclude from this finding, that household size is one of the factors that strongly determine food availability and trigger the sustainability of rural farm households where there are limited resources.

Educational status: As indicated in Table 8.4 educational status of the farm household heads had positively and significantly correlated with their food security status. The result revealed that holding other variables remains unchanged, the probability of the food security status of the farm households increased by 179% (beta coefficient = 1.785) as the educational level of the household increased by 1 unit. Moreover, educated farm households are 6 times more likely food secure than those farm households that cannot read and write (odds ratio = 5.959). The possible explanation behind this finding may be due to the fact that an educated farm household had better access to information, a better chance of managing their farmland, have the capacity to innovate and adopt new skills and implement appropriate technology which enhances agricultural productivity and in turn improves their food security status. Hence, as hypothesized, the educational level of the rural farm household heads is one of the determinant factors that influence the sustainability of the food security status of the farm households in the study area.

Similarly, a study conducted by Mulugeta *et al*. (2018) also reported that educational status is statistically significant and households that attended at least primary education are less likely food insecure than households who cannot read and write. Ahmed (2016) conveyed that farmers' educational level enables them to be more aware of and respond to improved and modern technology that boosts the productivity of farm households and thereby enhances their food security status. A study conducted by Wiranthi *et al*. (2014) in Indonesia confirmed that an increase in the educational level of the household heads would increase the likelihood of the households being food secure. Studies conducted in Benishangul-gumuz region in Ethiopia by (Ferede and Wolde-Tsadik, 2018) and in Mexico by Magaña-Lemus *et al*. (2016) also reported that less-educated households are more likely to be food insecure than their counterparts. Furthermore, the finding from studies conducted by Abdullah *et al*. (2019), Adjimoti and Kwadzo (2018), Alpízar *et al*. (2020), Dagne (2016), Fikire and Zegeye (2022), Maziya *et al*. (2017), Moroda *et al*. (2018), Muche *et al*. (2014), Tafesse *et al*. (2015) and Tefera T. and Tefera (2014) showed that education gives knowledge and awareness for the farmers, enables opportunity of getting non-farm employment and positively and significantly determines the food security status of the rural farm households.

Farmland size: As indicated in Table 8.4, the beta coefficient of rural farm landholding size was positively and significantly correlated with the food security level in the study area. The finding revealed that holding other factors remain constant, a unit increase in the size of farmland holding of the surveyed farm household had increased the likelihood of food security by 224.5%. Additionally, the odds ratio also showed that rural farm households with larger landholding sizes had 9.4 times more likely to be food secure than farm households with smaller landholding sizes (odds ratio = 9.441). The possible explanation for the finding of this study is mainly attributed to the fact that the larger farmland size cultivated by the rural farm household, the more agricultural production and food supply would be which in turn enables and increases the probability of food security status. As a result, the amount of land owned by a household is important in determining crop production quantity, and households that owned and cultivated more land performed much better in achieving food security than their counterparts.

In agreement with the finding of this research, various empirical studies also showed that farmland holding size was one important variable in explaining and determining the food security status of households. For instance, a study conducted by Goshu *et al*. (2013) in rural Ethiopia indicated that cultivated land size increased the food security status of the household by 28%. On the other hand, a study conducted by Ojeleye *et al*. (2014) in Nigeria revealed that a one-hectare increase in farm size increases the probability of food security level by 67%. Additionally, a study conducted by Bedeke (2012) in Kersa district eastern part of Ethiopia showed that a unit increase in farmland holding size increased the likelihood of their food security status by 41.4% and farmers with larger farm sizes are 1.5 times more likely food secure than a farmer with smaller landholding size (odds ratio = 1.513). A study conducted by Bimerew and Beyene (2014) in the Babile district (eastern Ethiopia) also showed that farmland size and food security status are positively and significantly correlated to each other indicating that a one-hectare increase in farm size holding increases the change of food security status 73%.

Moreover, studies conducted by Abdulla (2015) in Ethiopia, Bogale (2012) in Ethiopia, Dagne (2016) in Ethiopia, Mitiku *et al*. (2012) in Ethiopia, Moroda *et al*. (2018) in Boset distict of Ethiopia, Habyarimana (2015) in Rwanda and Henri-Ukoha *et al*. (2013) in Nigeria revealed that farmland holding size had positively and statistically significantly correlated with the food security status of the household. In their finding, they reported that the size of cultivated farmland is one of the principal factors that determines and influences the level and amount of food produced. Hence, land is the most fundamental resource for the rural farm households and an indicator of wealth, source of income, and most importantly associated with the sustainability of food security in the study area and the rural part of Ethiopia in general.

Livestock (TLU): The result of the logistic regression model presented in Table 8.4 portrayed that livestock was found to be significant at a 5% significant level and positively correlated with the food security status of the surveyed farm households in the study area. The finding showed that the odds ratio in favour of being food secure increased by a factor of 1.558 keeping other variables remaining constant. This means that farm households that owned the larger number of livestock (TLU) are 1.6 times more likely to be food secure than those farm households with a smaller number of livestock. In addition, the beta coefficient also indicated that holding others factor remains unchanged an increase in livestock by one TLU had increased the probability of being food secure by 44%. This finding revealed that households with relatively a large number of livestock (TLU) were found to be less vulnerable to the problems of food insecurity than households with no or a small number of livestock indicating that livestock is one of the factors that determine the sustainability of the rural farm households. This is mainly due to a household can sell part of their livestock and buy food to provide and meets sufficient food supply for their family in time of crop production failure.

The result of this study agrees with the finding of Gemechu *et al*. (2016) indicating that the number of livestock owned by the rural farm household had a positive and significant influence on the food security status, arguing livestock contributes to the household's economy as a source of cash income, source of pulling power, means of transportation and source of supplementary food. A study conducted by Silvestri *et al*. (2015) also confirmed that livestock significantly contributes to the earnings of the household's income and livelihoods and is an important factor influencing the level and food security status of the households.

Likewise, studies conducted by Abdulla (2015), Adjimoti and Kwadzo (2018), Asmelash (2014), Frelat *et al*. (2016), Maziya *et al*. (2017) and Mitiku *et al*. (2012) conveyed that livestock is an important and integral part of farming in the rural areas and source of food, income, traction of power for crop cultivation and ultimately improve household food security. They reported that the number of livestock is positively and significantly correlated with the probability of the households being food secure. This indicates that households with large numbers of livestock had a better chance to earn income from the sale of livestock and livestock products which enables them to buy stable food during food shortages. Contrary to the finding of this study, Abdullah *et al*. (2019), Bedeke (2012), Bogale (2012), Goshu *et al*. (2013), Tafesse *et al*. (2015) and Zemedu and Mesfin (2014) reported that although the coefficient of livestock is positive and contribute to the improvement of household food security status, it was found to be statistically insignificant in the model they have analysed.

Access to irrigation water: Accessibility and the use of irrigation water is one of the important variables assumed to impact the food security status of the surveyed rural farm households in the study area. Accordingly, results presented in Table 8.4 revealed that access to irrigation water was found to be significant at a 5% probability level. The beta coefficient showed that for those rural farm households who have had access to irrigation water, the probability of their food security status increased by 207% more than for those households that could not access to irrigation. Furthermore, the odds ratio also revealed that households with access to irrigation water were 8 times more likely food secure than those households with no access to irrigation water (odds ratio = 7.937). The finding portrayed that utilisation of irrigation has a positive and significant relationship with the food security status of the surveyed farm households indicating that access to and use of irrigation would improve agricultural production and its productivity and hence farms tend to produce more crops. Additional, access to irrigation water use can increase crop yield, increase the likelihood that food is available, reduce production risks and increase sustainable production, which has a significant effect on the sustainability of the rural household's food security status. However, in the study area agricultural production was mostly dependent on rainfall and only a small proportion of the surveyed farm households are access to irrigation water. Similarly, a study conducted by Eshetu and Guye (2021) reported that access to irrigation was found to reduce the vulnerability of rural farm households to food insecurity by 5.5% for irrigation users than their counterparts.

The result of this research was also consistent with the findings of Bogale (2012) and Dagne (2016) who noted that availability and access to irrigation water was among the variables with a positive coefficient and statistically significant relationship with a household's food security status arguing that irrigation enables sustainable production which reduces production risk to the smallholder farmers. Moreover, access to irrigation water enables rural farm households to produce and harvest two-three times per year, diversify the cropping systems, increase their income and consumption levels, improve nutrition outcomes which in turn helps to reduce household food insecurity and it is one of the strategies to alleviate poverty and prevent hunger in the rural area (Bogale, 2012). Ahmed (2016) also highlighted that farmers participation in irrigation would improve agricultural production and productivity, which improves farmers' income from crop production directly contributing to the food security status of the households. Studies conducted by Ferede and Wolde-Tsadik (2018), Mengistu *et al*., (2021) and Sani and Kemaw (2019) also noted that access to irrigation practices can enable farmers to grow crops more than once per year, enables to adopt new technologies, intensify crop cultivation, ensure stable production which could greatly determine the level of food production and improve the food security status.

Similarly, Ngema *et al*. (2018) in a study made in South Africa noted that irrigation technology positively influenced and significantly determined the food security status of the households with a beta coefficient of 1.886 and an odds ratio of 6.591. They also reported that irrigation infrastructure empowers farming household to adopt a more diversified cropping system and potential to boost productivity, which in turn improve the food security status of the households. Likewise, a study conducted by Dube and Sigaute (2015) in Zimbabwe also evidenced that irrigation technology had enhanced food production, and helped to produce surplus food, leading to improvement in food availability and accessibility where rainfall is erratic, unreliable, and inadequate.

Evidence from China also confirmed that irrigation is an important measure for increasing grain production and improving agricultural productivity and played a significant role in ensuring food security (Kang *et al*., 2017). Additional, Adebayo *et al*. (2018) in their study in Nigeria, showed irrigation technology has a significant and positive effect on crop yield, crop income and household food security. Nevertheless, studies conducted by Bimerew and Beyene (2014), Goshu *et al*. (2013) and Tafesse *et al*. (2015) reported there is a negative relationship between households' access to irrigation and their food security status.

Drought: Natural disasters such as drought associated with extreme weather events (Kogan, 2019) are one of the significant factors that trigger and increase vulnerability to shocks and thereby lead to food insecurity. Moreover, the frequent occurrence of drought events is the major constraint of rain-fed agricultural production resulting in unsustainable agricultural practices which have an impact on the sustainability of food security. As hypothesized in chapter four of this research paper, results presented in Table 8.4 revealed that drought (shortage and unreliable rainfall) is negatively and significantly correlated with the sustainability of household food security. As indicated in the Table the beta coefficient for drought was -1.832, indicating that holding other variables unchanged, the occurrence of frequent drought (shortage and unreliable rainfall) dad decreased the probability of food security status of the surveyed farm households by 183%. Moreover, the odd ratio presented in the model also showed that rural farm households that were not affected by drought were 0.16 more likely to be food secure than those farm households who reported and perceived their food security status was affected by drought and the unreliability of rainfall (Odds ratio = 0.160). Hence, the finding of the model revealed that drought which resulted in spatiotemporal variability of rainfall is one of the environmental crisis that could cause a decline in agricultural productivity and leads to severe food shortage, which in turn affects the sustainability of rural farm household food security.

The finding of this study agrees with the report of He *et al*. (2019) who stated that drought, which refers to below-average availability of water and rainfall deficiency resulted in the reduction of agricultural production and food availability in areas where the livelihood of the farmers largely depends on rain-fed agriculture and directly jeopardizes the food security status of the farm households. A study conducted by Tefera T. and Tefera (2014) also confirmed that the absence of adequate rainfall during cropping seasons had negatively and significantly influenced the food security status of the households. Furthermore, a case study conducted by Alpízar *et al*. (2020) in Central America reported that drought (the major hazard to household livelihoods) expressed by changes in rainfall patterns and variability negatively affected household food production and directly lead households to food insecurity. However, contrary to the finding of this study Abdullah *et al*., 2019 reported that drought has no statistically significant impact on food security.

Per capita off-farm income: Farm household participation in and utilisation of off-farm income was assumed to stabilize the overall household income and secure access to food in times of the food deficit period. Accordingly, as indicated in Table 8.4 per capita off-farm income is positively and significantly correlated with the food security status in the study. The odds ratio for per capita of farm income revealed that rural farm households participated in off-farm income and higher per-capita off-farm income found to be one time (odds ratio = 1.001) more likely food secure than those farm households not participating in off-farm income and households with smaller per capita off-farm income. This is mainly because participation in off-farm income activity is one of the means of livelihood diversification, which enables to reduce income risks, rises in purchasing power of the households in the time of drought, low farm productivity and maintenance of food security. Moreover, rural farmers' involvement in off-farm income activities may also have an impact on farm diversity and dietary diversity, which could help them to improve the sustainability of their food security status.

Consistent with the finding of this study, Abdulla (2015), Abegaz (2017), Awoke *et al*. (2022), Dagne (2016), Ferede and Wolde-Tsadik (2018), Gemechu *et al.* (2016), Mitiku *et al.* (2012), Mulugeta *et al*. (2018), Ojeleye *et al*. (2014) and Tefera T. and Tefera (2014) also confirmed that off-farm income was found to be positively and significantly associated with the probability of the farm households being food secure. Gemechu *et al*. (2016) found that farm household access to off-farm activity had increased the likelihood of being food secure by a factor of 3.5 arguing that income from non-farm activities increases the probability of the household market purchasing power to use modern agricultural inputs to produce more yield and better access to the food supply. Mulugeta *et al*. (2018) also reported that found that households who earn better off-farm income are 1.8 times more likely food secure than households who earn less off-farm income. In Nigeria, Ojeleye *et al*. (2014) showed an increase in non-farm income by one naira had increased the probability of the farm households being food secure by 3.7 holding other variables remain constant. They also reported that non-farm economic activities yield additional income to the farm household improving their access to agricultural inputs, improving their farm production, and enabling better access to food.

Furthermore, Adem *et al*. (2018) and Kassie *et al*. (2017) reported that farm household participation in different off-farm activities provides them with an opportunity for income and livelihood diversification, which enables them to fill seasonal income gaps and food deficits and hence had a positive impact on food access thereby improve food security status. Sibhatu and Qaim (2017) also noted that off-farm income enables farmers to purchase food regularly, particularly to smooth consumption during the lean season. However, contrary to the finding of this study Goshu *et al*. (2013), Tafesse *et al*. (2015) and Zemedu and Mesfin (2014) reported that participation in different types of off-farm economic activities is negatively correlated with the food security status of the farm households though it is not significant.

Household dietary diversity score (HDDS): Dietary diversity is among the variables that were hypothesized to influence and considerably determine the food security status of the rural farm households in the study area. Accordingly, results presented in Table 8.4 revealed that there is a positive and statistically significant relationship between a household's dietary diversity score and their food security status. Consequently, results in the regression model revealed that holding other variables remain unchanged, a one unit increase dietary diversity score increased the probability of the rural farm households by about 79% (beta coefficient = 0.792). Furthermore, results in the model portrayed that farm households with higher dietary diversity scores were found to be 2.2 times more likely food secure than those households with lower dietary diversity scores (odds ratio = 2.207). This is mainly since dietary diversity score dietary diversity has been correlated with dietary quality, adequate nutritional intake, dietary quantity and access and availability aspect of food security. This evidenced that dietary diversity is one of the important factors that can substantially influence the sustainability of rural farm households' food security status.

The finding of this research was consistent with the results of Mulugeta *et al*. (2018) on a study conducted in the Oromia region of Ethiopia, which reported that households with adequate dietary diversity were found to be 22% more likely food secure than those households with inadequate dietary diversity. Similarly, a study conducted in Nepal by Singh *et al*. (2020) validated that dietary diversity was significantly and negatively associated with food insecurity status reporting households with lower diversity scores were found to be 8.5 times more likely food insecure than households with higher dietary diversity scores. Jones *et al*. (2013) and Maxwell *et al*. (2014) also showed that dietary diversity is one of the proxy indicators of household food security and the greater the dietary diversity score the lesser would be the risk of food insecurity.

A study conducted by Akerele *et al*. (2017) indicated that an increase in food consumption diversity can substantially increase the probability of adequate consumption of food nutrients and intakes of calories and play an important role in addressing the food security status of the households. Furthermore, Chakona and Shackleton (2018) in their study in South Africa also confirmed that households consuming fewer food groups are those who are most likely food insecure arguing dietary diversity as an indicator of dietary quality, consumption of calories and food security. Moreover, Leroy *et al*. (2015) also noted that dietary diversity score is one of the indicators of a household's access to both quantity and quality (variety) of food, which is positively and significantly associated with the per capita calorie consumption and directly reflected the food security status. In their study, they reported that a 1% increase in dietary diversity score increased the per capita energy consumption by about 0.7%. Nonetheless, some studies (Cheteni *et al*., 2020; Vellema *et al*., 2016) reported that a household's dietary diversity cannot guarantee food security status.

Farm production diversity: As indicated in Table 8.4 farm production diversity was found to be positively and statistically significantly related to the probability of being food insecure in the study area. Results of the coefficient of the regression model portrayed that keeping other variables constant an increase in farm production diversity by one unit had increased the likelihood of the surveyed rural farm household food security status by 50%. Additionally, the odds ratio in the model also revealed that rural farm households with a higher diversity of crops were found to be 1.65 times more likely food secure than farm households with fewer crop diversity. The possible explanation behind this finding is that due to crop diversification's ability to improve soil fertility and suppress weeds, diseases and pests, which in turn improve yield, results in crop yield stability, diversifies income source, minimizes household income variability, reduces the risk of crop production failure and used as crop insurance (Njeru, 2013; Makate *et al*., 2016) as farm household depends on other crop types if one crop fails (Makate *et al*., 2016). Moreover, crop diversification is considered as one of the climate-smart agricultural options for enhancing the food security status of smallholder farmers.

In agreement with the finding of this study, research conducted by Silvestri *et al*., (2015) in eastern Africa (Uganda, Kenya, and Tanzania) found that crop diversity is one of the important factors that positively and significantly associated and increased the probability of the rural household's food security status. Njeru (2013) also confirms that crop diversification is one of the potential strategies to mitigate food insecurity by smallholder farmers as it can increase yield stability, diversify diets, and leads to more reliable household income that allows purchasing additional food. In Ethiopia, Bogale (2012) showed that crop diversification had a positive influence on the expected food expenditure of the household and thereby enhance the probability of being food secure. A study conducted on crop diversification and the livelihoods of smallholder farmers in Zimbabwe by Makate *et al*. (2016) reported that diversified cropping systems had a positive and significant impact on improving cereal crop productivity, income stability and farmers' food security status. In addition, they also argued that crop diversification has a direct effect on food availability and nutrition indicators (food consumption score and household dietary diversity).

A study conducted by Adjimoti and Kwadzo (2018) on crop diversification and household food security status in rural Benin reported that crop diversification had a positive coefficient and significant association with the household's food security status indicating that households growing many crops were found to be more likely food secure. Furthermore, Mengistu *et al*. (2021) also reported that farm households with less food insecurity can become food secure by increasing the diversification in their crop production.

8.3. Climate Variability, Sustainable Crop Production and Food Security

Assuring sustainable food security for all depends on several factors such as a sustainable environment (conserving natural resources and ensuring future generations' ability to meet their needs), climatic variability, sustainable production, and productivity (sustainable and adequate food supplies), sustainable access to food, price instability and political instability. Recent evidence suggests that among these factors, climatic variability was found to be one of the challenges to agricultural production and sustainable productivity, which have a direct impact on food availability (Goshme, 2019; Kogan, 2019). Climate change and variability are expected to influence the production of crops and rearing of livestock and the overall activities of agricultural systems (Abebe, 2018; Makate *et al*., 2016; Tafesse *et al.*, 2016) which is one of the major threats to development. Climate is a principal factor for agricultural productivity and its change affects all dimensions of food security: food availability, food accessibility, food utilisation and food system stability (Abebe, 2018; Tafesse *et al*., 2016; Shisanya and Mafongoya, 2016). In line with this, the surveyed rural farm households in the study area were asked if they had noticed a significant change in climatic conditions and climate change indicators over the last 15 years.

As indicated in Table 8.5 about 96.9% of the surveyed rural farm households noticed drought frequently occurred in their locality. On the other hand, about 94.1% of the sample respondents have perceived a decrease in the amount of precipitation while 70.6% perceived an increase in temperature over the last 15 years. Moreover, of the total surveyed sample respondents about 78% have recognized a decrease in the amount of crop production because of climatic variability. On the other hand, about 66.3% and 63.5% of the surveyed rural farm households perceived the occurrence of untimely rainfall and increased rainfall variability in the area, respectively. The finding revealed that a significant proportion of the surveyed farm households in the study area have noticed a climate change in their locality over the last 15 years and recognized the effect of climate variability on their production activity and overall food security status as the area depends on rain-fed agriculture. Several different socio-economic and natural factors have contributed to the growing perception of farm households about climate change variability in the study area.

Table 8.5: Rural farm households perceptions of climate change indicators

Variables	Frequency*	Percentage
Increased rainfall variability	162	63.5
Decreased crop production	199	78.0
Increased temperature	180	70.6
Frequent drought	247	96.9
Land degradation	49	19.2
Decreased precipitation	240	94.1
Flood	19	7.5
Untimely rainfall	169	66.3

*Multiple responses are possible

Figure 8.1: Crops affected due to moisture stress caused by shortage of rainfall (drought)

Source: Photographs were taken by the researcher (April 2018)

The key informant interview and focus group discussion participants also reported that the likely impact of climate change on future production and related risks and vulnerability to it was found to be the main determinants of the sustainability of agricultural production and food security in the study area. They repeatedly reported that climatic variability (late-onset, early cessation of rainfall, insufficient and unreliable rainfall) was found to be one of the main concerns that have had determined the sustainability of their food security status. Moreover, the key informant interview and focus group discussion participants also reported drought and hailstorm was also among the factors treating their agricultural production which in turn impacted their food supply.

Results obtained from the surveyed rural farmers' perception of climate change (rainfall variability) in their locality were also compared with the outcomes of historical trends of meteorological data in the study area. Accordingly, secondary data source on the climatic condition of the study area (mainly rainfall variability) obtained from the national meteorological agency also confirms there was a fluctuating trend in the amount of rainfall (both annual and seasonal) between 1999 and 2016 years (Figure 8.2). This implies that the variability of rainfall in quantity and the rainy days, particularly during the growing season have a significant impact on the amount of crop production and productivity.

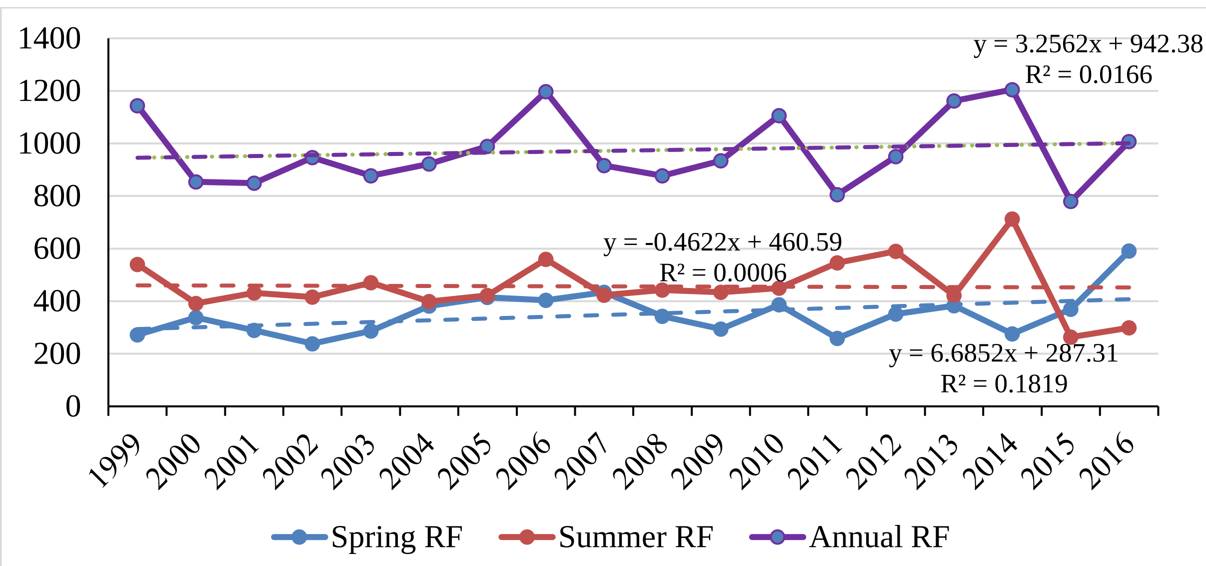

Figure 8.2: Annual and seasonal fluctuation of rainfall in the study area

Source: Household survey data, 2018

Results presented in Figure 8.3 showed that variation of annual rainfall in the study area results in variability of crop production over the last 10 years. The coefficient of variation in annual rainfall was found to be 15% and the coefficient of variation in annual crop production was 53% during the prescribed study period. The finding showed that annual crop production was found to be more variable than that of annual rainfall indicating a unit variation in the amount of rainfall results in higher variability in the amount of crop production, which in turn influenced the sustainability of food supply in the area. The finding evidenced that seasonality dynamics, increased frequency of droughts, altered patterns of precipitation and intensity are among the major factors that threaten sustainable agricultural practices, which in turn impacts the sustainability of food security among smallholder farming systems.

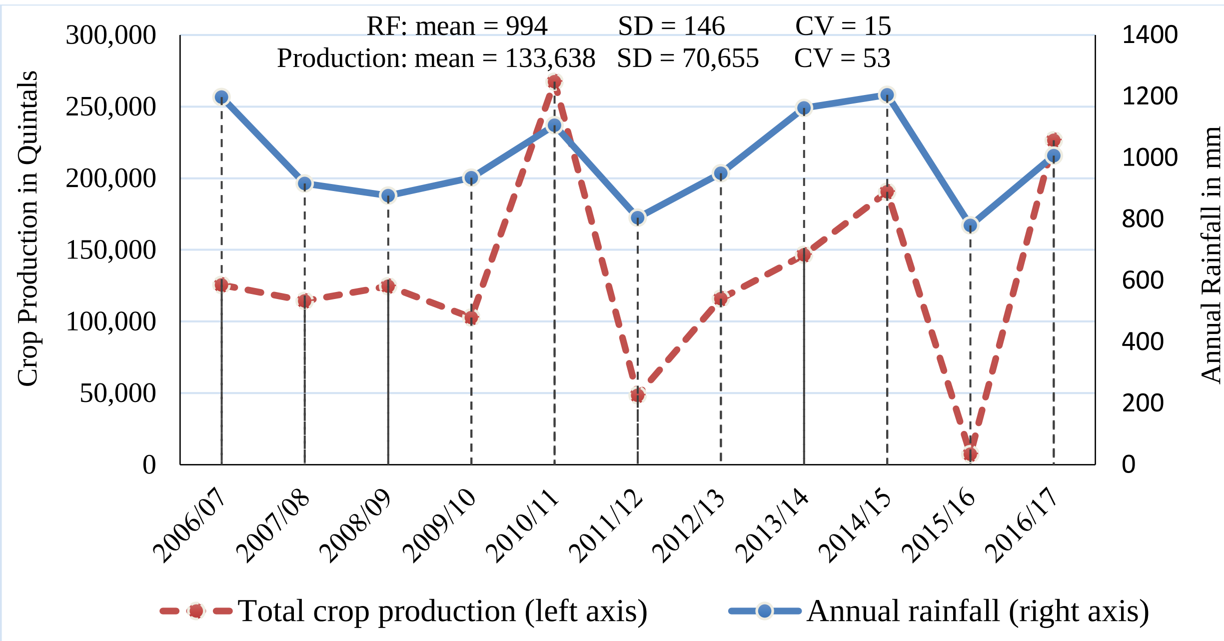

Figure 8.3: Rainfall trend and crop production in Kurfa Chele *woreda* (2006/07-2016/17)
Source: Household survey data, 2018

The analysis of the linear regression model presented in Table 8.6 revealed that there was a positive significant relationship between rainfall and crop production (food availability) in the study area. The beta coefficient of the regression model revealed that a one-millilitre increase in rainfall results in 329 quintals increase in crop production in the study area. Moreover, the regression coefficient of determination revealed that the climatic factor (rainfall variability) accounted for 40% variation in the total crop production and the remaining 60% could be attributed to other factors. This evidence showed that one of the substantial challenges for the sustainability of food security in the study area is the adverse effects of climatic variation mainly the recurrent drought and unreliable rainfall, which results in significant variability of food production and its productivity. Similarly, a study conducted by Ayanlade *et al*. (2017) also reported that growing season variability of rainfall has a significant impact on crop yield and productivity.

Table 8.6: Regression coefficient of rainfall and crop production

	Unstandardized Coefficients Beta	Standardized Coefficients Beta	t	Sig.
Constant	-193849.110		-1.628	.138
Rainfall	329.311	.680	2.780	.021
R square	.462			
Adjusted R square	.402			

Source: Household survey data, 2018

8.4. Implications for Sustainable food security

In common with the findings of other researchers, the sustainability of rural farm households food security status in the study area was strongly determined and influenced by the combined effect of socio-demographic variables (age of the household heads, household size and educational status), access to productive resources (farmland size and livestock production), production and economics variables (per capita off-farm income, dietary diversity, farm production diversity, institutional services (access to irrigation water facility) and environmental variables (drought). As in many other research results, the findings of the study demonstrate that farmland size and livestock production have played an important role in the sustainability of many food production systems by acting as a vector to produce sufficient food crops and highly contributing to the sustainability of rural farmer households' food security status.

Furthermore, the study's findings indicated that a reduction in household size and an increase in the age of household heads tend to improve the sustainability of rural household food security, implying the need for family planning strategies. Besides, the finding of the study document that higher educational attainment, improved dietary diversity, increased off-farm income, and increased farm production diversity are among the critical factors for reducing food insecurity and, as a result, tend to improve the sustainability of rural household food security. Furthermore, the study's findings implied that climatic variability, particularly recurring drought, and insufficient and unreliable rainfall, play an important role in reducing agricultural production and productivity, resulting in critical food shortages that could tend to jeopardize the sustainability of food security in the study area. As a result, the study recommends that local authorities, development practitioners, and other concerned stakeholders should take actions to improve rural farmers' literacy levels, increase poor farmers' income-generating capacity, diversify farming activities, improve farmers' access to irrigation infrastructure, and provide family planning services to achieve sustainable rural households' food security status in the study area.

8.5. Summary

This chapter presents the result of the study obtained from the surveyed rural farmers pertaining to factors affecting the sustainability of rural farm household food security status analysed using a logistic regression model. A regression model that brings out the relationships between variables whose relation is imperfect is used to estimate the maximum likelihood estimation method to discern the combined effects of these explanatory variables on the sustainability of rural household food security status. Accordingly, the analysis of the multivariate logistic regression model revealed that about ten potential explanatory variables were identified as the major substantial factors determining and influencing the sustainability of rural farm household food security status in the study area. These include household size, age of the household heads, educational status, farmland size, livestock expressed in TLU, access to irrigation water, drought, per capita off-farm income, household dietary diversity score and farm production diversity. The finding of the regression model-based assessment showed that the explanatory variables included in the model in combination explained nearly 75% of the total variation in the sustainability of rural farm households' food security status.

Moreover, climatic variability, particularly the recurrent occurrence of drought and unreliable rainfall was found to be one of the challenges to un/sustainable productivity which have an impact on food availability. The results of the study showed that seasonality dynamics (late-onset, early cessation of rainfall, insufficient and unreliable rainfall), increased frequency of occurrence of drought, altered patterns of precipitation and intensity were among the major factors that threatened sustainable agricultural practices which in turn impacted the sustainability of food security among smallholder farming systems. The next chapter examines the possible coping and adaptive strategies applied by farm households in times of critical food shortages.

CHAPTER NINE

INDIGENOUS KNOWLEDGE OF FARM HOUSEHOLD COPING AND ADAPTIVE STRATEGIES TO ENHANCE SUSTAINABILITY OF FOOD SECURITY

9.1. Introduction

As commonly experienced in other parts of the country, the rural farm households in Kurfa Chele *woreda* are vulnerable to food problems, and food security is a real challenge and has become one of the major concerns for the study area. To manage and react to the problems of food shortfalls, the surveyed rural farm households in the study area practised various alternative coping and adaptation mechanisms. Coping strategies are means to minimize possible shocks from food crisis and responses made by rural farm households to improve the declining situation of their food security status while adaptive mechanisms refer to a long-term adjustment and permanent change in the mix of ways in which food is required. Hence, this chapter documents research results related to the fourth objective of the study that mainly analysis indigenous knowledge of rural farm household coping and adaptive strategies used to enhance the sustainability of food security in the study area. Moreover, the chapter describes some policy implications for local authorities and development practitioners on how these coping and adaptive mechanisms can effectively be utilised in assisting to achieve SDGs. Thus, in this section, an attempt was made to assess how the surveyed farm households in the study area are responding to the food insecurity problems. This involves the use of multiple adaptive strategies and coping mechanisms to overcome the problems of severe food shortages resulting from different livelihood shocks and environmental stresses. Therefore, the integration of indigenous adaptation and coping strategies with scientific methods was used and analysed so as to enhance the livelihood, income diversification and agricultural food production of the rural farm households and thereby sustain their food security status.

9.2. Indigenous Knowledge of Household Coping Strategies to Seasonal Food Deficit

Coping strategies are behavioural responses (Devereux and Tavener-Smith, 2019) made by a household when facing seasonal food shortages to improve the declining situation of food insecurity problems and thereby mitigate their consequences (Feleke, 2019; Zemedu and

Mesfin, 2014; Sewnet, 2015). Almost all the surveyed farm households in the study area had experienced a food shortage and employed various types of coping strategies in times of food shortfall. Accordingly, the surveyed rural farm households were asked about the possible coping strategies that they had to employ when facing food shortages and ranked on the food insecurity mitigation options.

The various household food insecurity coping strategies identified by the study participants were grouped into four categories as dietary change, short-term measures to increase household food availability, short-term measures to decrease the number of people to feed and rationing or managing the shortfall (Gupta *et al.*, 2015; Ngidi and Hendriks, 2014; Sewnet, 2015). Accordingly, the surveyed farm households in the study area have identified several different individual coping behaviours in each of these categories. These include reducing the number of meals eaten per day, limiting the size of food consumption, eating less preferred and less expensive food, borrowing money or food from relatives, selling more livestock than usual to buy food, selling assets, selling firewood and charcoal, consuming seed stock kept for the next season, engage in petty trading, and looking for aid or relief assistance. The detailed description of the results obtained from the sample respondents in the study area was presented in the next section as follows.

9.2.1. Dietary Change

Dietary change is a strategy whereby the poor rural farm households switch their diet or food consumption from preferred to least preferred and less expensive foods (Sahu, 2018). It is a strategy whereby poor farm households change their diet frequently during droughts or insufficient food, by switching food consumption of preferred foods to cheaper and less-preferred substitutes. As indicated in Table 9.1 about 94.1% of the surveyed rural farm households reported changing their diet in times of food shortfall to eat less preferred and less expensive food. In addition, about 25.1% of the surveyed farm households ranked eating less preferred and less expensive food as the top three coping strategies in times of food shortages (Table 9.2). Additionally, about 18.3% of the food secure and 27.2% of the food insecure farm households in the study area ranked changing diet to mitigate the food shortfall as the top three options. Information obtained from the key informant and focus group discussion participants also revealed that farm household in the study area was forced to change their diet type to overcome the food shortfall in times of severe crisis. Accordingly, the focus group discussion participants in the study area were reported that farm households in their area were changed their diet and even some households limited or removed spices and oils added to make stew and the use of sweets like sugar. They also reported that in times of food shortages, some farmers ate roasted maize and sorghum to overcome the crisis.

Table 9.1: Rural farm households coping strategies to deal with food shortages

Coping strategies	**Indicators**	F*	%
Dietary change	Eat less preferred food and less expensive food	240	94.1
Rationing	Reduce the number (frequency) of meals eaten per day	247	96.9
	Limit the size of meal (food) consumption	246	96.5
	Skipping adults to feed the children	26	10.2
Enhancing short-term food availability	Borrow grain/money from relatives	125	49.0
	Sale more livestock than usual	229	89.8
	Sale assets other than livestock	186	72.9
	Look for aid or relief assistance	185	72.5
	Consume seed stock kept for the next season	135	52.9
	Seek work in urban areas (as a labourer)	70	27.5
Short-term measures to decrease the number of people to be fed	Send children to eat with relatives or neighbours	8	3.1

*Multiple responses are possible
Source: Household survey data, 2018

Similarly, a study conducted by Ngidi and Hendriks (2014) reported that reliance on less preferred and inexpensive foods was the most commonly used coping strategy in response to food shortages which was practised by 88.4% of the sampled households in their study. Abebe (2018); Alpízar *et al*. (2020); Dessalegn (2018); Sahu (2018) and Tora *et al*. (2021) also confirmed that during droughts and food shortfall periods households change their diet by switching food consumption of preferred foods to cheaper and less-preferred substitutes. Furthermore, studies done by Berlie (2015), Derribew (2013) and Dessalegn (2018) noted that consuming less preferred and wild foods were one of the possible coping strategies practised by farm households in response to food shortages and various climate-related shocks reducing food availability.

9.2.2. Short-term Measures to Increase Household Food Availability

Increasing short-term food availability is an approach whereby households try to enhance the availability of food supplies using short-term strategies (Sahu, 2018). The typical example of enhancing short-term household food availability include borrowing food or money from relatives to buy food, consume seed stock kept for the next season (Cordero-Ahiman *et al.*, 2018; Ngidi and Hendriks, 2014; Mohiuddin *et al.*, 2016; Sahu, 2018), look for aid or relief assistance, sale livestock, cash for work (Endalew *et al.*, 2015; Tefera T. and Tefera, 2014), seek work in urban areas (casual labourer), selling assets (property), (Dessalegn, 2018; Endalew *et al.*, 2015).

As depicted in Table 9.1 about 89.8% of the surveyed farm households have practised the selling of different kinds of live animals as one option of coping strategies in times of food crisis mainly for purchasing food grain. Moreover, about 59.2% of the surveyed sample respondents were ranked selling of more livestock than usual as the top three (ranked from 1 to 3) coping mechanisms (Table 9.2). Moreover, about 63.3% and 57.9% of food secure and food insecure sample households respectively used and ranked the selling of more livestock as one of the coping strategies in case of food shortages. This revealed that in times of food crisis, selling more livestock than usual is a common phenomenon among the sample households in the study area to meet household food consumption. Data obtained from the key informant interviews and focus group discussion participants were also conveyed similar results. They reported that farm households in their area begin with the selling of small stocks like lamb, goats, and sheep, then move on to selling small cattle (mainly calf) and cows as the food crisis became worsened.

Table 9.2: Top three ranked coping strategies by food security status

Indicators	Food Secure (n = 60)		Food Insecure (n = 195)		Total (255)
	F	%	F	%	
Limit size of meal (food) consumption	55	91.7	182	93.3	92.9
Reduce the number (frequency) of meals eaten per day	45	75.0	173	88.7	85.5
Sale more animals than usual	38	63.3	113	57.9	59.2
Eat less preferred food and less expensive food	11	18.3	53	27.2	25.1
Sale assets other than livestock	2	3.3	5	2.6	2.7
Seek work in urban areas (as a labourer)	17	28.3	24	12.3	16.1
Borrow money/grain from relatives	1	1.7	1	0.5	0.8
Look for aid or relief assistance	2	3.3	22	11.3	9.4

Source: Household survey data, 2018

Studies so far conducted in different parts of the world revealed similar results. For instance, studies conducted in Ethiopia by Alpízar *et al*. (2020), Derribew (2013), Endalew *et al.* (2015) and Muche *et al*. (2014) reported selling of livestock was used as a coping mechanism to cope with periods of food shortage and to increase the availability of food for their household members. Furthermore, a study that was done by Berlie (2015) and Tora *et al*. (2021) also confirmed that selling small ruminants and big livestock to buy food is among the coping strategies to cope with the climate-related shock and thereby increase the availability of food for the household.

In addition to livestock, the surveyed farm household also practices selling assets to cope with periods of food crisis and to satisfy their food needs. Accordingly, results presented in Table 9.1 indicated that about 72.9% of the sample respondents reported and practised selling of assets as a coping strategy to smooth consumption and increase food availability for their household members. However, continuous use of such kind of coping strategy resulted in the depletion of tangible assets, which exposes households to chronic food insecurity. In agreement with this finding, Mulugeta *et al*. (2018) confirmed that about 6.6% of the food insecure and 7.9% of the food secure households reported selling assets to combat the seasonal food shortage. Berlie (2015) also noted that the selling of productive assets like land and big livestock is among the coping strategies practised by farmers to smooth consumption in response to food shortages.

Borrowing grain or money from relatives or friends to buy food was also among the coping strategies employed by the surveyed farm households in the study area, which was reported by 49% of the sample respondents. In agreement with the finding of this research, a study that was done by Derribew (2013) on an assessment of coping strategies for drought-induced food shortages in Eastern Ethiopia reported that about 68% of the sample households borrowed grain or cash from friends and relatives to cope with drought-induced food shortages. Furthermore, Tsegaye *et al*. (2018) also stated that about 38% of the households practised borrowing food and money to cope during periods of food deficit for the family. Additionally, Mulugeta *et al*. (2018) found that borrowing money or food from family or neighbours was one of the most employed coping mechanisms for seasonal food shortages, practised by 43.8% of food insecure households and 31.7% of food secure households. Ezeama *et al*. (2015), Gupta *et al*. (2015) and Muche *et al*. (2014) also reported borrowing food and money as among the various coping strategies identified and practised by the participants to smooth food consumption in times of food deficit.

The consumption of seed stock kept for the next season was also identified as a coping mechanism in response to food insecurity, which was responded by 52.9% of the surveyed sample respondents in the study area (Table 9.1). However, the consumption of seed stock was not ranked in the top three coping mechanisms by any of the sample respondents. This mainly indicated that the consumption of seed stock was used as a coping strategy in severe food crisis and if the severity of food shortage increased when they do have no other options. Consistent with this finding, a study conducted by Cordero-Ahiman *et al*. (2018) confirmed that consuming seed stock held for the next season was one of the possible coping mechanisms of food shortage, which was employed by 41.46% of the households in their finding. Similarly, Ngidi and Hendriks (2014) also reported that the consumption of seed stock held for the next season was used and practised by 62% of the sampled households as coping mechanisms in time of food deficit period. Additionally, Berlie (2015) stated that about 49% of households consume reserved seeds as one of the possible coping strategies in times of severe food crisis.

In times of severe food crisis, most of the farmers in the study area relied on emergency relief food distribution from the government and non-governmental organizations. Hence, relief food distribution saved the lives of thousands of hungry people in the study area during the time of the food crisis. Many key informant interviewees and focus group discussion participants' have also passionate evidence of this fact. Results in Table 9.1 indicated that about 72.5% of the surveyed household respondents selected reliance on relief food assistance (looking for aid) as one of the possible coping strategies in times of food deficit. Of the total sample respondents, 9.4% of the surveyed households ranked reliance on relief food assistance as one to three coping strategies (Table 9.2). Consistent with this finding, a study conducted by Tefera T. and Tefera (2014) reported that food aid is among the coping strategies in times of severe stage of food shortages. Similarly, Tsegaye *et al*. (2018) also stated that reliance on aids (food and money) was one of the coping mechanisms reported by 26% of the households in their study to cope with food shortages. Moreover, a study conducted by Gupta *et al*. (2015) similarly conveyed that households relied on food aid as a coping strategy to increase the short-term availability of food for their household members.

9.2.3. Short-term Measures to Decrease the Number of People to be fed

Reducing the number of family members was one of the coping strategies whereby households reduce the number of people that must feed if there is inadequate food to meet the family needs (Sahu, 2018). This includes migration, separation of family members (Sahu, 2018), and sending household members elsewhere (Mohiuddin *et al.,* 2016; Ngidi and Hendriks, 2014). Results in Table 9.1 indicated that only 3.14% of the surveyed sample respondents reported sending their children to eat food with relatives or neighbours during the period of insufficient food. This revealed the culture of sending children to eat with neighbours in the study area is not well developed. Additionally, key informant and focus group discussion participants disclosed that holding coffee ceremonies among the neighbouring farmers is common which will help them for sharing food in times of crisis, though such practices were declined nowadays. Contrary to this, a study conducted by Ngidi and Hendriks (2014) showed that relatively a large number of households (44.9%) practice sending family members to eat elsewhere. A study conducted by Zemedu and Mesfin (2014) in three *woredas* of eastern Hararghe zone of Ethiopia on the other hand showed that about 17% of the respondents reported sending some members of the households to live and eat with relatives as coping strategies during food shortfall period.

9.2.4. Rationing or Managing Food Shortfall

Rationing food is one of the most solid coping strategies that households practice to manage the shortfall of food for consumption (Sahu, 2018). Accordingly, as indicated in Table 9.1 reducing the frequency of meals eaten per day and limiting the portion of food consumption per day is amongst the most frequently reported methods of managing the food shortfall coping strategies used by the sample respondents in the study area. This often refers to skipping one or more of the usual meals (breakfast, lunch, or dinner) in times of severe food crisis. Results in Table 9.1 revealed that about 96.9% and 96.5% of the surveyed farm households in the study area confirmed that they were enforced to reduce the frequency of meals and portion of foods eaten per day, respectively, to overcome food shortfalls in times of severe food crisis. Moreover, results in Table 9.2 revealed that limiting the size/portion of meals and reducing the number of meals eaten per day were among the common coping strategies frequently described and ranked from one to three by 92.9% and 85.5% of the sample respondents respectively as the problem of food crisis became worse.

In a similar fashion, about 91.7% of food secure and 93.3% of the food insecure surveyed farm households reported minimizing the portion of food consumed as coping strategies in times of critical food shortfall by ranking it from one to three in order. Furthermore, about 75% of the food secure and 88.7% of the food insecure sample households reduced the frequency of meals eaten per day during the food shortfall period. This finding portrayed that limitation of the portion sizes of food consumption and reducing the number of meals eaten per day was among the common coping mechanisms mentioned and used in times of food insufficiency as reported by the study participants. Information obtained from the key informant interview and focus group discussion participants disclosed that farmers usually eat meals three times per day under normal circumstances. Nevertheless, in times of food shortfall, the number of meals eaten per day was reduced to twice a day. Even under severe food crisis most adult farm households cut the frequency of meals eaten per day from two to one and typically feed their children twice.

Consistent with the finding of this research, Abebe (2018), Alpízar *et al*. (2020), Dessalegn (2018), Sani and Kemaw (2019), Tora *et al*. (2021) and Tsegaye *et al*. (2018) also reported that reducing the amount and frequency of meals eaten was the major coping strategy for food insecurity employed by the farm households. Furthermore, the finding of this research was consistent with previous studies done by Cordero-Ahiman *et al*. (2018) in Sierra Tarahumara in Mexico, Ezeama *et al*. (2015) in Anambra State of Nigeria, Mohiuddin *et al*. (2016) in Bangladesh, Ngidi and Hendriks (2014) in Kwazulu-Natal in South Africa and Sahu (2018) in Odisha (India) who confirmed that limiting the portion or size of meals at times and reducing the number of meals per day was among the common coping strategies used by households to manage food consumption during the time of food shortages.

Moreover, the surveyed farm household also reported that the meal intake of adult members in the household was deliberately limited or reduced in amount to ensure children get enough food to eat, thought skipping adults to feed children as coping strategies were mentioned by a few sample respondents. Results in Table 9.1 revealed that only about 10.2% of the surveyed farm households in the area were reported skipping adults to feed children as a coping strategy in times of food insecurity crisis. The key informant interview and focus group discussion participants also confirmed that skipping meals by adults (eating only once or twice per day) to feed children was used as one of the coping mechanisms in times of severe food crisis, which is practised by some of the farm households in the study area, especially among lower-income group households. The focus group discussion participants reported that during the normal period when there is no shortage of food, the adult members of the household usually ate three meals per day (breakfast, lunch, and dinner). However, if there is a food shortfall and the condition is severe, the adult members of the farm households eat only one or two meals per day. They also reported that those adult household members were sometimes eating breakfast and lunch at one buffering.

In agreement with the finding of this study, Cordero-Ahiman *et al*. (2018) stated that skipping meals and restriction of the consumption of adults for small children to have food is one of the coping strategies employed by the household in times of food shortfalls. Similarly, Abebe (2018); Dessalegn (2018) and Endalew *et al*. (2015) also reported that skipping adults to feed children is among one of the coping strategies used by households during the abnormal season and food crisis period.

9.3. Indigenous Knowledge of Adaptive Strategies to Food Insecurity

Adaptation is a long-term strategy for preventing a threat with consistent interventions (Berlie, 2015). Adoptive strategies refer to a long-term adjustment in different socioeconomic systems to reduce the vulnerability that involves a permanent change in the way food is required and available to the farm households (Endalew *et al.,* 2015; Tafesse *et al*., 2015). Accordingly, the long-term adjustment of adoptive strategies against climate-related shocks and to mitigate rural farm household's food insecurity locally practised by the sample respondents in the study area includes livelihood and income diversification, crop diversification, cultivating marginal land, practising small-scale irrigation, rainwater harvesting, fattening livestock, and cultivation of drought-resistant crops (See Table 9.3). These adaptation strategies derived from indigenous knowledge and practices were discussed hereunder as follows.

9.3.1. Income and Livelihood Diversification

Livelihood diversification is a strategy that aligns farmers' goals to short-term economic feasibility and long-term sustainability. It is a strategy that can boost farmers' income and promote sustainable land management practices (Kassie *et al*., 2017) that can contribute to sustainable agricultural production and productivity. It is also associated with farmers' participation in on-farm, off-farm and non-farm income diversification activities. Livelihood and income diversification are one of the major adaptive capacities that has been practised by the surveyed farm households in the study area. As indicated in Table 9.3 about 72.2% of the sample respondents reported diversifying their livelihoods by engaging in different income-generating activities, which in turn helped to improve their wellbeing. Farm households in the study area have participated in the production of various types of crop production, livestock rearing, engaged in petty trading, selling firewood and charcoal, working as causal labour and so on, which could help to diversify their livelihoods.

In agreement with the finding of this research, Endalew *et al*. (2015) reported that income diversification is used as one of the adaptive strategies for the food insecurity problem.

Furthermore, Shahid and Al-Shankiti (2013) noted that income diversification is one of the main tools of sustainable agricultural development strategies, which could increase the purchasing power of people and food availability at the household level. Kassie *et al*. (2017) also reported that income and livelihood diversification can potentially play a significant role in reducing vulnerability to poverty and food insecurity by stabilizing income flow and consumption levels. Adem *et al*. (2018) confirmed that smallholder farmers' participation in different income diversification activities could provide them with additional income that enables farmers to spend more on their basic needs and will have an impact on their food security status.

Table 9.3: Adaptation strategies used by farm households in Kurfa Chele *woreda*

Adaptive strategies	No. of response	Percentage
Income and livelihood diversification	184	72.2
Crop diversification	142	55.7
Cultivating marginal land	135	52.9
Fattening Livestock	123	48.2
Irrigation water use	31	12.2
Rainwater harvesting techniques	49	19.2
Sale of firewood and charcoal	66	25.9
Engage in petty trading	15	5.9

Source: Household survey data, 2018

9.3.2. Crop Diversification

Crop diversification refers to the cultivation of more than one variety of crops belonging to the same or different species in each geographical unit (Makate *et al*., 2016). Crop diversification is one of the most important risk management and farmers self-insuring strategies to the uncertain environmental conditions. The possible reason for this is mainly because crop diversification can reduce risks and income variability. Crop diversification also involves intercropping and crop rotation, which is mainly used to increase soil fertility, better use of scarce resources and minimise risks due to loss from other production activities. Intercropping of maize or sorghum with khat (see Figure 9.1) was widely practised and used as means of adaptive strategies to food insecurity problems. Accordingly, as indicated in Table 9.3 about

55.7% of the surveyed farm households in the study area practice crop diversification as a means of adaptive strategies to climate change and food insecurity problems. Farm households in the study area were cultivated different types of crop species such as maize, sorghum, wheat, barley, chickpea, horse bean, and so on though, the diversity varied based on the agro-climatic zones. Furthermore, farmers in the study area also produce cash crops like khat and coffee, vegetables such as potato, onions, pepper and so on, which could diversify the means of earning income and thereby directly enhances food availability.

Figure 9.1: Photo showing intercropping of sorghum with khat in the study area (Orde Goba) (Photograph were taken by the researcher, April 2018)

Similarly, Njeru (2013); Zemedu and Mesfin (2014) stated that crop diversification is one of the strategies used to increase food production by farm households and potentially used to mitigate food insecurity by smallholder farmers. Additionally, Makate *et al*. (2016); noted that crop diversification can reduce uncertainties in farming, increase resilience, improve soil fertility, improve farm productivity, and brings yield stability that could play a significant role to sustain food availability. Shisanya and Mafongoya (2016) also reported that crop diversification and growing different crop varieties are among the possible and preferred adaptation strategies practised by households in response to climate change and to secure a source of livelihood.

9.3.3. Cultivating Marginal Land and Diversifying Crops

Marginal land is less fertile land that is brought under cultivation with the help of soil and water conservation practices to improve its productivity. Marginal land includes land with low soil quality, occurs on steep terrain, has shallow soil depth, poor fertility and is used for grazing, (Shahid and Al-Shankiti, 2013) which do not have sufficient capacity for agricultural production. However, with significant management efforts made to improve its quality with the help of soil and water conservation practices, it could be used for farming. Accordingly, results presented in Table 9.3 showed that about 52.9% of the sample respondents in the study area cultivated and converted the marginal land for agricultural production to increase the availability of food, which could contribute to the improvement of the food security status of their family. This could be possible by partly conserving the land and rehabilitating natural resources on the marginal lands to maintain the sustainability of its productivity. Hence, the transformation of marginal land into agricultural land would likely increase yields and can sustain food production and productivity, which could help to address the problem of food insecurity and poverty alleviation. However, it should be noted that because of its marginality and poor quality the production obtained from and contribution to food security may not become sustainable.

Similarly, Endalew *et al*. (2015) reported that the cultivation of marginal land is one of the commonly used adaptive strategies which partly contributed to the availability of food supply although its contribution cannot be long-lasting (sustainable). Further, Shahid and Al-Shankiti (2013) also noted that marginal land can be improved and converted to potentially productive agricultural land with irrigation technologies that can increase productivity and farmer's income to support an expanding population.

The key informant interview and focus group discussion participants disclosed that, as family members increased in size and sign of food shortfall was observed, lands that were left fallow for a long time or land that were not under cultivation, land used for grazing will be ploughed and converted to crop production land to sustain the need of food consumption. Moreover, the key informant interview and focus group discussion participants confirmed that no land was left fallowed nowadays except the land that was not cultivable and unproductive by any means.

9.3.4. Fattening Livestock

Farmers of the study area engaged in oxen and small ruminant fattening practices to secure food for their families. This will also help to diversify their livelihood strategies, which in turn raise farm household income. Results presented in Table 9.3 portrayed that about 48.2% of the surveyed farm households reported fattening of livestock to diversify their livelihoods and income and thereby sustainably secure food for the household members. Moreover, some farm households in the study area reared improved sheep, goats, and cattle to increase production and productivity which was supplied and distributed by the *woreda* livestock and fishery development offices. Similarly, Derribew (2013) in his study in Eastern Ethiopia reported that fatting livestock is one of the preferred adaptation strategies suggested by the farm households which could diversify their livelihoods and raise earned income in turn contributing to the sustained availability of food supply for their family needs. Berlie (2015) also noted that fattening livestock and rearing improved sheep is among the possible adaptation strategies practised by farmers to cope with periods of food insecurity and smooth consumption.

9.3.5. Irrigation Water Use

Results depicted in Table 9.3 showed that only 12.2% of the surveyed farm households were accessible and used irrigation as a coping mechanism to cope with drought or climate changes. Most of the farmers' practising irrigation was also found in the lowland area (mainly in Hula Jeneta *kebele* see Figure 9.2) where water for the irrigation system was available. Consistently, Tafesse *et al*. (2015) in Ethiopia, reported that the use of irrigation is among the various adaptive strategies practised by farmers to mitigate the impact of climate change on agricultural production. Thus, the use of irrigation technology as an adaptive mechanism for climate change has a significant effect on the food security status of the households and its sustainability where rain-fed agriculture was primarily undertaken.

In their study conducted in China, Kang *et al*., (2017) noted that irrigation water was used as an adaptive strategy and played a significant role in increasing grain production and food supply thereby ensuring food security. Furthermore, Adebayo *et al*. (2018) confirmed that the use of irrigation technology had a positive and significant effect on crop yield, asset creation, farm income and household food security. Therefore, increasing the adoption of irrigation technology is an important adaptive strategy for increasing agricultural production and productivity that could be implemented to minimize the impact of climate change mainly drought and unreliable rainfall patterns. Additionally, Muluneh *et al*. (2017) stated that the adaptation of supplemental irrigation systems can be used to avoid crop failures in drought years and used to minimize the negative impacts of climate change on crop yield and food security. Hence, the use of irrigation technology for adapting to climate change viably stabilizes yield and thereby improves the food security status of rural farm households.

Figure 9.2: Khat production along Dawe River using irrigation in Hula Jeneta *kebele* (Photograph were taken by the researcher, April 2018)

9.3.6. Rainwater Harvesting Techniques

Unpredictable rainfall and scarcity of water are one of the main obstacles to food security in the study area. Hence, the use of rainwater harvesting technology could partly solve water deficiency during the dry season and farm households in the study area were collected rain and surface water in the dam or pond as alternative methods of sourcing and supplying water for irrigation in the dry season. As indicated in Table 9.3, about 19.2% of the surveyed farm households were reported to use/practice rainwater-harvesting technologies as an adaptive strategy to water scarcity. In this regard, the key informant interview and focus group discussion participants confirmed that farm households in their study area are doing all their best level efforts in harvesting rainfall water to minimize the effect of climate change and water scarcity.

Moreover, they were reported that using the harvested rainwater farmers produce khat, potatoes and onions after the end of the rainy season which could help them to improve their income, livelihoods, and feed their families continuously.

Teka (2018) reported that rainwater harvesting is one of the efficient management strategies for the people practising rain-fed farming by improving food security for those households who do not have access to irrigation. Hence, in water deficit areas, rainwater harvesting techniques greatly contributed and improved food availability and met climate change-related challenges if efficiently practised. Therefore, the implementation of rainwater harvesting techniques as an adaptive strategy helped to increase crop and livestock productivity, crop diversification and access to water points thereby improving and sustaining food security. Additionally, a study conducted by Berlie (2015) also confirmed that rainwater harvesting is one of the adaptive strategies practised by households to cope with erratic and unpredictable rainfall which could partly solve water deficiency during the dry season.

Shrestha and Nepal (2016) in their study conducted in Nepal also noted that rainwater harvesting is one of the locally successful adaptation strategies to cope with the impact of climatic variability which could increase production and help to improve the food security status of subsistence farmers. Moreover, a study done by Schindler *et al*. (2016) noted that rainwater harvesting had the highest positive impact on yield, income, and food diversification because of the increased availability of water which in turn influenced the sustainability of food security. Thus, rainwater harvesting technology is one of the possible adaptive strategies that tend to improve household food security by promoting intensive agriculture and improving the livelihoods of farm households.

9.3.7. Sale of Firewood and Charcoal

The analysis of the study results also revealed that some of the surveyed farm households tend to sell firewood and charcoal to generate income and purchase food grain for their family. Accordingly, the results presented in Table 6 showed that about 25.9% of the surveyed sample respondents reported selling firewood and charcoal as adaptive strategies to increase household food availability in times of severe food deficiency. Similarly, Endalew *et al*. (2015) stated that the sale of wood is one means of off-farm activities used to diversify farmers' income and employed as adaptive strategies in response to household food insecurity. Dessalegn (2018) also reported that households who sold firewood and charcoal are more likely to buy cereals and secure food in times of high risk of food insecurity. Thus, from this finding, it is possible to conclude that selling firewood and charcoal was among the possible adaptive strategies that helped to increase long-term food availability and satisfy the needs for food in the household members.

9.3.8. Engage in Petty Trading

Petty trading is one of the possible adaptive strategies that are used to increase the availability of food at households during a seasonal food deficit. As indicated in Table 6, about 5.9% of the surveyed sample households engaged in petty trading as a means of income diversification and adaptive mechanisms to food shortages to smooth household food consumption. Trading of Khat, potato, onions, buying and selling of small ruminants are among the trading activities practised by the surveyed sample respondents in the study area. Consistent with the finding of this research, Abebe (2018) and Dessalegn (2018) reported that participation in petty trading was identified as one of the possible adaptive mechanisms whereby the households diversify their income in the long-term to sustain household food supply. Similarly, studies conducted by Derribew (2013) in Ethiopia, confirmed that petty trading such as the selling of khat and groundnut, tomatoes, sugarcane, onions, and tea are small trading activities carried out during normal periods and drought years are the major adaptive strategies that enhance household food availability.

9.4. Policy Implication for Local Authorities and Development Practitioners

Sustainable food security is an all-encompassing process and a multi-dimensional and complicated concept that involves several factors to be considered and the participation of all actors in the chain. It includes dimensions such as the availability of food through agricultural production, physical and economic access to food, as well as adequate use and utilisation of available food by households or individuals throughout the year (Aborisade and Bach, 2014; Berry *et al*., 2015; Trentmann *et al*., 2015). On the other hand, simultaneously attaining both sustainability and food security requires looking at the overall food system, including well-developed adaptive mechanisms rather than simply focusing on agricultural production, market functioning and household food baskets (Prosperi *et al*., 2014). Moreover, achieving sustainable food security requires minimizing environmental impacts while improving agricultural productivity and its profitability (Aborisade and Bach (2014). Besides, smallholder rural farm households are vulnerable to poverty and food insecurity (particularly, in the present study area) mainly due to lack of access to farmland for crop production, shortage of grazing land for livestock, low productivity, poor rural infrastructural development, inadequate provision of modern agricultural inputs, lack of access to credit services, shortage of water resource for irrigation practices and domestic use, high rate of natural degradation, poor environmental management, high level of illiteracy, poor health and sanitation, above all the recurrent occurrence of drought and unreliable rainfall patterns. All these complicated and multifaceted factors call for all-rounded action in the formulation and implementation of development programs and strategies to improve the livelihoods of the vulnerable rural poor by considering the local area's knowledge of adaptation mechanisms.

Coping and adaptive strategies to improve the livelihoods and income of the poorest section of the communities (particularly the rural smallholder farmers) are essential to achieve food security for all and to meet the SDGs. Furthermore, it would be difficult to address the sustainability of food security without the full participation of local communities by addressing their basic needs and incorporating their indigenous adaptive capacities and strategies. Besides, achieving the first (ending poverty) and second SDGs of ending hunger will require an immense, concerted effort across scales to address all aspects of food security while at the same time, strengthening the coping and adaptive capacity of the vulnerable communities so that they can respond to food shortage and other challenges in the future. Moreover, indigenous knowledge and respect for natural and cultural heritages are typically abundant in local communities to combat environmental vulnerabilities and shocks related to food security problems to the best of their level. Hence, to overcome the prevailing and pressing problems of poverty and ending hunger (SDGs 1 and 2) with the aim of achieving the sustainability of food security by minimizing the magnitude of the deriving factors, local authorities, development actors and mainly the non-governmental organizations (NGOs) should have to incorporate and integrate the indigenous coping and adaptation strategies with scientific methods while designing policies and programs. The integration of local communities coping and adaptive mechanisms with the scientific methods is recommended to contribute toward improving food security and alleviating poverty in the country and the study area also. As a result, it could have a role to play in achieving the Sustainable Development Goals. Furthermore, the local authorities and development practitioners should emphasize on capacity building, asset accumulation and improving resilience by focusing on local communities coping and adaptation strategies to assist the country in achieving SDGs.

Specifically, the poor rural farmers in Ethiopia and the study area used different coping mechanisms to cope with the existing and pressing food insecurity such as consuming wild food, reducing the frequency and quantity of meals per day, seeking relief assistance, relying on less expensive and less preferred food, borrowing food and money. Hence, the local authorities, development practitioners and other food security reduction programs (including PSNP) should try to implement policies and projects that work on providing credit, post-harvest and food waste management activities, the help in improving the lifestyle of the rural farmers. Moreover, local authorities and development practitioners should focus and work on assisting the local poor farmers on issues related to soil and water conservation practices, promoting rainwater harvesting techniques, practising irrigation systems, drought-resistant crop diversification, fattening animals, enhancing different means of income earning capacity and livelihood diversification strategies as adaptive mechanisms so that they can respond to the crisis and vulnerabilities related to food insecurity. Generally, local authorities, development practitioners, policymakers and other concerned stakeholders (including funding programs) should identify and incorporate local area's knowledge on adaptation strategies to assist the vulnerable people affected by the crisis of food shortage and to minimize the challenges of poverty and hunger that can help efforts to eradicate food insecurity and assists the country in achieving the SDGs.

9.5. Summary

This chapter presents the major adaptive strategies and coping mechanisms practised by the sample respondents to overcome the problems of severe food shortages resulting from different livelihood shocks and environmental stresses. The study finds out that dietary change, short-term measures to increase household food availability, short-term measures to decrease the number of people to feed and rationing or managing the shortfall are identified as short-term coping strategies to cope with food shortages. Farm households frequently changed their diet during droughts or insufficient food, by switching food consumption of preferred foods to cheaper and less-preferred substitutes to cope with food shortages. Furthermore, the study found out that borrowing food or money from a relative, selling assets, selling livestock, selling firewood and charcoal, looking for relief (aid) assistance, engaging in petty trading, are among the coping strategies identified as increasing short-term food availability by the surveyed sample respondents. It was also identified that limitation of the portion of food consumption and reducing the number of meals eaten per day was reported as the most common coping mechanisms of rationing food shortfall in times of food insufficiency. The result of the study showed that livelihood and income diversification, crop diversification, cultivating marginal land, practising small-scale irrigation, rainwater harvesting, and fattening livestock are among the long-term adjustment adaptive strategies against climate-related shocks and to mitigate rural farm household's food insecurity problems locally practised by the sample respondents in the study area. The next chapter scrutinizes the summary, conclusions, and holistic recommendations of the study in line with the objectives and findings of this study.

CHAPTER TEN

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

10.1. Summary

Food security and sustainability issues have been one of the main agendas of all the countries to support the demand of the ever-growing population in the world. Moreover, food security and sustainability of food systems are and have been of prime significance for people and the survival of political administrations all through history and over the globe. However, achieving sustainable food security is one of the basic rights of people and this includes the ability to produce or purchase the food they need, without harming the social and biophysical environment and remains a major challenge in a world of growing human population. What is more, food security and sustainability in the food sector is a fundamental objective of development policy and a measure of the success thereof and for which almost all governments of developing countries have introduced a variety of regulations and policies to address the phenomenon.

Ethiopia, which is in the Horn of Africa with an estimated total population of over 100 million is the second-most populous country on the continent. In Ethiopia, most of its population (nearly 80%) are rural dwellers, primarily depending on rain-fed agriculture (which is vulnerable to climate change) producing crops and rearing livestock and for an overwhelming majority of the people, agriculture is a basic means of livelihood and source of income. Despite considerable resources invested each year by the government of Ethiopia and its partners to fight hunger and reduce food insecurity, both transitory and chronic food insecurity problems are continuing at the individual and household levels in the country with poverty and food insecurity more prevalent in rural areas. If the condition continued in such a way the issue of achieving sustainable food security, particularly in the rural area and meeting the sustainable development goal of ending hunger in all its forms by 2030 will be worrying. Hence, the main objective of the study is to assess the status and level of sustainability of food security and examine the socio-economic, demographic, institutional and environmental determinants of sustainability of rural household food security in Kurfa Chele *woreda* of East Hararghe Zone, Ethiopia.

The study was conducted in Kurfa Chele *woreda* of East Hararghe Zone which is found in the eastern part of Ethiopia. To achieve the intended objective of the study, a descriptive (cross-sectional) and extensive survey research design with a combination of both quantitative and qualitative research approaches was applied. Moreover, a total of 255 rural farm sample households were selected using multistage sampling techniques from four sample rural *kebeles* (Hula Jeneta and Jiru Gemechu from *kolla*, Orde Goba from *woina-dega*, Arele Tika from *dega agro-climatic zone*) in the *woreda*. The study was used both primary and secondary sources, whereby the relevant data was gathered through a household survey questionnaire, focus group discussions and key informant interviews.

The collected data were analysed using both qualitative and quantitative methods whereby data obtained from household survey questionnaires were coded, tabulated, and entered into a computer specifically using SPSS (Statistical Product and Service Solutions) version 24. Finally, the data were analysed using both descriptive (frequency distribution, mean, percentage, SD) and inferential statistics (independent sample t-test, one-way ANOVA, chi-square, correlation, and multivariate logistic regression model). Moreover, Microsoft excel sheet 2016 was employed to present the analysed data in the form of figures and diagrams. Finally, the food security status of the surveyed rural farm households was analysed using three harmonized food security indicators such as the FAO Food Balance sheet model (HFBM), household dietary diversity score (HDDS) and months of adequate household food provisioning (MAHFP). Additionally, the Foster-Greer-Thorbecke model (FGT) was used to estimate the incidence, depth and severity of rural household food insecurity.

The following is a summary of the findings from the second objective of the study concerning the surveyed farm households' socio-demographic and farmer's access to various productive assets in terms of their impact on food production and un/sustainability of food security status. Accordingly, results on the surveyed rural farm household respondents on socio-demographic characteristics indicate that of the total sample households only 11.4% were headed by females and the rest 88.6% were male-headed. The age distribution of the sampled household respondents ranged from 25 to 80 years and the majority (42.7) of the household heads were in the age group of 39 to 45 years and with an average age of 44.75 years. Regarding the household size of the sample respondents, the majority (54%) had between 7 to 9 household members, with an average household size of 6.75. The finding of the study also revealed that nearly two-thirds of the sample respondents had no access to formal education. As to safe drinking water, the study indicated that 35.7% of the sample household respondents had no access to clean and safe drinking water supply with great variations among the sampled kebeles.

Finding on the surveyed rural farm households' access to economic and productive assets indicated that, the majority (41.57%) of the sample respondents in the study area held 0.25 hectares to 0.50 hectares of land with nearly half of the households held less than or equal to 0.50 hectares of land. The total available land for the entire sample household respondents ranged from 0.13 hectares to 2 hectares with an average land of o.63 hectares. Concerning the number of plots, the results of the study indicated that the majority (43.5%) of the sample respondents had three plots of land with an average plot of 2.77. As to the quality and fertility status of agricultural land, about 48.6% of the sample farmer respondents perceived that their land was infertile while 6.3% of farmers perceived their farmland was fertile. As to livestock possession of the sampled farmer households, nearly six percent of the respondents had no livestock, and the maximum holding is 11.4 TLU with an average livestock holding of 3.88TLU. Moreover, the study found that of those who engaged in off-farm income-generating activities, the largest proportion (53.6%) of the respondents participated in the selling of charcoal followed by selling of firewood and engagement in petty trade, which accounts for 40.6 and 26%, respectively. The result also revealed that the main sources of on-farm income-generating activities for the surveyed farm households in the study area was selling of Khat followed by potatoes and onions. Besides, the finding of the study showed that the overall average per capita annual income for the surveyed sample households in the study area was 1,405 birr/year/person and 8,974 Birr/year/household with slight variations among the sampled *kebeles*.

Regarding the institutional services and rural infrastructure, about 81% of the surveyed household respondents had access to agricultural extension services and had contact with the development agents, while only 19% of the sample respondents had access to credit services. Moreover, the finding of the study showed that the majority (95%) of the sampled respondents had practised soil and water conservation mechanisms on their farmland while only 12% of the survey household respondents in the study area had access to and utilised irrigation system. The finding of the study also portrayed that more than half (53%) of the sampled household respondents had access to and applied chemical fertilizers on the farmland, while about 70% of the respondents had utilised animal manure (compost) to boost the soil fertility of their farmlands. Furthermore, the study indicated that nearly two-thirds (67%) of the surveyed household respondents had utilised improved seeds which was mostly provided to them by emergency seed assistance, while only 2.4% of the sampled households had used herbicides.

As to distance to the nearest market centres, about 9% of the sampled respondents travelled less than 30 minutes, while 33% and 40% of surveyed households had travelled 30-60 minutes and 60-90 minutes, respectively. Moreover, nearly 18.4% of the sampled households travelled more than one and half hours while around 4% of them travelled more than two hours to reach the nearest market centres in the area. Regarding the distance to the nearest all-weather road, about 42% of the sampled households reported travelling less than 30 minutes while nearly one third (33%) and 7% of the respondents reported travelling more than one and half hours and more than two hours. The finding of the study also indicated that about 22% of the surveyed rural farmer household respondents in the study area had radio and access to information and nearly a quarter of the sampled respondents had access to mobile phones. Concerning the productive safety net program about 30% of the sampled household respondents were supported by PSNP in the form of public work for those able to perform labour-intensive work and direct support component for those unable to participate in public works. Data from the surveyed sampled farm households indicated that over half (55%) of the PSNP beneficiaries had received the transfer in the form of food for public work followed by cash for public work which accounts for 28%. Regarding the type of work engaged for those who participated in public work, the majority (37.8%) of the PSNP beneficiaries have participated in soil and water conservation followed by hillside terracing which accounts for 27%.

Findings on the surveyed rural farm household's production activities indicated that sorghum (99%) and maize (97%) are the two main crops (stable foods) being most frequently reported and produced by the surveyed households followed by wheat (54%), barley (35%) and haricot bean (21%). Regarding the amount of crop production, on average, the surveyed farm households in the study area produced 12 quintals and with an average of 14.5 quintals, farm households in *dega* agro-climatic zone produced relatively higher crops than farm households in *woina-dega* (11.5 quintals) and *kolla* (10.4 quintals) agro-climatic zones. Additionally, farm production in the study area mostly depends on the two rainfall seasons, mainly summer (*Meher*) and spring (*Belg*) rains which are constrained by the onset, duration, and cessation of these rainfall seasons. Furthermore, nearly 6% of the sampled household respondents in the study area reported they had no livestock with a slight variation among the sampled agro-climatic zones. The findings of the study also indicated that on average farm household respondents in the study area produced 7.7 different types of production diversity with 3.5 livestock diversity and 4.2 crop diversity and significant variation in production diversity among the sampled agro-climatic zones. Additionally, the finding also showed that drought and erratic rainfall (delayed onset and early cessation of rainfall), poor soil quality, and small landholding are among the major factors perceived, identified, and frequently reported by the rural farmers causing the variation and declining trends in crop production and productivity in the area.

Concerning the first objective of the study about the food security status of the sampled rural farm household respondents, three household food security indicators such as Household Food Balance model (HFBM), Months of Adequate Household Food Provisioning (MAHFP) and Household Dietary Diversity Score (HDDS) were used to categorize the surveyed farm households into different food security states. Accordingly, using the household food balance model, more than three-quarters (76.5%) of the sampled households were in a state of food insecurity during the year under investigation and consumed below the minimum recommended daily per adult equivalent kilocalorie allowance (2100 kcal) and the figure indicates the prevalence of critical food shortage facing the rural farm households in the study area. The mean per capita kilocalories available to the surveyed households per adult equivalent per day for the entire sampled household was found to be 1,704 kcal accounting for 81% of the minimum recommended. In addition, the range of daily per capita food availability per adult equivalent was 3,415 kcal with the minimum daily per capita per adult equivalent kilocalorie being 615 and the maximum being 4,065 kcal. The food insecurity gap index (depth of food insecurity) showed that on average 22.7% of the surveyed households consume less than the recommended minimum caloric intake and indicated that on average a minimum of 477 kcal per adult equivalent per day would be required to get out the households from and eliminate the food insecurity problem.

Concerning the months of adequate household food provisioning, about 80% of the surveyed rural farm households had relatively low access to food and were mostly food insecure and reported facing difficulties in obtaining adequate food for more than three months to meet the needs of their household members. Moreover, the finding revealed that about 14 % of the surveyed farm household respondents had moderate access to food and were classified as moderately food insecure and faced up to three months of food shortage in the year. Generally, the mean value of MAHFP was 6.5, which indicates on average the surveyed rural farm household in the study area has low access to food. Furthermore, the higher daily per adult equivalent kcal consumption, household size, farmland size, livestock unit, farm production diversity household dietary diversity score, per capita income, and per capita off-farm income the more access to food (more months of adequate household food provisioning) will be and these variables are identified as the factors determining the sustainability food availability and food security status of the surveyed farm households in the study area. Besides, utilisation of irrigation scheme, fertilizer, improved seeds, utilisation of animal manure, access to extension services, access to credit services and beneficiaries of PSNP are among the variables that are significantly associated with MAHFP and are expected to determine the sustainability of food security status in the study area.

As to HDDS, the finding of the study indicated that the surveyed rural farm households in the study area on average consumed around four different food groups. Of the total surveyed sampled household respondents, approximately 17% had consumed greater than six different food groups in contrast to 43% who had HDDS of three or less. Moreover, the finding of the study revealed that nearly two-thirds (65%) of the sampled households consumed less than the mean of the surveyed sample household (4 food groups) indicating most of the households in the study area lack the varieties of dietary diversity reasoned as a pre-condition for a decent healthy life. The average dietary diversity score of the food secure and food insecure sampled farm household is 4.75 and 3.89, respectively. The result of the study also indicated that the amount of kcal consumption, household size, landholding size, per capita income, per capita off-farm income, and farm production diversity are among the variables significantly related with household dietary diversity score. Additionally, variables such as household food security status, educational status of the household heads, beneficiaries of PSNP and utilisation of animal manure are also a significant relationship with household dietary diversity score.

Generally speaking, all the three methods of household food security indicators used in this research showed that more than three-quarters of the sampled household respondents are food insecure indicating the unsustainability of food security status in the study area is mainly attributed to different interrelated environmental (drought, unreliable rainfall, poor soil fertility), economic (inability to produce sufficient grains and livestock, shortage farmland, inadequate non-farm income, poor farming technology and inability to access nutritious food), socio-demographic (large household size, poos access to social infrastructure, poor social and communication network) and institutional factors (inadequate agricultural extension services, lack of access to credit, lack of training and skills, poor market access).

As to the third objective of the study, the bivariate analysis of the relationship between the dependent variable (food security status in terms of daily per capita kcal availability) and the hypothesized explanatory variables revealed that approximately 17 potential predictor variables were statistically significant and influenced the un/sustainability of food security status in rural farm households. These variables include age of the HH, household size, farmland size, livestock, per capita income, per capita off-farm income, household dietary diversity score, farm production diversity, educational status, utilisation of chemical fertilizer, manure, improved seeds, access to irrigation, access to credit, PSNP beneficiary, access to media and drought. Moreover, the result of the multivariate logistic regression model showed that about 10 explanatory variables in turn were found to be statistically significant in determining the food security status of the surveyed rural farm households in the study area. Those variables that are found to have significant coefficients in the logistic regression model include household size (at 1% significant level), age of the household heads, educational status, TLU, access to irrigation water, drought, per capita off-farm income, HDDS, farm production diversity (at 5% significant level) and farmland size (at 10% significant level). The finding implied that these variables are the most substantial factors in determining and influencing the un/sustainability of rural farm household food security status in the study area. Additionally, climatic variability such as the recurrent occurrence of drought, seasonality dynamics (late-onset, early cessation of rainfall, insufficient and unreliable rainfall), altered patterns of precipitation and intensity were among the major factors that threatened sustainable agricultural practices which in turn impacted the sustainability of food security among smallholder farming systems in the study area.

Finally, the result on the fourth objective of the study portrayed that limiting the size of meals, reducing the frequency of meals eaten per day, eating less preferred and less expensive food and selling more livestock to buy food were among the most common coping strategies while income and livelihood diversification, crop diversification, cultivating marginal land and fattening livestock are among the adaptation strategies identified by rural farm households to cope with food shortages.

10.2. Conclusions

Access to Productive Resource, its Implication and Food Security Status Quo (Ob1&2)

Accessibility to agricultural productive resources such as farmland, livestock, utilisation of modern agricultural inputs like chemical fertilizers, improved seeds, herbicides, application of animal manure, access to irrigation water, agricultural extension services and credit are among the productive variables assumed to substantially influence agricultural yields, its productivity and in turn, impacting the sustainability of rural farm household food security status. In line with this, the study finds out that the majority of the rural farm households owned a farmland size of less than one hectare with an average landholding size of 0.63 hectares. As land is an important economic resource in terms of determining the size of crops harvested, the types of crops grown as well as livestock rearing, it has great implications on food availability and sustainability of the rural farm household food security status. However, most of rural farm households in the study area were unable to produce sufficient food because of the limited access to landholding and its unequal distribution besides other socio-economic, institutional and environmental factors that impacted the sustainability of food security.

Besides landholding size, farm households in the study area also owned on average 3.88 livestock in terms of tropical livestock units, which is relatively low compared to the other parts of the country. Livestock production is an important source of livelihood for rural farm households contributing to their economy mainly as a source of traction power, cash income and means of transportation and influencing the sustainability of food security. Furthermore, the study reveals that only a few sample respondents have had access to credit service, irrigation and utilizing herbicides impacting agricultural production while, more than half of the surveyed respondents reported themselves as the beneficiaries of extension service programs, chemical fertilizers, improved seeds and animal manure.

Concerning crop production, with an average of 14.5 quintals, farm households in *dega* agro-climatic zone produced relatively the largest number of crops than farm households found in *woina-dega* and *kolla* agro-climatic zones while the *kolla* agro-climatic zone relatively produces more livestock than others. Besides, a low agricultural production diversity was noted among the farm households across the three agro-climatic zone in the study area with average production diversity of 7.7. The finding also showed that drought and erratic rainfall (delayed onset and early cessation of rainfall), poor soil quality, and small landholding are among the major factors perceived by the rural farmers causing the variation and declining trends in crop production and productivity in the area.

Three household food security indicators such as household food balance sheet (dietary energy supply expressed by daily per capita Kcal), months of adequate household food provisioning and household dietary diversity score were used to categorize the surveyed farm households into different food security states. Using the household food balance model (dietary energy supply) extent of food insecurity at 2100 minimum recommended kilocalories per adult person per day and adequacy of food production and consumption pattern of farm households in the study area have been assessed. Accordingly, the finding suggests that about 76.5% of the sample households are regarded as food insecure and fail to meet the required minimum Kcal intake per day. Conversely, using months of adequate household food provisioning threshold about 80.4% of the sample respondents were regarded as food insecure and do not meet the all-year-round food requirements for their household members from their own production. Furthermore, the finding portrayed the age of the household heads, household size, farmland size, number of livestock (TLU), per capita income and off-farm income, production diversity, access to irrigation facilities, access to credit and extension services, application of chemical fertilizers and improved seeds are among the variables identified to influence and determine months of adequate household food provisioning and threaten the sustainability of food security in the study area.

The study indicated that on average, rural farm households consumed around four different food groups implying dietary diversity was typically low in the study area. It was also identified that about 83% of the surveyed farm households in the study area were considered as food insecure based on household dietary diversity threshold indicators of food security status. The result revealed that the food secure households had by far better dietary diversity scores than the food insecure households. Moreover, farm households in the *dega* agro-climatic zone had better dietary diversity than that of households in the *woina-dega* and *kolla* agro-climatic zone The finding also depicted that dietary energy supply expressed as Kcal, household size, farmland size, educational status of the household heads, household food security status, per capita income, months of adequate household food provisioning, per capita off-farm income, crop and farm production diversity are among the possible identified variables significantly determined household dietary diversity score of the surveyed farm households.

The overall incidence of food insecurity was 76.5 % while the depth of food insecurity expressed as the average per cent increase in calories required to meet the recommended daily requirement was 22.3 %. Thus, the study confirmed the widespread existence of household food insecurity in the study area. Food insecurity indices declined with higher levels of landholding and livestock passion (TLU) while increased with household size. Furthermore, the incidence of food insecurity was slightly higher among illiterate household heads than in literate headed households, but the severity was lower. Agro-ecologically, the incidence of food insecurity was higher in the *kolla* zone than *woina-dega* and *dega* agroclimatic zones.

Moreover, the surveyed farm household's self-assessment results on the perceived causes of household food shortage portrayed that for about 98% of the respondents their food security status was not sustainable over the last 15 years mainly attributed to several factors. Accordingly, the finding showed that from the environmental factors drought/unreliable rainfall, poor soil fertility and pests and disease, from economic factors inability to produce sufficient grains, shortage of farmland, inability to rear livestock, poor farming technology, poor access to irrigation; from the socio-demographic factors large household size and poor access to infrastructure; from the institutional factors lack of access to credit, inadequate extension services and lack of training skills were identified as the potential variables resulting shortage of food and impacting the sustainability of food security in the study area.

Sustainability of Rural Households Food Security and its Determinants (Ob3)

The study finds out that interrelated factors such as socio-demographic, economic, institutional, and environmental variables were found to be influenced the sustainability of the rural farm households' food security status in the study area. The bivariate analysis of the relationship between the dependent variable (food security status measured by daily per capita kcal availability) and explanatory variables depicted that about seventeen potential predictor variables were found to be statistically significant in determining the sustainability of food security status of the surveyed farm households. Accordingly, the finding of the survey study portrayed that the older household heads had higher per capita kcal per adult equivalent per day than that of the younger age household heads and were found to be more likely food secure than their counterparts. This is mainly because the older household heads have a relatively richer experience of the social and physical environments and they are expected to have greater experience of farming activities, a stable economy in farming and better access to farmland than the younger household heads. Additionally, the finding also showed that households with small members had higher per capita kcal than households with larger family members had and were found to be more food secure. This showed that a larger number of unproductive persons living in the household had negatively correlated with the sustainability of household food security status as food requirements increase with the number of persons in a household.

Educational attainment of the household head is also one of the explanatory human capital variables, which refers to the knowledge, skills, and ability of the household to engage in different work to pursue their livelihood strategies and achieve the desired livelihood objectives. It could also lead to awareness of the possible advantages of modernizing agriculture and can have a positive contribution toward food security and better living standard for rural households. Moreover, an educated household is assumed to be a better adopter of the new technologies such as the use of modern chemical fertilizers, improved seeds, herbicides and so on, which in turn increases the productivity of the farm households and the sustainability level of their food security status.

The finding on resource endowment portrayed that households with larger farmland sizes were found to be more likely food secure than households with smaller land sizes. This shows that availability and access to farmland size have an impact on livelihood diversification for the rural farm households, which in turn impacts the sustainability of their food security status. This is mainly because access to an adequate amount of farmland encourages rural farmers to adopt and use new agricultural technologies such as the application of chemical fertilizers, improved seeds, pesticides, and herbicides, which boosts the productivity of their agricultural yields and have an implication on their food security status. Additionally, the finding also portrayed that livestock ownership significantly and positively correlated with the sustainability of the rural farm household's food security status indicating that households with relatively large numbers of livestock were found to be less likely vulnerable to food insecurity problems than households with smaller number of livestock. Besides, livestock contributes to the sustainability of food security in different ways such as by providing nutrition, manure, draft power, cash income, serving as assets and being used to cope with food insecurity problems during food shortages.

Furthermore, the finding of this research depicted that the participation of farmers in diverse types of income-generating off-farm and on-farm activities had a positive and significant relationship with the food security of the farm households. This is mainly because diversification of rural farm income activities helped to diversify livelihood strategies, which could stabilize household income and reduce farm household income risk and in turn, enhance the sustainability of rural farmers' food security status. The finding also showed farm households who had applied modern farm inputs such as the utilisation of modern chemical fertilizers, high yielding improved seeds, and application of animal manure are more food secure than households who do not use these inputs. This is mainly due to the application of these modern farm inputs are expected to improve the productivity of agricultural land and increase the overall crop yield/production of the rural farm households. Additionally, the use of irrigation schemes by farm households is also positively associated with the sustainability of food security status mainly application of irrigation facilities increases agricultural production and probability which could enhance the likelihood of farm household food security status.

The study indicated that farm production diversity is found to be positively related with household food security status. This could be partly explained by the fact that failure in the production of one crop mainly due to different factors can be compensated by the returns obtained in the production of other crops which enhances the sustainability of the rural farm household's food security status. The study also indicated that on average, rural farm households consumed around four different food groups implying dietary diversity was typically low in the study area. Additionally, the finding portrayed that households who have consumed more diverse food groups were found to be more likely food secure than their counterparts as dietary diversity significantly improve energy availability.

The logistic regression analysis identified ten potential explanatory variables such as household size, age of the household heads, educational status, farmland size, livestock expressed in TLU, access to irrigation water, drought, per capita off-farm income, household dietary diversity score and farm production diversity as the significant and major substantial factors in determining and influencing the sustainability of rural farm household food security status in the study area. These significant predictor variables explained nearly 72% of the total variation in the sustainability of rural farm households' food security status in the study area. Finally, comparing the rural farm households that were classified as food secure and food insecure based on the three indicators used in this research; it can be concluded that households which were found food secure are older, have a high average landholding size, high livestock size (TLU), have small household members, have a better education level, and high access to irrigation water. Furthermore, these rural households have also higher per capita off-farm income, high production diversity and high dietary diversity scores.

Climatic Variability, Sustainable production, Coping and Adaptation Strategies to Food Security (Ob4)

Climatic variability, particularly the recurrent occurrence of drought and unreliable rainfall was found to be one of the substantial challenges to sustainable agricultural productivity which had a direct impact on food availability. The results of the study showed that seasonality dynamics (late-onset, early cessation of rainfall, insufficient and unreliable rainfall), increased frequency of occurrence of drought, altered patterns of precipitation and intensity are among the major factors that threaten sustainable agricultural practices which in turn impacts the sustainability of food security among smallholder farming systems. The regression coefficient of determination revealed that the climatic factor mainly rainfall variability alone in the study area accounted for about 40% of the variation in the total crop production.

Rural farm households in the study area practice several possible coping mechanisms and adaptive strategies to overcome the problems of severe food shortages resulting from different environmental stresses and livelihood shocks. The study finds out that dietary change, short-term measures to increase household food availability, short-term measures to decrease the number of people to feed and managing the shortfall are identified as the major short-term coping strategies to cope with food shortages. Farm households frequently changed their diet during droughts or insufficient food, by switching food consumption of preferred foods to cheaper and less-preferred substitutes to cope with food shortages. Moreover, the study finds out that borrowing food or money from a relative, selling assets, selling livestock, selling firewood and charcoal, looking for relief (aid) assistance, engaging in petty trading, are among the coping strategies identified as increasing short-term food availability by the surveyed sample respondents. It was also identified that limitation of the portion of food consumption and reducing the number of meals eaten per day was reported as the most common coping mechanisms for rationing food shortfall in times of food insufficiency. In the nutshell, the finding of this study portrayed that, reducing the size of meals, reducing the frequency of meals, the reliance on less preferred and inexpensive foods and selling livestock to buy food were among the major coping strategies practised by the sample households. From this, it is possible to deduce that farm households in the study area largely practised rationing food and increasing the short-term availability of food to cope with food shortages.

The result of the study showed that livelihood and income diversification, crop diversification, cultivating marginal land, practising small-scale irrigation, rainwater harvesting, and fattening of livestock were observed among the long-term adjustment adaptive strategies against climate-related shocks and to mitigate rural farm household’s food insecurity problems locally practised by the sample respondents in the study area.

10.3. Recommendations

Based on the research findings and overall conclusions noted above, the following possible way forwards and recommendations were made for the concerned stakeholders who need to intervene and improve the food security status of rural farm households.

The result of the study portrayed that the size of farmland owned by the rural households in the study area was found to be positively and significantly correlated to the food security status of the farm households. Nevertheless, the average landholding in the study area is 0.65 hectares, indicating that land has become increasingly scarce due to population growth. Thus, if farmers' access to cultivable land becomes impossible, the concerned body should work intensively on other options such as regulating population growth, increasing access to modern farm technologies and inputs (more intensification to increase farm outputs), applying and expanding soil and water conservation practices on farmlands, rehabilitation, and reclamation of degraded land into production, and afforestation. Moreover, in addition to this, the concerned bodies should encourage engagements in off-farm activities and other means of generating income to shift some proportion of the population from direct reliance on the land.

The result of this research portrayed that the rural farm households' educational status has a direct and positive bearing on food security status in the study area. Moreover, the finding showed that literate rural farm households had better in their food security status than their counterparts. Therefore, it is recommended that the concerned bodies should increase access to education mainly through adult education and training for rural farmers. Informal education, particularly when targeted at rural farmers with limited formal education, could be effective in the short term.

The study also revealed that household size has a negative and significant relationship with the food security status of rural farm households. Moreover, the finding showed that the household size was on average large in the study area and hence rapid growth of the population in the study area should be controlled considering scarce and limited resources mainly through the practices of different family planning programs, increase access to the provision of health extension services, awareness creation and provision of adult education.

In the study area, the livestock sub-sector is essential to guarantee food security status of the farm households. As a result, this sector must be improved by providing common grazing land, improved husbandry and rangeland management systems, and improved veterinary facilities. By increasing the traction power and amount of animal manure, livestock development aids crop production. Furthermore, among all livestock resources, oxen are a strategic asset, particularly for farming households, because they provide traction power for rural farm households. As a result, concerned stakeholders should assist poor farmers by providing draught power.

It was found that those households which utilised agricultural inputs such as fertilizer, application of manure and improved seeds are better in their food security status than those households that do not. Furthermore, the utilisation of such modern farm inputs is expected to improve the productivity of agricultural land and increase the overall crop yield of the rural farm households and in turn, contribute towards the improvements and sustainability of the rural farm households' food security status. Thus, as a policy implication, there is a need to increase the utilisation and accessibility of these agricultural inputs among the rural farm households in the study area. Additionally, access to and the use of irrigation schemes by farm households had also positively correlated with the food security status of the surveyed rural farm households. This is mainly due to the application of irrigation facilities would increase agricultural production and probability which thereby farm production diversity and livelihood diversification and in turn could enhance the likelihood of farm household food security status.

The finding of this research showed that diversification of farm production had positively and significantly correlated with the food security status of the surveyed farm households as it has implications for crop production stability, improves yields, increases crop income, and helps to diversify the household diet. Hence, with growing evidence of stress in rural smallholder farmers from the impact of climate change and related factors in the study area, implementation of diversified farming/cropping systems as coping and adaptation strategies can considerably contribute towards the improvement of the sustainability of rural farmers' food security status.

Furthermore, climate change and variability mainly unreliable precipitation, late occurrence and early session of rainfall were greatly impacting agricultural production and its productivity in the study area. Hence, the concerned stakeholders should encourage the rural farm household to exercise soil and water conservation practices and water harvesting technology as a possible means of combating the adverse effects of such environmental stress and drought. At last harnessing, the potential role of coping and adaptation strategies currently practised by the rural farm households at times of food shortfall to mitigate food insecurity shall be considered and incorporated as policy options by concerned stakeholders in achieving sustainable food security as well as sustainable development goals of ending poverty and zero hunger for the poor rural farm households.

Moreover, there is a need for further research on food security and its sustainability over time, as the concept of food security is holistic and caused by multifaceted as well as interconnected variables. Hence, additional research encompassing all dimensions of food insecurity using the integration and harmonized use of different food security indicators, as well as a detailed explanation of communities' coping and adaptive strategies in the context of achieving sustainable development goals, both in rural and urban area is required. Besides, further research into the multiple effects of climate change and human activities on food security in the woreda is an important part of the sustainability of food security in the woreda. This is important to address policymakers and other stakeholders in the development of a long-term and sustainable food security plan in the study area as well as to further address the challenges and threats to food security that individuals, households and communities face in the *woreda*.

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LIST OF APPENDICES

Appendix I: Ethical Clearances

UNISA university of south africa

CAES RESEARCH ETHICS REVIEW COMMITTEE

Date: 17/02/2016

Ref #: **2016/CAES/021**
Name of applicant: **Mr MS Girma**
Student #: **57662088**

Dear Mr Girma,

Decision: Ethics Approval

Proposal: Sustainability of rural household food security in Mulo and Sululta Wordea, Shewan Plateau, Central Highland of Ethiopia

Supervisor: Dr Muluneh Woldetsadik Abshare

Qualification: Postgraduate degree

Thank you for the application for research ethics clearance by the CAES Research Ethics Review Committee for the above mentioned research. Final approval is granted for the duration of the project.

Please note points 4, 5 and 6 below for further action.

The application was reviewed in compliance with the Unisa Policy on Research Ethics by the CAES Research Ethics Review Committee on 17 February 2016.

The proposed research may now commence with the proviso that:

1) *The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.*
2) *Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the CAES Research Ethics Review Committee. An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.*
3) *The researcher will ensure that the research project adheres to any applicable*

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national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.

4) *The use of recording devices and taking of photographs must be reflected in the consent form.*
5) *In the questionnaire, the researcher is advised to test the literacy of participants by asking their level of education rather than directly asking whether they are literate or illiterate.*
6) *The Committee proposes that due to the length of the questionnaire the researcher should allow participants rest breaks during the interview.*

Note:

The reference number [top right corner of this communiqué] should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants, as well as with the CAES RERC.

Kind regards,

Signature
CAES RERC Chair: Prof EL Kempen

18 Aug'16

Signature
CAES Executive Dean: Prof MJ Linington

NB: Actions for further work

Appendix II: Turnitin Report

turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	Sg Muleta
Assignment title:	GGH 2022
Submission title:	PhD Geography thesis
File name:	PhD_Thesis_Final_Draft_Siyoum_57662088_Final.docx
File size:	5.91M
Page count:	313
Word count:	95,969
Character count:	534,751
Submission date:	04-Jul-2022 10:59AM (UTC+0200)
Submission ID:	1866502276

(UN)SUSTAINABILITY OF RURAL HOUSEHOLD FOOD SECURITY IN KURFA CHELE WOREDA, EAST HARARGHE ZONE, ETHIOPIA

By

Siyoum Girma Muleta

Submitted in accordance with the requirements for the degree of

Doctor of Philosophy

in the subject

GEOGRAPHY

in the

COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

DEPARTMENT OF GEOGRAPHY

at the

UNIVERSITY OF SOUTH AFRICA

Supervisor: Dr. Muluneh Woldetsadik Abshare

Co-supervisor: Prof Melanie Nicolau

May 2022

Open Rubric

Appendix III: Household Survey Questionnaire

University of South Africa

College of Agriculture and Environmental Sciences

Department of Geography

Household Survey Questionnaire

Dear respondent! This *questionnaire* is aimed to collect data for the study entitled "*Sustainability of Rural Household Food Security in Kurfa Chele Woreda, Eastern Hararghe Zone, Ethiopia*." The study is one of the requirements for the completion of PhD (Doctor of Philosophy) in Geography at the University of South Africa. Questions included in this instrument enable the researcher to get information pertaining to household demographic characteristics, household asset ownership, farm agricultural production, access to modern agricultural input, household food consumption, factors influencing sustainability of food security at the household level, its coping and adaptive strategies. The information you will give serves only the stated academic purpose and thus your honest and genuine response to questions is very important in achieving the goal of the study. Information you will honourably provide me will also be kept confidential and will be coded and recorded without names. To this end, I ask you to respond to these questions kindly. Thank you in advance for your cooperation!!!

Part I: Household's Demographic Characteristics

1. Sex of household head: 1= Male ☐ 2= Female ☐
2. Age of household head (in years) _____________
3. Marital status: 1=single ☐ 2=married ☐ 3= divorced ☐ 4=widowed ☐
4. Household size: Number of permanent household members (including household head), during the last twelve months: Male _____ Female ______ Total _________
5. Household size by age group

   Below 15 ______ 15-64 ______ above 64 _______ Total _________

6. Educational level of the household head

1=illiterate ☐ 4=grade 5-8 ☐

2=can read and write ☐ 5=grade 9-10 ☐

3=grade 1-4 ☐ 6=grade 11-12 ☐

Part II: Resources Endowment/asset ownership

A. Household land ownership

7. Do you have land for cropping and pasture?

1=Yes ☐ 2=No ☐

8. If your response for Q7 is yes, what is the source of your land for cultivation? (Multiple responses are possible).

1=Rent ☐ 3=Inherited with parents ☐

2=Share cropping ☐ 4=land redistribution ☐ 5=other specify_______________

9. If your response for Q7 is 'yes', what is the total size of land you are holding? In hectare or unit in local measure (timad) ____________

10. What has happened to the size of your landholding over the last 20 years?

1= decreased ☐ 2= increased ☐ 3= no change ☐don't know ☐

11. If your response for Q10 is decreased, what was the reason? (Multiple responses are possible)

1=Large household size ☐ 4=Decline in the quality of land ☐

2=Redistribution of land ☐ 5=Others specify__________________________

3=Land degradation ☐

12. How do you rate the sufficiency of your landholding?

1=Scarce ☐ 2=Sufficient ☐ 3=Excess ☐

13. What do you think was the soil quality/ fertility status of your farmland on average?

1= Infertile ☐ 2=Moderately fertile ☐ 3=Fertile ☐

14. How many parcels or plots of land do you have? ________________

15. Have you practised soil and water conservation on your farmland?

1 = Yes ☐ 2 = No ☐

B. Livestock ownership

16. Do you have your own livestock? 1. Yes ☐ 2. No ☐

17. How was the size of your livestock over the last 10 years?

1=decreased ☐ 2=increased ☐ 3=no change ☐ 4=don't know ☐

18. If your response for Q.17 is 'decreased' what is the reason? (Multiple responses are possible

1=Lack of pasture ☐ 4=Drought ☐

2=Sold to buy food ☐ 5=Other specify ______________________

3=Sold to buy seeds ☐

19. If your answer for Q16 is 'yes', indicate the type and the number of livestock you owned currently.

Types of Livestock		No. of livestock currently owned	Estimated equivalent in cash
Cattle	Oxen		
	Cows		
	Heifer		
	Bull		
	Calves		
Sheep and Goats	Sheep (adult)		
	Young		
	Goat(adult)		
	Young		
Equines	Horses		
	Mules		
	Donkeys (adult)		
	Young		
	Camels		
Apiculture	Beehives		
	Chickens		

Part III: Climatic perception, access to water and vegetation cover

20. How do you evaluate the condition of rainfall in your area for crop production and livestock rearing?

1=Excess ☐ 2=Sufficient ☐ 3=Insufficient ☐

21. Have noticed significant climate change over the last 15 years in your locality?

1=Yes ☐ 2=No ☐

22. If your response for question is yes, what do you think are the effect/indicators of climate change

1=Increased rainfall variability ☐	7=Flood ☐
2=Decreased crop production ☐	5=Land degradation ☐
3=Increased temperature ☐	6=Decreased precipitation ☐
4=Frequent drought ☐	8=Untimely rain ☐

23. Have you noticed any rainfall shortage years in your locality over the last 20 years?

1=Yes ☐ 2=No ☐

24. What was the main consequence/s of rainfall shortage that you have noticed? (Multiple responses are possible)

1=Shortage of food ☐	4=Shortage of drinking water ☐
2=Crop failure ☐	5=Shortage of pasture for livestock ☐
3=Death of livestock ☐	6=Others (specify)______________________

25. Do your household have access to irrigation water? 1=Yes ☐ 2=No ☐

26. Did you have access to clean and protected drinking water in your locality?

1=Yes ☐ 2=No ☐

27. If your response for Q26 is 'No' did you treat your drinking water? (Multiple responses are possible)

1=Yes, filtration ☐	3=Yes, water guard (wuha agar) ☐	
2=Yes, boiling it ☐	4= Yes, Aquatabs ☐	5=No ☐

28. What are your current main sources of water for household consumption?

1=Protected spring ☐	4=Pond ☐
2=Unprotected spring ☐	5=River ☐
3=Piped water ☐	6=Others specify_________________________
4=Harvested rainwater ☐	

29. How was the coverage of forest or vegetation in your locality over the last 20 years?

1=decreased ☐ 2=increased ☐ 3=no change ☐ 4=don't know ☐

30. If your response for Q29 is 'decreased', what is the main reason? (Multiple response)

1=For crop cultivation ☐ 3=Sale of charcoal ☐

2=Sale of wood ☐ 4=Other specify ________________________

Part IV. Access to infrastructure and modern agricultural inputs

A. Market and road accessibility

31. How long do you take to reach the main market from your home? ____hour____ minutes

32. What is the distance of the main road from your home? ______hour_____ minutes

33. How do you transport your production to the nearby market? (Multiple responses are possible)

1=on animal back ☐ 3=using public transportation ☐

2=carry it yourself ☐ 4=others specify__________

B. Access to agricultural inputs

34. Did you use modern fertilizer in your farmland in order to improve your crop yield?

1=Yes ☐ 2= No ☐

35. Did you use manure in your farmland? 1=Yes ☐ 2=No ☐

36. If your response for Q34 and Q35 is yes, what type of crops is covered by modern fertilizer and manure in the previous year (2008/9 E.C)? Complete the table below.

No.	Type of crop	Put '√'	
		Chem. Fertilizer	Manure
1			
2			
3			
4			
5			

37. Did you use herbicides in your farmland in the previous cropping year?

1=Yes ☐ 2= No ☐

38. Did you use improved seeds on your farm in the last year?

1=Yes ☐ 2=No ☐

39. If your answer for Q38 is yes, which improved seeds you have used? (Multiple responses are possible)

1=Maize ☐ 3= Wheat ☐ 5=Haricot bean ☐ 7=Horse bean ☐

2=Sorghum ☐ 4= Teff ☐ 6=Barely ☐

Part: V. Agricultural services

***A.* Access to financial capital**

40. Have you received any types of credit in 2008/9 E.C? 1=Yes ☐ 2= No ☐

41. If your response to question No.40 is yes, what is the source of credit?

1=bank ☐ 3=microfinance enterprise ☐

2=individuals ☐ 4=other specify ____________________

42. For what purpose you obtained the credit? (Multiple responses are possible).

1=to purchase oxen ☐ 4=to purchase agricultural inputs ☐

2=to purchase seed ☐ 5=for soil and water conservation ☐

3=to purchase food ☐ 6=others specify _______________________

43. Did you save your money in bank or any saving and credit association?

1=Yes ☐ 2=No ☐

44. Have you received any kind of remittance over the last 12 months?

1=Yes ☐ 2=No ☐

45. If your response for Q44 is yes, what is the total amount of money that you obtained from remittance last year? ______________

46. Did you or your household member participate in non-agricultural or additional household income-generating activities?

1=Yes ☐ 2=No ☐

47. If your response for Q.46 is yes, in which non-farm activities you have been engaged? (Multiple responses are possible)

1=Government job ☐ 5=Engaged in petty trade ☐

2=Selling charcoal ☐ 6=Engaged in labour migration ☐

3=Selling of firewood ☐ 7= others specify________________

4=Blacksmith ☐

48. If your response is yes for Q.46, what is the estimated total amount of money you obtained from non-farm income sources per week? ___________

49. Are you the beneficiaries of Productive Safety Net Program (PSNP)?

1=Yes ☐ 2=No ☐

50. For how many years did you participated in the PSNP? _________ Since when?

51. If your response for Q49 is yes, what kind of beneficiaries you have gotten?

1=Direct support (cash) ☐ 3=Direct support (food or grain) ☐ 5=Credit/Loan ☐

2=Public work (Cash) ☐ 4=Public work (Food or grain) ☐

52. What kind of work you are involved in during food for work or cash for work in PSNP?

1= Soil and water conservation ☐ 4=Terracing ☐

2=Road construction ☐ 5=Others specify______________

3=Tree planting ☐

B. Extension services and community work participation

53. Have you got advice in agricultural activities from extension services in the year 2007/8 E.C.? 1=Yes ☐ 2=No ☐

54. If your response for Q.53 is yes, on which of the following advice was given to you? (Multiple responses are possible)

1=crop production ☐ 5=Use of improved seeds ☐

2=animal husbandry ☐ 6=soil and water conservation ☐

3=Use of fertilizer ☐ 7=other specify ______________________________

4=Use of herbicide ☐

55. If your response for Q.53 is yes, how often did you get advice?

1=every week ☐ 4=once in two months ☐

2=every two weeks ☐ 5=once in three months ☐

3=once in a month ☐ 6=once in a year ☐

56. Have you participated in a cooperative working group? 1 = Ye☐ 2 = N☐

57. In which of the following community-based organization you have participated? (multiple responses are possible)

1=Labour sharing (debo) ☐ 3=Equb ☐

2=Religious social group (Idir) ☐ 4=other specify ____________________

58. Is your household access to health services? 1 = Yes ☐ 2 = No ☐

59. Distance from health facilities, Hour _____ Minutes _____

60. Have you access to information such as radio and TV? 1 = Yes ☐ 2 = No ☐

61. Do have mobile phone? 1 = Yes ☐ 2 = No ☐

Part VI. Major Cereal Crop, Fruits and Vegetable Production

62. What were the total amount of harvest for each crop in your land and the different sources of food for your family last year (Nov. 2008-Nov.2009) (in local unit)? (Nov.2016 – Nov.2017)

Type	Production and amount used for consumption in 2008						2009 Production
	Amount of production	Purchased from market	Received from others	Used for seed	Sold	Given to others	
Sorghum							
Maize							
Wheat							
Barley							
Teff							
Oats							
Horse bean							
Haricot Bean							
Chickpea							
Field Pea							
Lentil							
Linseed							
Fenugreek							
Groundnut							

63. Production of perennial crops, fruits and vegetables in 2008 and the estimated amount of income earned from these productions

No.	Crop type	Amount in Kg	Monthly income	Annual income
1	Coffee			
2	Khat			
3	Tomato			
4	Onion			
5	Garlic			
8	Potato			
9	Cabbage			
14	Other			

Part VII: Household Food Consumption (Dietary diversity)

64. Food staff consumed at your home during the last seven days and last 24 hours: put (√)

	Household food consumption or Dietary diversity		For how many times	
No.	Food staff or Food Group	Example	Last 7 days	Last 24 hours
1	Cereals	Grain such as teff, maize, barley, sorghum, & Starchy food (injera, porridge, bread, pasta, rice, macaroni)		
2	Pulses, legumes and nuts	Includes any food made from Beans, peas, lentils, nuts, Chickpea, faba bean, horse bean, field bean, lentil, pea, peanut (groundnut), soybean		
3	Vegetables	Includes carrot, sweet potato, fenugreek greens, lettuce, cabbage, garlic, green pepper, onion, tomato		
4	Fruits	Mango, avocados, banana, orange, lemon, mandarin		
5	Meat	Beef, goat, sheep, chicken		
6	Eggs	Chickens eggs		
7	Fish	Fresh or dried fish		
8	Milk and milk products	Includes food items made from dairy except butter due to its high fat content (Cheese, yogurt, whole milk, skimmed milk)		
9	Oils and Fats	Butter, ghee, mayonnaise, vegetable/nut oils		
10	Sweets	Food items with a high content of different sweeting agents (Sugar, honey, candies)		
11	Tubers and roots	white potatoes, yams, cassava, or other foods made from roots		
12	Spices/condiments and beverages	Incudes items commonly used in small quantities and mainly used to enhance the flavor of the dish. (spices, tea, coffee, salt, beer, wine, hard spirits, ketchup, chilies)		

Part VIII: Household perception towards their food security status and its sustainability

65. How was the trend of your agricultural production over the last 15 years?

1=Get better ☐ 3=Vary from year to year ☐

2=Get worse ☐ 4=Unchanged ☐

66. If your response for Q65 is 'get worse' or 'vary from year to year', what are the main causes for the decline of agricultural production in your locality? (Multiple responses are possible)

1=Drought (erratic rainfall) ☐ 5=Crop disease ☐

2=Poor soil quality ☐ 6=Pests ☐

3=Land degradation ☐ 7=Other specify _______________

4=Small landholding ☐

67. What is normally the most important source of your main food at this time of the year?

1=own Production ☐ 4=food for work/Safety net transfer ☐

2=bought ☐ 5=free relief food ☐

3= borrowed ☐ 6=other specify _______________________

68. Do you meet the all-year round food requirements of your household members from your own production?

1=Yes ☐ 2=No ☐

69. If your response for Q68 is no, for how many months' food shortage was critical for the last years (2008)? ______________ month/s

70. If your response for Q68 is yes, do you have surplus food consumption?

1=Yes ☐ 2=No ☐

71. If your answer for Q67 is yes, for how many more months was your household food secured last year (2008 E.C.)? ________________

72. According to your own self-assessment, how was the condition of your household food security status over the last 20 years?

1=Get better ☐ 3=vary from year to year ☐

2=Get worse ☐ 4=unchanged ☐

73. How is your ability to cope with the food shortage for the last 15 years?

1=Get better/increased ☐ 3=no change ☐

2=Get worse/decreased ☐ 4=don't know ☐

74. Do you think that your *kebele* will be affected by drought in the future?

1=Yes ☐ 2=No ☐

75. Do you think that food shortage will occur in your *kebele* in the future?

1=Yes ☐ 2=No ☐

76. According to your own self-assessment, is your household sustainably food secure over the last 20 years?

1=Yes ☐ 2=No ☐

77. If your response for Q76 is 'No' what do you think are the main factors triggering the sustainability of food security? Rate or rank the following factors that affected the unsustainability of your food security.

No.	Reason for the unsustainability of food security	Level of effect (put √)			
		Highest effect	Medium effect	Low effect	No effect
1	Drought (Unreliable rainfall)				
2	Inability to produce sufficient grains				
3	Shortage of farmland				
4	Inability to rear livestock				
5	Poor farming technology				
6	Inadequate income from non-farm activities				
7	Inability to access nutritious food				
8	Large household size				
9	Failure to utilise irrigation				
10	Poor soil fertility				
11	Pest and diseases				
12	Weed				
13	Lack of access to appropriate technologies				
14	Inadequate extension services				
15	Poor storage				
16	Lack of access to credit				
17	Lack of training and skills				
18	Poor access to social infrastructure				
19	Poor access to market				
20	Poor access to media				
21	Poor access to mobile phone				
22	Poor social and communication network				
23	Group member participation				

Part IX: Coping and Adaptive strategies (Indigenous knowledge to reduce food insecurity problem)

78. Rank the following food insecurity coping and adaptive strategies you have used

No.	**Coping strategies**	If yes, then rank	No
1	Reduce the number (frequency) of meals eaten per day		
2	Limit the size of meal (food) consumption		
3	Eat less preferred food and less expensive food		
4	Borrow money/grain from relatives		
5	Sell more animals than usual		
6	Selling assets other than livestock		
7	Selling of firewood and charcoal		
8	Consume seed stock kept for the next season		
9	Seek work in urban areas (as labourer)		
10	Send children to eat with relatives or neighbours		
11	Look for aid or relief assistance		
12	Engage in petty trading		
13	Skipping adults to feed children		
Adaptive strategies			
1	Income and livelihood diversification		
2	Crop diversification		
3	Cultivating marginal land		
4	Fatting Livestock		
5	Irrigation water use		
6	Rainwater harvesting techniques		

Appendix IV: Checklist for Key Informants Interview and Focus Group discussion

1. How was the availability of health, school, agricultural inputs, credit, agricultural extension and irrigation services and facilities in your area and what do you think that their impact on the sustainability of food security?
2. How do you see the conditions of land resource change: vegetation, soil, safe water, water use and distribution?
3. How do you see climatic variability/rainfall variability in your locality?
4. How is the influence of drought on crop production and food availability?
5. How do you see agricultural production and its productivity in your locality?
6. What are the main constraints for agricultural activities that lead to household food shortages in your area?
7. Food consumption patterns in the study area mainly nutritious food consumption/ consumption of animal products like (meat, butter, cheese, milk, egg, chicken), consumption of fruits and vegetables, etc.
8. Do you observe any household that cannot cover its food need (acutely and chronically)? If so, how do they cope with food shortages?
9. What is the food security status of the households in your locality and how was its sustainability?
10. How was the sustainability of food security in your locality over the last 20 years? What do you think are the main factors triggering the sustainability of food security in your locality?
11. What are the possible coping and adaptive strategies for a food shortage or food security in your locality?
12. How do you see the effectiveness of the Productive Safety Net Program (PSNP) in your *kebeles*?

Appendix V: Conversion Factors

Table V-1: Conversion factor used to estimate Tropical Livestock Unit (TLU)

No.	Livestock Type	TLU (Tropical Livestock Unit)
1	Ox	1.1
2	Cows	1
3	Heifer	0.5
4	Bull	0.6
5	Calves	0.2
6	Sheep/ Goat	0.15
7	Horses	1
8	Mules	1.15
9	Donkeys	0.65
10	Chickens	0.0005
11	Camel	

Source: G. Ramakrishna and Assefa Demeke, 2002.

Table V-2: Conversion factor used to estimate caloric content of the food grain consumed in the study area

Types of Cereals	Food energy in Kcal per	
	100grams	1Kg
Teff	345	3450
Wheat	344	3440
Barley	339	3390
Sorghum	355	3550
Maize	363	3630
Oats	388	3880
Horse bean	342	3420
Haricot bean	339	3390
Chickpea	340	340
Field pea	337	3370
Lentil	339	3390
Linseed	534	5340
Fenugreek	335	3350
Groudnut	579	5790

Source: Platt (1985); USAID (2016)