Exploring the potential of sustainable utilisation of the baobab tree (Adansonia digitata) to improve food security. A case study of the south-east lowveld of Zimbabwe

by

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DECLARATION

I declare that this dissertation submitted for MSc Agriculture (Unisa) titled "Potential of sustainable utilisation of the baobab tree (*Adansonia digitata*) to improve food security. A case study of the south-east lowveld of Zimbabwe" is my own original work and has not been previously submitted to any university for any qualification.

I further declare that all the sources used or quoted in text have been indicated and acknowledged by a comprehensive reference list. This work was not plagiarised in accordance with the Unisa policy on plagiarism.

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Date:...10/12/2018.....

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ABBREVIATIONS

BAOFOOD	Baobab food
CAMPFIRE	Conservation and Management for Indigenous Resources
ESAP	Economic Structural Adjustment Programme
EU	European Union
FAO	Food and Agriculture Organisation
FTLRP	Fast Track Land Reform Programme
GDP	Gross Domestic Product
HFIAP	Household Food Insecurity Access Prevalence
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
ICRAF	World Agroforestry Centre
IFAD	International Fund for Agricultural Development
IUCN	International Union for Conservation of Nature
MDG	Millennium Development Goal
NTFP	Non-timber Forest Products
NUTREE	Nut tree
ODI	Overseas Development Institute
SADC	Southern African Development Community
SAFRUIT	Sahelian fruits
SAFIRE	Southern Alliance for Indigenous Resources
SDGs	Sustainable Development Goals
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations International Children and Education Fund
USA	United States of America
USAID	United States of America Aid
WHO	World Health Organisation
ZimVac	Zimbabwe Vulnerability Assessment Committee

ABSTRACT

The baobab tree represents a major contribution to rural communities of the south-east lowveld of Zimbabwe. The livelihood base of the study area was largely rain-fed subsistence farming whose production has declined due to frequent droughts. Harvesting of baobab tree products; leaves, fruits and bark fibre, has prospered due to poverty. These products are harvested for food, medicinal use, cash and animal harness. A mixed method approach on collection of data was employed through questionnaires, semi-structured interviews, 48-hour dietary recall and Household Food Insecurity Access Prevalence (HFIAP) template. Sixty-eight households from Wengezi and Gudyanga communities participated in this study. All the respondents from the study area indicated they were involved in using baobab products in one way or the other. According to the information collected by the HFIAP template, 76% of the households were moderate to severe food insecure. Baobab bark harvesting was common in the Gudyanga and harvesters were aware of sustainable way of harvesting it. Value-addition on baobab fruit pulp to make ice-lollies and seeds roasted to produce a coffee substitute was practised by youth projects with the help of a non-governmental organisation. Ninety-five percent of the households in the study area were in support of the idea of possible baobab tree commercial cultivation in the community. The support was in anticipation of job opportunities and reduced food insecurity.

Key words: indigenous tree, commercial production, rural community, baobab fruit pulp, bark fibre, consumption

CHAPTER 1

1.1 Introduction

The baobab tree (*Adansonia digitata*) is an indigenous tree to Africa and Australia. It is sometimes called the "upside down tree" because of its huge stem supporting roots-like branches (Wickens, 1982). The Southern African Development Community (SADC) identified the baobab tree as a keystone indigenous tree which is central to livelihoods of rural households of the region (Venter and Witkowski, 2011). The SADC is made up of countries in southern Africa, namely: Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, Swaziland, South Africa, Tanzania, Zambia and Zimbabwe. For centuries, the baobab fruit tree has been used by communities in southern Africa as a buffer tree which provides people with nutrients during drought periods and cereal shortage thereby improving food security.

Food security was defined by World Food Summit (1996) as existing when people, at all times have physical and economic access to sufficient, safe and nutritious food that meet their dietary needs and preferences for an active and health life. Food security in SADC is challenged by frequent occurrences of drought and extreme weather conditions induced by climate change (Manyeruke *et al,* 2013). As member states of United Nations (UN), SADC countries are expected to frame their agendas in line with sustainable development goals (SDGs), which act as indicators of achievement of food security. According to Food and Agriculture Organisation (FAO, 2005), SDG 1 aims at eradicating extreme poverty and hunger in member states. In support, the World Health Organisation (WHO) (2012) outlined the four pillars of food security which include food availability, food access, food use and stability.

In the past two decades, Zimbabwe has been experiencing increased food insecurity at household and national level (Manyeruke *et al,* 2013). This is emanating from reduced production and yield of the main crops partly due to climate change and other socio-political events. This resulted in a drop of crop yields by 30% (World Bank 2016). The rural households of the south-east lowveld are hardest hit by the effects of climate change due to their high dependence on rain-fed agriculture (Manyeruke *et al*, 2013). This resulted in the increase in harvesting of baobab fruits by local communities as a means to supplement cereal shortages (Gandiwa *et al,* 2015). Mpofu *et al,* (2012) stated that there is a 10% the increase in number of households using baobab tree products in the south-east lowveld to

improve economic status and household stability. The high demand for the baobab fruit pulp is putting pressure on the wild baobab tree population in the south-east lowveld of Zimbabwe hence the need to explore the sustainable utilisation of the tree.

1.2 Problem statement

African indigenous plants have the potential to play a central role in addressing food insecurity and associated health concerns in sub-Saharan Africa (Cordeiro, 2013). The indigenous trees such as the baobab increase the coping ability of local communities through providing food and income (Kamatou *et al,* 2011). Therefore, to ensure sustainable utilisation and food security among communities, there is need to have a better understanding of local use of indigenous trees to realise their potential.

The use of baobab tree products is cited in communities of southern Africa, with value-addition in Malawi and Zimbabwe (Venter and Witkowski, 2011). It is important that more knowledge be disseminated to communities on sustainable utilisation of this species. The Ministry of Agriculture in Zimbabwe does not have a clear strategic plan regarding the harvesting of indigenous tree resources (Mpofu *et al*, 2012). In the south-east lowveld of Zimbabwe, the baobab trees are owned communally and harvested freely according to availability (Sanchez *et al*, 2011). Studies on the baobab trees as an indigenous resource in region, have mainly concentrated on national parks where the baobab tree population is being threatened by the elephant population (Gandiwa *et al*, 2015). Since the use of baobab tree products is not regulated in Zimbabwe, this study will contribute to inform policy on the status of its utilisation. The use of the baobab tree products would be accessed in order to understand the socio-economic potential of this resource.

The aim of the study

To use recommendations from the study to advise policy formulation on baobab tree utilisation to enhance food security in the communities in the south-east lowveld of Zimbabwe.

1.3 Research questions

How is the baobab tree utilised to enhance food security in the south-east lowveld of Zimbabwe?

How are baobab tree products harvested by communities in the south-east lowveld of Zimbabwe?

Who is using and buying baobab fruit pulp in communities of the south-east lowveld of Zimbabwe to enhance their livelihood?

What are the perceptions or views regarding possible commercial cultivation of the baobab tree by households in the south-east lowveld of Zimbabwe?

Which baobab trees have preferred characteristics for food and trading by the rural communities of south-east lowveld of Zimbabwe?

1.4 Research objectives

- To assess the ways being used to utilise the baobab tree in enhancing food security in the south-east lowveld of Zimbabwe.
- To assess harvesting methods of the baobab tree products being used by households in the south-east lowveld of Zimbabwe.
- To determine the size of population involved in harvesting, consuming and selling baobab tree products in the south-east lowveld of Zimbabwe.
- To obtain perceptions or views regarding possible commercial cultivation of the baobab tree by households in the south-east lowveld of Zimbabwe for sustainability.
- To identify and describe the baobab trees with preferred characteristics for food and trade by communities of south-east lowveld of Zimbabwe.
- To estimate the prevalence of household food insecurity in the south-east lowveld of Zimbabwe

1.5 Rationale and motivation

For centuries, communities have harvested baobab tree for food, medicine and craftwork. The creamish baobab fruit pulp is used to make porridge and ice-lolly juice which has become popular favourite with the urban population (Sanchez *et al*, 2011). During a study on baobab trees carried out in Zimbabwe, Wynberg *et al,* (2012) observed that baobab tree bark is a source of fibre used to make craftwork of mats, hats and bags. Ropes to handle

farm animals are commonly made from the baobab tree fibre in the rural areas. A study carried by Romero *et al,* (2001) in the south-east lowveld of Zimbabwe cited that the baobab trees in the area were subjected to many years of debarking for fibre. The tree has a fibrous stem which usually regrows after any damage. There is limited study done by biologists on effects of stripping of the baobab trees (Sanchez, 2012). The fresh leaves are cooked and eaten as a vegetable by local communities in the west and southern Africa (Akinnifesi *et al,* 2008). The fruit kernels are burnt, and the ash is used as a substitute for bi-carbonate of soda in cooking mostly in the eastern and southern African communities (Sanchez, 2011). Kernels are also used as firewood in rural households in Malawi and Zimbabwe (Akinnifesi *et al*, 2008). Figure 1 shows a baobab tree with fruits and the fruit pulp.

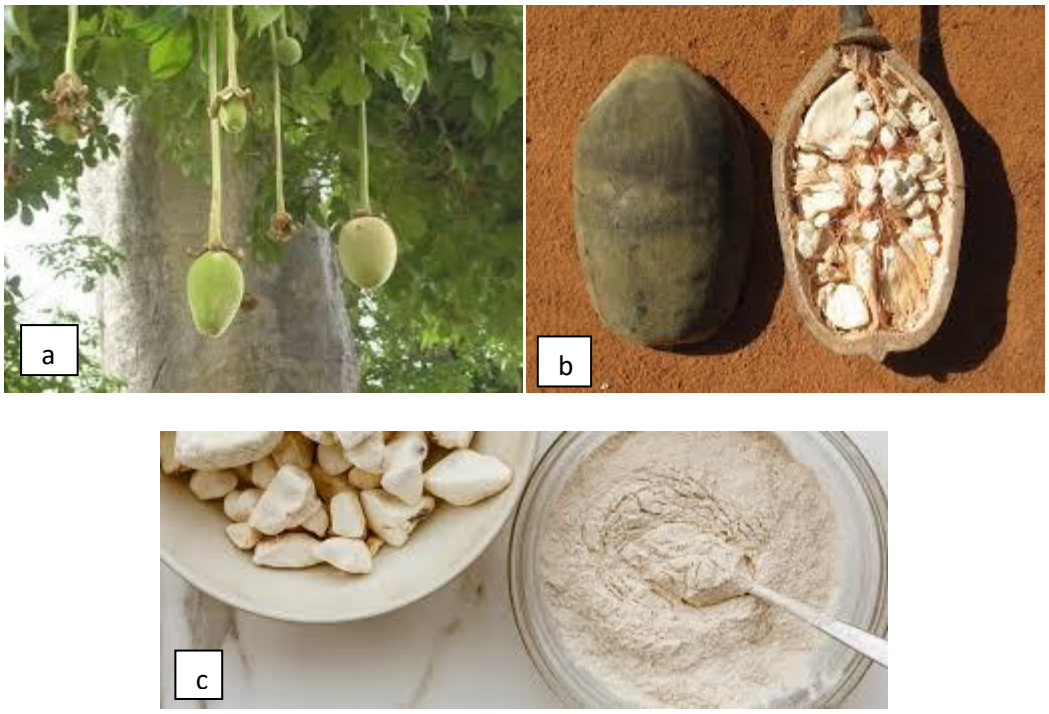

Figure 1: A Baobab tree with young fruits b. Mature baobab fruit c. Baobab fruit pulp

(Source: Van Wyk and Van Wyk, 2013)

According to Manyeruke *et al,* (2013) climate change poses a drastic threat on Zimbabwe's agricultural industry due to an increase in the average temperature. This resulted in the shifting of the farming seasons and agro-ecological zones. The lowveld of Zimbabwe is hardest hit since it has a drier climate and most of the rural households depend on rain-fed agriculture. The baobab fruit offers alternative source of food for households in the communities during times of cereal shortages. Government-led irrigation facilities in some

parts of this area, are no longer functional due to long periods of neglect and vandalism (FAO 2015). This has led to an increased demand for the locally available baobab tree resources for food and income for the communities in the south-east lowveld of Zimbabwe (Akinwunmi and Bewaji, 2015). Wickens and Lowe (2008) suggested that overharvesting of a resource may result in extinction of species so sustainable utilisation is one of the ways of preventing this catastrophe. There is no legislative mechanism in the area which controls the harvesting of baobab tree products (Mugandani *et al*, 2012).

The average annual rainfall received in the lowveld of Zimbabwe is below 600mm and it has become less due to frequent droughts experienced in the southern African region (Sanchez *et al*, 2011). The mean temperature experienced is between 25°C and 35°C which is favourable for the growth of the baobab tree. Akinnifesi *et al,* (2008) suggested that the baobab tree is an indigenous tree species that is more adapted to local conditions of southern Africa where the altitude is low (0-800m), annual precipitation is low (<400mm annually) and mean temperature is high (25 ° C and 40 °C). The ability of the baobab tree to adapt well in hot and drier climate make it central to food security as climate change leads to occurrence of extreme climate events.

Burkina Faso, Mali and Niger are countries where the baobab tree has been successfully propagated for commercial purposes (Svejgaard *et al*, 2011). The concept of baobab domestication in these western African countries involved integrating conservation, breeding and propagation. Selection of baobab trees for commercial production was done with farmers in a participatory process. Sahelian Fruit Trees (SAFRUIT), a European Commission organisation and Nut Trees (NUTREE), an American-funded organisation, were the non-governmental organisations which were involved in these projects aimed at enhancing food security among rural households. Wickens and Lowe (2008) pointed out that a participatory approach was used due to lack of knowledge available in scientific literature concerning the use of baobab tree. Grafting was used to accelerate maturity age from 4 to 10 years. There are reports of successful experiments on baobab tree seed germination and grafting reported in Malawi (Sanchez *et al*, 2011). Local farmers in Malawi rural areas are accessing the indigenous baobab tree in situ to harvest the fruit for its pulp. Wickens and Lowe (2008) also reported an increased export of baobab fruit pulp from South Africa and Senegal to the European Union (EU) and the United State of America (USA) by a few commercial companies.

A report on commercial production of the baobab tree in Malawi by Munthali *et al,* (2012) reported that only light dry-season irrigation was done to the baobab transplants. This management practice was recorded to have a minimal impact on average fruit pulp percentage which averages 16.5% of fruit weight (Sanchez et al, 2011). The extensive shallow rooting system of baobab trees enables it to absorb moisture from the soil even in periods of light rains (Munthali *et al*, 2012). At the same time, the large fibrous trunk of the baobab tree stores water making it more adaptable to water stress and climate change (Sanchez, 2012).The baobab fruit pulp was endorsed and accepted as a food component by the EU and USA (Charade *et al,* 2009). The baobab fruit is an organic product, since the trees are not treated with any fertilisers or pesticides. Most European markets have a high demand for organic products (Svejgaard *et al*, 2011). Exporting the fruit pulp would go a long way in improving the livelihood of the communities of the south-east lowveld of Zimbabwe since they would get a share of the income from the sales (Conservation and Management Programme for Indigenous Resources (CAMPFIRE) (Frost and Bond, 2008).

CHAPTER 2

Literature review

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2.1. Characteristics of the baobab tree

The baobab tree is deciduous tree with an extensive shallow rooting system and a large trunk that accumulates water. It is sometimes called the “upside down” tree because of its root-like branches (Figure 2). It is among the nine global species in the genus *Adansonia* from the family Malvaceae and sub-family Bombacaceae (Venter and Witkowski, 2013). Most scientists believe the common name ‘baobab’ which is used globally is derived from the Arabic name ‘buhibab’ meaning fruit with many seeds (Diop *et al*, 2006). The baobab (*Adansonia digitata L*) tree is not listed as an endangered species on the International Union for Conservation of Nature (IUCN) Red List.

Figure 2: Baobab tree (*Adansonia digitata*). Source: Diop *et al*, 2006

The baobab tree can grow to a mature height of 25m and the trunk diameter ranges from 6-10m (Chadare *et al,* 2009; Wickens, 1982). The tree can live up to 1 000 years according to carbon dating method used to estimate the age (Gebauer *et* al, 2002). There are limited methods of verifying the age of baobab tree since they do not produce annual rings (Wickens and Lowe, 2008). Radiodating of a baobab tree in Namibia indicated an age of 1,272 years (Patrut *et al*, 2007). According to Mpofu *et* al, (2012) earlier research by Woodborn *et* al (2010) showed that very large baobab trees are not necessarily among the oldest since the medium-sized individuals can also be very old. This makes it more complicated to estimate the age using size. The bark is smooth, reddish brown to grey, soft and fibrous. According to Diop *et al,* (2006), the baobab tree has an extensive root system

which can extend as far as 50m from the trunk with a shallow depth which rarely goes beyond 2m. This allows the trees to collect and store massive amounts of water during wet season (Sidibe and Williams, 2002). This could explain why these trees are often toppled in old age.

Leaves of juvenile baobab trees are simple but become compound with 3-9 leaflets in mature plants (Van Wyk and Van Wyk, 2013). White, showy solitary flowers are produced during both dry and wet seasons. The fruit is ovoid to elliptic about 120mm long with a hard-woody shell densely covered with yellowish grey hairs. Wickens and Lowe (2008) estimated that it takes 8 to 23 years for a baobab tree to flower, mature and plants over 60 years can produce between 160-250 fruits per year. Studies to domesticate the baobab tree showed that time to reach maturity can be reduced to six years through vegetative propagation methods and genetic improvement (Sanchez, 2011).

2.3. Distribution and occurrence of baobab tree

The African baobab tree (*A. digitata*) is well-adapted to arid and semi-arid conditions of western, north-eastern, central and southern Africa (Sidibe and Williams, 2002). It occurs naturally in most African countries in the south of the Sahara and is especially associated with drier parts of the savannah biome of a minimum of 300mm of annual rainfall. It is found in areas of latitude between 16° N and 25° S not receiving more than one day of frost per year (Kamatou *et al,* 2011). It grows well in alluvial soils and is sensitive to waterlogging and deep sands (Jensen *et al,* 2011).

Apart from *A. digitata,* is native to Africa, there is also Australian baobab, *Adansonia gibbosa, Adansonia cunni* and six other baobab species native to Madagascar namely *Adansonia grandidieri* Baill, *Adansonia madagascariensis* Baill, *Adansonia rubrostipa* Jum & H.Perrier, *Adansonia perrier* Capuron, *Adansonia suarezensis* H. Perrier and *Adansonia za* Baill (Sidibe and Williams, 2002). The ninth species discovered in Namibia through morphology, ploidy and molecular phylogenetics is *Adansonia kilima* sp. nov. (Pettigrew *et al,* 2012). *Adansonia kilima* was found to be phenotypically similar to *Adansonia digitata* though it can be differentiated on the basis of floral morphology, pollen characters and chromosome number (Pettigrew *et al,* 2012).

The population of baobab across southern Africa is estimated to 28 million trees, (PhytoTrade 2008). This equates to a potential sustainable annual yield of 6 73 000 tonnes of whole baobab fruit and 108 000 tonnes of baobab fruit pulp powder. The southern African indigenous baobab population covers a land area of approximately 93 000 km^2 in eight countries. The largest areas of baobab population are in Mozambique, South Africa, Malawi and Zimbabwe. Table 1 below shows the occurrence of baobab trees in southern African countries.

Table 1: Estimated occurrence of baobab trees in southern Africa (PhytoTrade, 2008)

Country	**Total land area of country (km^2)**	**Areas of baobab occurrence**	**Estimated baobab coverage as % of country's total land area (%)**	**Estimated land area with baobab population (km^2)**
Botswana	582 000	Hard area in north-east and north-west	1	5 820
Malawi	118 484	Shire valley, Nsanje	10	11848
Mozambique	801 590	By Lake Malawi, Chipanga, Magude, Cabo Delgado and Nampula provinces.	5	40 080
Namibia	825 000	Northern Namibia	0.5	4 125
South Africa	1 233 404	Limpopo basin, norther Zoutpansberg mountains, Limpopo and Mpumalanga provinces	1	12 334
Zambia	752 615	Luangwa, Gwembe valley, Zambezi valley	1	7 526
Zimbabwe	390 580	Zambezi valley, Save valley, Limpopo basin	3	11 717
Total	**4 703 673**			**93 450**

2.4 Ecological importance of the baobab tree

For priority indigenous fruit tree species, the World Agroforestry Centre identified the baobab tree as one of the top five species that is central to the livelihoods of rural SADC communities (Venter and Witkowski, 2011). Apart from providing food and nutritional security to households, the baobab tree is a vital component of the dry semi-arid ecosystem where they grow. The baobab trees reduce soil erosion and provide cover or shade with their canopies (Wickens and Lowe, 2008). Wild animals and livestock utilise the shade especially during the hot part of the day. These animals leave droppings around the tree trunk adding nutrients to the soil and food for other organisms in the food chain (Wickens and Lowe, 2008; Venter and Witkowski, 2011). Hollow baobab tree trunks are home to wild animals and if the tree happens to be at a homestead, it is used as a storage place. The baobab tree produced large white flowers at the beginning of the rain season (van Wyk and van Wyk, 2013). The flowers are pollinated by bats and small animals, so protection of these animals is important for fruit production (Venter and Witkowski, 2013). Nevertheless, the baobab is adapted to wind pollination (Mpofu *et al*, 2012). When flowers and leaves fall to the ground, fresh or dry, they provide food for animals such as cattle, goats and wild animals (Wickens and Lowe, 2008).

The ability of the baobab tree to withstand extreme stress during drought allows it to survive during periods of little or no rainfall and still produce fruits (Stucher and Lopez-Grunn, 2015). With the current climate variability and change, the baobab tree's resilience makes it essential in fulfilling its ecological importance and providing essential ecosystem goods. Its spongy fibrous stem does not burn easily and can endure veld fires (Mpofu *et al*, 2012; Chadare *et al*, 2009). African beliefs and customs in SADC communities do no permit the cutting of the baobab tree so farmers are known to retain and protect the baobab trees on their land, whether it is around homesteads or farming land (Venter and Witkowski, 2011).

2.5 Nutritional value of the baobab products

For centuries the baobab tree products have been used as a buffer during food shortages or drought (Wicken and Lowe, 2008). The fruit and leaves are used as food and for medicinal purposes with the bark included (Jackson and Maldonado, 2015). According to Porkouda *et al,* (2010), baobab fruit pulp is very rich in vitamin C which is 1.690mg/kg compared to 1.060mg/kg in fresh hot pepper. In support, Ramadhani (2002) stated that the baobab fruit pulp contains ten times vitamin C content compared to the same weight of oranges. The fruit

pulp contains 50% crude fibre, so it is an ideal fibre supplement (Jackson and Maldonaldo, 2015). Fresh baobab leaves which are eaten as vegetables contain 307 to 2 640mg/ 100g of calcium, which is twice as much of the same quantity of milk. Vermaak *et al,* (2011) cited the presence of magnesium, phosphorus, vitamin B_1 and vitamin B_2 in the baobab fruit. Seeds and kernels of the baobab fruit are eaten fresh, dried or roasted and are a good source of lipids containing 11.6 to 33.3g/100g dry weight for seeds while kernels contain 18.9 to 37.7g/100g dry weight (Chadare *et al,* 2009).

2.6 Baobab tree utilisation in Africa

There has been extended commercial interest in different baobab products (Svejgaard *et al*, 2011). The African baobab is a multi-purpose tree, mostly used for food, medicine, fodder and clothing (Rahul *et al,* 2015). Furthermore, there is a worldwide increased demand for baobab products in the medicinal industry, food industry and cosmetic industry. In a study searching for novel ingredients to be used in the cosmetic industry, the baobab seed received the highest interest (Komane *et al*, 2017). Topical application to the skin of the baobab seed oil by the participants showed that the seed oil possesses hydrating, moisturising and occlusive properties (Komane *et al*, 2017; Vermaak *et al*, 2011; Jackson and Maldonado, 2015).

The inclusion of baobab seed oils at 5% to 25% levels in varying poultry diets can improve poultry performance (Chisoro *et al*, 2017). They are of the opinion that baobab seeds have the capacity to replace convectional protein sources used in formulating commercial poultry diets. Stadlmayr *et al,* (2013) suggested the use of baobab seeds in animal diets and treatment in order to destroy anti-nutritional factors is required. A high variability of nutrient content is reported in baobab pulp. This variability offers the potential for baobab trees with high nutrient and lowest anti-nutrients to be selected for domestication. Buchmann *et al,* (2010) cited that domestication can be a viable strategy in reducing competition between subsistence and commercial use of the baobab trees.

The Baobab Food (BAOFOOD) project, funded by German Federal Ministry of Food and Agriculture, is working on several projects globally aimed on sustainable utilisation and conservation of baobab resources (Meinhold *et al*, 2016). The research involved identification of mother trees for domestication that have superior fruit characteristics and adaptability to increase climate variability. The increasing climate variability may influence

the occurrence and abundance of baobab trees as predicted by Sanchez *et al,* (2011). However, the baobab tree's ability to survive in dry and semi-arid conditions is one of the qualities which make it to adapt well to current climate variability (Melnhold *et* al, 2016). With the current climatic conditions of extreme weather patterns, the baobab tree is cited as one of the plants which stand a better chance to thrive in these conditions. Several studies (Assogbadjo *et al*, 2005; Venter and Witkowski, 2010; Meinhold *et al*, 2016) cited lack of natural regeneration of the baobab tree observed in different countries in the sub-Saharan Africa region. This means that the current baobab tree population is ageing, and human intervention is required to avoid its extinction (Venter and Witkowski, 2010). The potential monetary value of baobab fruit pulp in national and international market and rise in awareness of its nutritional value could stimulate the willingness of households for planting this tree (Sanchez *et al*, 2011).

Leaky and Akinnifesi (2008) reported that the domestication of indigenous fruit tree observed that baobab tree proved to be advantageous to promote rapid adoption of the tree by farmers. This has enhanced livelihood in communities where this strategy was used. In Mali, Burkina Faso and Niger, the harvesting of the baobab fruits was a success and managed to improve rural livelihoods, household income, nutritional status and biodiversity conservation (Tchoundjeu *et al,* 2006). According to Svejgaard *et al,* (2011), World Agro Forestry Centre (ICRAF) worked with communities in the West African region promoting domestication of the baobab tree. For southern Africa, several experiments on baobab seed germination and grafting were reported in Malawi (Gondwe and Chanyenga, 2006). This study supported sustainable utilisation of the indigenous trees since it improved food security in the region. Wickens and Lowe (2008) observed that people do not propagate the baobab tree because of the long time it takes to mature. Vegetative propagation of mature trees has shortened the period from planting to fruit production. Grafted material of *A. digitata* starts flowering between three to five years after grafting compared to eight to 23 years for seed propagated material (Sanchez, 2011).

In Zimbabwe, promotion of indigenous trees utilisation was done on *Uapaca kirkiana* which grow in moderate rainfall regions of the country which are quite different from the south-east lowveld area whose rainfall is erratic (Mugandani *et al*, 2012). The baobab tree in Zimbabwe has been studied in relation to its decline due to human activities such as bark-peeling for craftwork and wildlife destruction by elephants in national parks (Gandiwa *et al*, 2015).

2.7 Food security

Food security is defined as, ‘’when all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life’’ (USAID, 2006). There are four main components of food security which are: food availability, food accessibility, food utilisation and stability. The policy statement of the United Nations on food security, (WHO, 2012), defined food availability as sufficient quantities of domestic production, commercial imports or donors that are consistently available to individuals within a household. According to FAO (2008) food availability is the pillar to address the supply side of food security which is determined by the level of food production, stock level and net trade. It defined food utilisation as occurring when food is properly used, processed and stored and adequate knowledge of nutrition and child care exists and is applied, also adequate health and sanitation services exist’’. The fourth component of food security, food stability, affects all the other three components (Klennert, 2005). Stability is determined by weather variability, price fluctuations, political and economic factors.

2.7.1 Food security in Zimbabwe

The livelihood of rural communities in Zimbabwe depended on rain-fed subsistence agriculture (Mazzeo, 2011). With frequent droughts experienced in the region caused by climate change, many rural households are at the risk of hunger and malnutrition from time to time (Mutambara, 2014). A report by the United Nations Development Programme (UNDP) (2011) cited that the proportion of people suffering from malnutrition, a proxy for food insecurity, has increased in Zimbabwe. The studies have shown that temperature in Zimbabwe has increased by 0.4°C while rainfall declined by 5% since 1900 hence increased frequency of drought. Furthermore, it is mentioned that there has been increased food and nutrition insecurity at household and national levels. The poverty rates rose to 72% with half of the population in extreme poverty. Acute malnutrition rate of 5.7% was recorded as the highest in 15 years (UNICEF, 2016; GoZ and UNDP, 2011). The food insecurity situation is emanating from reduced production of main crops and a lack of a comprehensive agricultural policy (Manyeruke *et al*, 2013; Mazzeo, 2011; Tawodzera *et al*, 2016).

Post-independence political and economic policies adopted by the Zimbabwean government are blamed for food insecurity level in the country, both at national and household level (Mupindu, 2015). The country changed from being an exporter of food to become a food importer, with the large portion of imports coming in as humanitarian aid (UNICEF, 2016).

Zimbabwe's gross domestic product (GDP) contracted by over 40% between 2000 and 2006 putting pressure on the marginalised rural communities (Coomer and Gstraunthaler, 2011). Annual inflation increased from two-digit figures in 2000 to 231 million percent in July 2008 and external debt ballooned to United States Dollar (USD) $6 million in the same year. Tawodzera *et al,* (2016) reported that political violence and an accumulation of failed economic policies contributed to the crisis. These challenges led to a decrease in food production creating a humanitarian emergency that affected millions of households in Zimbabwe. The main causes of the deteriorating food security in Zimbabwe are the Economic Structural Adjustment Programme (ESAP) of the 1990s, the Fast Track Land Reform Programme (FTLRP) from 2000 and Operation Murambatsvina (Restore Order) of 2002 (Coomer and Gstraunthaler, 2011; Matondi, 2012: Scones *et al*, 2010; Tawodzera *et al*, 2016).

The ESAP is cited as the foundation for serious downward trajectory in Zimbabwe's economy in the 1990s and 2000s (Coomer and Gstraunthaler, 2011). Though it was meant to revamp the national economy whose growth was slowing down, foreign investment declining and unemployment rising, it is cited as one of the causes of the country's meltdown. The Zimbabwean government's aim was to encourage investment and reduce the country's domestic debt through trade liberalisation, domestic deregulation, investment promotion and fiscal monetary policies to curtail state expenditure (UNDP, 2011). Contrary, ESAP led to closure of factories, large-scale retrenchments, a decline of real wages, sky-rocketing consumer prices and a decline in formal economy.

The FTLRP of 2000 was a critical development which directed implications on food security (Matondi, 2011). The Zimbabwean government embarked on expropriation of white-owned farms and redistributed them to indigenous farmers. Although over 1.2 million black farmers benefited and national agricultural production drastically declined as the new occupants lacked financial resources, inputs, labour, equipment and expertise to produce on the same scale as the previous owners (Scones *et al*, 2010). The rural households were greatly affected by the decline in food supply since they have less food available during drought periods.

2.7.2 Food availability

According to USAID (2006) food availability, sufficiency and consistency of food availability cannot be said of the southern African households. The United Nations World Food Programme (2015) reported that this region has been experiencing frequent droughts due to effects of climate change and El Nino weather phenomenon. The World Food Programme (2016) declared Zimbabwe as one of the most food insecure countries with half of its population in extreme poverty. In Zimbabwe, the low-lying area of the south east lowveld are hardest hit since the rural farmers depends on rain-fed agriculture (Mugandani, *et al,* 2012). This has decreased household access to sufficient food to meet their dietary needs and preferences.

2.7.3 Food accessibility

According to WHO (2012) food accessibility is determined by having sufficient resources to obtain appropriate food for a nutritious diet. This access to food is determined by purchasing power of the population. One of the aims of the Sustainable Development Goals adopted by world leaders on 25 September 2015 is to increase access to food to the all people especially those living in vulnerable situations (FAO 2015). People's income, transport and market infrastructure of an area were quoted as some of the means of allowing access to food at all times. A commodity may be available in the community, but accessibility is limited due to factors such as legislative policies, infrastructure or religious beliefs.

2.7.4 Food utilisation

One other fundamental pillar of food security is food utilisation (UNICEF, 2016). Food utilisation, known as food use encompasses aspects such as food safety, hygiene and manufacturing practices applied by primary and secondary agricultural production (FAO, 2005). All processes involved in food production from farm up to household use, form part of food utilisation. Harvesting, storage, processing, transportation, retailing, household diet quality, diversity to meet micro and micro nutritional requirements determine food use (UNICEF, 2016). A key component to food utilisation is food safety which is an assurance that food will not cause harm to the consumer when it is produced and consumed according to its intended uses (Mupindu, 2015). The UN Millennium Development Goals adopted on 25 September 2015, set to eradicate poverty by addressing food utilisation as one of their Sustainable Development Goal (SDG) (UNICEF, 2016).

Unlike developed countries, Zimbabwe's food control systems are fragmented involving a multitude of middlemen in underdeveloped countries (Mupindu, 2015). There is lack of resources and infrastructure for post-harvest handling, processing and storage which lead to severe diminishing of quality and quantity. The UNICEF (2016) stated that 2.3 million households in Zimbabwe are unable to meet their daily food requirements. An acute malnutrition rate of 5.7% in children, highest for Zimbabwe in 15 years, was recorded by UNICEF (2016) while severe acute malnutrition remains at 2.1%. Food utilisation in Zimbabwe is compromised by a decline in food production after the fast track agrarian land reform programme, high dependence on imported food and failure to implement food security policy effectively (Mupindu, 2015). This has further threatened household food preference. There is a growing prevalence of food related diseases and frequent pockets of poverty (Lunga and Musarurwa, 2016).

2.7.5 Food Stability

Stability of supply and access of food is determined by weather variability, price fluctuations, political factors and entrepreneurship (USAID, 2006). Climate change impacted heavily on economies of southern Africa as a result of poor crop harvest (WHO, 2012). Madagascar, Malawi and Zimbabwe are countries at threat. Food accessibility, availability and utilisation are all determined by stability.

Over 80% of Zimbabwe's rural population is suffering from chronic food and nutritional insecurity (UNICEF 2016). Acute malnutrition rate of 5.7% was recorded, in which women and children were the most affected. Persistent periods of household failure to meet their minimum food requirements are caused by poverty, lack of assets and inadequate to financial resources (UNICEF, 2016). Coping strategies were used by rural communities which included harvesting of indigenous fruit trees, disposing assets to buy food and borrowing food or cash. Mupindu (2015) reported that some coping strategies used by rural households were reducing the number of meals per day, cutting meal portion size, receiving aid from friends or relatives, and reducing spending on non-food items. Terminally-ill people were said to be in danger in cases where the number of meals are reduced especially for those suffering from Human-Immune Deficiency (HIV) and Acquired Immuno-Deficiency Syndrome (AIDS). Quinn *et al,* (2011) confirmed that adverse coping strategies may support short-term survival while undermining the well-being in the medium and long-term. The adverse coping strategies were liquidation of crucial productive assets, reduction of food, avoiding essential medical expenditure and withdrawing children from attending school.

The harvesting of the baobab tree products in the semi-arid regions of Zimbabwe served as a coping strategy for rural households (Quinn *et al*, 2011). The naturally low water content of the baobab fruit pulp allows for its long-term storage and late consumption in times of need. This makes it easier to transport it to domestic and international markets (Gruenwal and Galiza; Meinhold *et al*, 2016). In times of food scarcity, baobab tree leaves, young roots and oil from seeds are eaten to improve food and nutritional security of economically-marginalised communities of the hot and drier parts of sub-Saharan Africa (IFAD, 2011). When all the four pillars of food security are satisfied, that is when one is said to be food secured (FAO, 2008).

2.8 Baobab tree products utilisation in Africa

2.8.1 West Africa

Buchmann *et al,* (2010) identified three hundred traditional uses of the baobab in Benin, Mali, Burkina Faso and Senegal across 11 ethnic groups and four ecological zones. Baobab fruits and leaves are consumed throughout the year and seeds are used as food ingredients in a fermented concoction called 'maari' (Porkouda *et al*, 2010). This study promoted seed fermentation using bacteria and this proved to produce a cheaper food thickening. Private organisations such as SAFRUIT and NUTREE, were involved in Mali, Burkina Faso and Niger projects aimed to relieve local communities from poverty using baobab tree sustainable utilisation through conservation, breeding and propagation (Svejgaard *et al,* 2011).

2.8.2 Baobab utilisation in southern Africa

Consumption of the baobab tree fruit pulp is common among rural households in southern Africa. In Malawi, the baobab fruit pulp is used as a substitute for cereal and to make fruit juice mixed either with water or fresh milk (Sanchez, 2011). Juice-making industries are buying baobab fruit pulp to make frozen juice sold as ice-lollies introducing baobab tree product consumption into urban communities of Malawi. In Namibia, the baobab fruit pulp is used for subsistence by cash-stricken households (Kamatou *et al*, 2011). In South Africa, baobab tree population is restricted to the Limpopo and Mpumalanga provinces (Kamatou *et al*, 2011). Rural communities in these provinces use the baobab fruit pulp to make juice mixed with water or fresh milk (Vermaak *et al,* 2011). Traditional healers use the pulp to treat diarrhoea, dysentery and measles (Bamalli *et al,* 2014). Leaves are sometimes cooked and eaten as vegetables but according to Vermaak *et al, (*2011) the leaves are mainly used for

medicinal purposes in the treatment of fever and bladder diseases. During the rainy season, the baobab tree leaves are food to wild animals such as elephants, kudus, nyalas and impalas (Venter and Witkowski, 2013). Cattle feed on fallen leaves and flowers.

A study conducted in Nyanyadzi and Gudyanga wards in Zimbabwe's Chimanimani district revealed that at least 70% of interviewees used baobab products (Wynberg *et al*, 2012). Utilisation of the tree is centred on its fruit, seeds and fibrous bark. Like in other southern African communities, in Zimbabwe the fruit pulp is dissolved in water or fresh milk to make a juice which is drank or eaten frozen as ice-lollies (Chipurura and Muchuweti, 2013). Seeds are roasted and ground into powder which is used as a substitute for coffee (Sanchez, 2011; Chipurura and Muchuweti, 2013). The craft items made from baobab fibre has been exported to South Africa from Zimbabwe since the early 1990s (Wynberg *et al,* 2012). This has contributed to livelihood security in the semi-arid areas of Zimbabwe. Figure 3 below shows the value chain for baobab products from Gudyanga and Nyanyadzi wards of the south-east lowveld of Zimbabwe.

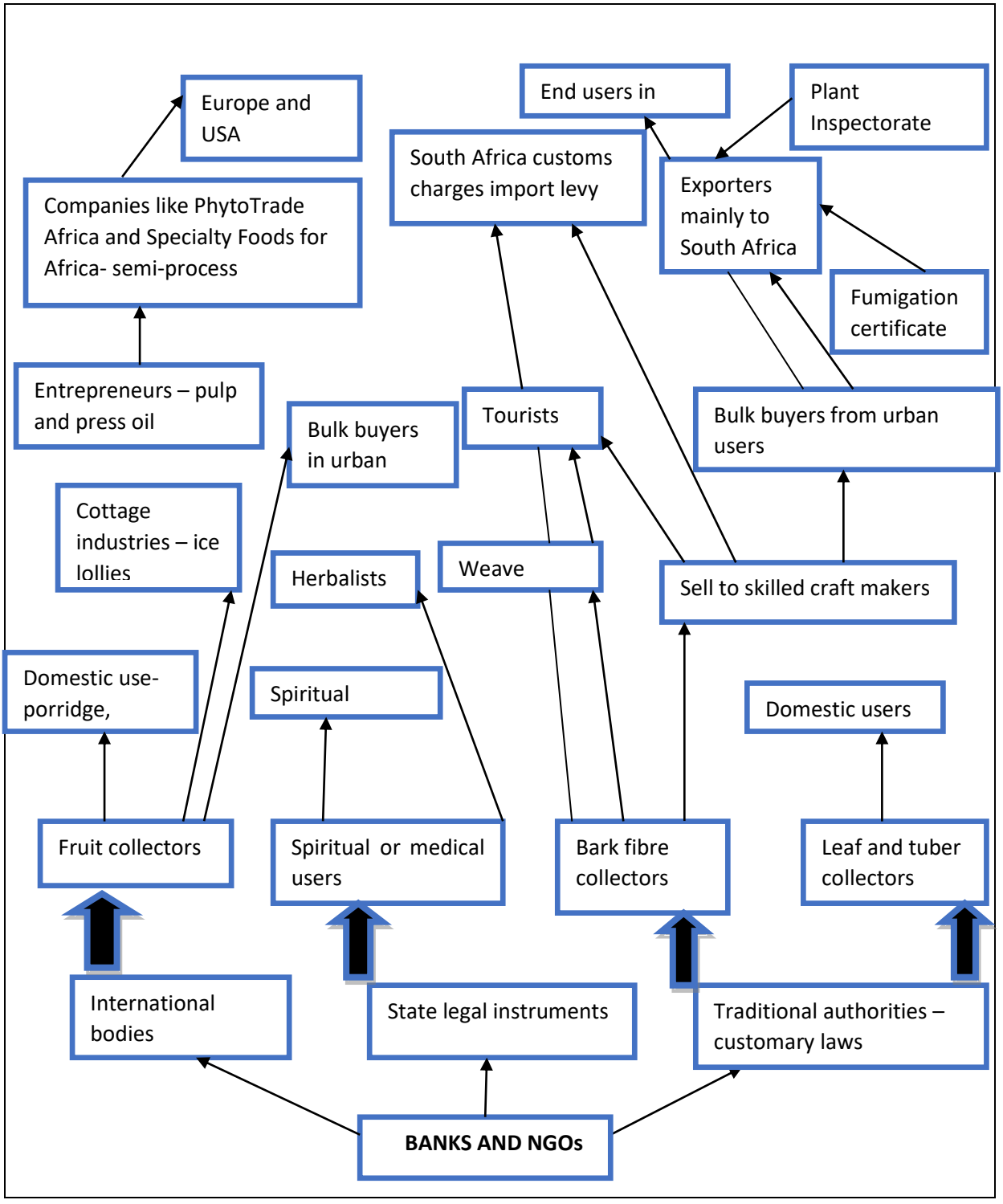

Figure 3: Value chain for baobab products from the south-east lowveld of Zimbabwe (Wynberg *et al*, 2012)

The baobab tree has the potential of providing additional income to farmers in the dry rural communities of Zimbabwe (Kuhnlein, 2003; Wynberg *et al*, 2012). The commercialisation of the tree is centred on its fruit, seeds and fibrous bark. A study carried by the Overseas Development Institute (ODI) based in London projected that the European market for baobab products could generate more than US$750 million annually for producer counties in southern Africa, making it the highest earner of all non-timber forest products (NTFP) in the region (Wynberg *et al*, 2012). This means that baobab products have a great potential in contributing to national economies and improving livelihoods of communities that have access and manage the tree.

A study conducted by Sanchez *et al,* (2011) concluded that some countries such as Namibia, Botswana, Sudan and Ivory Coast will not have suitable habitats for baobab trees in the future due to climate change. Although there are uncertainties this should not justify no conservation actions regarding baobab. The ability of the baobab tree to withstand extreme weather conditions such as drought is likely to result in a potential increase in utilisation pressure on the baobab tree as other plant species fail to cope with predicted changes in climate (Sanchez *et al*, 2011). To reduce the impacts of the predicted climate changes on the baobab population, Venter and Witkosky (2011) suggested better conservation strategies to ensure successful recruitment is the protection of baobab seedlings. Fencing to protect the seedlings from herbivores and animal trampling, treating seedlings against insect infestation where insects might be the cause of seedling mortality (Sidibe and Williams, 2002). Furthermore, raising awareness among local people about propagation and managing of baobab seedlings are ways to protect the baobab tree from extinction.

The diagram below (Figure 4) is a summary of the key issues that the current study seeks to explore including other contextual factors that are likely to affect the utilisation of the baobab tree to enhance food security.

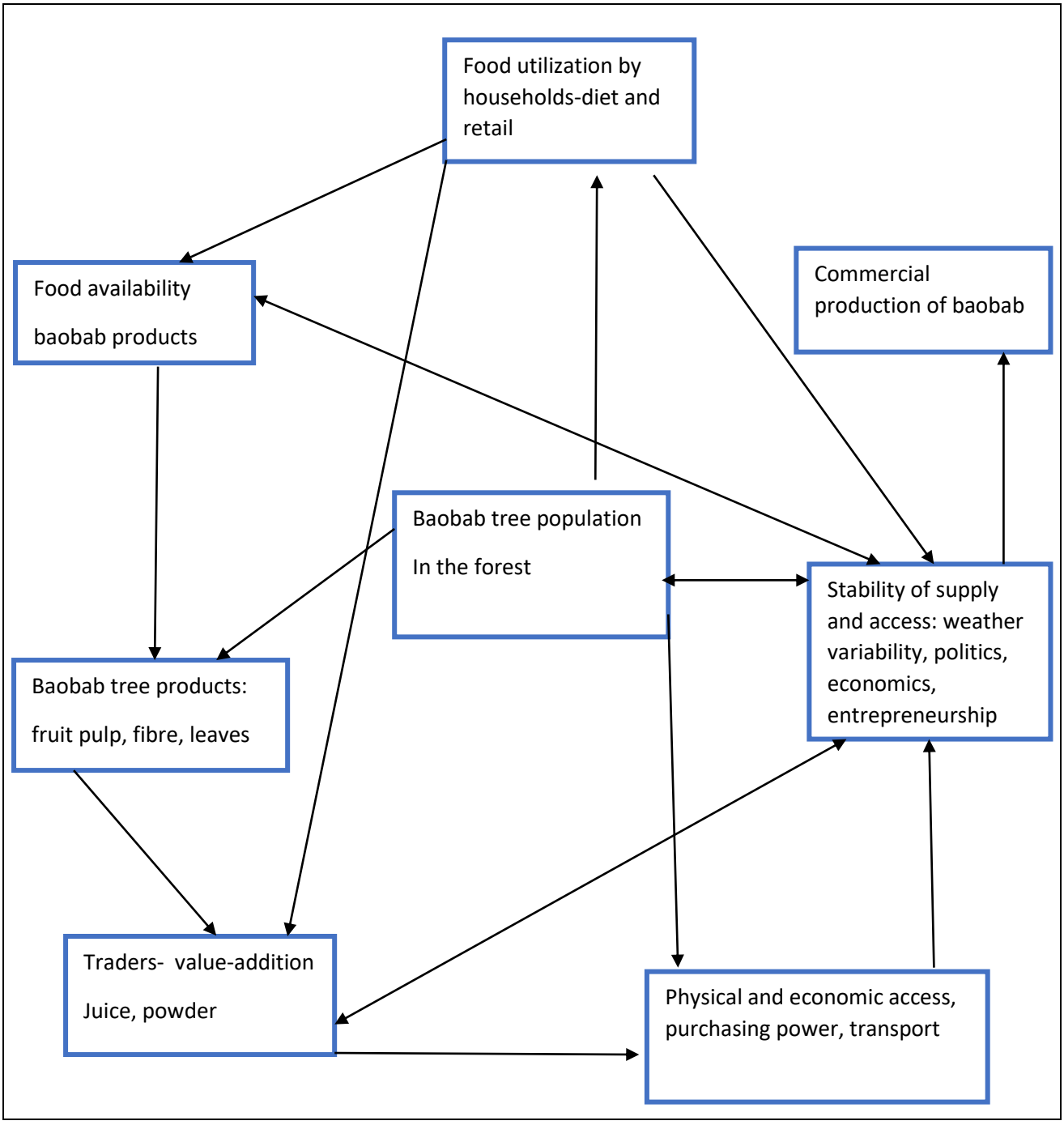

Figure 4: Conceptual model for the baobab study

CHAPTER 3

MATERIALS AND METHODS

3.1 Introduction

The main objective of the study was to assess ways being used by households of Wengezi and Gudyanga, in utilising the baobab trees for enhancing food security. The two communities were purposively selected as they have been documented in the harvesting of baobab products from their surroundings (Quinn *et al*, 2011; Wynberg, *et al*, 2012, ZimVac, 2012). A holistic approach (meshing qualitative and quantitative methods) was employed in this study. This involved the use of a cross-sectional study using a mixed method approach. Mixed methods mean that both quantitative and qualitative data gathering and processing methods were employed. Creswell (2014) defined a mixed method research that includes at least one quantitative method and one qualitative method to any particular inquiry paradigm. The complementary nature of this method provides strengths that offset the weakness of both quantitative and qualitative research (Hadegon, 2010). A mixed method for this study is motivated by the fact that food security is a complex process and the issues around the subject can be expressed in a variety of ways (Cordeiro, 2013). In support, Creswell and Plano (2011) argued that using mixed methods within the confines of a single study can simultaneously broaden and strengthen the study results and interpretation.

3.2 The study area

The study was conducted in two rural communities found in the south-east lowveld of Zimbabwe, namely Gudyanga and Wengezi. These two communities are found in the Chimanimani district of Manicaland province (19° 78’09’S 32’42’97’E) and elevation below 900m (FAO, 2015). The map of Zimbabwe is shown below (Figure 5).

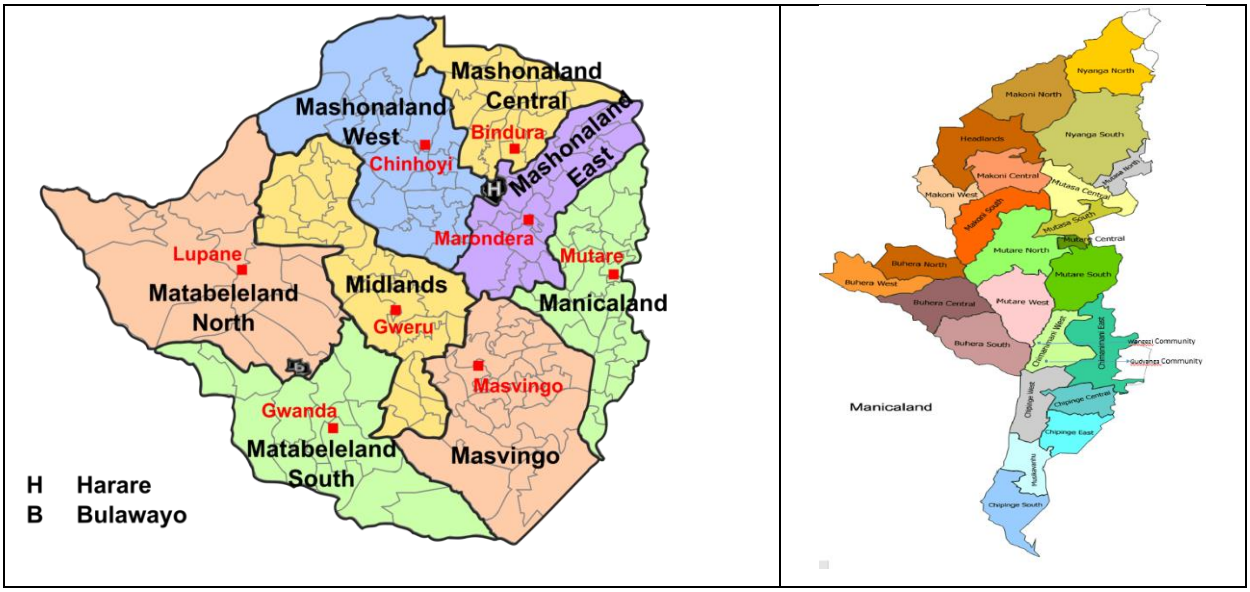

Figure 5: Map of the study area

The Gudyanga and Wengezi rural communities are located in the southern region of Manicaland province, at an altitude of 530m above sea level within the Save Valley, Zimbabwe. Subsistence farming is the main source of livelihood for households in these two communities. Sorghum, millet and maize are the main crops grown using rain-fed agriculture and irrigation Each family owns livestock such as cattle, goats, chickens and turkeys, which are reared as source of income and for home consumption.

The two communities were purposively selected for the study as they have abundant baobab trees within their locality which are used by the local people for various purposes. There is an open access to natural resources by all inhabitants with minimal control from traditional leaders, institutional structures and the local government. In a study by Mutambara (2014), it was revealed that the livelihood of people in the south-east lowveld of Zimbabwe is at the mercy of natural resources as they are highly vulnerable to drought, floods and diseases. These natural stressors conspired with various socio-economic factors such as cash-flow bottlenecks caused by the adoption of multi-currency in the economy. This has led to most households in the Wengezi and Gudyanga communities trapped in vicious cycles of poverty (Mutambara, 2014).

3.2.1 Climate

The south-east lowveld of Zimbabwe is generally described as low-lying semi-arid area. Rainfall is minimal, erratic and in the recent years it has become unpredictable ranging from 250-300mm per annum (Chikodzi *et al*, 2013). The rainfall is restricted to the summer months (October to April) when temperatures are high ranging from 19^{o}C to 43^{o}C (Department of Meteorological Services, 1981). The onset of rainfall has been changing with the rains coming in late, mid-November to December(Chikodzi *et al*, 2013). Dry spells have also increased affecting the animal and crop production rhythm (Simba *et al*, 2012). The cessation of rainfall became unpredictable, with rainfall periods extending into June and July and sometimes ending much earlier in March (Chikodzi *et al*, 2013). Winters are moderately warm and dry with an average temperature of 19.5^{o}C and frost is seldom. Relative humidity for an average year is recorded as 41.7%, 27% in September to 55% in February (Simba *et al*, 2012).

3.2.2 Geology and soil

The south-east lowveld of Zimbabwe is located on the footstep of the Eastern Highlands of Zimbabwe. The drainage of the area is dominated by the Odzi river for the Wengezi community on the northern part and the Save river for the Gudyanga community on the southern part. Kopjes, hills and mountain ranges are dotted in the area. Soils are deep (depth >150cm) well-drained loams (chromic luvisols and chromic cambisols) of alluvial origin (Mujere and Mazvimavi, 2015). The soils have colluviums influence of the Umkondo formations in the east (Thomson and Purves, 1981).

3.2.3 Flora and fauna

The south-east lowveld of Zimbabwe lies within the woodland savanna biome. The dry deciduous woodland of the Wengezi and Gudyanga communities is dominated by the *Colophospermum mopane* (mopane), *Accacia nilotica* (scented thorn), *Terminalia sericea, Berchemia discolor* and *Adansonia digitata* (Mudavanhu, 1998). Underneath the bushes, grows annual grasses which include *Urochloa mosambicensis* (bushveld signal grass), tufted finger grasses and *Eragrotis carvula* (love grass). The grasses are described as sweet veld and highly palatable to animals.

Wengezi and Gudyanga communities are located in the woodland savannah biome which supports a variety of animals both wild and domesticated. Wildlife is more concentrated in the mountains, kopjes and along rivers due to habitat encroachment by humans. There is minimal control from traditional leaders and the Zimbabwean government over the use of natural resources in rural areas which has led to chronic poaching of wild life around homesteads (Venter and Witkowski, 2011). Human habitation has driven away most of the big wildlife to areas where there is no human encroachment. Frequent droughts in the study area reduce forage availability for animal life (Mutambara, 2014). Remaining wild animals in the area are hares, *Crocuta crocuta* (spotted hyenas), *Felis silvestris lybica* (African wild cat) and a variety of fish, reptiles, amphibians and birds. Most households keep cattle, goats and chickens kept on a subsistence level.

3.2.4 Socio-economic activities

Wengezi and Gudyanga communities lie 70km and 120km respectively along the Mutare-Birchnough road in the Manicaland province. This south-east part of the Manicaland province is home to the Manyika-speaking and Ndau-speaking people (Shona dialects). The two communities are under the jurisdiction of the Chimanimani Rural District Council. The Wengezi and Gudyanga communities have a high unemployment rate and poverty (Mutambara, 2014). The major source of livelihood is rain-fed subsistence agriculture although part of the population is involved in craftwork and retail business. Romero *et al,* (2001) pointed out that due to the low and erratic rainfall received in the south-east lowveld of Zimbabwe, the area is classified as suitable for extensive cattle ranching or agriculture with irrigation. Crop failure and poverty are exceedingly common in the area.

Livestock production is usually a major source of livelihood in predominantly dry parts of the country and is given less priority in the two communities (Mutambara, 2014). Crops are grown using natural rain in summer (October to April) and vegetables are grown during the drier parts of the year. Crops grown include maize, sorghum, millet, groundnuts, watermelons and roundnuts. Each family owns a crop-field fenced with either thorn branches or barbed wire depending on family income availability (Wernberg *et al*, 2012). Vegetable plots are usually small located near water sources for example a boreholes or streams to provide water during the dry season. Quinn *et al,* (2011) stated that availability and access of water is a challenge in the study area as most irrigation pumps are non-functional. Seventy percent of households in the Wengezi and Gudyanga communities, own goats, at an average of five goats per household (Mutambara, 2014). Sheep are not popular in the two

communities. Poultry ownership is widespread and is regarded as women's duties. Cattle are esteemed ownership although their population in the study area has dwindled due to a national shortage of veterinary drugs and poor extension services available to rural farmers (Bird and Prowse, 2008). This has reduced draught power for agricultural activities for more than 90% of households who used it. Cattle ownership is vital to Wengezi and Gudyanga communities (Quinn *et al,* 2011) since they are closely related to food security. Households with cattle were found to be food secure since cattle are used as coping mechanism for multiple stresses. They are used for ploughing fields, transports, traditional rituals and a source of instant cash. In the study by Mutambara (2014) revealed that majority of households in the south-east lowveld of Zimbabwe lack basic productive assets such ploughs, cultivators, wheelbarrows and harrows which adversely affects the animal and/or plant production.

ZimVac (2011) reported that an estimated 11.9% of rural households of the south-east lowveld of Zimbabwe are more likely to be food insecure during peak hunger periods (January-February). Unfortunately, these peak hunger periods coincide with peak labour requirement for summer when farmers prepare fields for planting, weeding, herding cattle and firewood collection activities. Productivity is severely compromised for the vulnerable households.

3.3 Data collection

3.3.1 Pilot study

A pilot study was carried out in the Chiadzwa community, which is one community of the current study. A pilot study is described as a mini-version of a full-scale study or trial run done in preparation of the complete study (Saunders *et al*, 2016). It gives validity to research instruments (Creswell, 2014). The pilot study enabled the researcher to identify flaws prior to conducting the main research which helped in refining the research approach and instruments (Myers, 2011; Flick, 2011 and Creswell, 2014). Participants, who were drawn out for the pilot study, were not used as part of the sample of the main research to minimise bias which result from prior knowledge of research tools (Leed and Ormrod, 2010).

3.3.2 Questionnaire

A final form of the pre-tested questionnaire was administrated to the Wengezi and Gudyanga communities. The semi-structured questionnaire design was used to capture data on how households utilise baobab tree products, their views and perceptions regarding possible commercial cultivation or the tree and the size of population involved in harnessing the baobab products. Enumerators fluent in English and local languages were trained to administer the questionnaires (Saunders *et al*, 2016). They asked questions in local languages and recorded the responses in English. All the 27 and 41 households of Wengezi and Gudyanga communities, respectively, were issued with questionnaires. The reason for issuing questionnaire to all household in the study area was to produce a random sample of the population and maximize on questionnaire retrieval which would increase validity of the results (Saunders *et al*, 2016). Household heads and adults were targeted to capture concerned views about household food security (Brinkmann and Kvale, 2015). In the absence of such person in a household, the most influential or informed male or female with the age of 20 years was interviewed (Creswell, 2014).

A total of 51 questionnaires were retrieved from both communities of Wengezi and Gudyanga. For this study, a minimum response retrieval of 19 households was the expected. This was obtained after calculation according to Israel (1992) who proposed this formula to compensate for people that will not be contacted (10%) and another 30% for non-response. Likert Scale was adopted to record the responses to evaluate ways used to utilise baobab products, household views or perceptions regarding possible cultivation of the baobab tree and the number of households involved in utilising baobab products (Creswell, 2014; Myers, 2011; Jick, 2013). Closed and open-ended questions were used to assess baobab utilisation for each household and responses were coded for easy entry and analysis (Saunders *et al*, 2016).

3.3.3 Interviews

Key informants at institutions, with specialised knowledge on baobab utilization in the two communities of Wengezi and Gudyanga, were interviewed. The interviews were semi-structured guided by the research questions. Participants included agricultural extension officers, village heads and traders. These individuals gave informed assessment of baobab utilisation in the community (Brinkmann and Kvale, 2015). Participants used venues of their choice in both communities on dates convenient to them (Creswell, 2014). Interviews were

timed in such a way that they would cause minimal interruptions on participants' daily routines. Interview questions were guided by open-ended questions from the questionnaires so as to generate narratives around generated quantitative data (Creswell, 2014; Saunders *et al*, 2016).

The interviews were carried out according to the guidelines of Saunders *et al,* (2016). These were done as follows:

- The researcher was introduced and explained the aim of the interview.
- The participants were made aware of the duration of the interview.
- The participants were provided the right to pull out of the interview at any time when they feel like doing so.
- The issue of anonymity of the participant's contributions in the final research document was communicated to all those who were interviewed.
- The researcher asked open-ended questions avoided leading questions and probe when necessary to seek clarity from the participant.
- The research wrote down all the proceedings of the interviews in notebook.
- At the end of an interview, the researcher read the notes to the participant to verify if the correct information has been captured from the participant.

3.3.4 Field survey

A general survey to get an overall assessment of baobab tree condition in the two communities was done. The survey was mainly centred on assessing baobab trees condition. A vehicle was used to traverse the selected roads and baobab tree sighted on either side of the road within and around homesteads were studied (Mpofu *et al*, 2012). The survey was guided by items stated on field survey template (Appendix C). These included:

- Baobab tree distribution in the study area involved a transactional study. Stratified random sampling was used due to different land-use (crop fields, hills and residential areas).
- Visual assessments of baobab trees' condition in the study area. With the permission of the participants, the field team observed activities such as harvesting baobab fruits, debarking for fibre.
- Photographs were taken by the field team during the survey and comments noted down by the field team.

3.3.5 48-hour Dietary Recall and Household Food Insecurity Access Prevalence

Each household was issued with a 48-hour dietary recall template attached to the questionnaire (Appendix D). This study was carried out in December 2017 to obtain information about food and beverages consumed by respondents in the previous 48 hours. The dietary recall helped to assess the level of food security among households within the two communities of Wengezi and Gudyanga. The 48-hour dietary recall had a list of 13 food groups. Households in both communities were issued with a 48-hour dietary recall template where they had to complete the template indicating food items consumed in the previous 48 hours. Thirteen different food groups are provided on the template (Appendix D). The following information was collected from household responses to the dietary recall. The food groups were cereals (foods from grain), roots or tubers, leafy vegetables, fruits, meat, eggs, fresh or dried fish, beans (all nuts including peas, peanuts and lentils), dairy products, food made with oil (fat or butter), sugar, drinks (snacks) and other foods (named by the respondents). Respondents indicated that the food group eaten in the past four weeks by putting a tick either in the 'Yes' or 'No' column.

A HFIAP template (Appendix E) was used to estimate the prevalence of food insecurity in the Wengezi and Gudyanga communities (FAO, 2008). It was applied as a way of consolidating data collected by the 48-hour dietary recall. The aspects of food access cause predictable reactions and responses that were captured and used to categorise each household. Qualitative data was collected on the HFIAP (Appendix E) during face-to-face interviews to apply triangulation with quantitative data in the 48-hour dietary recall. Administration of the HFIAP was done within 15 minutes per household. The HFIAP indicator template groups households into four food access insecurity categories (FAO, 2008). Out of 27 households in the Wengezi community, the field team managed to have access to 19 households to complete the HFIAP template. In the Gudyanga community, 32 household out of 41 were interviewed. Table 2 shows categories that were set and used to aid in data analysis on the HFIAP template.

Table 2: Household food insecurity indicator categories (FAO, 2008)

Household food security category	**Reported indications (feelings/consequences/ reactions)**
1. Food secured household	- experience none of the food insecurity conditions such as anxiety, uncertainly, insufficient quality, insufficient intake, monotonous diet
2.Mild food secured household	-worries about not having enough food (sometimes/ often) -unable to eat preferred foods -eat a more monotonous diet than desired. -eat some food considered undesirable but only rarely.
3. Moderate food insecured household	-sacrifices quality more frequently by eating a monotonous diet or undesirable foods sometimes or often. -cutting back on meal sizes and number of meals rarely or sometimes. -does not experience the most severe conditions
4. Severe food insecured household	-cutting back on meal size and number of meals often. -runs out of food often. -go to bed hungry or spend a whole day or days without food.

Using information from Table 2, the first category was the food secured household category. Households in this level experienced none of the food insecurity (access) conditions or just experienced worry but rarely. The second category was termed as mild food secured household category in which members of the household worry about having enough food. The households were unable to consume preferred food items but ate a more monotonous diet than what they yearned for. There was no cut back on the quantity or quality and did not run out food (UNDP, 2011). The third category was called the mild food insecured category. In this category households sacrificed quality of their diet more often by eating monotonous or undesirable foods. There was frequent cut on meal size and the number of meals. The fourth category was the severely food insecure household. Households in this category had cut backs on meal size and number of meals. There were frequents food shortages and family members spent the whole day without food or went to bed hungry (FAO, 2015).

There was a feeling of shame when members of households in the fourth category were being interviewed.

3.4 Data analysis process

3.4.1 Quantitative data

A non-experimental design was employed to collect numerical data. A survey using a questionnaire (Appendix A) and a HFIAP template were used. Responses obtained from the questionnaire such as the frequency of using baobab tree products, were analysed quantitatively. Other questions which also produced quantitative data from participants' responses included the quantities of baobab fruits harvested per household. Numerical data on number of households whose response to the idea of baobab tree commercial cultivation was in support, against or not sure, was also recorded

- Perceptions that food is of insufficient quality
- Lack of dietary diversity, nutritional adequacy or preferences
- Reported reduction of food intake (for adults and children)
- Reported consequences of reduced food intake
- Feeling of shame to discuss household food access

Each response was an indicator of a household being a food secure, mild food secure, moderate food secure or severe food insecure household. (FAO, 2008). Frequencies obtained from the raw data were used to calculate percentages of household food insecurity prevalence of the study area.

3.4.2 Qualitative data

Qualitative data analysis was an ongoing and iterative process. The data collection, processing, analysing and reporting were intertwined and not a merely a number of successive steps (Maree, 2013). The researcher went back to study area to meet participants to collect additional data and verify it, verify conclusions and solicit feedback from participants who responded in the research (Figure 6).

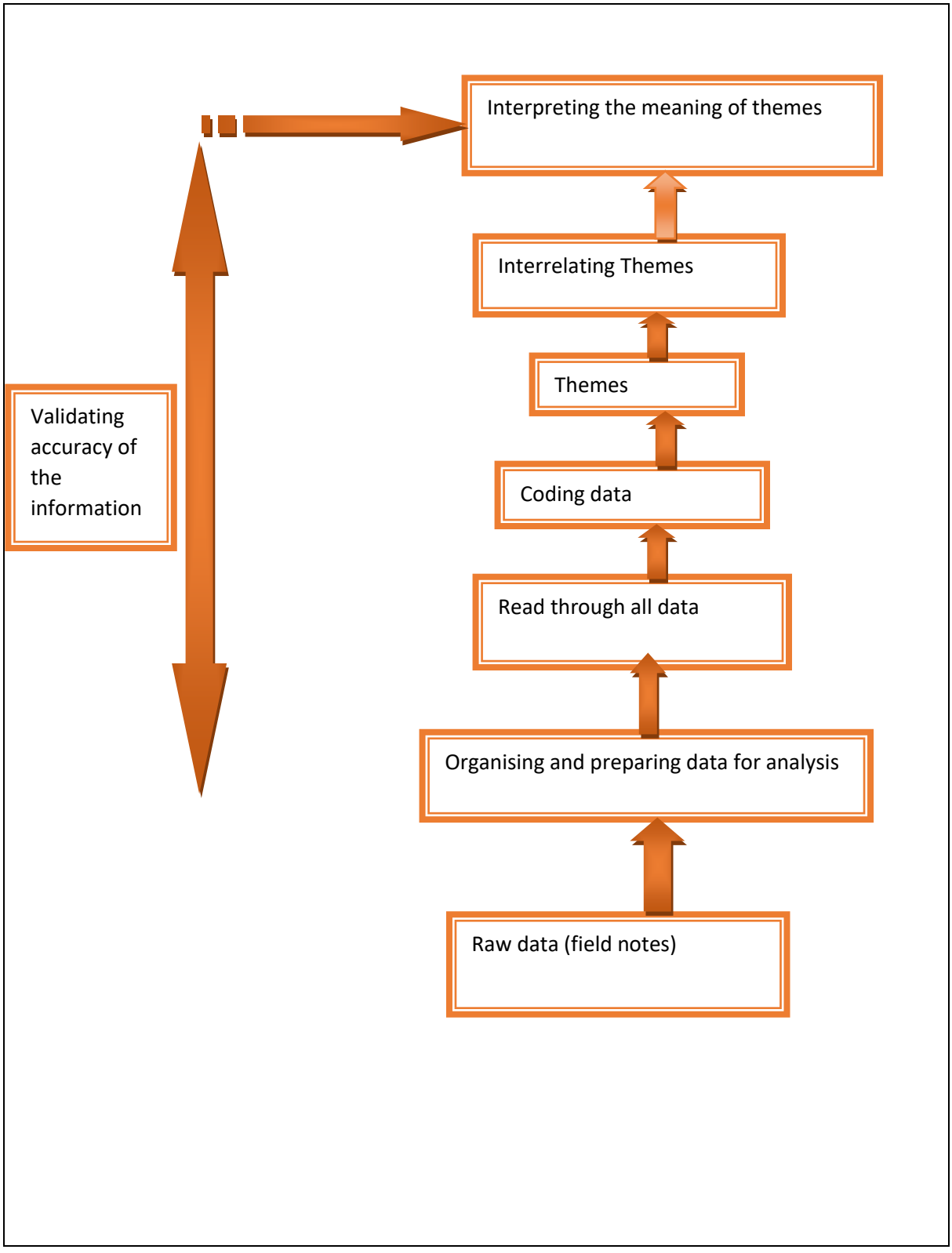

Figure 6: Summary of qualitative data analysis design employed in the study Source: Creswell, 2014

Data were captured by Microsoft Word and Microsoft Excel Spreadsheet 2013 and saved all data in separate files. Each participant was given a pseudonym (Saunders *et al*, 2016). Data were then coded into thematic ideas which sorted data into segments (Creswell, 2014). Coding was done back and forth between steps using the idea of saturation which is gathering new data no longer reveal new properties to the themes (Saunders *et al*, 2016). Enumeration and categorising were used in summarising results. The regularity with which a word or code appeared assisted in making clarifications on how participants shared the same understanding.

Member-checking was one of the validity strategies which were used. Two follow-ups on interviewed participants in the study were done to give them an opportunity to comment on the findings (Maree, 2013). Data collected from interviews was compared and contrasted with the quantitative data from the study which resulted in triangulation. The purpose of triangulation was to decrease the deficiencies of one method thus increasing aptitude to interpret the findings (Creswell, 2014; Maree, 2013; Leed and Ormrod, 2010).

3.5 Limitation of the study

The study was cross-sectional, which may have resulted in the researcher missing some important activities which occur during the other parts of the year especially food availability and household activities in the study area. Baobab leaves are harvested for food when they are still tender which occurs at the beginning of the rain season when deciduous trees sprout. Baobab fruits can be stored in a dry place for a long time, so its consumption may vary throughout the year.

Another drawback to this study is lack of information dissemination on the nutritional value of the baobab fruit pulp to the community and the country as a whole. Consumption of baobab fruit products is restricted to a small population. In some communities, the consumption of indigenous fruits is looked-down upon while ready-made food stuffs have become a symbol of modernity and wealth (Cruiz and Howard, 2013). The economic crises in Zimbabwe have led to poor government funding to projects in rural communities (ZimVac, 2012; Mutambara, 2014; Coomer and Gstraunthaler, 2011). There is little media coverage concerning the economic importance of the baobab fruit pulp as a foreign currency earner.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents data collected by various instruments in trying to answer the research questions. The results were presented in tables, graphs and pie charts and a discussion followed. The results and discussions were centred on ways being used to utilise baobab tree in enhancing food security, the size of population involved in harvesting and selling baobab products in the southeast lowveld of Zimbabwe. Data on the perceptions and views regarding possible commercial cultivation of the baobab tree would also be presented and discussed. Included also are the results on desirable characteristics baobab trees being harvested for food and trade by households.

4.2 Ways being used to utilise baobab tree in enhancing food security

Different ways used by the people of Wengezi and Gudyanga communities in utilising the baobab tree were recorded and the results are displayed in Table 4. The results show that households in the study area used the baobab trees as a source of food, income, medicinal purposes and for harness animals. Tender baobab leaves are cooked and eaten as vegetables.

Table 3: Different ways used to utilise baobab tree products in the study area.

Utilisation of baobab products by households	**Number of households at different frequency of utilisation per month**					**Total**
	Never	Once	Not sure	Sometimes	Always	
Eat baobab tree products such as porridge, ice-lollies, drink or leaves as vegetables	1	2	0	32	16	51
Make craftwork like mats, hats, bags	13	2	0	12	24	51
Sell baobab products	10	0	2	9	30	51
Medicinal use of baobab products	10	4	6	17	7	44
Other uses (harness, shade)	3	6	6	15	4	34

The results show that most households sometimes eat baobab tree products (63% households) while most households always make a living through craftwork and selling baobab tree products (59% households). Frequency of baobab products consumption in the study area differs from household to household. From the responses collected, all the households used baobab products in one way or the other. Other uses of the baobab trees mentioned included shade for humans and animals, animal harnessing ropes and chewing of fresh baobab fibre as a way to quench thirst when one is in the forest. Households in the Gudyanga community mentioned the use of tender baobab leaves as relish during periods of drought when food shortage would be rife. The baobab leaves are cooked as vegetables and eaten as food. The field team observed younger baobab trees around homesteads with pruned branches (Figure 7).

Figure 7: Young baobab tree with branches cut to provide livestock feed in the Gudyanga community. Source: B Mugangavari

The cutting of the lower baobab tree branches is used as browse (leaves, stem, branches, fruit, bark of trees and shrubs) fed to cattle and goats during periods of drought. Drought reduced foliage availability in the study area (Mutambara, 2014). Households in the Gudyanga community were actively involved in making craftwork out of the baobab fibre and consumption of fruit pulp. It was a common sight of baobab fibre craftwork displayed along the main road in the Gudyanga community (Figure 8).

Figure 8: A mat made using baobab bark fibre

Local shops in the community have locally produced baobab products which include fruit juice and ice-lollies. Southern Alliance for Indigenous Resources (SAFIRE), a non-governmental organisation operating in the Chimanimani district, is assisting groups of youth in Gudyanga community involved with juice-making using baobab fruit pulp. Their products are sold locally and surrounding communities. These traders pointed out that they are failing to meet the market demand for the baobab food products. Feasibility studies which carried out in sub-Saharan Africa by Mienhold *et al,* (2016) showed that small enterprises based on baobab products and other indigenous fruit trees are profitable. The same sentiments were echoed by the groups of youth in Gudyanga community. The ability of the baobab tree to produce even during periods of low rainfall, (Chikodzi *et al,* (2013), make it a keystone indigenous tree for households of the study area. The Figure 9 shows the number of households which are using the baobab tree for different purposes.

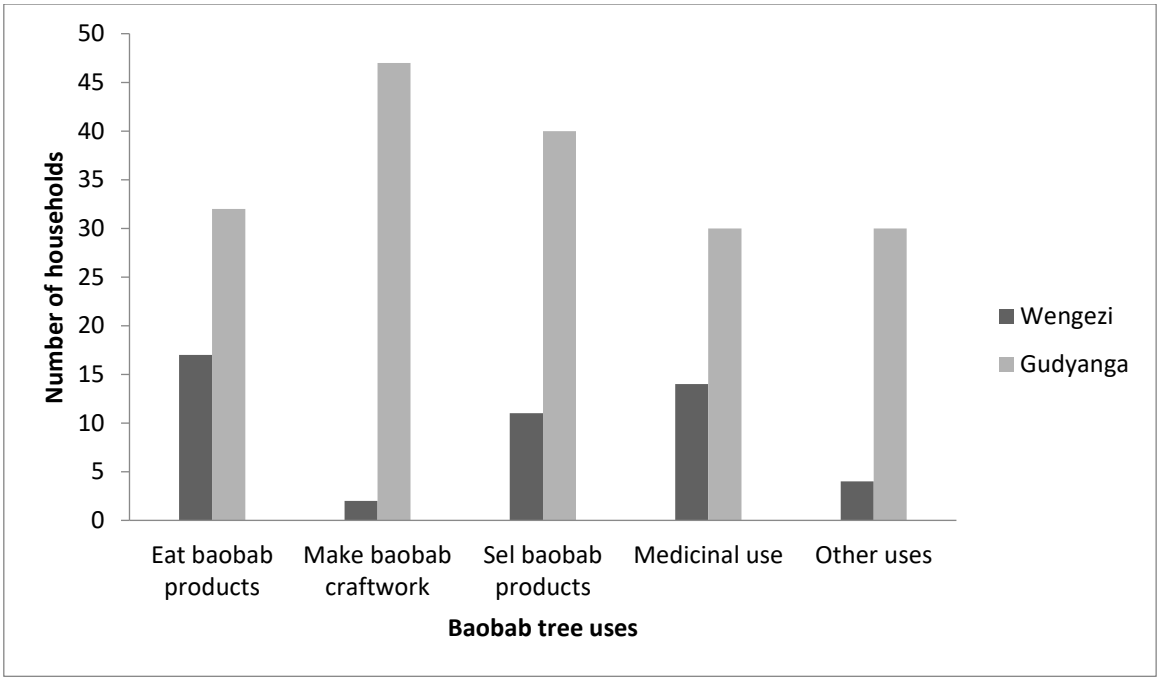

Figure 9: How the baobab tree is utilised by households.

There were more households in Gudyanga community than in Wengezi community using the baobab tree for each purpose given on the questionnaire. The questionnaire used to collect data on utilisation of baobab products in the study area had five categories, which were; eat baobab food, make craftwork, sell baobab products, medicinal use and other uses.

Figure 9 shows a higher number of households in Gudyanga than Wengezi who are using baobab trees for different purposes. Those who eat baobab products in Gudyanga community were 32 households (65%) while Wengezi recorded 17 households (35%). Ninety-six percent households involved in craftwork using baobab bark fibre were from the Gudyanga community while the Wengezi community had only 4% of the households. The display of baobab bark fibre craftwork was a common sight along the highway which pass through the study area. Selling baobab products was done by 40 households in Gudyanga (82%) while Wengezi recorded 11 households (18%). A total of 44 households from the study responded positively to the use of baobab tree parts for medicinal purposes. Other uses of the baobab tree recorded from the study area included making animal harness ropes out of the bark fibre, shade for people and animals. Thirty-four households responded with 30 of these households (88%) from Gudyanga community and four (12) households from Wengezi community. During the interviews, participants indicated that they usually mix baobab fruit pulp with gastrolyte hydrates in the treatment of diarrhoea. Mazzeo (2011) observed that rural communities in the lowveld of Zimbabwe are using more traditional

methods to combat most illnesses as available cash is usually channelled to food items. Traditional healers in the Wengezi community use the baobab tree bark mixed with water to bath newly-born babies as it believed to impart longevity and good health in the newborns (Venter and Witkowski, 2011).

4.3 Methods of harvesting baobab tree products

Harvesting of baobab fruits usually starts from May when they are matured and dry (van Wyk and van Wyk, 2013). Some or all the baobab fruits fall to the ground when they are matured making it easier for harvesters but on other trees, fruits will remain attached to the mother tree even when they are matured and ripen. The fruits that remain attached on the mother tree usually require other means of detaching them from the tree. Figure 10 shows the different baobab fruits harvesting methods used by households in the study area.

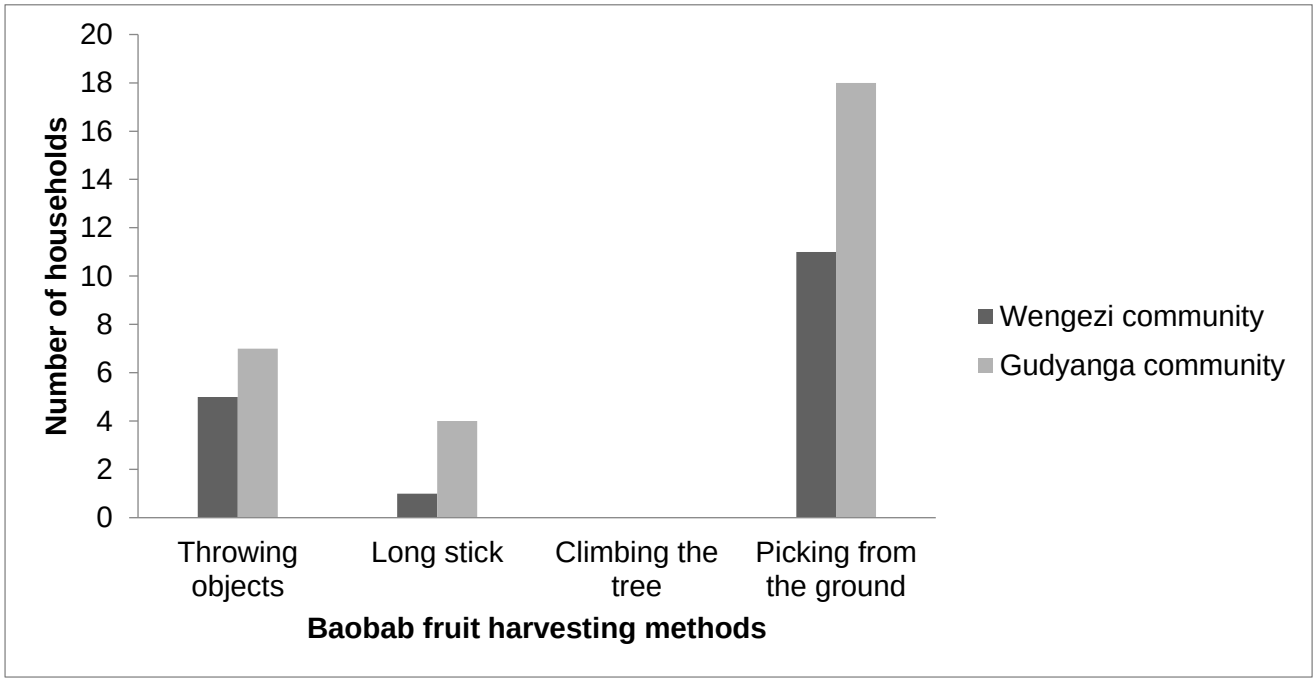

Figure 10: Methods used to harvest baobab fruits by households in the Wengezi and Gudyanga communities

It was observed that that picking of fruits from the ground was most popular in both communities (30 households). Throwing of objects such as stones or sticks, on the baobab fruits to detach them, was the second most popular method of harvesting fruits by households in the two communities. Participants were aware of the damages the later

method may inflict on the trees. Sanchez (2011) observed that some branches die off when harvesting is not done properly. This will adversely affect fruit production in the subsequent seasons. Respondents observed that baobab trees whose fruits had been harvested by throwing objects have broken branches, bark bruises and unripe fruits left lying underneath the tree. None of the households who responded to the questionnaires climb the baobab trees to harvest the fruits. During face-to-face interviews, participants highlighted the danger of falling when you climb due to the slippery nature of the baobab tree stem and branches. The trees have smooth stem and branches which makes it very slippery.

Apart from the harvesting of fruits for pulp, households in the Gudyanga community are involved in harvesting of baobab fibre for craftwork. It was a common sight to observe baobab trees with debarked stems in this community. The ability of the baobab bark to recover from debarking makes it a good source of fibre (Romero *et al*, 2001). Out of 51 households involved in the harvesting of baobab fibre for craftwork, only one was from the Wengezi community. Baobab trees in the Wengezi community showed less sign of debarking compared to those in the Gudyanga community. The baobab fibre was used to make mats, hats and ropes for harnessing farm animals. The skills of craftwork are passed on from generation to generation within households through socialisation. The SAFIRE embarked on educating community members of the south-east lowveld of Zimbabwe on the correct way of harvesting baobab fibre without damaging the trees. This was done after several studies revealed that the rate of baobab bark fibre harvesting in the study area was unsustainable (Wynberg *et al,* 2012; Romero *et al*, 2001; Mpofu *et al,* 2012; Fisher, 1981; Mudavanhu, 1998). The SAFIRE and the Forest Commission of Zimbabwe are working together to ensure the conservation of forests regulating baobab tree fibre harvesting. Community leaders also help on monitoring the offenders and non-compliance.

There was evidence of a period when debarking was rampant in the Gudyanga community, shown by scars on some tree trunks. Out of the 49 households involved in baobab bark fibre harvesting, 47 households were from the Gudyanga community (Figure 10). Wynberg *et al,* (2012) cited that 90% of the baobab population in the Gudyanga community have been exposed to bark harvesting. All interviewees showed that they are aware of the consequences of uncontrolled bark harvesting and this is monitored by community leaders together with the Forestry Commission of Zimbabwe. The ability of the baobab tree stem to regenerate quickly after debarking is pointed out by Rahul *et al,* (2015) as one of the qualities that make the tree to live longer. A study carried out by Fisher (1981) found out that

unlike most trees that regenerate bark slowly from the vascular cambium on the wound. The baobab bark is produced from the parenchyma tissue underneath the surface of the exposed xylem. The period of bark regeneration or recovery period was observed to take two to three years (Romero *et al*, 2001).

The development of fungal black soot spot (Figure 11) on some older baobab tree is suspected to be related to debarking (Wynberg, 2012). Mudavanhu (1998) observed that bark harvesting increased baobab trees' vulnerability to a 'sooty baobab disease' caused by bark-attacking fungal pathogens. More studies are being carried out to find the real cause of this disease (Gebauer, *et al*, 2016) Venter and Witkowski, 2010).

Figure 11: A baobab tree infected with bark sooty disease. Source: B Mugangavari

4.4 The human population involved in harvesting, consuming and selling baobab products

Households in both the Wengezi and Gudyanga communities communally own indigenous trees within and outside their premises. Community members are free to harvest from any baobab tree growing outside a family household. Kamatou *et al,* (2011) observed that households in the rural communities of southern Africa do not cut down indigenous fruit trees within their homesteads or fields. So harvesting of baobab fruits is done at household level

for family consumption or for sale to traders in the area. A group of youth with the help of SAFIRE in the Gudyanga community was involved in buying baobab fruits from the community members and process the fruit pulp to make juice and ice-lollies. This value-addition on the baobab fruit pulp is a step towards commercialisation of this indigenous tree (IFAD, 2011). From the two communities, only one household indicated that they have not harvested any baobab tree product. Table 3 shows the number of households involved in baobab utilisation.

Table 4: Number of households involved in harvesting, consuming and selling baobab products

Activity	Community		Total number of households
	Wengezi	Gudyanga	
Harvesting baobab products	6	40	46
Consumption of baobab products	14	35	49
Selling baobab products	11	30	41

From the data shown in the Table 3, 46 households are involved in harvesting baobab products which is 90% of the 51 households from both Wengezi and Gudyanga communities. According to Romero *et al,* (2001) the severe drought of 1991-1992 and the economic crisis in early 2000s in Zimbabwe caused increased need for additional non-agricultural income by the people in the study area. Out of the 51 households, 41 households (80%) indicated that they sell baobab products for livelihoods. Thirty of the households were from the Gudyanga community which constituted 73% of the total households.

Harvesting of fruits, bark and other parts of the baobab tree was done by all respondents from both communities of Wengezi and Gudyanga. Baobab trees that are within and near homesteads are usually the ones that were harvested first, and harvesting would progress further away from the homesteads depending on the prevailing demand for the fruits (Fisher,

1998). Harvesting starts from May to July when the fruits are ripened (Wickens, 1982). Fruits were picked from the ground or were physically detached from the mother tree. Baobab fruits from trees growing far from human dwelling such as mountains are usually a food source for wild animals such as monkeys and baboons (Mpofu *et al*, 2012).

Harvesting of baobab bark was mainly done by men as indicated by participants. Out of the 46 households involved in baobab fibre harvesting, 45 of these were from the Gudyanga community. Participants who harvested baobab fibre were aware of the need to allow the debarked tree to recover before they can be debarked and younger trees are totally avoided (Romero *et al*, 2001). Community leaders together with the Ministry of Forest Commission monitor the baobab fibre harvesting so that trees are given adequate recovery period (Romero *et al*, 2001; Wynberg 2011). Respondents in the Gudyanga community where baobab tree bark harvesting was common showed that they are aware of the adverse effects of uncontrolled debarking. The SAFIRE was also involved in educating communities in the study area on how the baobab tree, as a resource, can be used sustainably.

Tender baobab leaves are cooked and eaten as vegetables by households in both communities. Baobab seeds separated from pulp were roasted and ground to produce a coffee substitute which was common in households and in local shops. Plans were underway to make a baobab-seed oil cake to feed cattle and goats. Oil extracted from the baobab seed would be sold because it has received enormous acceptance in the cosmetic industry (Jackson and Maldonado, 2015; Bamalli *et al*, 2014; Vermaak *et al*, 2011).

Households in Wengezi and Gudyanga communities eat baobab products. The number of households which consumed baobab products as food are shown on Figure 12.

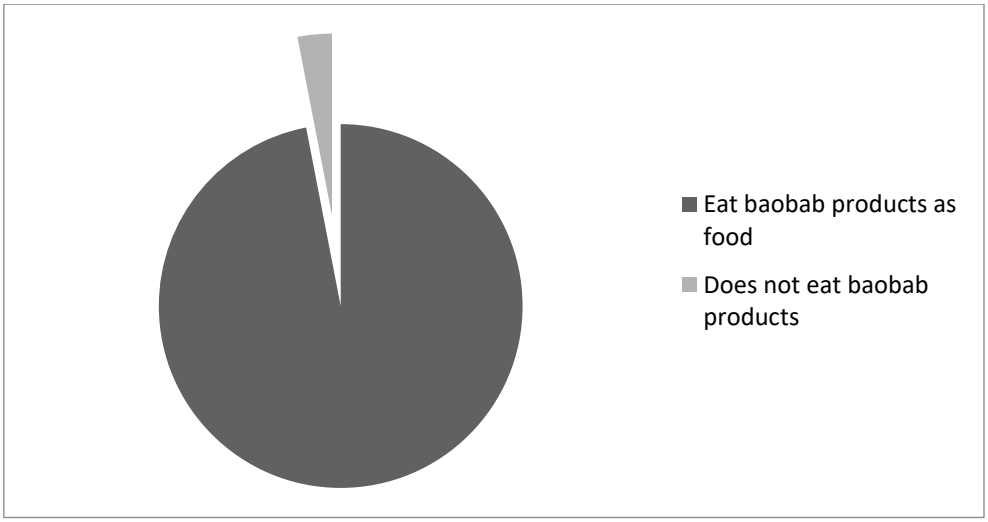

Figure 12: Households which consume baobab products as food

From Figure 12, 96% of the households consume baobab products as food. Only 4% of the households do not eat baobab products as food. The prevailing unemployment rate coupled with reduced crop production in the two communities forced households to resort to available indigenous resources for their livelihood (Coomer and Gstraunthaler, 2011; Tawodzera *et al*, 2016). Although there was a high percentage of households which consumed baobab products as food, the frequency of consuming baobab products as food differed from one household to another (Figure 13).

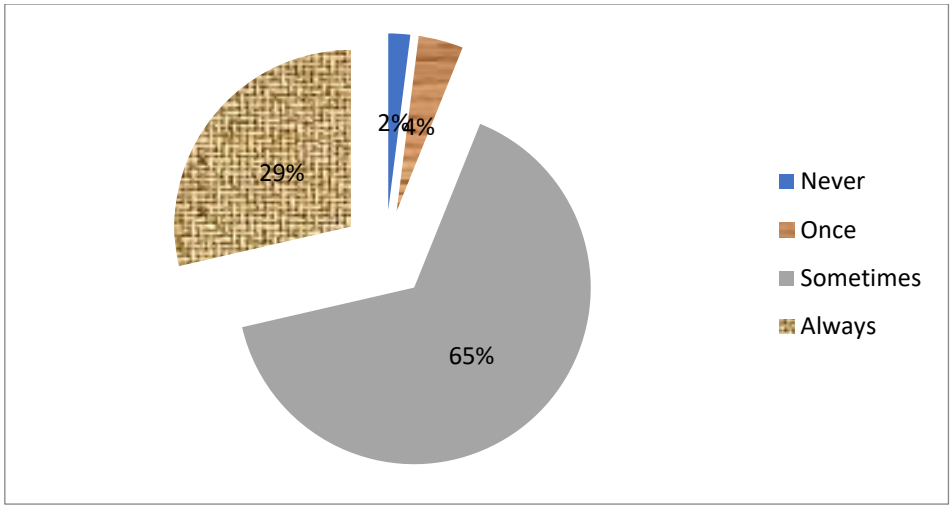

Figure 13: Household frequency of consuming baobab food products in the study area

The field team observed that households which responded to consume baobab products always, had baobab trees growing within their homestead and or crop fields. The fruits were stored in a place where they were not exposed to moisture.

The results showed that consumption of the baobab tree products in the Wengezi and Gudyanga communities are not only for food but medicinal use too. Forty-four households out of 51 (86%) indicated that they used baobab tree parts such as the bark, leaves and pulp to treat certain ailments. Out of the 41 households, 14 households were from the Wengezi community while 30 households were from the Gudyanga community. Thirty-one of the 44 households (71%) sometimes used the baobab tree for medicinal purpose while 13 households (29%) used the baobab tree in treating certain ailments always. Results of interviews revealed that some households used baobab tree parts to treat ailments such as diarrhoea, anaemia, dysentery, toothache, colds and constipation. It is common for newly born babies to be bathed in water containing baobab bark to enhance good health and long life (Wickens, 1982).

Forty-one households were involved in the selling of baobab products. Households cited the need to obtain cash to buy food items as their main reason for selling baobab products. The cash was used to purchase or pay other necessities such as school fees and other food items. Baobab products sold by households in both Wengezi and Gudyanga communities included the whole fruit, mats, bags, ropes for harnessing animals and ice-lollies. These items were sold locally, to nearby communities and travellers passing through the area, especially mats, bags and hats made from baobab fibre.

4.5 Perceptions and views regarding possible commercial cultivation of the baobab tree by households

Out of 51 households from both Wengezi and Gudyanga communities, 41 of them supported an idea of commercial cultivation of the baobab tree. In Gudyanga community, one household already had baobab trees growing in the homestead which they planted from seedling stage. All participants gave references to the domesticated baobab tree growing in their community. Respondents pointed out that the causes of poor regeneration of baobab trees in Wengezi and Gudyanga are due to erratic rainfall patterns experienced in the area and livestock (cattle, goats and donkeys) which trample and feed on young plants (Venter

and Witkowski, 2013). The responses regarding possible baobab tree commercial production in the two communities are summarised in Figure 14.

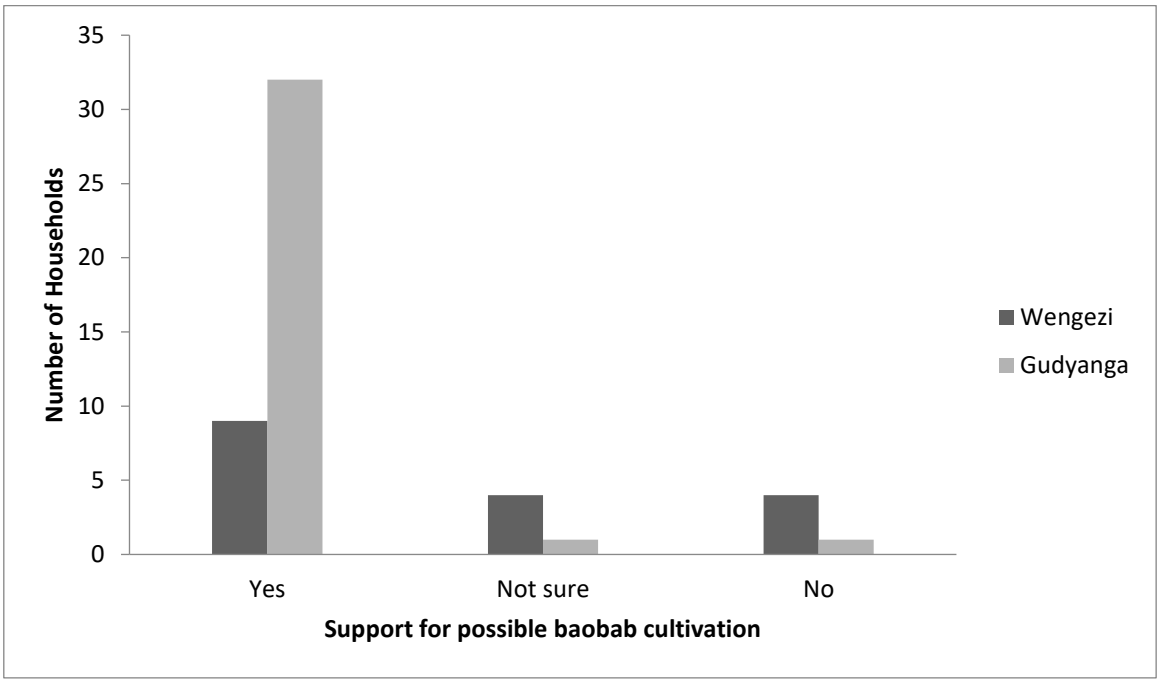

Figure 14: Possibilities of baobab cultivation

Figure 14 shows that there was overwhelming support for the possible cultivation of the baobab trees from both communities (9 households from Wengezi community and 32 households from Gudyanga community). Those households which supported the idea of baobab trees commercial cultivation indicated the possibilities of creating employment and increased household income. From both communities, a total of 5 households (4 households from Wengezi and 1 household from Gudyanga) did not support the idea of possible cultivation of the baobab tree in their communities. The reasons which were given by those households against the idea about baobab tree cultivation included frequent droughts and the long-time taken by the baobab tree to reach maturity. Five households from both communities were also not sure if it was possible to cultivate baobab trees. Some of the causes for their doubt were partly caused by lack of knowledge on indigenous trees propagation. The overall responses to the possibility of baobab trees cultivation in the two communities showed an overwhelming support in the Gudyanga community with 93% of the households in support of the idea (Figure 15). In the Wengezi community, 53% of the households supported the idea while an almost equal percentage of households, 23% and

24%, responded ‘Not sure’ and ‘No’, respectively. Those who responded, ‘Not sure’ and ‘No’ from Gudyanga community were each 3% of the households (Figure 15).

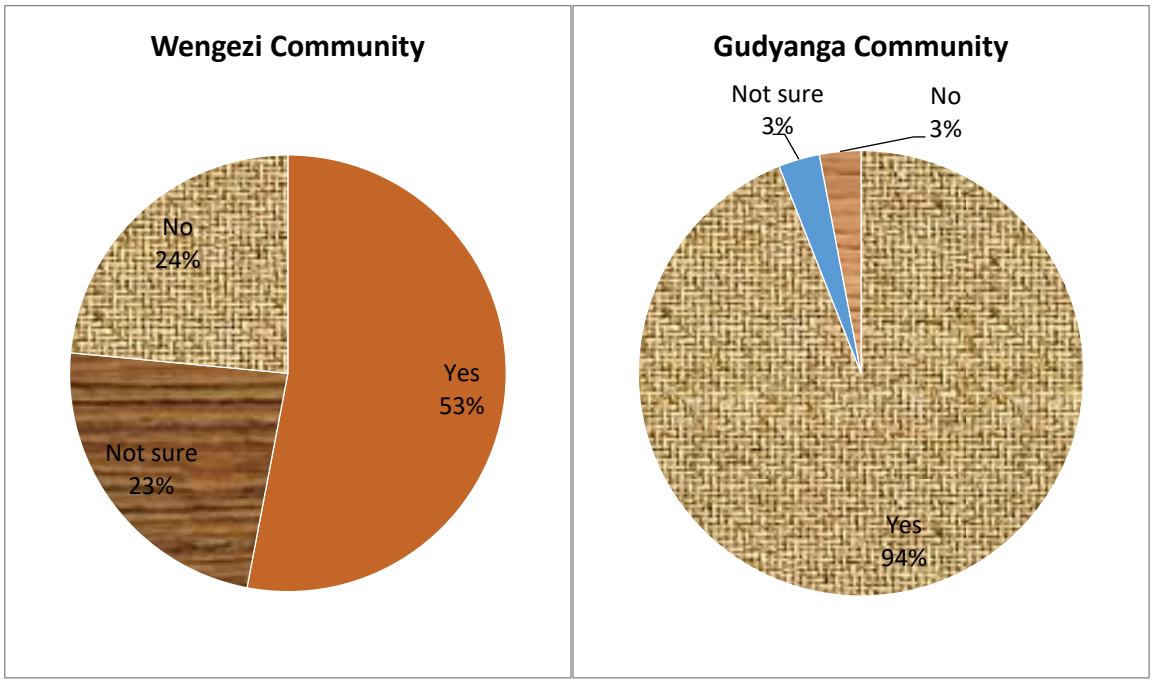

Figure 15: Views and perceptions regarding possible commercial cultivation of baobab tree

Lack of regeneration of baobab trees in both the Wengezi and Gudyanga communities was observed during the survey implying that the area holds an ageing population of baobab trees (Venter and Witkowski, 2010). Uncontrolled grazing of livestock such as cattle and goats from both communities was partly to blame for poor regeneration of baobab seedlings and transplants (Venter and Witkowski, 2013). The grazing cattle trample on the young baobab plants while goats browse on them.

4.6 Baobab tree preferred characteristics for food and trade

Baobab trees produce fruits of different shapes; some are more optical, some oval while others are lobe-shaped. Neither fruit shape nor size was important to households that were consuming the baobab fruits as ice-lollies, porridge or juice (Sanchez, 2011). Similar sentiments were echoed by households responding to baobab pulp taste preferences. Sweet or sour taste of the fruit pulp was insignificant to consumers. Out of 49 households which responded, 24 indicated that they were not particular about the pulp taste. Traders who buy baobab fruits for the pulp indicated that pulp taste is of no concern to them and the products

which they make. However, 18 households preferred sweet pulp while seven households were of the opinion that sour pulp was their favourite. Baobab seeds collected after removing fruit pulp are roasted to make a coffee. Only a small percentage of the seeds is used to make the coffee leaving large heaps of the seeds at the baobab pulp processing plant at the local shopping centre in the Gudyanga community. Lack of industries which extract oil from the seeds was blamed for the wastage of this resource.

Traders, who buy baobab fruits from the Wengezi and Gudyanga communities, did not choose specific type of fruits. They only make sure the fruits were dry so that they can be stored easily. The ability of the baobab fruits to be stored dry for a long time after being harvested makes it easier for traders to keep them until the following harvest season without losing quality (Gruenwald and Galiza, 2005; Meinhold *et al*, 2016). The baobab fruit pulp has low water content allowing long-term storage and late consumption in times of need by households (Meinhold *et al*, 2016). From both Wengezi and Gudyanga communities, households indicated that in times of food scarcity, tender leaves, young roots and oil from seeds are eaten (Gebauer *et al*, 2016).

4.7 48-hour dietary recall

The results on 48-hour dietary recall and the responses made by households in the Wengezi and Gudyanga communities are shown in Figure 16. The unwillingness on the part of some households to reveal their diet may suggest that they were ashamed of their meals. Manyeruke *et al,* (2013) pointed out a concern on low level of income expenditure among the rural households of Zimbabwe. Rural communities were considered to be food insecure due to their inadequate access to food on a period basis risking deterioration of their nutritional status. The FAO (2008) found that the causes of food insecurity in rural households of the south-east lowveld of Zimbabwe were due to adverse weather conditions, political instability, unemployment and rising food prices.

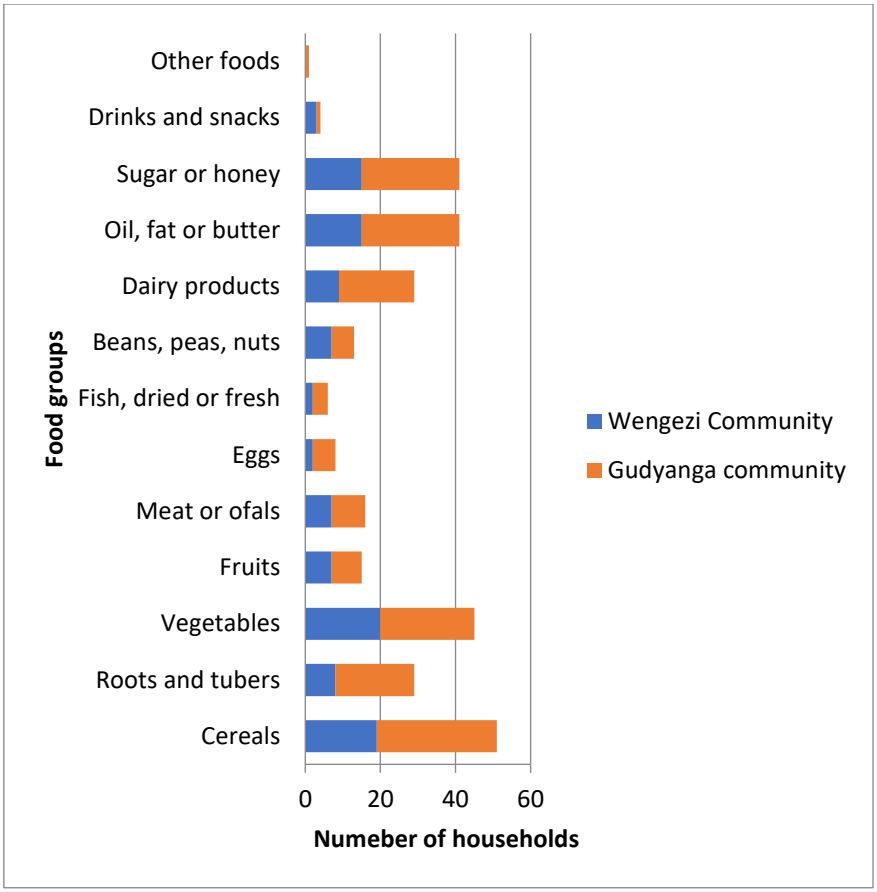

Figure 16: The 48-hour dietary recall from households

The 48-hours dietary recall revealed that all households had previously eaten a cereal meal (Figure 16). Maize meal is the staple food for Zimbabweans (Manyeruke *et al*, 2013). Small grain crops such sorghum and millet were some of the other common cereal meals mentioned by household members. Leaf vegetables were second most popular food that had been eaten in the previous 48 hours. Vegetables grown in the backyard gardens and crop fields were intercropped with major crops such as millet and maize (UNICEF, 2016). Each family owned a small portion of land within communal gardens erected adjacent to boreholes sunk at different points within the community. These community gardens found in both Wengezi and Gudyanga community were the source of fresh vegetables for households during the drier parts of the year. Milk for family consumption was available to 47% of households in the Wengezi community (19 households) and 63% of the households had consumed milk which was milked by household members from their cows and goats kept for subsistence consumption.

The 48-hour dietary recall also revealed that very few households consumed fruits, meat, eggs, fish and beans. Only 11% of the households in the Wengezi community ate eggs and fish in the previous 48 hours. Although these food items were available in the nearby shops, respondents cited a lack of cash to buy them. The FAO (2015) reported that Zimbabwe has over 80% unemployment rate. Rural households were reported to be under moderate to severe food insecure (ZimVac, 2016). With severely food insecure households, cutting back on meal sizes or the number of meals was reported, with some households going to bed hungry as reported by Mutambara, (2014) and ZimVac, (2016).

4.8 Household Food Insecurity Access Prevalence (HFIAP) for the study area

The information in Figure 17 was derived from the responses captured using the administration of the HFIAP template (Appendix E). Only one household, from the two communities was reported to be food secured according to their dietary intake of the previous 48 hours (Figure 17). Out of the 52 households which participated in the survey, 40 of these households were in the mild food insecure and moderate food insecure categories. This entails that family members in these households worries about not having enough food often and or are unable to eat their preferred food (FAO, 2015; Codeiro, 2013; Contreras, 2011).

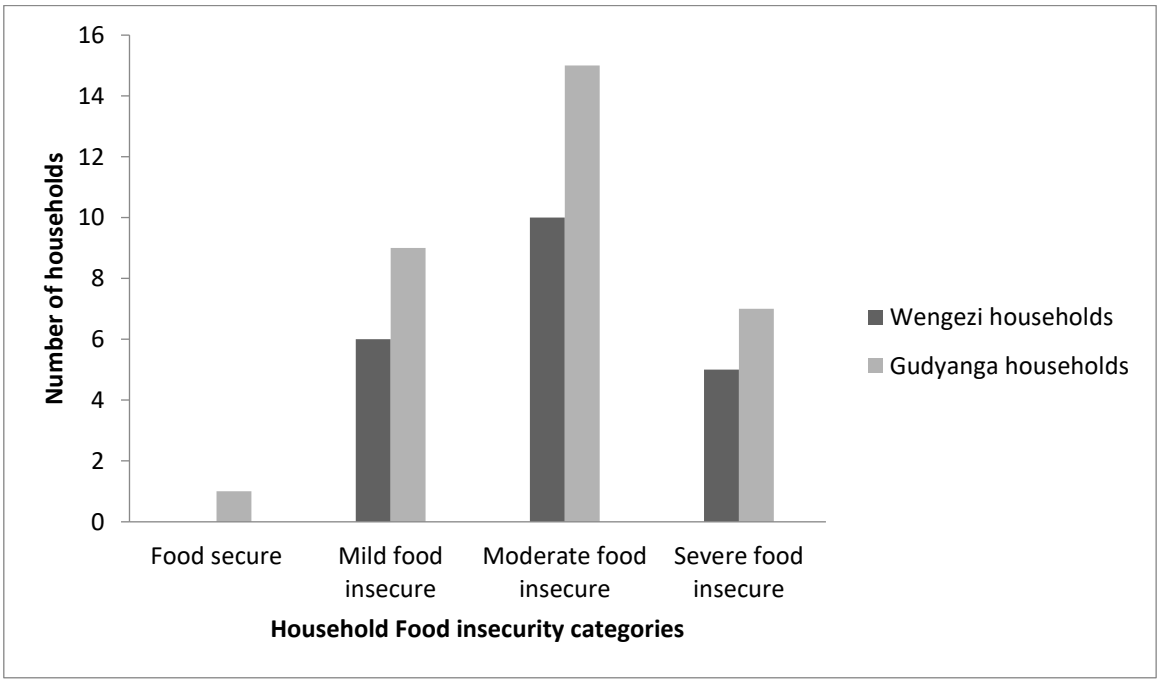

Figure 17: Household food insecurity indicator categories

Households that were categorised as severe food insecure reported that they sometimes go to bed hungry. They reported that when they got food, they would cut back on the meal size and the number of meals. Senior members of some families in these households were reported to have gone to bed hungry or spend the whole day without food and any food they may get was given to the children (ZimVac, 2012). Due to the extended periods of poverty, lack of assets and inadequate access to productive or financial resources, these households joined the Food for Work programme offered by the Zimbabwe government for rural communities (Lunga and Musarurwa, 2016; Tawodzera *et al*, 2016; Mazzeo, 2011). The programme was meant for households which were food insecure. They were given food parcels at the end of each month after taking part in manual work such as reclaiming land damaged by floods in the community. During the time of the study, the Food for Work programme had been suspended indefinitely.

4.9 Interviews

Participants for the interviews were purposively selected from the study area. Interview questions were developed from the research questions. Thematic analysis of the transcript attached (Appendix F**).** For the selection of Agricultural extension officer to be interviewed, a coin was tossed to determine the one to interview out of the two (one from Wengezi community and the other from Gudyanga community). The following are two interviews carried out by the researcher. Mr X and Mr Y are pseudonyms (not real names) of the interviewees so as to maintain confidentiality (Balian, 2011; Creswell, 2014).

4.9.1 Interview transcript with Mr X

Interviewer: Do you think baobab trees are important to people in this community?

Mr X: Oh yes, so much.

Interviewer: Why do you say so?

Mr X: The baobab tree is a very important tree to all households in this community. It is a source of food in form of the tender leaves which are cooked as vegetables, the pulp is used to make homemade drinks mixed with water, sugar and fresh milk. In the shops we now have ice-lollies made with the fruit pulp. Dry fruit shells are burnt and used as a substitute for bicabornate of soda. Crop production in this

community has gone down, so the baobab products are helping a lot.

Interviewer: Is it only food that you get from these trees?

Mr X: No. Some families harvest the baobab fruits for sale. Fruits are sold to traders who make juice and coffee substitute made from ground roasted baobab seeds. With the money they get from selling baobab fruits, these families can pay school fees and buy other things which they need. There is high unemployment in this community. An agricultural estate near this community used to employ most of the locals but now that it is closed, there is lot of unemployment. The baobab fruits are helping us to put food on the table.

Interviewer: Is there anything that is being done by community members to look after the baobab trees in this community?

Mr X: Debarking of the baobab trees is monitored by community leaders who work together with the Government Department of Forestry Commission. A non-governmental organisation called SAFIRE is providing educational workshops on baobab tree management to the community.

Interviewer: Do you think it is possible to grow baobab trees commercially in this community?

Mr X: Definitely, it's possible. This will relate to more baobab fruit pulp for making juice and ice-lollies. Jobs would be created.

Interviewer: Thank you Mr X for your time. After writing down this interview I shall come back to you so that you can verify correctness of our discussion.

Mr Y: It's my pleasure.

4.9.2 Interview transcript for Mr Y

Interviewer: Can you confidently say that the baobab tree is an important tree to people in this community?

Mr Y: Yes, I can confidently say so basing on what is happening in this area. Households are making a living out selling baobab fruits and mats. There are households in this communities who are known of making a living through making mats out of baobab fibre then sell them to tourists from the neighbouring countries such as South Africa.

Interviewer: Apart from being a source of income, what else do you and the community benefit from the baobab trees?

Mr Y: The baobab fruit pulp is used to make juice, porridge and ice-lollies. The juice and ice-lollies are currently popular with most shops and children really like them. Demand for ice-lollies in local schools is high. The consumption of porridge made from baobab fruit pulp is popular during drought periods since the fruit pulp is available at no cost since baobab trees are communally owned. On the other hand, some herbalists in this community used parts of baobab tree to treat some ailments. Traditionally the baobab tree bark is mixed with bath water for under-weight babies to make them gain weight faster. Ropes used to harness draught animals are commonly made of baobab tree fibre.

Interviewer: Is there anything that can be done to the current baobab trees in the area for community to continue benefiting from them?

Mr Y: We had a meeting with the Forestry Commission and SAFIRE where we were taught how to take care of our indigenous trees. Those whose harvest baoabab bark fibre were taught the correct way of doing it. We were advised to use patch barking because ring barking can kill the tree.

Interviewer: Do you think it is possible for this community to grow baobab trees for commercial purpose?

Mr Y: Definitely yes, because right now we have a group of local youths who are assisted by SAFIRE to make ice-lollies using baobab fruit pulp. More baobab

fruit trees would mean that business can expand, and people are employed. That would be really good development for this community.

Interviewer: Thank you Mr Y for your time. After writing down this interview I shall come back to you so that you can verify correctness of our discussion.

Mr Y: It's my pleasure.

4. 10 Thematic analysis

The information gathered from the interviews with Mr X and Mr Y was analysed qualitatively so as to give a meaning to words or phrases presented (Creswell, 2014). Codes were preset using research questions to be answered (Figure 18).

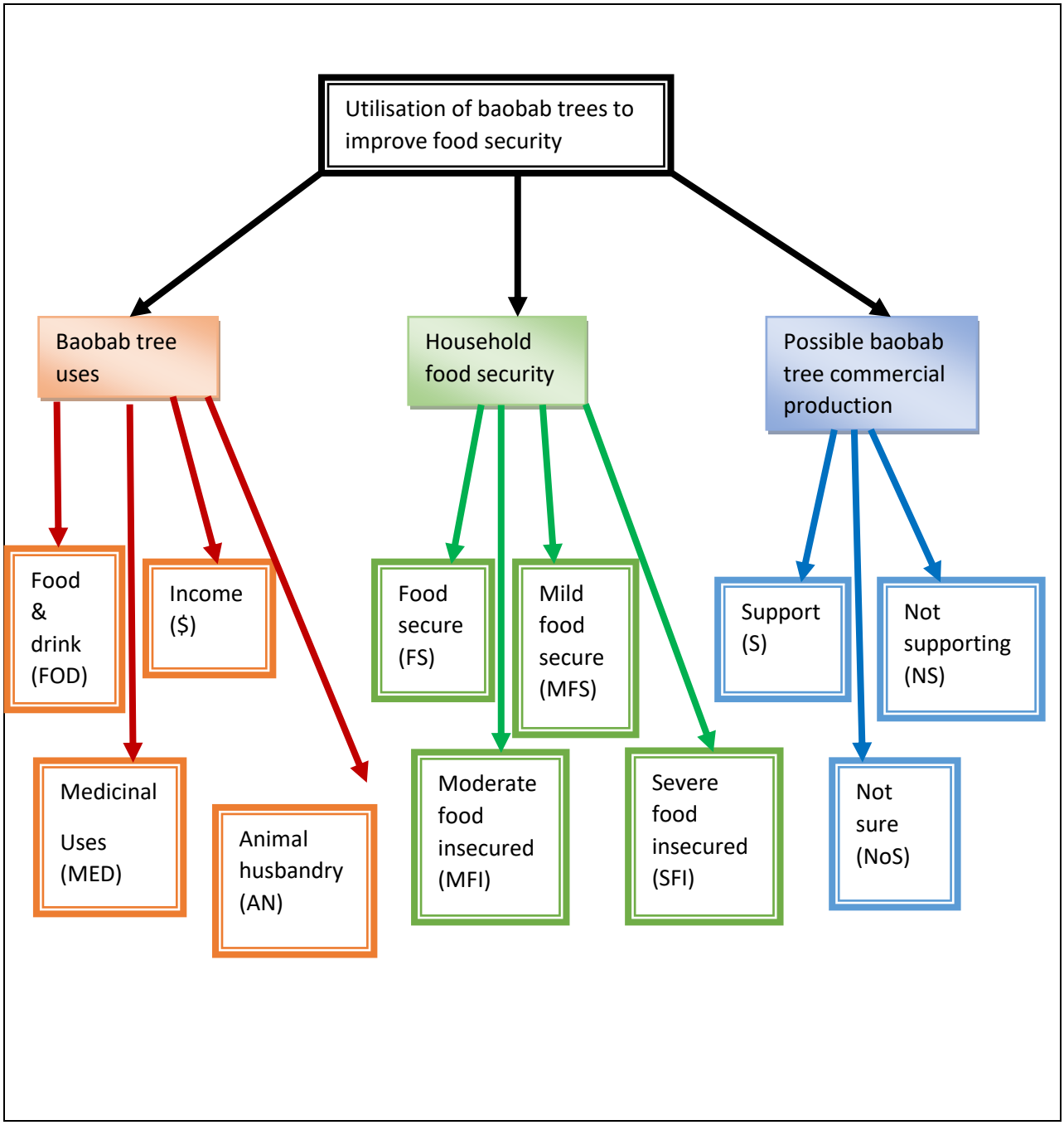

Figure 18: Thematic analysis used for the qualitative data.

The main theme which developed was 'Utilisation of baobab tree to improve food security'. This was derived from the research questions. Sub-themes were developed and then a list of categories were formed (Maree, 2013; Saunders *et al*, 2016). From the sub-themes, baobab tree uses, food security and possible domestication of baobab trees, categories were made (Appendix F). Categories were given codes in which matching data searched from each interview transcript was placed (Saunders *et al*, 2016).

One of the research questions answered using the thematic analysis was:

How is the baobab tree utilised to enhance food security?

Both Mr X and Mr Y pointed out that the main uses of baobab trees in the study area were food and as a source of income for households. Fruit pulp, leaves and seeds were mentioned as the food part consumed. Mr X mentioned that some households are making a living out of harvesting and selling baobab fruits. Mutambara (2014) observed that households in the rural south-east lowveld of Zimbabwe minimised the prevalence of food insecurity through sales of indigenous livestock and plants as these are surviving recurring droughts in the region. Mr Y revealed that medicinal importance was also attached to the baobab tree by the community. He said:

Herbalists in this community use some of the baobab tree to

treat certain ailments. Traditionally the baobab tree bark is

mixed with bath water for underweight babies to gain weight

The indigenous knowledge of medicinal use of the baobab, as acknowledged by Mr Y, showed that the community has managed to maintain its rural life (Fujisawa, 2019).

Another research question that was responded to was:

What are the perceptions or views regarding possible commercial cultivation of the baobab tree by households in the south-east lowveld of Zimbabwe?

Mr X's response was in support of commercial cultivation of the baobab tree. He was of the opinion that households in the study area would receive more income through baobab products sales and employment creation. Any domestication programme for an indigenous species is bound to be accepted by the local community if it incorporates local knowledge and information (Svejgaard *et al*, 2011). Mr Y also felt that commercial cultivation of baobab trees in the area would result in reducing unemployment. The success of the youth project in the study area was a motivational factor

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study showed that households in the Wengezi and Gudyanga communities used the baobab trees as a source of food, cash and for medicinal purposes. The baobab trees' ability to adapt to frequent droughts experienced in the study area is proving to be essential to household food security. All the households in the study area are benefiting from the baobab tree to enhance their food security. However, in the community of Gudyanga there is higher percentage of households using the baobab trees and a high level of awareness on its sustainable utilisation to prevent over-exploitation of the resource. Awareness can be attributed to the training programmes available to the Gudyanga community from NGO such as SAFIRE. With adequate community and local government co-operation on ensuring sustainable harvesting of baobab products, an increased level of household food security can be realised in the study area. The willingness of households to the possibility of baobab commercial production is a positive factor in ensuring sustainable utilisation of the resource. Opening of new market niches for baobab products would promote the needs and demand for baobab products. This can bring rural transformation of the study area thereby improving food security through adequate household nutrition, income, health and greater environmental sustainability.

5.2 Recommendations

5.2.1 Utilisation of the baobab tree to enhance food security The study revealed that households in the study area harvested baobab tree products for food, income and medicinal purposes as the main uses. The fruit pulp and leaves were used for food. The fruit pulp together with craftwork made out of baobab bark fibre were sold within the study area and surrounding communities. Cash obtained from the sale of these commodities is essential for amenities such as food, education, daily expenses and medical expenses. The baobab tree products are socially accessible and acceptable in the study area which is vital in promoting household food and nutritional security.

5.2.2 Harvesting methods of baobab tree products

Accessing baobab tree products from the forests and around homesteads is done by household members. Leaves harvesting for consumption was practised in such way that

there was less disturbance to the physiological functions of the tree. Household baobab fruit harvesting involved throwing objects to detach fruits from the tree. A higher percentage of households used long sticks with metal hooks. Monitoring the harvesting of fruits by the concerned Ministry together with local leaders for sustainable utilisation of the tree is required. The community has been educated on the harmful effects of debarking baobab trees for bark fibre. However, there were some baobab trees which showed that they had not being given adequate time to recover between bark stripping. The Ministry of Forestry and community leaders can come up with a deterrent measure so that baobab bark fibre harvesting is sustainable.

5.2.3 Perceptions or views regarding possible commercial cultivation

Households in the study area are supporting the idea of commercial cultivation of the baobab trees in their area. The long-lived nature of the baobab trees makes its short to medium term sustainability issues less critical at current. However, the poor regeneration cited in the area requires concerned stake holders to support subsistence and commercial cultivation of the baobab tree. The Ministry of Agriculture, Manicaland province or any relevant stakeholder can use this opportunity to bring rural transformation to meet household baobab product consumption and sustainable increase of the baobab trees to meet global demand.

5.3 Summary of study

The study sought to assess utilisation of baobab trees to improve food security by households of the south-east lowveld of Zimbabwe. Objectives of the study were to assess ways being used by households in the study area in harvesting, consumption of products, views and perceptions of respondents regarding possible baobab commercial production. The study was conceptually based on the food security policy pillars: accessibility, availability, stability and utilisation. The study was carried out on 68 households of Wengezi and Gudyanga communities. Field survey, questionnaires and face-to-face interviews were adopted as tools for gathering data. Data were analysed using descriptive statistics. The study revealed that most households were using the baobab tree products for food, income generation and medicinal purposes. Food insecurity prevalence data collected indicated that most households were moderate to severe food insecured. Respondents were aware of sustainable utilisation of the baobab tree and positive about its commercial production.

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Appendices

APPENDIX A: **QUESTIONNAIRE**

TOPIC: Potential of sustainable utilisation of the baobab tree (*Adansonia digitata*) to improve food security. A case study of south-east lowveld of Zimbabwe.

Good day. Beaulah Mugangavari is taking this brief survey in order to determine the number of people who are using baobab products for their livelihoods. Your answers will be helpful in enhancing the sustainable utilisation of baobab products. Your response would only be used for survey purpose. To maintain confidentiality, please do not write name on this paper.

Please indicate your level of agreement with each of these statements by placing X in the box of your answer.

1. What is your gender? 1☐ Male 2☐ Female

2 What is your age?

1. 11 – 20 years	
2. 21 – 30 years	
3. 31 - 40 years	
4. 41 – 50 years	
5. 51 – 60 years	
6. Over 61 years	

3. What is your occupation? 1☐ Farming 2☐ Self-employed 3☐ Civil servant
4☐ Private sector 5☐ Other

If other, specify _____

4. How often do you use baobab products for the following:

	1 Never	**2 Once**	**3 Don't know**	**4 Sometimes**	**5 Always**
4.1 Eat baobab food					
4.2 Make craftwork like mats, hats, bags					
4.3 Sell baobab products for money					
4.4 Medicinal use					
4.5 Other uses					

5. Which type of baobab fruit pulp would you prefer to use as food?

1☐ Sweet 2☐ Sour 3☐ Any taste

6. Why do you use baobab tree products for food / to get income?

1 ☐ Easy to access 2 ☐ Prefer them 3 ☐ No other food available

7. Do you think it is important to harvest baobab tree fruits and fibre wisely in this area?

1☐ Yes 2 ☐ No 3 ☐ Not sure

Explain:_____
_____
_____
_____

8. How do you harvest baobab fruits from the trees?

i ☐ By throwing objects to hit the fruit off the tree.

ii ☐ By using a long stick or metal with hook

iii ☐ Climbing the tree and pick fruits by hand

iv☐ All the above methods

v ☐Other methods. Specify .....

9. Have you observed any damage to the baobab trees which has occurred due to harvesting methods being used?

1 ☐ Yes 2 ☐ No 3 ☐ Not sure

10. If Yes to question 9, what kind of damage was it?

i ☐ Broken branches of the tree

ii ☐ Part of the tree drying or dead

iii☐ The whole tree dead

iv☐ Tree no recovering from debarking

v ☐ Tree showing signs of disease

vi Other. Specify .....

11. How many baobab fruits do you harvest per season?

☐ ☐ ☐ ☐ ☐

1 >20 2 20-39 3 40-59 4 60-79 5 over 80

12. From how many baobab trees do you harvest the following products?

12.1. Baobab fruits 1 ☐ 1-5 trees 2 ☐ >6 trees 3 Not sure

12.2. Baobab fibre....1..... 1-5 trees 2 ☐ >6 trees 3 ☐ Not sure

12.3. Leaves .....1. ☐ .. 1-5 trees 2 ☐ >6 trees 3 ☐ Not sure

13. Do you support the idea of planting baobab tree in this area for commercial purpose?

1 ☐ Yes 2 ☐ No 3 ☐ Not sure

14. Is it possible to plant more baobab trees in this area for commercial purposes?

1 ☐ Yes 2 ☐ No 3 ☐ Not sure

Explain:_____
_____
_____
_____
_____

I THANK YOU SO MUCH FOR PARTICIPATING!

APPENDIX B: **INTERVIEW GUIDE**

TOPIC: Potential of sustainable utilization of the baobab tree (*Adansonia digitata*) to improve food security. A case study of south-east lowveld of Zimbabwe.

PURPOSES AND INSTRUCTIONS FOR THE INTERVIEW

In my letter requesting for the interview, l have indicated to you that l am busy with a research project on the potential of sustainable utilisation of the baobab tree to improve food security. You have consented to this interview. I would like to reiterate that the aim of this interview is to obtain your ideas and opinions regarding this topic as a community leader/ agricultural extension officer/farmer/trader or consumer of baobab products in this area. The information obtained will be used will be used for research purposes and no name of participants, departments or any identifying data regarding you, would be made known in the report. Do you have any questions before we start the interview? May l audio-record the interview as it would help me to listen to it again later and make a transcript of the interview for data analysis purposes. Thank you.

QUESTIONS FOR AN INTERVIEW

1. Do you think baobab trees are important to people in this area? Explain why.

2. Can baobab products such as the fruit pulp, leaves, seed, fibre or whole fruit, be used to improve the food availability of the people in this area?

3. Are the baobab trees in this area accessible to all community members who may need to use it?

4. Is there any of the baobab products which you think is more important to people's livelihoods than the others?

5. Is there anything that can be done to the current fruiting baobab trees to make them live longer producing good fruits?

6. Do you support the idea of using the baobab trees in such a way that its products would always be available in this area?

7. Do you think it is possible to grow baobab trees for commercial purposes by households in the south-east lowveld of Zimbabwe?

I will be analysing the information you and others gave me and present data in my research. I will be happy to send you a copy to review if you are interested.

Thank you very much for your time and for sharing your thoughts and ideas with me.

APPENDIX C: **RESOURCE MAP**

TOPIC: Potential of sustainable utilisation of the baobab tree (*Adansonia digitata*) to improve food security. A case study of the south-east lowveld of Zimbabwe.

The researcher would carry out a field observation on how the existing baobab population of the south-east lowveld of Zimbabwe is being managed by the rural farmers of the area. Tree distribution, condition, harvesting techniques of products used and care of the baobab trees in the south-east lowveld of Zimbabwe. Photographs would be taken to support the written observations. Comments will be written also down during the course of the survey.

Date: ……

Location: …….

Tree distribution

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Tree condition

…….

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Harvesting techniques

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Care of existing baobab tree and regeneration

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Researcher's signature:…… Date:……

Participant's signature:…… Date:……

APPENDIX D: **48-hour dietary recall**

The researcher would carry out a survey to determine the different types of foods consumed by households in Wengezi and Gudyanga communities. A record of food eaten during breakfast, lunch and supper would be taken. The information would be recorded on the questionnaire in triplicate to cater for breakfast, lunch and supper.

In the past 48 hours, have you eaten the following foods during your breakfast/ lunch/ supper?

Food groups eaten by households	**Yes**	**No**
1 Cereals (foods made from grain)		
2 Roots or tubers		
3 Vegetables		
4 Fruits		
5 Meat, poultry or offal		
6 Eggs		
7 Fresh or dried fish or shell fish		
8 Foods made from beans, peas, lentils or nuts		
9 Cheese, yoghurt, milk or other milk products		
10 Foods made with oil, fat or butter		
11 Sugar or honey		
12 Drinks and snacks		
13 Other foods (name them):.....		

Researcher's signature: ..... Date: .....

Participant's signature: ..... Date: .....

APPENDIX E: **Household Food Insecurity Access Prevalence Template** (FAO, 2008)

Category	**Question**	**Response Options**	**Code**
Food secured household	1. In the past 48 hours, did you worry that your household would not have enough food?	0=No 1=Yes	
Mild food insecured household	2. In the past 48 hours, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0=No 1=Yes	
	3. In the past 48 hours, did you or any household member have to eat some food that they really did not want to eat because there was not enough food?	0=No 1=Yes	
Moderate food insecured household	4. In the past 48 hours, did you or any household member have to eat a smaller meal than you felt you needed because there was inadequate food?	0=No 1=Yes	
	5. In the past 48 hours, did you or any household member skip a meal because there was not enough food to eat?	0=No 1=Yes	
Severely food insecured household	6. In the past 48 hours, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0=No 1=Yes	
	7. In the past 48 hours, did you or any household member go to sleep hungry because there was not enough food to eat?	0=No 1=Yes	
	8. In the past 48 hours, did you or any household member spend a whole day and night without eating anything because there was not enough food?		