# ENHANCING FOOD SECURITY AMIDST CLIMATE VARIABILITY AMONG SMALLHOLDER FARMERS: WHAT ROLE FOR NEGLECTED AND UNDERUTILISED CROPS IN PETAUKE, ZAMBIA?

by

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**A dissertation submitted to the University of Zambia in partial fulfillment of the requirements for the award of Master of Science Degree in Geography.**

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## Declaration

I, Mabvuto Mwale, do hereby declare that this study, *Enhancing food security amidst climate variability among smallholder farmers: What role for neglected and underutilized crops in Petauke, Zambia,* has not been published at any other University for any type of academic degree.

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Mabvuto Mwale Date

## Certificate of Approval

This dissertation of Mabvuto Mwale (Student ID No. 2018254499) has been approved as partial fulfilment of the requirements for the award of the degree of Master of Science in Geography by the University of Zambia.

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**Abstract**

Neglected and underutilized crops (NUCs) are useful species of crops which are largely overlooked by farmers, consumers, breeders, extentionists, researchers and policy makers. They represent a cluster of biodiversity with potential to solve food security problems among smallholder farmers in the developing world especially in the spectre of climate variability. This study examined the potential of NUCs in enhancing food security of smallholder farming households amidst climate variability in Petauke, Zambia. Objectives of the study were to: (i) determine knowledge levels on NUCs among smallholder farming households in Petauke district, (ii) investigate the extent to which cultivation of NUCs has improved food security amidst climate change amongst smallholder farming households in Petauke, and (iii) examine the role of government and other stakeholders in promoting the cultivation of NUCs in enhancing food security amidst climate variability amongst smallholder farmers. Data was collected through structured interviews with 165 smallholder farmers and nine key informants. Data was analysed using descriptive statistics and thematic analysis. Results show that respondents identified 24 crops as NUCs. Thus, 25 percent of respondents identified cow peas (*Vigna unguiculata*), 26 percent identified Bambara nuts (*Vigna subterranean*), 23 percent identified local maize varieties while below 13 percent each were identified for pigeon pea (*Cajanus cajan*), sorghum (*Sorghum bicolor*) and cassava (*Manihot esculenta*) amongst crops that were neglected and underutilised. Reasons advanced for their neglect and underutilisation were loss of knowledge about production, use and storage (19 percent); non-availability of seeds (30 percent); preference for hybrid crop varieties (40 percent); shortage of land (4 percent); low yields (10 percent); and maize-centric government policies. Two thirds (66 percent) of respondents acknowledged the importance of NUCs in enhancing food security amidst increased climate variability. This was because, inter alia NUCs were adapted to the climatic variability within the local environments in which they are bred through local seed distribution systems. Being open pollinated varieties, farmers can replant them season after season with little or no loss in yields. Henceforth, diversification using NUCs is an important option to hedge against risk of individual crop failure amidst climate variability. The study noted low participation from both public and private sectors in enhancing NUCs production. The study concludes that improving household food security requires enhancing production of NUCs without which household food security will remain a challenge amidst climate variability among smallholder farming households in a developing country context. The study recommends that the Ministry of Agriculture must expand its input subsidy programme to include NUC seeds. Further, stakeholders in the agricultural sector must involve smallholder farmers in selecting the type of crops to be given to beneficiaries to reduce on problems of low adoption rates. There is need to research on community seed banks which used to exist in the past and establish what led to their failure.

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## Abbreviations and Acronyms

| | |
|---|---|
| COMACO | Community Markets for Conservation |
| FANSER | Food and Nutrition Security Enhancement Resilience |
| FARA | Forum for Agriculture Research in Africa |
| FISP | Farmer Input Support Programme |
| FSP | Food Security Pack |
| GRZ | Government of the Republic of Zambia |
| MOA | Ministry of Agriculture |
| NUCs | Neglected and Underutilised Crops |
| OPVs | Open Pollinated Varieties |
| UNDP | United Nations Development Programme |
| ZARI | Zambia Agriculture Research Institute |

## Table of Contents

## List of Figures

## List of Tables

# CHAPTER ONE

# INTRODUCTION

## 1.0 Chapter overview

This chapter introduces the research by setting the context of the study. It includes the statement of the problem, aim of the study, study objectives, research questions and the significance of the study. It ends with an outline of how the rest of the dissertation is organised.

## 1.1 Introduction

Global food security has become increasingly dependent on a handful of crops (Jaenicke and Hosche- Zeledon, 2006). It is estimated that over fifty percent of the daily global requirements of plant based caloric intake is met by just three crops - maize, wheat and rice (International Fund for Agriculture Development and Bioversity International, 2021, Joshi et al, 2020). More arable land is being allocated to commercial non-indigenous crops. For example, in the Sahel region of Africa, exotic fruit trees are taking over land once occupied by indigenous fruits such as Baobab and Tamarinds (Jaenicke and Hosche- Zeledon, 2006).

Further, the replacement of local varieties by improved, high input varieties has contributed to a narrowing of livelihood options for the poor (Joshi et al., 2020). This similar situation is also obtaining in Zambia. For example, food crop production in Zambia is dominated by maize which accounts for 79 percent of total output of major food crops (Food and Agriculture Organisation of the United Nations [FAO], the French Agricultural Research Centre for International Development [CIRAD] and the European Union, 2022). This resulted in maize annual production of more than 2.8 million metric tons. Smallholder farming households account for 85 percent of Zambia's maize production whereas emerging commercial farmers and large commercial farmers account for ten percent and five percent respectively (Abate, 2015).

This significant progress in maize productivity in Zambia over the last decade, with an annual productivity gain of 97 Kg/ha/year has been achieved due to the government giving higher priority to maize than to any other crop (Abate, 2015). For instance, the improved maize productivity is as a result of higher fertilizer use, presence of well-established seed companies that produce hybrid

seed varieties. Another contributing factor is the Farmer Input Support Programme (FISP), a nationwide subsidy programme focused on providing hybrid maize seed and mineral fertilizer to smallholder farmers (Mubanga and Ferguson, 2017). From pre independence days up to 2010, government's focus was giving maize seed and fertilisers to the programme's beneficiary farmers. This situation arguably led to marginalisation of other crops such as millet (*Eleusine coracana* ), sorghum (*Sorghum bicolor*), cowpeas (*Vigna unguiculata*), Bambara ground nuts (*Vigna subterranean*), groundnuts (*Arachis hypogaea*), cassava (*Manihot esculenta*), sweet potatoes (*Ipomoea batatas*), fruit trees and cucurbits (*Cucumis sativus*), elephant beans, pigeon peas (*Cajanus cajan*), lentils (*Lens esculenta*) and maize landraces (Chivenge et al. 2015). The term 'landrace' has generally been defined as a cultivated, genetically heterogeneous variety that has evolved in a certain ecogeographical area and is therefore adapted to the edaphic and climatic conditions and to its traditional management and uses (Casanas et al. 2017). An example is the case for maize variety known as *kenya*. Therefore, hybrid maize became one dependable cereal though it was less tolerant to drought.

However, from 2010/2011 other crops were included in the FISP pack. These included rice seed, sorghum during 2012/ 2013, groundnut during 2013/ 2014, soya beans, beans and sunflower during 2015/ 2016 season (Ministry of Agriculture, 2016). This was after observing the poor performance of maize during the time Zambia started experiencing sustained droughts and floods. All this was done in order to promote crop diversification - growing crops that would cope with changing climatic conditions. Therefore, indigenous crops were advocated for due to their various potentials to grow in marginalised areas and enhance household food security among smallholder farmers. This, therefore, called for the re-emerging of previously neglected and underutilised crops. Neglected and Underutilised Crops (NUCs) include species that have not been categorised as major crops, lacking adequate research and currently experiencing low consumption and utilisation (Baa-Poku, 2018).

### 1.2 Statement of the problem

Maize is the staple crop for the majority of Zambians of which 85 percent is grown by smallholder farmers using rain-fed agriculture (Abate, 2015). Its cultivation, therefore, dominates the cultivation of other crops. However, since 2000, droughts and flooding episodes across Zambia have become more frequent and of increasing intensity, a manifestation of long-term climate change

(Government of the Republic of Zambia [GRZ] and United Nations Development Programme, 2010[UNDP]). This can be seen through either late onset of the rains or short rain season or intra season dry spells or early offset of the rains, outbreak of army and fall worms of which maize is susceptible (Food and Agriculture Organisation of the United Nations [FAO], the French Agricultural Research Centre for International Development [CIRAD] and the European Union, 2022). Consequently, many smallholder farming households have become food insecure. Furthermore, the overdependence on maize cultivation has contributed to neglect of other crops.

Likewise, neglect of NUCs by private, public and government itself has led to insufficient household food security. This is because some NUCs are well adapted to growing in marginal conditions in which maize does not thrive but are not supported. Subsequently, there is loss of knowledge about production, use and storage of NUCs by most of the smallholder farmers.

Therefore, neglecting these crops will create a problem of food insecurity as it exposes many smallholder farming households to food insecurity. This is because these crops are no longer being grown the way they used to be grown long ago despite their potential to grow in marginalised areas. Thus, to avoid increased food insecurity exacerbated by changing climatic conditions, smallholder farmers increasingly need to adapt their agricultural systems to climate variability (Temu, et al. 2016). This is because hybrid crop varieties and hybrid animal breeds they currently maintain are challenged by climate variability (Temu, et al. 2016). It is thus, imperative to diversify agriculture by promoting and expanding the use of the crops which are adapted to marginal growing conditions in order to enhance food security. Therefore, NUCs offer an option to solving the problem of food insecurity amidst climate variability among smallholder farming households as they are adapted to marginal growing conditions. They can play a role in mitigating risks and enhancing resilience of agricultural production systems (Temu, et al. 2016). Moreover, NUCs can be intercropped with maize as was practiced long ago and still is among a minority of smallholder farmers (Chivandi et al. 2015). However, there has been little documentation or research on NUCs (Jaenicke and Hosche-Zeledon, 2006 and Forum for Agriculture Research in Africa [FARA], 2021).

### 1.3 Aim

The aim of this study was to investigate the role of NUCs in enhancing household food security amidst climate variability among smallholder farming households in Petauke, Zambia.

## 1.4 Specific objectives

To achieve the aim, the specific objectives of this study were to:

**(i)** Determine knowledge levels on NUCs among smallholder farming households in Petauke district.

**(ii)** Investigate the extent to which the cultivation of NUCs can improve food security amidst climate variability amongst the smallholder farming households in Petauke.

**(iii)** Examine the role of government and other stakeholders in promoting the cultivation of NUCs in enhancing food security amidst climate variability amongst smallholder farmers.

## 1.5 Research questions and hypotheses

The following were the research questions for this study:

**(i)** What knowledge do smallholder farming households in Petauke have about neglected and underutilised crops?

**(ii)** What are the reasons for cultivating NUCs by smallholder farmers?

**(iii)** What is the area allocated to the cultivation of NUCs by smallholder farmers in the study area?

**(iv)** What is the role of the government and other stake holders in promoting the cultivation of NUCs in enhancing household food security among smallholder farmers?

The following were the research hypotheses for this study:

**(i)** The mean number of crops identified by the respondents in the study area was statistically significantly higher than the mean number of crops grown.

**(ii)** The mean number of crops known by the respondents in the study area is influenced by the type of education (informal or formal) a respondent possesses.

**(iii)** A female headed household type grew more crops than a male headed household type in the study area.

## 1.6 Significance of the Study

This study is significant in that it provides information about the role NUCs play in enhancing household food security amidst climate variability in Petauke District. This information can be used to design and implement interventions by agricultural development actors which include both those in the public and private sectors in Petauke district as well as other districts in the province to find ways of enhancing the production of NUCs. The recommendations in this study might be used by policy makers and all stakeholders involved in NUCs promotion.

## 1.7 Organisation of the Dissertation

This study is organised in the following order:

Chapter one introduced the study. Chapter two is a review of related literature highlighting role of neglected and underutilised crops amidst climate variability. Chapter three presents the study area of interest in detail. Chapter four describes the research methodology applied to achieve the proposed aim and objectives while Chapter five presents and discusses results. Finally, Chapter six gives a conclusion and recommendations based on the research findings and analyses.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.0 Introduction

This section presents the literature reviewed. It starts by giving definitions of what Neglected and Underutilised Crops (NUCs) are. It further highlights why these crops are neglected, and explains the food security benefits of NUCs, performance of NUCs amidst climate variability and role of stakeholders in the making and unmaking of NUCs.

## 2.1 Neglected and Underutilised Crops - What are they?

Currently there is a lack of a consensus definition for neglected and underutilised crop species (NUCS) (Chivenge et al, 2015 and Forum for Agriculture Research in Africa [FARA], 2021). There is even a lack of consensus on what these crops should be referred to (FARA, 2021). However, Baa-Poku (2017) has described NUCS as crops whose potential contribution to the national economy have not been adequately explored due to the decreased attention to their production, consumption and utilisation. Generally, NUCS that are common include species of cereal, root, tuber, pulse, fruit, vegetable and nut crops, among others (Siddique et al., 2021). For example, millet, sorghum, Bambara nuts, cowpeas, pigeon peas, amaranthus, local varieties of maize, maroon cucumber and lentils. Chivenge et al., (2015) define this collective group of crops (NUCS) as crops that have not been previously classified as major crops, have previously been under-researched, currently occupy low levels of utilisation and are mainly confined to smallholder farming areas and are grown in marginal environments that are too harsh for staple cereal crops such as maize, rice and wheat and are cultivated in mixed agricultural/garden systems. Historically, such crops have played an important role in ensuring community and household food and nutrition security through providing healthy alternatives when the main crop failed or during periods in-between subsequent harvests (Gregory et al., 2019).

The term ‘Neglected and Underutilised Crops’ has been used among several descriptions including ‘minor’, ‘under-used’, ‘under-exploited’, ‘under-developed’, ‘orphan’, ‘promising’, ‘lost’, ‘alternative’, ‘traditional’, ‘niche crops’, ‘crops of the future’ or ‘future smart foods’, ‘new crops’, and ‘neglected’ (Chivenge et al., 2015, Padulosi, et al. 2013, IFAD and Bioversity International,

2021, FARA, 2021 and Mayes et al,2012 ), to represent crop species that have potential but fallen to disuse due to various reasons (Padulosi, et al. 2013).

On the other hand, the Global Facilitation Unit for Underutilised Species (GFU) defines underutilised crops as “those species with a potential, not fully exploited, to contribute to food security and poverty alleviation’ and that tend to have the following features: a strong link to cultural heritage, poorly documented and researched, adapted to specific agro-ecological niches, weak or non-existent seed supply systems, traditional uses and produced with little or no external inputs”.

Basically, the word 'neglected' underlines the low level of research investments made on these species when compared with mainstream commodity crops and 'underutilised' alludes to their untapped livelihood potentials (FARA, 2021 and IFAD and Bioversity International, 2021). Therefore, for the purpose of this research, the term neglected and underutilised crops (NUCs) referring to this collective group will be adopted. In this case it refers to indigenous crops to which little attention is paid or which are largely overlooked by farmers, researchers, educators, breeders, extentionists and policy makers despite their potential to grow in marginalised conditions and improve household food security.

### 2.2 Crop neglect and underutilisation - why?

Although there is a wide diversity in terms of crop species available in most communities, not all are utilised at optimum levels (Underutilised Species Policies and Strategies, 2006). The underutilisation of the majority of the crops and plants can be attributed to a number of policy, institutional, and other related factors. Hendre et al., (2019) and Siddique et al., (2021) contended that the Green Revolution that substantially increased agricultural production in the last century was mainly based on improved grain yield and focused primarily on wheat and rice. Likewise, Adhikari et al. (2017), in a study conducted in the mountains of Pakistan and Nepal argue that agriculture intensification which is increasingly relying on a narrow range of crops has resulted in a decline in the cultivation of traditional food crops and the underutilisation of this nutritionally valuable food source. This has led to low dietary diversity and ultimately a higher prevalence of malnutrition in many households.

In the same way, African countries have traditionally been positively over-incentivising production and consumption of maize, which has reached a point where there is an unbalanced ratio of calorie intake and other dietary components such as minerals, vitamins and proteins. According to Padulosi, et al. (2013), the neglect of NUCs and failure to use them stems from a lack of awareness of their economic and nutritional value. This is often so because researchers, farmers, consumers and policy focus on the major commodity crops. IFAD and Bioversity International (2021), also highlighted lack of sufficient knowledge of the potential or useful traits of these crops as well as low interests in agricultural research, as some of the reason for the observed underutilisation of these crops or plant species. Their study further noted that the potential of plant species that are cultivated for food in most countries have not been fully exploited and therefore, less utilised. Baa-Poku, (2017), argued that in many African countries considerable attention has not been given to the impacts of less utilised crops on food security. This meant that comprehensive empirical research that provides an inventory of lesser known and less utilised crops as well as their potential to enhance food security and broaden the genetic base of food crops in most African countries has not been adequately explored. This can be attributed to most African countries pursuing agricultural and food policies based on a limited number of crops such as maize and rice (Baa- Poku, 2017).

Similarly in Zambia, farming for crop production since precolonial years, has been biased towards maize production. This is because agricultural policies and markets favour genetically uniform varieties of a few high-yielding staple and commodity crops such as maize, wheat, rice, tea, coffee and cacao (Underutilised Species Policies and Strategies, 2006; Gregory et al., 2019). This, therefore, leads to the importance of NUCs being often overlooked.

Most of these underutilised crops became commercially uncompetitive and, as such, less attractive to most farmers, in particular large scale commercial farmers (Chivenge et al., 2015). There has also been a change in consumer tastes influenced by the changing food cultures. Weller et al. (2015), postulate that some indigenous foods, historically were and even today considered as 'famine' foods, eaten only when no other food options were available. Additionally, limited farmer production knowledge, low access to production inputs, little knowledge of appropriate postharvest handling, limited knowledge of market dynamics and the lack of validated nutritional information (Hendre et al.,2019) about local-grown are considered to be some of the factors leading to the neglect and underutilisation of these crops. Similarly, a study by Baa-Poku (2017), exposed lack of

sufficient knowledge of the potential or useful traits of these crops as well as low interests in agricultural research, as some of the reason for the observed underutilisation of crops.

### 2.3 NUCs and food security

Global food security over the years has been constrained by several factors including heavy reliance on a very few key staple crops (Chivenge et al., 2015, Hendre et al., 2019; Mayes et al., 2012), a situation that has nutritional, agronomic, economic and ecological implications. According to Baa-Poku (2017), usage of highly valuable but presently underutilised crop species has been identified as an essential element of any model of sustainable agriculture. Further, the cultivation of underutilised crops provide greater genetic biodiversity and can potentially improve food security (IFAD and Bioversity International 2021).

Dansi et al., (2012), explained that traits and physiological responses attributed to underutilised crops contribute significantly to crops ability to endure periods of water stress. These features make NUCs favourable crops in enhancing food security amidst climate change. Massawe (2015) proposed that a key changing climate adaptation strategy is the development and promotion of NUCS. He vied that exploiting the larger reservoir of minor and NUCS would provide a more diversified agricultural system and food sources necessary to address food and nutritional security concerns in the face of climate change. Consequently, underutilised crops have the potential to improve food and nutrition security, increase agricultural diversification and minimise environmental degradation. Therefore, in marginal environments, where poverty and food insecurity are most prevalent, NUCs are often central to farmers' strategies for reducing climatic and economic risks.

Jaenicke and Hosche- Zeledon (2006) and IFAD and Bioversity International (2021) postulated that over-dependency on a few plant species exacerbates many acute difficulties faced by communities in the area of food security. Jaenicke and Hosche- Zeledon (2006) contended that diversifying production and consumption of a broader range of plant species including those currently identified as underutilised can therefore, contribute significantly to improved health and nutrition, income generation and ecological sustainability. Their study further disclosed that neglected crops represent an enormous wealth of agro biodiversity and have great potential for contributing to improved incomes, food security and nutrition and for combating the ‘hidden hunger’ caused by

micronutrients deficiencies and also are strongly linked to the cultural heritage of their places of origin. They argued that these crops are mainly local and traditional with their ecotypes and landraces whose distribution, biology, cultivation and uses are poorly documented (Jaenicke and Hosche- Zeledon, 2006).

The NUCs have several advantages over conventional crops such as being widely distributed in SSA, adapted to the local climatic and edaphic conditions and tend to be more tolerant to drought, fire and pests. Nonetheless, despite their potential, these crops have only recently been regarded as a priority focus to address food security in most countries (Chivandi, et al., 2015; FARA, 2021). Consequently, these crops have largely been relegated to a secondary role in terms of food security in communities where they are sometimes even frowned upon and considered as food for the poor and wild animals (IFAD and Bioversity International, 2021) and often, it is women who cultivate them for subsistence purposes, while men prefer to cultivate the major cash crops (Mayes et al., 2012). And yet women are encumbered with domestic and reproductive roles which seriously constrain their agricultural productivity (Pelekamoyo and Umar, 2019)

Additionally, Padulosi, et al. (2011) argue that the importance of NUCS in contributing to food security and nutrition security has received substantial coverage by scientists in the recent years. They suggested that the roles of NUCS in income generation in both domestic and international markets have been also highlighted in several studies and projects. Their research further suggested that only a diversified agricultural production system with the capacity to withstand future changes such as climate change. Thus, the role of underutilised species to that end need to be better recognised (Padulosi et al., 2011). Underutilised species help agriculture to adapt to climate variability through their contribution in enhancing the diversification and resilience of agro ecosystems in order to withstand the impacts of climate scenarios such as drought and increased frequency and intensity of extreme weather events such as cyclones and hurricanes.

## 2.4 NUCs, food security, and climate variability

Massawe (2015) and GRZ and UNDP (2010), argue that higher temperatures, unpredictable rainfall and weather patterns, changes in growing seasons, increased occurrences of drought and extreme weather events will exert a greater strain on agriculture. They contend that emerging evidence suggests that climate change will cause shifts in food production and yield loss due to more

unpredictable and hostile weather conditions. Mabhaudi et al. (2019) postulated that change in the observed climate will affect the growth of crops through multiple mechanisms, including changing phenology, heat stress, water stress, waterlogging, and increases or reductions in pests and diseases. Similarly, Chivenge et al., (2015) added that already there are suggestions that some of these staple crops may not be able to adequately ensure food and nutrition security, particularly under the predicted climate change. This is especially true for much of SSA where climate change and variability threaten gains made in food security. Therefore, with the changing climate, it is important to practice crop diversification.

Kharam, et al., (2018), explains crop diversification as the addition of new crops or cropping systems to agricultural production on a particular farm considering the value-added crops with complementary marketing opportunities. In this case, it does not refer to substituting the local crops but adding new ones to the already existing ones. These added crops are adapted to marginal growing conditions including poor soil, low water availability, intense drought, frost, and flood risk areas (IFAD and Bioversity International, 2021). NUCs are often better adapted to extreme weather and soil conditions compared with high yielding commodity crops and reduces risks like harvest failure under extreme and unpredictable weather conditions, predicted to become more frequent and extreme in the future. Many of them are resistant to drought, have early maturation and short growth cycle, low water requirements, and can thrive in poor marginal soils while others can better cope with salinity, heavy rainfall and waterlogging.

Therefore, when smallholder farmers go for a single crop type, they are exposed to high risks in the event of unforeseen extreme whether events that could severely impact agricultural production such as emergence of pests and the sudden onset of floods or droughts (IFAD and Bioversity International, 2021). In addition, once diversification using neglected crops is overlooked, it leaves the smallholder farmers vulnerable to risks of total crop failure, a situation leading to household food insecurity.

Thus, it is imperative to diversify agriculture by promoting and expanding the use of the local crop varieties which are adapted to marginal growing conditions in order to enhance food security. NUCs offer an option to solving the problem of food insecurity amidst climate variability among smallholder farming households (Mayes et al. 2012). These NUCs are adapted to marginal growing conditions including poor soil, low water availability, intense drought, frost, and flood risk areas.

Consequently, NUCS can play a role in mitigating risks and enhancing resilience of agricultural production systems (Temu, et al. 2016).

### 2.5. Role of stakeholders in the making and unmaking of NUCs

Stakeholders play an important role in the making and unmaking of NUCs. These stakeholders include both public and private sectors.

#### 2.5.1 Role of stakeholders in the making of NUCs

Stakeholders are important in making of NUCs (Dansi et al. 2012; Gregory et al. 2019). For example, Dansi et al. (2012) in a study conducted in Benin contended that, for the promotion of NUCs to be a reality in Africa, a large cadre of well-trained and motivated African agricultural scientists will have to play a critical role in providing farmers with a steady flow of new technologies, improved farming practices, and newly developed varieties. Similarly, Bvenura and Afolayani (2015), in a study conducted in South Africa on wild vegetable stresses the importance of stakeholders in enhancing NUCs production. They contended that through partnership with the Department of Science and Technology, an initiative by the South African government to promote and protect the use of indigenous knowledge systems had led to changes in food production through the establishment of home gardens in many provinces of South Africa. Gregory et al., (2019) cited an example of Crops For the Future (CFF) which has developed a Global Knowledge Base that brings together data from different facets of underutilised crops including geographical, climatic, edaphic, agro ecological, nutritional and biological information in forms that can be used to provide initial answers to specific questions. CFF has established itself as a centre for innovative research on underutilised crops in a range of food systems. Consequently, conservation of genetic diversity and seed supply systems was also realised. Due to this, documentation of the nutritional aspects of NUCs has been significant over the years due to the influence of stakeholders.

Further, the Forum for Agriculture Research in Africa (FARA, 2021), an organisation which is developing a manifesto on African forgotten foods, stipulated the need to facilitate the engagement of private sector for investment into production, processing and marketing of NUCs. They elaborate that to harness NUCs production, collective actions are required which include creating awareness and communicating the economic, nutritional, environmental and cultural values of these foods to

improve their consumption. They further argued that what is needed was an enabling environment for the development of these foods through research, empowering farmers in production and supporting the private sector in processing, value addition and marketing. Similarly, a study by de Boef et al. (2012), revealed that after the state Government of the Santa Catarina realised that smallholder farmers have been gradually losing the culture of maintaining seed and of growing their own staple food crops to feed themselves, it began to assist these farmers in their social organisations with the aim of re-establishing food security. The intervention was successful as communities decided to restore food security and revive the habit of growing their own food. Therefore, each community defined the composition of their kit of several seeds through a participatory decision-making process. This helped restore the culture of maintaining varieties and producing seed at the community level, enhancing the autonomy of the community in food security and its sovereignty over the maintenance and exchange of seed of local food crop varieties. Also, Temu et al. (2016), explains that the potential of certain NUCs can be realised and their value chains upgraded through concerted efforts by research, development, business and policy actors.

Similarly, Danso et al. (2019), highlighted that the private sector may identify the potential of NUCs especially in terms of market value and engage researchers to exploit it. Likewise, researchers may also present potential of NUCs to private sector. Once both researchers and private sector perceive their mutual benefits and team up, research priorities to efficiently improve availability and marketability of NUCs will be defined. National and international bodies interested in promoting NUCs for adaptation to climate change, nutrition sensitive agriculture can also find their place in this model by providing funding for research. Therefore, setting up innovation platforms that bring together all stakeholders interested in promoting NUCs is important for the success of the model. Such a platform will create a co learning and co innovation environment for the stakeholders.

In Zambia, the public sector includes Zambia Agricultural Research Institute (ZARI) which coordinates soil and crops research. It is responsible for seed variety development and improvement suited to the different agro-ecological conditions, for both hybrid and open pollinated varieties (OPVs) (Nakaponda, 2012). The government disseminates ZARI research information through its Extension Service Department. Additionally, the Zambian government promotes the development of the informal sector through the following measures: (a) by providing breeders' basic seed on a cost recovery basis to those who may not have the capacity to develop their own varieties or produce

basic seed; (b) by encouraging the participation of farmers in local germplasm conservation and utilisation; (c) by protecting farmers from using insufficiently tested varieties; and (d) by promoting the establishment of community seed banks in support of seed production and supply at community level (Nakaponda, 2012). Therefore, governments should play its role in devising and implementing regulations and incentives such as, flexibility in taxation of investment in NUCs value chains that create a conducive environment for promoting NUCs value chains as a whole.

### 2.5.1 Role of stakeholders in unmaking NUCs

IFAD and Bioversity International (2021) pointed out that investing in the production of NUCs by both public and private sectors means higher market risks. This is because the value chain development for NUCs involve more risks and investments as it often entails a product development, market development or diversification strategy. On the other hand, making decisions regarding investments in processing, packaging or pricing is easier for commodity crops compared with NUCs value chains as a lot of information and experience is already available, whereas, for NUCs it is easier to make wrong decisions, as less information is available when breaking new ground. Thus, the overall market risks in NUCs value chain development are higher for private sector partners and that explains why it is often difficult to get companies on board and why they often require greater support when exploring NUCs value chains. However, competition is often less pronounced for NUCs value chains compared with established commodity crops. Additionally due to underinvestment mainly in African regions, the human and institutional capacity required for research, marketing, and knowledge sharing on NUCS is weak or absent. This situation leads to undermining the production of NUCs.

Maize has been a central preoccupation of Zambian agriculture since the colonial era (Chamberlin et al. 2014). The government's current approach to the maize sector revolves around two principle programs: the Food Reserve Agency (FRA), which purchases maize at pan-territorial, often above market rates, and the Farmer Input Support Programme (FISP), which provides between 50-80 percent subsidies on fertilizer and maize seed (Chamberlin et al., 2014). This has led to other crops without read market to be sidelined hence become neglected. Additionally, the available market for hybrid maize seed provided by the Ministry of Agriculture and Ministry of Community Development and Social Services through the FISP and FSP respectively, has led to most seed companies concentrate on maize, leaving most of the traditional crops unattended to, resulting in a

shortage of quality seed and the limited distribution of improved varieties for such crops (Nakaponda, 2012). Further, ZARI is also biased towards conducting improvement activities for crops in which the private sector is involved in, such as hybrid maize, wheat and soya bean (Nakaponda, 2012) which are on demand as a result of a ready market from both public and private sectors. Consequently, the farmer-saved seed sector continues to decline as new improved varieties, particularly hybrid maize, continue to roll in the informal sector, through FISP and FSP, to the extent that the conservation and use of local varieties or local knowledge associated with these crops and varieties, and the maintenance and seed production of those crops, is threatened. Furthermore, the non-availability of a ready market of NUCs from the government through Food Reserve Agency and other private stakeholders has greatly threatened the enhancement of production of NUCs among smallholder farming households.

## 2.6 Chapter Summary

In summary, food security has been anchored on a limited number of crops. Other food varieties which are mainly the indigenous crops have often been overlooked. They have been neglected and become underutilised despite their potential to grow in marginalized conditions by smallholder farmers, extentionists, researchers and both the private and public sectors. Therefore, knowledge about their production is gradually being lost. Hence, we need to overcome this knowledge gap to heighten food security. Therefore, information into the role of NUCs in enhancing food security amidst climate variability is important. Hence this research.

# CHAPTER THREE

# DESCRIPTION OF THE STUDY AREA

## 3.0 Introduction

This chapter presents the geographical setting of the study area by describing the location of the study area, climatic variables, soils and vegetation and further discusses the study area's socio-economic characteristics.

## 3.1 Location of the study area

The study was carried out in Petauke District, Eastern Zambia (Figure 3.1). Petauke District is located in Eastern Province of Zambia. It lies between longitudes 31˚22' and 31˚28' E and latitudes 13˚54' and 14˚20' S (Commissaris, 1973).

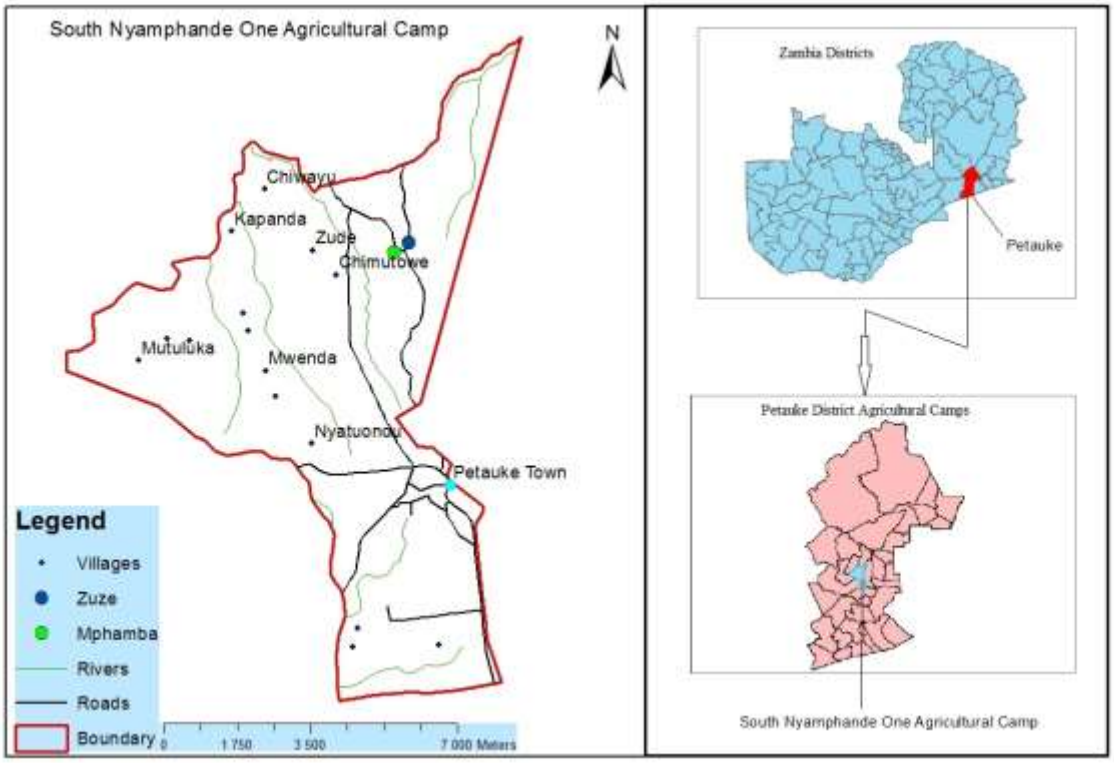


Figure 3.1. Locations of the study area and study sites, Mphamba and Zuze. Source: Field data, 2020

The district is divided into three agricultural blocks, which are further divided into 25 agricultural camps (Ministry of Agriculture, 2020). The Ministry of Agriculture has divided each district in Zambia into agricultural blocks, each of which is supervised by a block supervisor. The blocks have been further divided into agricultural camps with an agriculture camp officer being in charge. An

agricultural camp is the lowest level of agricultural administration and is ideally supposed to cover a radius of 15 km (Mubanga et al., 2015). The agricultural camp of interest for this study was South Nyamphande 1 Agricultural Camp because it were the study sites which are Mphamba and Zuze villages are found. This agricultural camp was purposively selected because it is the predominantly agricultural area nearest to Petauke town. It was envisaged that proximity to the town centre would have implications on access to agricultural services and agricultural markets.

### 3. 2 Climate

Temperatures in Petauke vary considerably between the cold and hot seasons. The temperatures rise and exceed 32.5 °C in hot months (October - December) whereas in cold months (June-July), they drop to 11.8 °C (Chikowo, 2013). The mean annual temperature in Petauke District is 21.8 °C, (Petauke District Meteorological office, 2019).

The study sites, Zuze and Mphamba villages, are located in the plateau agro-ecological zone IIB, which is characterised by medium rainfall, with average annual rainfall of up to 1000 mm (Government of the Republic of Zambia, 2002). The rain season is warm and wet and occurs from November to April. Much of the rainfall is concentrated between December and February. Agro-Ecological Region IIB has a crop-growing period of 120 - 150 days. Its relief ranges from 1000m to 1200m above sea level.

### 3.3 Soils and Vegetation

The common soil types in Petauke District include Lixisol, Luvisols, Alisols, Acrisols, Leptosols and Vertisols (Sichinga, 2015). They are some of the best agricultural soils in Zambia and host much of the country's farming sector. These have been described as to include very deep to deep, well drained, strong brown to red, friable, moderately leached loamy to clay classified as *Chromi-haplic* (Mwale et al., 2008). Additionally, the local vegetation comprises the *Miombo* woodland dominated by *Brachstegia* genera trees and *Hyperhania* grass species.

### 3.4 Population of the study area

Petauke District has a population of 241,056 according to the 2010 census (Central Statistics Office, 2010). According to the village registers, at the time of the study (2020), Mphamba and Zuze villages had a combined population of 3,150 people and a total of about 500 households.

### 3.5 Socio-economy

Smallholder agriculture is the dominant economic activity in Petauke District. The district has suitable soils for chief crops such as maize, cotton, groundnuts, soya beans and sunflower. Other non-traditional crops such as okra, beans, paprika, sweet-potatoes, onions, tomatoes, eggplant, sweet-corn, bananas and cucumbers are the main sources of income for the majority of the population in Petauke district (CSO, 2014). The predominant economic activity in the study site is mixed agriculture which comprises livestock, poultry and crop farming. However, the type of livestock kept by most of the smallholder households in the study area include free range chickens, goats, pigs and cattle. Apart from consumption, these are also sold or exchanged with other commodities to satisfy the needs of the household.

In the case of land ownership, the land is under customary land tenure. This means that the villagers inherited it from their forefathers while those who came to stay in the village from other places are given by the headmen who are the chief's representatives. However, those who need more land for farming, rent from those who have bigger family land on local arrangement.

This study area is in Chief Nyamphande's chiefdom and *ciNsenga* and *ciChewa* are the most widely spoken languages corresponding to the two predominant ethnic groups in the area namely, the *Nsengas* and *Chewas.* The main cultural activity that the people of this area are well known for is the traditional dance called '*Gule wamkulu'* which is the popular dance amongst the *Chewa* speaking people of Zambia.

# CHAPTER FOUR

# RESEARCH METHODOLOGY

## 4.0 Introduction

The chapter presents the research design, sampling procedures, data collection and data analysis methods of the study. It ends with a reflection on the philosophical orientation, research ethics and study limitations.

## 4.1 Research Design

The research study used the convergent parallel design of mixed methods research (Bryman, 2012). This involves combining or integration of qualitative research and quantitative research in a single study by seeking convergence across qualitative and quantitative methods (Cresswell, 2014). The researcher simultaneously collected both forms of data at roughly the same time and then integrated the information in the interpretation of the overall result. The researcher used focus group discussions and unstructured key informant interviews for the qualitative part of the research and employed a questionnaire survey for the quantitative part. Convergent parallel design was beneficial for this research because it helped the researcher to triangulate the findings from all the various categories of people who provided information during the interviews. This enhanced the authenticity and reliability of the data collected.

## 4.2 Sampling methods

The two study sites, Mphamba and Zuze villages were purposively selected as they are predominantly agricultural areas which are close to Petauke town. They had an estimated 500 farming households. This information was according to the village registers for the two villages. The sampling frame was all smallholder farming households in the two villages. A total of 165 households were interviewed during the survey part of the study. A sample size of 176 was determined through *a priori* power analysis using the software G power 3.2 (Erdfelder and Buchner, 1996). This sample size provided a statistical power of 90 % for detecting moderate effect size at a (two tailed) 0.05 level of significance (Erdfelder and Buchner, 1996). However, this sample size was not attained during the survey and only 165 households (82 from Zuze and 83 from Mphamba)

were interviewed. This comprised 38 male adult small holder farmers and 127 female adult smallholder farmers. This was due to the non-availability of some potential respondents as most households were preoccupied with harvesting of crops at the time of data collection.

Quota sampling was used to select respondents from the two study villages. The Quota sampling was adopted because this research was carried in a village set up as such, it was difficult to use probability sampling methods. However, this limitation was mitigated by having a relatively large sample size, as articulated by the Central Limit Theorem (Ghasemi and Zahediasl, 2012). Further quota sampling does not require the sample proportions to be proportionate to those of the population but simply to have representation from all population strata and this was done. In this case, the researcher aimed to interview an equal number of adult members of smallholder farming households from the two study villages. The researcher then conveniently selected respondents by moving from one household to the next in the study sites. This non-probability sampling method is justified through current statistical thinking which suggest that when samples are large, the biases are minimized or outright removed. The sample size was determined using a priori power analysis factoring in effect size and alpha and was deemed large enough to detect any differences in parameters of interest.

Purposive sampling was used to select a total of nine key informants. This sampling procedure was used to select key informants based on their defining characteristics such as positions held in their organisations that make them holders of specific data needed for the study (Bryman, 2012). These key informants provided information on the role of stakeholders in enhancing NUCs production in the study area.

For the focus groups, key informant recruitment was used. According to Cresswell (2014), this method entails stakeholder organisations actively assisting in the recruitment of participants. Therefore, in this case, the key informants who comprised village head persons and a lead farmer under FANSER from the villages were used to assist in coming up with two focus group members that is one for men and another for women. These were purposively sampled.

### 4.3. Data collection methods

Semi structured interviewing method was used to collect data from smallholder farmers. This method was used so that the researcher can keep an open mind about the contours of what he or she needs to know about, so that concepts and theories can emerge out of the data (Bryman, 2012 and Cresswell, 2014). Key informant interviewing was used to collect data from key informants on NUCs. This method allows researcher to have a list of questions or fairly specific topics to be covered, often referred to as an interview guide, but the interviewee has a great deal of leeway in how to reply (Bryman, 2012).

#### 4.3.1. Semi structured interviews

Semi structured interviews were conducted with the aid of semi structured interview schedule (Appendix I) to collect information from the farming households in the study sites. It consisted of open and closed ended questions. The researcher asked the same questions to all the respondents, in the same manner and order as printed on the schedule (Bryman, 2012 and Cresswell, 2014). These were administered by the researcher in *ciNsenga* and *ciChewa*, the languages most widely spoken in the area. The respondents were asked questions such as the crops they knew, crops they grew, crops they felt were neglected, reasons for growing or not growing them. These questions were in line with the first objective of this study, that is; to determine knowledge levels on NUCs among smallholder farming households in Petauke district. Questions pertaining to the extent of cultivation of NUCs by smallholder farmers in enhancing food security were also included in the interview schedule as well as questions on perceptions about climate variability and the possible roles of NUCs in enhancing food security in a changing climate context. Respondents were interviewed from their places of residents.

#### 4.3.2. Key informant interviews

A total of nine key informant interviews were held. The key informants were from the local office of the Ministry of Agriculture in Petauke, the agro-processor Common Market for Conservation (COMACO) in Petauke, Zambia Agricultural Research Institute's (ZARI) Msekera Research Station in Chipata, and the Food and Nutrition Security Enhancement Resilient (FANSER) in Chipata, a programme being implemented by the German Development Cooperation in Zambia and

the elderly people of the area. The interviews focused on role of government and other stakeholders in enhancing the cultivation of NUCs (Appendices II and III).

### 4.3.3 Focus Group Discussions

A total of two focus group discussions (FGDs) were carried out in Mphamba and Zuze villages on the 26th of June, 2020. One for the female participants was held at the residence of the female lead farmer in Mphamba village while the one for men was held at headman Zuze in Zuze village. These had their discussions separately. Using key informant recruitment (Bryman, 2012), the participants were purposively selected from the members of the study area. This was done with the help of a female lead farmer from FANSER and village headpersons (head woman Mphamba and headman Zuze) who knew the people who would provide the researcher with the best information about the problem under investigation. These made it possible for the researcher to make contact with 'respondents' in the study area. A total of 12 discussants, all of whom were smallholder farmers from the study area constituted a group. Different age ranges were represented between the age of 23 and 78. The facilitator asked the discussants to mention the crops they know, crops they grow, which crops they perceived to be neglected, give reasons for neglecting other crops as among other questions in their area and how they had addressed them. The men's group was facilitated by the researcher, while the women's group was facilitated by a female lead farmer under FANSER women's group who the researcher had trained on how to conduct the focus group discussion using focus group discussion guide. Notes were taken after informed consent was obtained. All the discussions were carried out in the local languages of the area.

## 4.4 Data Analysis

Qualitative data was analysed using thematic analysis. The themes were decided upon before the analysis based on the study objectives. This approach is applied to the analysis of documents and texts that seeks to quantify content in terms of predetermined categories and in a systematic and replicable manner (Bryman, 2012).

For quantitative data collected during the semi structured interviews, a paired T test was used to determine if the mean number of crops identified by the respondents in the study area was statistically significantly higher than the mean number of those grown. Also, ANOVA was used to

establish whether education type (formal or informal) an individual possesses had an influence on the number of identified crops. Further to establish which household type knows many crops than the other, a Two Independent sample T Test was employed. All the statistical tests were conducted at a significance level of 0.05 with the aid of the statistical software Minitab 14. It was assumed that the data met the conditions for use of inferential statistics as the sample size was large (n>30).

### 4.5 Epistemological and Ontological positions

An epistemological position described as interpretivist was employed in the study. In this case, the stress is on the understanding of the social world through an examination of the interpretation of that world by its participants (Bryman, 2012). Interpretivists share a view that the subject matter of the social sciences people and their organisations are primarily different from that of the natural sciences (Bryman, 2012). The study of the social world therefore requires a different logic of investigation technique, one that mirrors the individuality of humans as beside the natural order.

The ontological position which the study employed was pragmatism which embraces plurality of methods (Kaushik and Walsh, 2019). Its position asserts that researchers use the philosophical and methodological approach that works best for the particular problem that is being investigated. It is associated with mixed methods or multiple methods and the focus is on the consequences of the research and on the research questions rather than on the methods (Kaushik and Walsh, 2019). The researcher relied on the opinions and perceptions of the people about NUCs, hence the views of the people was what constituted reality to them.

The researcher used interpretivism because the research data was to be collected based on the interactions and therefore puts meaning to the collected data. Pragmatism was used because it is associated with mixed methods or multiple methods and the focus is on the consequences of the research and on the research questions rather than on the methods. This choice of position helped the researcher to gain access to people's 'common-sense thinking' and hence to interpret their actions and their social world from their point of view (Bryman, 2012). In this sense, therefore, this world view reflects the processes through which meaning is constructed in everyday life.

### 4.6 Ethical considerations

Before the research was undertaken, the researcher sought ethical clearance approval (NASREC: 2020, OCT- 002) from the University of Zambia, Directorate of Research and Graduate Studies. The researcher also requested for permission from traditional gatekeepers (headpersons). Further, permission was also sought from respondents and discussants to interview them. The researcher ensured informed consent by first informing the participants about the aims of the study and its potential benefits. The respondents were also assured of anonymity and confidentiality in the whole process of the research and that at no instance will their identity be revealed to anyone. Therefore, willingness to participate in the interview was entirely on voluntary basis.

### 4.7 Limitations of the study

The researcher encountered some challenges. Many smallholder farmers were sceptical about being interviewed. They said that they had been interviewed many times by many organisations but could not benefit from the programmes and therefore felt there was no need to participate in the interview. The researcher overcame this challenge by assuring the respondents that the research was purely for academic purposes. This made the discussions to take longer than planned as the researcher kept explaining the purpose of the discussion and re-directing the discussion to the research topic. The interviews were conducted in villages where most of the respondents had little or no formal education. This necessitated the translation of the instruments into the local language and elaboration of concepts during interviews. Having lived in Petauke District which is mostly occupied by Nsenga speaking people for over 10 years and attained fluency in speaking *ciNsenga*, the researcher was able to translate the questions for the respondents and sought help when needed from the local people whom the researcher identified as being conversant with the language, for some terminologies, and for respondents who spoke very deep *ciNsenga* and *ciChewa.* The other challenge was that respondents were expecting to be given a 'token of appreciation' each time they were interviewed. Hence, some shunned the interview, until the village head persons were contacted, who later explained the reasons for the researcher's visit to their subjects. The two village head persons have authority over their subjects and this ensured some improved compliance from respondents.

# CHAPTER FIVE

# RESULTS AND DISCUSSION

## 5.0 Introduction

In this chapter, results of the study are presented and discussed. The results presentation and discussion are made according to the study objectives. The first objective was to determine the knowledge of neglected and underutilised crops (NUCs) among smallholder farming households. The second objective was to investigate the extent to which the cultivation of NUCs has improved food security amidst climate variability among smallholder farming households. Lastly, the study examined the roles of the government and other stakeholders in promoting the cultivation of NUCs to enhance food security amidst climate variability among smallholder farming households.

## 5. 1 Knowledge of NUCs among smallholder farming households

This section reports and discusses results on crop known to and grown by smallholder farming households in the study area. Further, the section reports on crops perceived to be neglected by smallholder farmers and the reasons for their neglect.

### 5.1.1 Crops known to or grown by smallholder farmers

In total, the respondents (n= 165) reported knowing about 25 food crops, out of which 22 or 88 % were grown (Figure 5.1).

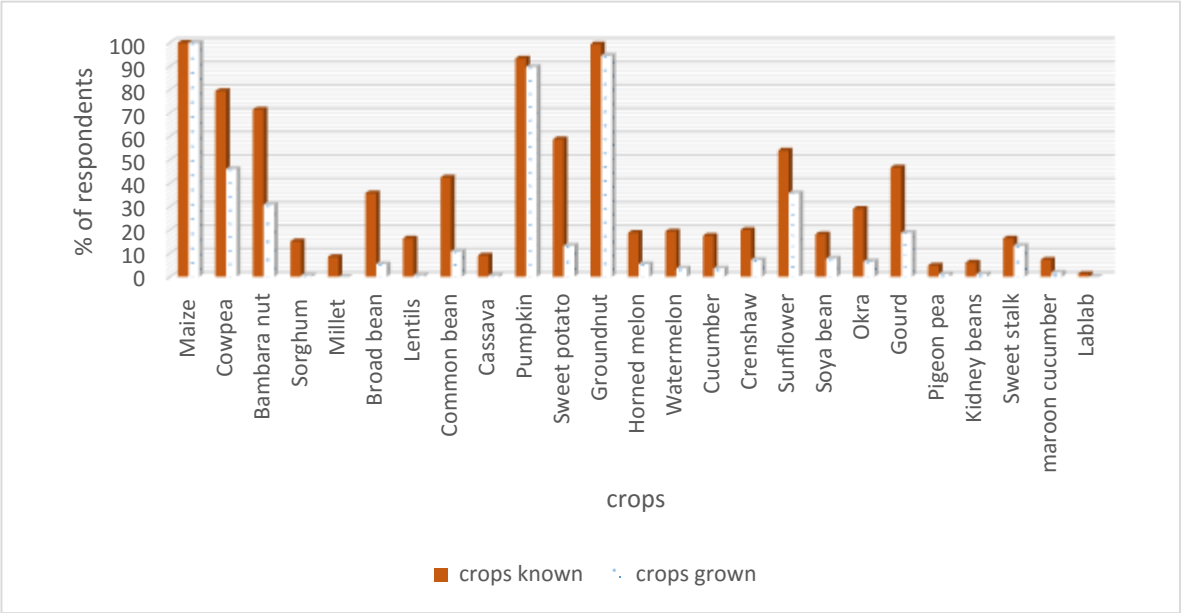


Figure 5.1: Crops known to and grown by smallholder farmers in Mphamba and Zuze villages
Source: Field data, 2020

Some crops were known only by a few respondents. For instance, crops such as lablab, pigeon peas, broad beans, millet, cassava, kidney beans and maroon cucumber were known by less than 10% of the respondents. All the respondents knew of and grew maize, which is Zambia's most important staple crop (GRZ and UNDP, 2010). Maize was closely followed by groundnut, arguably the most important cash crop in the Eastern Province of Zambia (Mukuka and Shipekesa, 2013). Both respondents and focus group discussants observed that farmers have a lot of knowledge on crops that are highly valued locally. Thus, the crops that were widely known were also widely grown (Figure 5.1). For 14 (54%) of the crops, less than 20% of the respondents mentioned them when asked to mention crops they knew. The mean number of crops mentioned as known per respondent was 8.6 (St Dev = 3.8) while the mean number of crops grown per household was 4.6 (St Dev = 2.2). This indicates that smallholder farming households were growing fewer crops than those they knew of. In other words, some crops were not being grown despite being known to the farming households. Thus, while having knowledge about a crop is a prerequisite for its production, it may not necessarily be the case that smallholders grow all the crops they know of.

Further, the results of a Paired T- Test reveal that the mean number of crops identified was statistically significant higher than the mean number of crops grown (T=16.04, p= 0.0001).

In the same vein, the study tried to establish type of education (Formal or informal) an individual possesses had an influence on the number of identified crops. The ANOVA test results (F= 0.95, p= 0.419) reveals that the number of crops identified is not different for respondents on the basis of type of education one possesses. This implies that type of education does not play a significant role in identification of crops by the respondents in the study area. This can be attributed to the fact that the smallholder farmers practice seed sharing and this therefore, implies that what is shared is what is known by the majority of them.

Additionally, to establish which household type knows many crops than the other, the households were segregated in to two groups comprising of male headed and female headed households. Then, a Two Independent sample T Test was employed and the output (T= 0.04, p= 0.483), reveal that there was no statistically significant difference in the mean number of crops known between the male headed households and the female headed households. This meant that household head type does not influence the knowledge individuals have on NUCs. This can be attributed to the fact that these people share the type of seeds they have and they live in one area hence, no statistically significant difference.

### 5.1.2: Views on neglected and underutilised crops

The respondents identified up to 24 crops as neglected and underutilised (Figure 5.2). For maize and groundnuts only the landraces, not the hybrid varieties, were viewed as NUCs. All the other crops identified as NUCs were landraces.

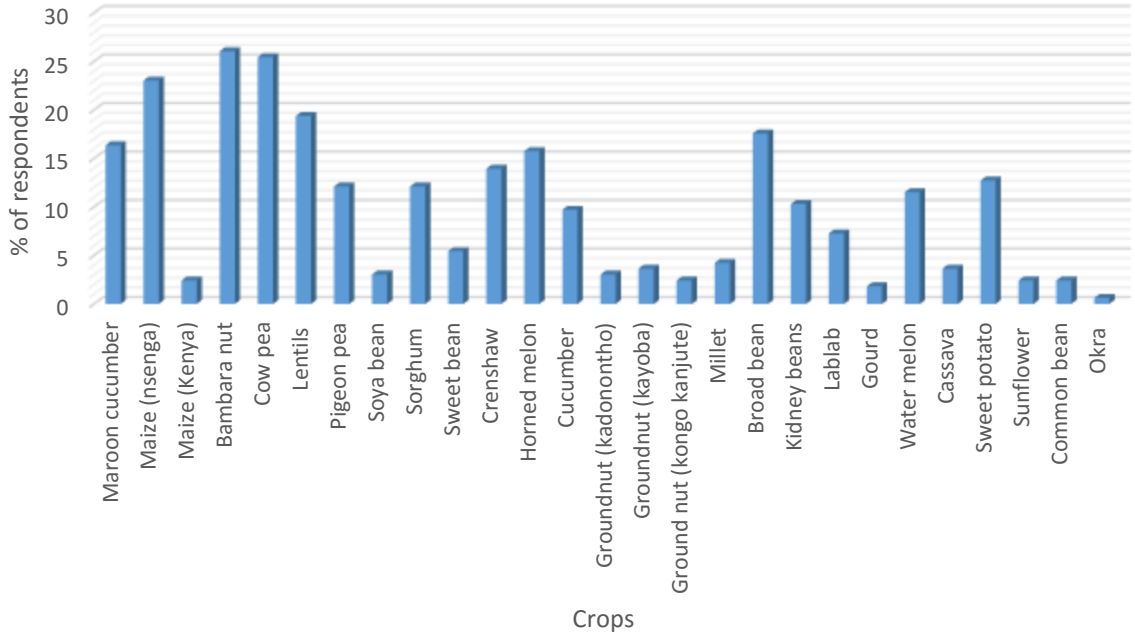


Figure: 5.2: Crops categorised as neglected and underutilised by smallholder farmers in Mphamba and Zuze villages.
Source: Field data, 2020

Further, the study also revealed respondents' views on gender mediated crop production as illustrated in Figure 5.3.

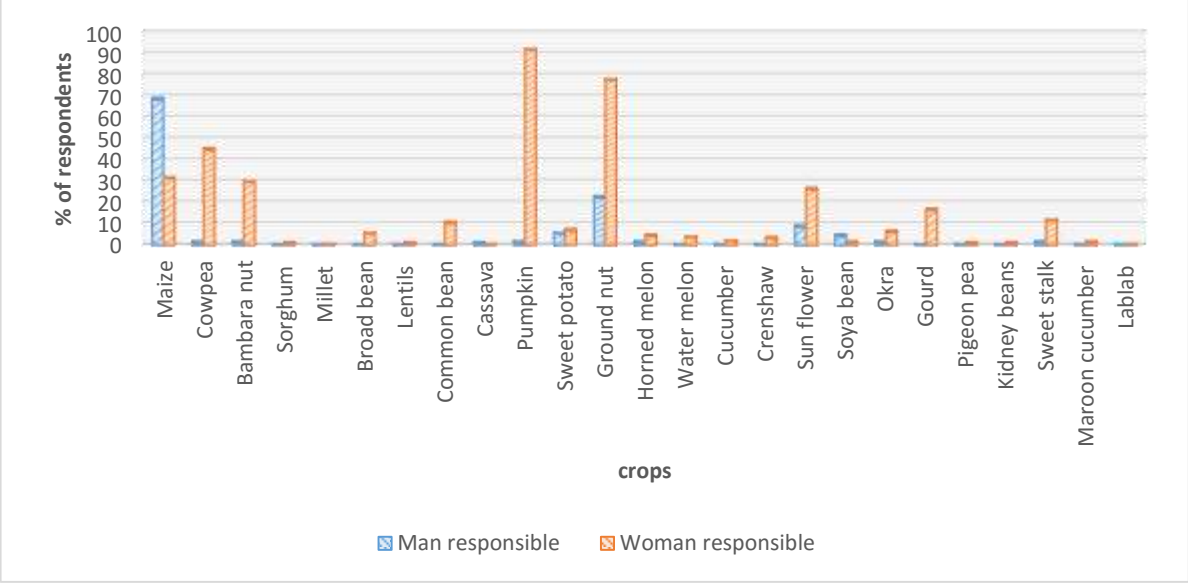


Figure: 5.3. Comparing gender responsible for cultivated crop by smallholder farmers in Mphamba and Zuze villages.
Source: Field data, 2020

The respondents revealed that most of the crops grown by women tend to be cultivated on a low scale compared to those cultivated by men. In this case, crops mostly grown by men are allocated more land than those mostly grown by women. For example, the land allocated to cowpea and Bambara nut that are under women responsibility is smaller than that allocated to maize and soya beans which are primarily considered to be men's crops. However, the higher percentage of women growing groundnuts can be attributed to the fact that despite this crop being perceived as women's crop, the men still have authority when it comes to disposal of it. This was echoed in one of the female respondents who said "*My husband has locked the storage shelter for groundnuts and has said that we should not sell them until the prices on the market increase."* Additionally, all the FGD's reported that crops that are mainly grown for consumption (relish), were under the jurisdiction of women. Gender roles can explain crop neglect and underutilisation. More land and resources are dedicated to cash crops, while food crops are left to be managed by women for household consumption purposes. Women may only require small quantities and thus produce very little and infrequently so. With changes in diets, production of some of the crops stops completely. Similarly, Mayes (2012), pointed out that many NUCs still exist as minor crops and if cultivated at all, are seen as of "low status" so that often it is the women who cultivate them for subsistence while the men prefer cultivating the major crops.

More so, the Analysis of Variance test (ANOVA) results reveal that there is no difference in the mean number of crops grown based on gender of household head ($F= 0.18$, $p= 0.948$). This result can be attributed to the perception that women are the ones who are responsible for production of NUCs which are mainly for consumption. Subsequently, NUCs are labelled as women's crops.

Likewise, the respondents suggested reasons for the neglect and underutilisation of crops (Figure 5.4). The most commonly cited reason was a preference for the so-called 'modern crops' or hybrid crops. This was closely followed by a lack of access to seed. The preference for hybrid crops and lack of seed can be attributed to the government's agricultural policy and the marketing preferences of private seed companies. The nationwide agricultural subsidy programme, known as the Farmer Input Support Programme (FISP) (MOA, 2018), favours very few crops and only supplies hydride seed packages to smallholder farmers as part of the input subsidy package. Private seed companies prioritise hybrid seed and rarely supply open pollinated crop varieties for sale to farmers (Nakaponda, 2012). This is because, as profit-motivated entities, they are interested in repeat sales;

they focus on breeding seed that farmers would require to buy every season. This implies that crops that are not promoted by both FISP and private seed companies do not have a continuous supply of seed.

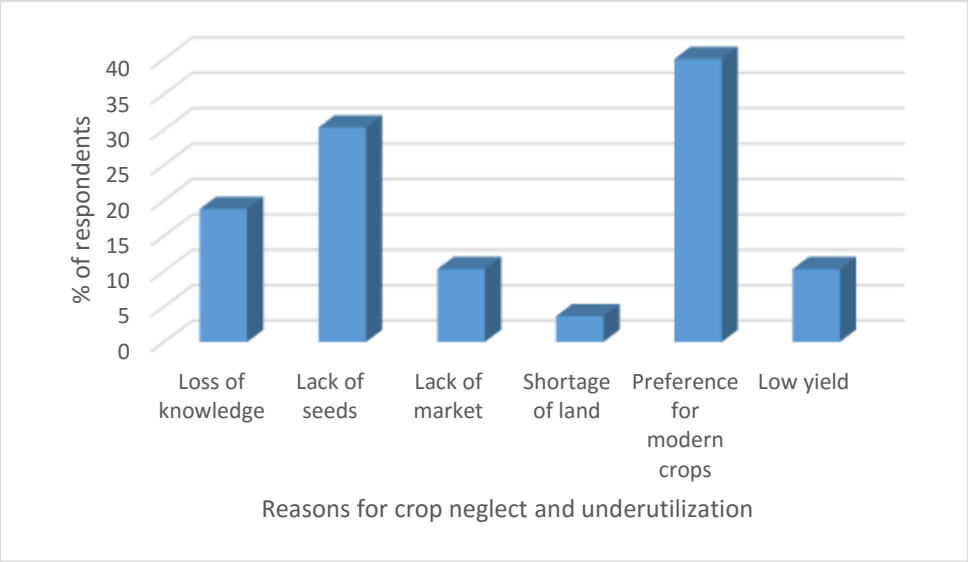


Figure 5.4: Reasons for crop neglect and underutilisation by smallholder farmers in Mphamba and Zuze villages.
Source: Field data, 2020

The focus on hybrid seed, which has to be purchased, has led to a reduction in the growing of landraces, whose seeds are harvested and stored for planting the next season. Over time, the knowledge on how to select and store seed for replanting has been lost. Therefore, most NUCs are not being grown and since they are not grown, they are not being consumed by households. Over time, such crops have disappeared from the diets of most households. Thus, there is little demand for them. Farmers are therefore not motivated to grow them due to lack of market. Respondents noted that landraces are characterised by low yields. Thus, farming households looking to increase total production and income, look to hybrids. With the increasing instances of local land pressure, farming households prefer to increase production from the land available to them through intensification.

According to a long-time resident, who has lived in Mphamba for 35 years, one of the study sites, another reason for the neglect and underutilisation of crops such as broad beans and pigeon pea was the long duration they take to mature. She elaborated that as these crops mature later than main

staple crops such as maize, majority of the farmers were not willing to go back to their fields later in the year to harvest these crops which normally mature between July and August. The key informant said, "*I have broad beans and pigeon pea at my field, but I cannot go back to harvest them because I already harvested the important crops*."

The men's FGD cited cattle and pastoralists as a deterrent to NUCs production. In the words of one discussant from the group, "*We have lost these crops because of the cattle and herders who dig and eat the remains of the crops at our fields after harvesting more especially cassava and sweet potatoes*."

These stated factors by the respondents concerning late maturing varieties of NUCs and the cattle and cattle herders have really robbed the community of needed seed varieties to enhance NUCs production. However, sensitisation must be enhanced to educate the smallholder farmers to appreciate the importance of these crops such that they are not left to go to waste when they harvest the so called important crops to them.

Likewise, a key informant from the Common Market for Conservation (COMACO) narrated how the organisation's programme on empowering farmers near game management areas, had at one time in the year 2012 supported the smallholder farmers in these areas with pigeon pea growing. Pigeon pea improves soil fertility by fixing nitrogen within three years. However, the programme was not well received as no smallholder farmer participated in growing pigeon peas. The farming households reportedly did not want to keep their land under fallow for three years. Similarly, another key informant from Msekera Research Station in Chipata district of Eastern Zambia revealed that in 2015, some farmers rejected the variety of groundnuts that was supplied to them by the Ministry of Agriculture. The key informant explained that the farmers claimed that the groundnuts were low yielding and smaller compared to the local varieties they grew. Additionally, a key informant from the Food and Nutrition Security Enhancement Resilient (FANSER) Project reported low adoption levels for the orange fleshed sweet potato which the project was promoting among smallholder farming households in eastern Zambia. The project beneficiaries had reported that orange-fleshed sweet potato was very watery despite being rich in vitamin A. Such mismatch between researcher and household preferences hinder adoption and result in neglect and underutilisation of crops. Padulosi et al., (2013), which concluded that some crops tend to be neglected due to lack of awareness of their economic and nutritional value by farming households

and consumers. This researcher contends that in some cases, the neglect may stem from crops not aligning with consumer taste preferences, as in the case of the orange-fleshed sweet potatoes and groundnuts.

The researcher argues that the pervasive practices by both government and non-governmental organisations of providing hand-outs to farmers has created dependency such that farming households no longer plant crops unless these agents are there to supply free inputs and continuous training. In the end, only those crops for which this had been done for long periods are now being grown. This has contributed to most crops joining the list of neglected and underutilised crops (NUCs). Some of the crops identified as NUCs by respondents in the study area have been outlined using local, English and scientific names (Table 5.1).

**Table 5.1: Local, English and scientific names for identified NUCs by respondents in the study area**

| **Local name** | **English name** | **Scientific name** |
|---|---|---|
| Kasongo | Maroon cucumber | *Cucumis anguiria* |
| Vinchele | Local maize | *Zea mays* |
| Nzama | Bambara nut | *Vigna subterranea* |
| Nyemba | Cowpea | *Vigna unguicula* |
| Kankhoma | Lentils | *Lens culinaris* |
| Nyamndolo | Pigeon pea | *Cajanus cajan* |
| Mapila | Sorghum | *Sorghum bicolor* |
| Misale | Sweet stalk | *Sorghum bicolor* |
| Kalichele | Crenshaw | *Cucumis melo* |
| Nshawa | Groundnuts | *Arachis hypogaea* |
| Cimbamba | Broad beans | *Panicum miliaceum* |
| Citeje | Kidney beans | *Phaseolus vulgaris* |
| Lupoko | Millet | *Panicum miliaceum* |
| Mphonda | Gourd | *Lagenaria sicerania* |
| Vwembe | Watermelon | *Citrullus lanatus* |
| Mbwasi | Sweet potato | *Ipomoea batatas* |
| Cinangwa | Cassava | *Manihot esculenta* |
| Kayela | Beans | *Phaseolus vulgaris* |
| Delele | Okra | *Abelmoschus esculenta* |
| Vibwete | Horned melon | *Cucumis metuliferous* |
| Mang'uta | Cucumber | *Cucumis sativus* |
| Nkhusa | Lablab | *Lablab purpures* |

Source: Field data, 2020

Once crops are neglected, Temu et al., (2014) note, knowledge about productivity, use and storage is lost. This may include loss of knowledge on how such crops perform during extreme climatic

conditions and their contribution to household food security during such times. The next section delves into the performance of NUCs during extreme climate events such as droughts and floods.

### 5. 2. NUCs and household food security amidst a changing climate.

This section investigates the extent to which the growing of NUCs can improve household food security among smallholder farmers. This is situated in a changing climate context. Climate change and/or variability is a major challenge affecting the majority of the Zambian smallholder farmers across the country. It can potentially lead to household food insecurity, as most smallholder farmers depend on rain fed agriculture. Across the country, climate change and climate variability manifests in different ways including late onset of the rain season, shorter rain season, intra seasonal droughts, and early offset of the rain season and the outbreak of the armyworms (GRZ and UNDP, 2010).

During this study, 165 respondents were asked if they had experienced changes in rainfall and temperature. A large majority (85.5%) had noticed changes in rainfall, while the rest (15.4%) had not. Conversely, 95.2% had not observed any changes in temperature while 4.8% had. Those that had noticed changes in rainfall elaborated that unlike in the past, it has now become difficult for them to predict the rain season. They stated that the rain season was either characterised with late onset or early offset of the rains, early onset or early offset of the rains, long dry spells and the outbreak of pesticides such as armyworms. Furthermore, a male key informant, 60-year-old smallholder farmer who has been farming for forty years said,

*In the past, the rain season was predictable. There were the first rains, which started in October for filling the soil pores, then for quenching the fire and now the last for planting signifying the seriousness of the rainy season.*

A few respondents also stated that extremely low temperatures and extreme high temperatures were increasingly common during months such as May and September, a departure from past trends. The sentiments expressed above can be observed from the district annual rainfall figures covering a period from 2000 to 2022 (Appendix VI), which show varying changes in the onset and offset of the rainy season which result in the farming season become unpredictable as compared to the past.

### 5.2.1. Performance of NUCs during extreme climate events

Respondents reported that most of the crops they had categorised as neglected and underutilised performed well during extreme climatic events (Table 5.2).

**Table 5.2: Respondents views on performance of NUCs during extreme climatic events in the study area**.

| Crop | % Drought resilient (n=165) | | | | | % Above normal rainfall resilient (n=165) | | | | | % Pests resilient (n=165) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Local maize | 9 | 8 | 78 | 4 | - | - | - | - | 58 | 40 | 5 | 12 | 85 | 7 | - |
| Cowpeas | - | 9 | 29 | 1 | - | - | - | - | 1 | 39 | - | 4 | 21 | 8 | 5 |
| Bambara nuts | - | - | 7 | 19 | 4 | - | - | - | - | 30 | | | | | |
| Broad beans | - | 1 | 2 | 2 | - | - | - | - | - | 5 | - | - | - | 1 | 4 |
| Lentils | - | - | 1 | - | - | - | - | - | - | 1 | - | - | - | - | 1 |
| Common beans | 2 | 4 | 2 | - | - | - | - | - | - | 7 | - | - | 2 | 1 | 4 |
| Cassava | - | - | - | 1 | - | - | - | - | - | 1 | - | - | - | - | 1 |
| Pumpkins | 2 | 15 | 7- | 3 | - | - | - | 2 | 4 | 85 | - | 2 | 5 | 24 | 59 |
| Sweet potatoes | - | 1 | 8 | 1 | - | - | - | - | - | 10 | - | - | - | - | 9 |
| Groundnuts | - | 10 | 97 | 5 | - | - | - | - | - | 100 | - | 2 | 7 | 29 | 75 |
| Horned melons | - | 1 | 3 | - | - | - | - | - | - | 4 | - | - | 1 | - | 3 |
| Water melons | - | 1 | 1 | - | - | - | - | - | - | 2 | - | 1 | 1 | - | 1 |
| Cucumbers | - | - | 2 | - | - | - | - | - | - | 2 | - | - | 1 | - | 1 |
| Crenshaws | - | 2 | 4 | - | - | - | - | - | - | 6 | - | 1 | - | 1 | 5 |
| Sunflower | - | - | 10 | 21 | 3 | - | - | - | 1 | 34 | - | - | - | 2 | 32 |
| Soya beans | - | - | 3 | - | - | - | - | - | - | 3 | - | 1 | 1 | 1 | - |
| Okra | - | - | 7 | - | - | - | - | - | - | 7 | - | - | - | 2 | 5 |
| Gourd | - | 1 | 9 | 1 | - | - | - | - | - | 10 | - | - | - | 2 | 10 |
| Maroon cucumber | - | - | 1 | - | - | - | - | - | - | 1 | - | - | - | 1 | 1 |
| Pigeon peas | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| Kidney beans | - | - | - | - | 1 | - | - | - | - | 1 | - | - | - | - | 1 |
| Sweet stalk | - | 1 | 2 | 1 | - | - | - | - | - | 4 | - | - | 1 | 2 | 1 |

Source: Field data, 2020

**Key:**

**1= Very poor 2= Poor 3= Average 4= Good 5= Very good**

Most respondents observed that crops such as maize landraces, cowpeas, bambara nuts, broad beans and pumpkins had their performance against drought resilience rated as average (Table 5.2). Focus group discussants and key informants had similar reports. The FGDs asserted that most of the crop landraces were more resilient to drought compared to the so-called improved varieties. For instance,

the majority claimed that maize landraces such as *Cibawe*, *Nsenga*, *Mcizanjala* and *Kenya*, cowpea landrace known as c*imphonongo*, and bambara nut performed fairly well during drought as compared to the hybrid maize and hybrid cowpeas. The FGDs elaborated that when they plant landraces, they harvest "something" even when there was a drought unlike when they plant hybrid varieties.

Further, all respondents claimed that most crops performed very well during above normal rainfall (Table 5.2). However, slightly over half were quick to mention that the hybrid varieties performed far much better than the landraces. The same responses were also reported in all the focus group discussions that were conducted.

The landraces were further extolled for their pest resilient properties by respondents. For instance, maize landraces *Nsenga, Kenya and Mcizanjala*, bambara nut, cowpea and broad bean landraces were noted to be very resilient against pest attacks and recommended to be ideal crops to enhance food security amidst climate variability among smallholder farmers by the respondents. This was also echoed in both the focus groups for men and women where they claimed that the hybrid crops have brought pests, which are difficult to control. Similarly, a 78-year-old key informant from one of the study sites declared, "*I cannot plant hybrid maize seed because it brings pests*." This shows that some smallholder farmers have appreciated the resilience of some of these NUCs to climate variability and are perceived to be the option to enhancing household food security. Further, hybrid seeds have proved to be more vulnerable to pests attack (GRZ and UNDP, 2010).

Conversely, respondents claimed that hybrid seed supplied to them by the Government and other organisations such as hybrid maize and hybrid cowpea were more affected by pests than landraces (Table 5.2). They further said that without the application of pesticides, hybrid crops would result in very poor yields. This was supported by a key informant from FANSER Project who acknowledged that the hybrid cowpea variety the project supplied to farmers was very susceptible to pests. However, the key informant was quick to mention that the beneficiaries were sensitised on crop pest control, trained how to use biological pest control methods and discouraged from using chemical pesticides. This study's findings echo those of Chivandhi, et al. (2015), which contended that agricultural risks faced by smallholder farmers in Sub- Saharan Africa due to unreliable and lack of effective rainfall, mid- seasonal spells and at times flooding which predispose them to household food insecurity could be avoided by incorporating the indigenous crops. Massawe (2015)

suggested that a key strategy to adapt to a changing climate is the development and promotion of NUCs to enhance food security. Additionally, the Food and Agricultural Organisation of the United Nations, FAO (2015), pointed out that with climate variability, there is need for building resilience of agriculture systems by *inter alia*, the use of adapted varieties or breeds with different environmental optima and or broader environmental tolerance, including currently neglected crops and considering that increased diversification of varieties or crops is a way to hedge against risk of individual crop failure. On the contrary, hybrid varieties of crops for instance, hybrid maize is expensive to acquire. It is unaffordable by the majority smallholder farmers. These hybrid varieties of crops yield highly though are more susceptible to pest attack (army worms), easily affected by droughts, long dry spells and floods. They also require the intensive use of inorganic fertilizer to grow well.

### 5.2.2. Food security benefits of NUCS and ways of enhancing their production

Almost two-thirds (65.5%) of the respondents that answered the question on whether NUCs enhanced household food security noted that NUCs can enhance food security while the rest (34. 5%) did not think that they could. They explained that cowpea, Bambara nut and broad bean can be used as 'relish' (that is, as a supplement to a main cereal-based dish) or just eaten on their own as snacks. The respondents elaborated that NUCs are used to supplement the staple crop maize thereby enhancing food security. Furthermore, cucurbits such as pumpkins and gourd were reported to mature early and therefore, could be consumed before maize the staple crop matures. This reduces the pressure on maize as in the words of a male key informant aged 64 years who said, "*In the past, when we were young, our parents used to prepare for us cowpeas or Bambara nuts which could be eaten at lunch."* This view clearly shows that NUCs enhanced household food security as well as promoting dietary diversity.

Similarly, during focus group discussions, it was reported that the maize landrace *mcizanjala* could enhance household food security, as it was early maturing. Additionally, crops such as horned melon, Crenshaw, watermelon, cucumber and sweet stalk were also noted to be very important in enhancing dietary diversity. These findings echo those from a study by Chivandi et al., (2015) which argues that indigenous tree blossom and produce fruit at different times of the year, thus making fruits available throughout the year. This however, does not only apply to indigenous trees

but other indigenous crops which may also include those which mature late such as broad beans, pigeon peas and maroon cucumbers among other crops.

The respondents were asked about how they used the cultivated crops. Their responses suggest that the NUCs are predominantly used for home consumption (Figure 5.5)

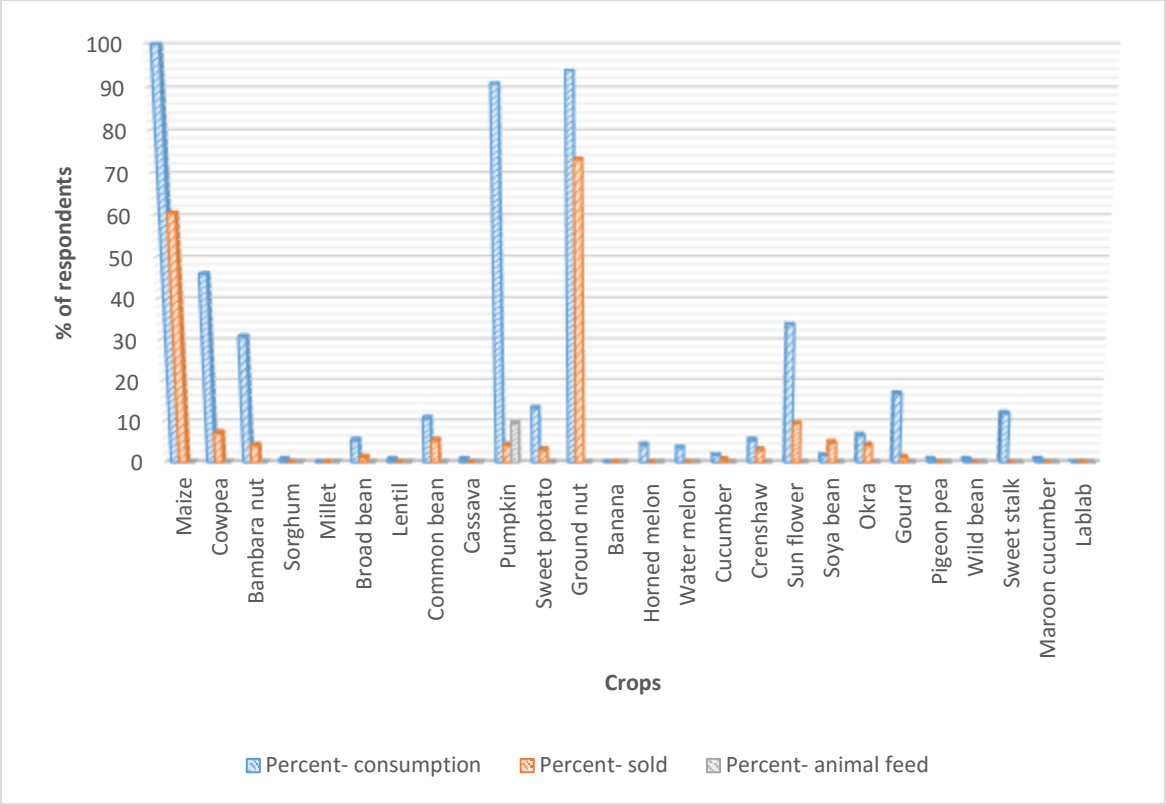


Figure 5.5. Uses of crops by smallholder farmers in Mphamba and Zuze villages.
Source: Field data, 2020

The use of a crop and the quantities required can determine its production and the quantity produced, as well as the size of land allocated to its cultivation and the frequency of its production. Crops that are only for a single use (consumption only) are less cultivated. For example, the cultivation of crops such as cowpea, bambara nut, and broad bean is low due to their use being predominantly home consumption while other crops such as groundnut, maize and sunflower, which are consumed and sold to earn an income for the household, are grown on a larger scale. This was also revealed by a key informant from the FANSER project who pointed out that most of their beneficiaries were growing NUCs for consumption in their backyards gardens, as they were considered for consumption only and not for sale.

Therefore, due to their potential to enhance food security, the respondents thought the growing of NUCs could be enhanced in several ways (Figure 5.6). They asked for sensitisation on the importance of growing NUCs and provision of seeds for such crops to promote crop diversity more especially in this era of climate variability.

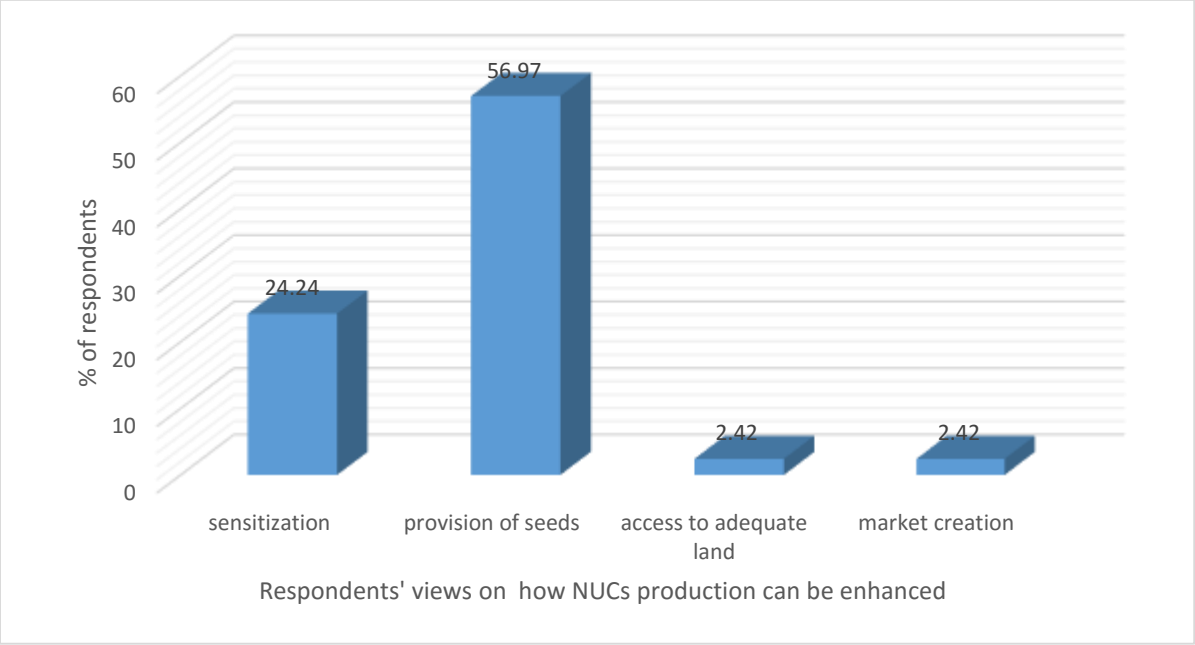


Figure 5.6: Options for enhancing NUC production by smallholder farmers in Mphamba and Zuze villages
Source: Field data, 2020

Some respondents contended that a lack of markets hindered the cultivation of NUCs such as bambara nuts, cowpeas, horned melon, pigeon peas, millet and kidney beans and that creation of markets would enhance their production. Similarly, most respondents (57 percent) suggested that NUCs production can be enhanced through government provision of seeds as well as sensitization on the importance of these crops. It has been widely reported that markets play an important role in crop choice decision making by smallholder farmers (Mubanga et al., 2015; FAO, 2020; Zivanomoyo and Mukarati, 2013). A few respondents alluded to the need for increased access land. They seemed unwilling to allocate the land they cultivated to NUCs, as the land is dedicated to the production of dominant crops such as maize and groundnuts. Padulosi, et al. (2013) suggest that public awareness campaigns, better information and training can help farmers and consumers realise the benefits of NUCs and can encourage scientists and policy makers to optimise and promote these benefits. Their study further suggests the entire agricultural sector needs to recognise

the importance of NUCs and to protect and conserve traditional knowledge about NUCs for future generations.

With regard the extent of the cultivation of neglected and underutilised crops by the respondents in the study area, the findings of the study were as outlined in Table 5.3.

Table 5.3: Approximate area allocated for production for each crop cultivated by smallholder farmers in the study area.

| Crop cultivated | Area allocated to each crop ($m^2$) | Mean area cultivated for crop per household (ha) | % Total cultivated area allocated to crop (n=165) |
|---|---|---|---|
| Maize | 3,258,500 | 1.96 | 66 |
| Cowpea | 109,025 | 0.12 | 2.22 |
| Bambara nut | 67,375 | 0.12 | 1.37 |
| Broad bean | 13,475 | 0.12 | 0.55 |
| Common bean | 26.950 | 0.12 | 0.55 |
| Pumpkin | 222,950 | 0.12 | 4.5 |
| Sweet potato | 30,625 | 0.12 | 11.52 |
| Ground nut | 742,350 | 0.49 | 15.1 |
| Horned melon | 11,025 | 0.12 | 0.2 |
| Watermelon, cucumber, Crenshaw | 7,350 | 0.12 | 0.15 |
| Sunflower | 271,950 | 0.49 | 5.53 |
| Soya bean | 44,100 | 0.25 | 0.9 |
| Okra | 17,150 | 0.12 | 0.35 |
| Gourd | 42,875 | 0.12 | 0.87 |
| Pigeon pea, kidney beans, sorghum, lentils, cassava | 1,225 | 0.12 | 0.02 |
| Sweet stalk | 29,400 | 0.12 | 0.6 |
| Maroon cucumber | 2,450 | 0.12 | 0.05 |

Source: Field data, 2020.

Small holder farmers in the study area reserved 66 % of their total cultivated land towards the growing of maize (Table 5.3). The other crops which were extensively cultivated following maize included sunflower, groundnuts and sweet potatoes. However, for the rest of the crops, only less than 5 % for each was reserved.

The respondents, however, pointed out that the area allocated to a crop is determined by the value attached to that crop. Thus, the relative importance of each of these crops to the farmers could be seen from the proportion of land they allocated to their cultivation (Table 5.3). Likewise, the dominance of maize production in Mphamba and Zuze villages is clear but not unique. For instance, Mubanga et al. (2015) in a study conducted in Central Province of Zambia note that commentators on Zambia's historical and current agricultural sector development have observed the sectors pre-occupation with maize production. They argued that dominance of maize production among smallholder farmers is attributable to several related factors. For example, since the country's independence in 1964, government agricultural policy has mainly focused on the provision of incentives for maize production and marketing to the exclusion of other crops (Chamberlin et al. 2014).

These findings are in line with a study by Braimoh et al (2018) who argued that 90 percent of smallholder farmers in Zambia grow maize as their main crop, reflecting the large subsidies that go in to maize production. Other crops are groundnuts, cassava, mixed beans and sweet potatoes produced by fifteen percent of farmers, while other crops like sunflower, soya beans, rice, sorghum, bambara nuts and cowpeas are produced by not more than ten percent of farmers.

This resulted in crops like maize, ground nuts and sunflower being allocated more hectarage (on average 1.96 ha) while other crops such as cowpeas, pumpkins, broad beans, bambara nuts and sweet stalks being allocated less (0.123 ha). Furthermore, the respondents explained that crops such as pumpkin and cowpea were cultivated to that extent shown in Table 5.3 only because they were intercropped with major crops such as maize, groundnut and sunflower. They contended that if these crops had been cultivated separately, they would have been allocated much less land, if any at all. NUCs that are not intercropped such as Bambara nut, beans, sweet potato and *msandile* cowpea are hardly cultivated nowadays. Respondents averred that this was because these crops are not intercropped. This is because these crops do not yield well once they are intercropped as they are not able to creep as such they are overshadowed by those crops which grow to longer heights such as maize crops. These findings are similar to those in a study by Chivandi et al (2015), which points out that some NUCs get the opportunity of being cultivated by smallholder farmers just because they are cultivated in mixed agricultural/garden systems.

When asked about the frequency of cultivation of NUCs, the respondents said that how often the crop is cultivated depended on the benefits derived from it. For instance, food crops mostly grown for home consumption are 'women's crops' as they are usually grown on plots controlled by women (Orr et al. 2014). This meant that women had more jurisdiction over these crops as they were the ones who realized the benefits derived from most NUCs. The same is true for cash crops dominated by men. This included the farming households' desire to secure consumption from own production, market failures, and roles of state and non-state actors (Mubanga et al., 2015). For instance, depending on the size of the land they possess, some crops like cowpea, bambara nut, sweet potato, sweet stalk and broad bean were not cultivated every year as compared to other crops. This situation has led to the decline in production of most of the crops and hence resulted in their neglect and underutilisation. Further, Shekara et al. (2016), in a study conducted in India, argued that the extent of area allocated to a crop may be determined by several factors such as past and present experiences of farmers, expected profit and risk, market demand and government policies and schemes regarding the crops being cultivated in the country. As a result of these factors, many smallholder farmers tend to allocate more area to crops where they are assured of benefitting more. Consequently, this has resulted in allocating less area to crops whose benefits are perceived to be minimal in their households.

Likewise, the provincial statistics for the Eastern Province, shows similar trends whereby the area allocated to NUCs or minor crops by smallholder farmers was decreasing, while the opposite was the case for the major crops (Appendix IV- c). Between 2015 and 2020 the production trends for maize, sunflower, soya beans, ground nuts and sweet potatoes were rising while the production trends for cowpeas, sorghum, Bambara nut and millet were decreasing. For instance, the hectares planted for Bambara nuts and cowpeas by 2020 declined from 153.37 and 121.55 hectares to 99.69 and 98.69 hectares respectively (Appendix IV- c), (Ministry of Agriculture Eastern province office, 2020). Crop production area estimates for Petauke for the period 2015 to 2019 (Appendix V), revealed that the district is focusing on the crops that the central government is promoting through its FISP under the Ministry of Agriculture. In this case, the district only reported on crops such as maize, soya beans, mixed beans, sunflower, cotton, cassava and sweet potatoes, which it was fully involved in producing. A key informant from Ministry of Agriculture also pointed this out and observed that the ministry was only promoting cultivation of maize, groundnuts, sunflower, soya bean, cotton, common beans, cassava, sweet potatoes and cashew nut. As a result, the district

agricultural office is only able to compile data for crops which it promotes through FISP while crops not part of its programme are left out. As such, no data is available in the district with regard to production, area under cultivation and the number of households involved for most NUCs.

Therefore, noted from Table 5.3 are the relatively high proportions of land allocated for sunflower and soya beans. However, despite their being perceived as unpopular, farmers in the study area apportioned relatively large proportions of their land to the cultivation of sunflower and soya beans because they have a ready market. For instance, sunflower could be refined for free in exchange for sunflower cake. Apart from this, they could use the oil for cooking and sell some of the oil to buy some of their households needs.

Contrary, crops with no guaranteed market were only cultivated in trace amounts as they were considered mainly as crops for household consumption only. Therefore, most NUCs produced were consumed due to lack of markets. This highlights the important role that activities of private business entities and NGOs play in influencing smallholder farming households' crop choices. Additionally, the low extent of production of NUCs could be explained by their low tradability as they are easily perishable crops as well as the perception of not having a good taste.

However, despite NUCs having potential to grow in marginalised conditions, their extent of cultivation still remains low. Hence, their contribution to food security is still low among many smallholder farmers in the study area. Their potential has remained unexploited amidst climate change. This situation has been attributed to the fact that these crops do not have a ready market as smallholder farmers are not only compelled to cultivate crops for consumption only but also consider the availability of market for the cultivated crop. Further, the smallholder farmers have opted to allocate more area under cultivation to hybrid varieties as these improve productivity, despite food and crop resilience being not guaranteed. This is so as these varieties are susceptible to pests and diseases compared to traditional varieties.

### 5.3. Role of stakeholders in enhancing the production of NUCs.

There are several stakeholders working with the smallholder farmers in the study sites. They include governmental and non-governmental agricultural entities. Their role in enhancing the production of NUCs is reported and discussed in this section.

### 5.3.1. Agricultural interventions on NUCs

The two organizations which smallholder farmers received support from in the study area are the Ministry of Agriculture through the Farmer Input Support Programme (FISP) and the FANSER Project. However, the level of participation in these two interventions was low; only 36% and 15% of the respondents participated in FISP and FANSER Project respectively. Participation is through membership to farming cooperatives and women's clubs for both interventions. Since majority of the respondents do not belong to any farming cooperatives and women's groups, they were unable to benefit from the agriculture support offered by the two organisations.

Regarding the FISP, this programme is spearheaded by the agricultural camp extension officer in the study area. An agricultural camp extension officer is technically agricultural trained worker who is in charge of imparting technical advice on improved methods of farming to the farming community and identify their farming problems (Ministry of Agriculture, 2009). According to a key informant from the Ministry of Agriculture and Cooperatives, the agriculture camp in which the study sites are located has approximately a total of 3, 324 smallholder farmers. She further explained that as required, one extension officer is expected to oversee 600 farmers. However, this is not the case in this agriculture camp. The camp extension officer is responsible for coordinating agro activities in the camp. Therefore, their roles includes motivating the community to implement their plans, focus on methods and techniques of transfer of technology, act as a catalyst for implementation of other activities outside the agricultural sector with the village/camp developmental committees taking the lead in demanding the services from other agencies (Ministry of Agriculture, 2009).

Additionally, the camp officers encourage increased dialogue between community/village residents and themselves. They are therefore, considered as methodological resource persons who design a schedule of activities and proposes different methods for group interactions. They are technical resource persons who present a conceptual frame and tools for diagnosing and analysing problem situations and for elaborating strategies for improving problem situations. Furthermore, these officers are charged with the responsibility of assisting communities to develop linkages with other service providers and other sources of information. In so doing, agriculture camp officers also monitor programmes that are implemented by private stakeholders which are in line with the agriculture policy. They help the private sector in identifying the beneficiary smallholder farmers

and help in the implementation of the programme by working with the beneficiary smallholder farmers by providing technical support. This is done through various ways such as field days, sensitisations, seminars, demonstrations and workshops. This clearly show how important these camp officers are in advancing any agricultural development. They are the ones who are involved in the recruitment of farmer cooperatives which are under the FISP. They work with the cooperative executives in ensuring that all their farmer cooperatives register, pay contributions in time and receive their allocated FISP packs in time. They are the ones who are responsible for identifying the viable but vulnerable farmers who are eligible to receive the subsidised inputs from the government through the various farmer cooperatives in the study sites. A camp officer in the study area is also the one who is working with FANSER project in monitoring the implementation of the project by beneficiary farmers. However, as seen from the number of smallholder farmers' one agriculture camp officer superintends over, it has been difficult for them to perform their duties diligently as they are overwhelmed. This makes them to prioritise which activities to be considered. Thus, most of these agriculture officers therefore concentrate on the FISP recruitment. This situation was supported by a key informant who explained that a FISP pack did not include any education from the extension officers. They were just being given the inputs without being enlighten on the way they could use them effectively. On the contrary, a key informant from the Ministry of Agriculture and Livestock pointed out that they have been concentrating on improving maize yields hence they were more involved in educating the farmers on ways of enhancing production in crops they were promoting through government initiated or private stakeholder's programmes. This therefore leaves out other crops (NUCs) not in the FISP from being incorporated into their work plans.

However, the respondents claimed that it had been difficult for them to become members of these groups because of the criteria used to pick members. For instance, only women of reproductive age (15- 49 years) and families with children under two years of age in their households were allowed to become members of FANSER as the intervention is aimed at alleviating malnutrition and improving nutrition among children. This disqualifies a lot of households especially those with older smallholder farmers. This was confirmed by a key informant from FANSER Project who explained that the project was targeted at a specific group of people and was formulated in consultation with the National Food and Nutrition Commission. The latter runs an initiative dubbed '1000 Most Critical Days of human life' aimed at reducing stunted growth in children.

Respondents contended that agricultural cooperatives under FISP were biased and favoured those members that were known by executive members. Key informants in the study area and during FGDs echoed this. All claimed that some of them had registered as far back as 2017 but at the time of fieldwork (2020), they had not received any subsidised inputs under FISP.

### 5.3.2. Type of assistance received by smallholder farmers in study area

When asked about assistance the beneficiaries received from the stakeholders, their responses were as shown in Figure 5.7.

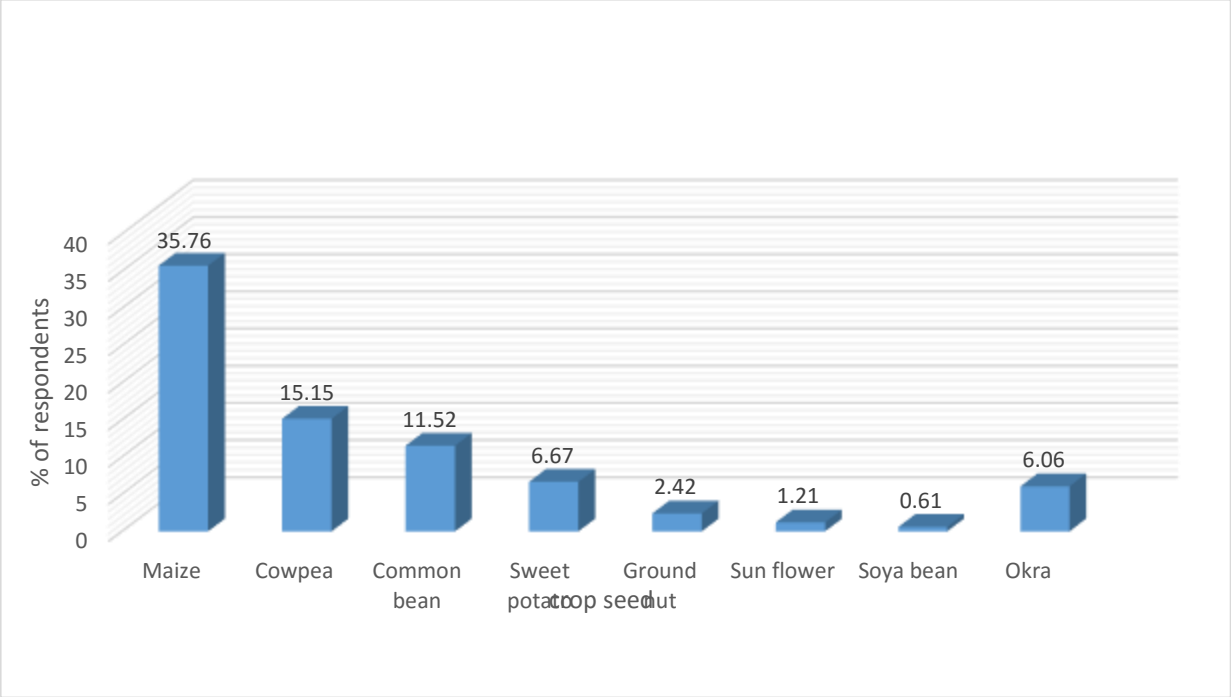


Figure 5.7: Seed given to smallholder farmers in the study area from FISP and FANSER
Source: Field data, 2020

Under the FISP, the beneficiaries received hybrid maize seed and fertilizers. However, they said that there were no agricultural extension programmes concerning this government administered programme. This was also reported from all the FGD's which stressed that the FISP pack only contained hybrid seed maize and chemical fertilizers. The discussants further reported that they had no choice of the type of hybrid maize variety such that they plant what was availed to them by the Ministry of Agriculture. This was also pointed out by a key informant from Ministry of

Agriculture who revealed that the ministry was only promoting cultivation of maize, groundnuts, sunflower, soya bean, cotton, common beans, cassava, sweet potatoes and cashew nut. These are bred by both public and private sectors. The public sector includes Zambia Agricultural Research Institute (ZARI) which coordinates soil and crops research in Zambia. It is responsible for seed variety development and improvement suited to the different agro-ecological conditions, for both hybrid and open pollinated varieties (OPV's) (Nakaponda, 2012).

However, the available market for hybrid maize seed provided by the Ministry of Agriculture and Ministry of Community Development and Social Services through the FISP and FSP respectively, has led to most seed companies concentrate on maize, leaving most of the traditional crops unattended to, resulting in a shortage of quality seed and the limited distribution of improved varieties for such crops. Similarly, ZARI is also biased towards conducting improvement activities for crops in which the private sector is involved in, such as hybrid maize, wheat and soya bean (Nakaponda, 2012). Consequently, the farmer-saved seed sector continues to decline as new improved varieties, particularly hybrid maize, continue to roll in the informal sector, through FISP and FSP, to the extent that the conservation and use of local varieties or local knowledge associated with these crops and varieties, and the maintenance and seed production of those crops, is threatened. Additionally, a key informant from Msekera Agriculture research Institute, a seed breeding institution, elaborated that as an institute, they were breeding seeds of crops such as maize and groundnuts which were part of government's FISP pack and cowpeas on request by private stakeholders like FANSER. This shows how both public and private sector have neglected research on NUCs and concentrated on those crops which are of commercial value.

Therefore, most crops are left out making them to be more vulnerable hence neglected by many smallholder farmers as they are not promoted by the stakeholders. This is because the majority smallholder farmers grow crops availed to them. Further, most farmers shun the use of seed multiplied in their communities in preference for branded seed.

On the other hand, FANSER project beneficiaries were provided with seeds of cowpeas, okra, amaranthus, tomato, sweet potato and carrot. A key informant from FANSER, explained that these crops were arrived at through the guidance of the National Food and Nutrition Commission which is charged with the responsibility of enhancing nutritional food crops production to alleviate

malnutrition in children under five years and pregnant women through a programme dubbed 1000 most critical days. The Zambia National Food and Nutrition Commission (NFNC) was established in 1967 as an advisory body to the government on matters concerning food and nutrition. Its broad objective is to promote and oversee nutrition activities in the country, primarily focussing on vulnerable groups such as children and women (www.nfnc.org.zm). NFNC has undertaken several activities aimed at nutritional improvement with varying degrees of success of which many of these have been done through collaborative effort with both local and international stakeholders. It also liaises with government ministries, other government departments, international and non-governmental organisations in the coordination and integration of development plans and programmes relating to food and nutrition. She said that some crops were suggested to them from which they picked the ones they are currently implementing in the study area. She further highlighted that through their project, the beneficiary smallholder farming households were sensitised about the importance of these crops in enhancing household nutrition. However, respondents from the women's FGD complained that the FANSER pack did not include fertilizer and pesticides, which to them posed a serious challenge to control crop pests.

Similarly, another key informant from FANSER pointed out that the smallholder farmers planted the crop varieties given to them by the organisation hence, did not participate in selection of the crops. This situation was also supported by a key informant from Petauke district agriculture office who said that the government was in the process of introducing vegetable crops to the farmers as a way of diversifying. These remarks clearly show that stakeholders do not involve the smallholder farmers in selecting crops to be included in the pronounced crop diversification. Therefore, smallholder farmers are just involved during implementation. In this case, a top-down approach is used by many stakeholders which is based on imposing the variety of crop in which it has interest in, regardless of smallholder farmers' needs. This approach deprives the smallholder farmers to advance their views which can be used in decision making. In this case, the farmers' voice is usually absent. This is contrary to the bottom-up approach or the participant participatory approach which in this case may work well as it involves the smallholder farmers' participation at all stages of the programme.

However, unlike what prevails in the study area, a study by de Boef et al. (2012), revealed that the Government of Santa Catarina upon realising that smallholder farmers have been gradually losing

the culture of maintaining seed and of growing their own staple food crops to feed themselves, it began to assist these farmers in their social organisations with the aim of re-establishing food security. By so doing, communities decided to restore food security and revive the habit of growing their own food as each community defined the composition of their particular kit of several seeds through a participatory decision-making process. This helped restore the culture of maintaining varieties and producing seed at the community, enhancing the autonomy of the community in food security and also its sovereignty over the maintenance and exchange of seed of local food crop varieties. This ensures full participation of the farmers as they become part of the custodians of the programme and therefore, become empowered. They, therefore, recommended that the farmer participatory approach was a better approach to be used when enhancing NUCs production.

Similarly, Forum for Agriculture Research in Africa (FARA, 2021), an organisation which is developing a manifesto on forgotten foods in Africa elaborates that to harness NUCs production, collective actions are required which include creating awareness and communicating the economic, nutritional, environmental and cultural values of these foods to improve their consumption. It contends that what is needed was an enabling environment for the development of NUCs through research, empowering farmers in production and supporting the private sector in processing, value addition and marketing. All this points to the importance of participatory approach which is inclusive of all stakeholders at every stage.

The literature and the findings of this study indicate that non-involvement of the smallholder farmers by both public and private stakeholders in deciding which crops must be produced in crop diversification and in the maintenance of crop seeds can lead to poor adoption of NUCs into the agricultural food systems. This is because most smallholders may not like the introduced crop and therefore may decide not to adopt. In most cases, it is in such instances where issues of low adoption of some crops have arisen among smallholder farmers. This reaction can be seen as a protest against the imposed crop. Additionally, lack of training in seed preparation and maintenance among the beneficiaries of the FANSER project in the crops they were cultivating has affected the production of NUCs. Consequently, the culture of seed maintenance is being lost and this leads to continuous dependency of seed provision by stakeholders. Further, the exclusion of other crops from FISP, FSP and FANSER project to which smallholder farmers have no input to choose crops leaves them vulnerable to erosion from the food system. However, this current

scenario can be rectified by promoting the participatory approach which advocates for inclusion of all stakeholders' views in arriving at a decision. By so doing, the cultivation of NUCs would be enhanced as all responsible players will be actively involved.

# CHAPTER SIX

# CONCLUSION AND RECOMMENDATIONS

## 6.0 Introduction

This chapter covers the conclusions of the study and recommendations. The recommendations are drawn from the study findings.

## 6.1 Conclusion

This study aimed at investigating the role of neglected and underutilised crops (NUCs) in enhancing food security amidst climate change in Petauke Zambia. The study finds that most smallholder farmers in the study area acknowledge that there are crops and crop varieties that are neglected and underutilised despite their potential to enhance food security. The study finds that these NUCs play a role in enhancing food security among smallholder farming households. They include; maroon cucumber, maize *(nsenga),* maize *(kenya),* Bambara nut, cowpea, lentils, pigeon pea, soya bean, sorghum, Sweet bean, Crenshaw, horned melon, cucumber, groundnut *(kadonontho),* groundnut *(kayoba),* Groundnut *(kongo kanjute),* millet, Broad bean, kidney beans, lablab, gourd, watermelon, cassava, sweet potato, and sunflower. They attributed the neglect of such crops to several factors ranging from; loss of knowledge about production, use and storage, government policy favouring specific crops on the expense of other crops, farmer preference for modern crop varieties, shortage of land and the low yields from these crops. Generally, the area under cultivation for NUCs was perceived to be decreasing annually while that for major crops such as maize, sunflower and groundnut was increasing. The women are at the centre of production of NUCs as they were regarded as women crops and mainly grown for consumption.

The research finds that extent of area allocated to crop may be determined by several factors such as past and present experiences of farmers, expected profit and risk, market demand, gender in charge of the crop and government policies and schemes regarding the crops being cultivated in the country. As a result of these factors, many smallholder farmers tend to allocate more area to crops where they are assured of benefitting more. This has resulted in allocating less area to crops (NUCs) whose benefits are perceived to be minimal in their households. They are only used for consumption by smallholder farming households and therefore, should not be allocated more area. Further, the

study finds that since NUCs are mainly grown for consumption, they are not frequently grown by most smallholder farming households. Their space can easily be traded for other crops which the farmer considers to be more beneficial in that particular season. This has led to the gradual decline in the cultivation of NUCs among smallholder farming households.

Additionally, regarding the role of the government and other stakeholders in promoting the cultivation of NUCs, it can be concluded that there is little attention paid to their promotion. For instance, with the case of the Zambian government, it is only promoting the cultivation of hybrid maize as can be seen through the FISP package offered to its beneficiaries. Similarly, FANSER project is only involved in cowpeas production in its programme. Consequently, this leaves the other crops being neglected as they are left out despite being perceived by the majority smallholder farmers to be more resilient to climate variability and hence could potentially enhance household food security in a changing climate context. The research also concludes that there is little documentation of the NUCs with regard to production, use and storage from both the public and private sectors.

The study highlights that most smallholder farming households in Zambia are being threatened with food insecurity due to climate change or climate variability. This is a result of most high yield improved seed varieties being more susceptible to extreme climate events and pests and diseases. To the contrary, landraces (NUCs) offer better options to improving smallholder farming households' food security amidst climate variability despite their low yields. Although local varieties yield less than improved varieties, they may be better adapted to diverse and location specific low-input agricultural conditions. There is also a source of seed security in case the improved varieties fail. It is further noted that most smallholder farmers are aware about their indigenous crops. They are knowledgeable about the crops which have been neglected and underutilised hence, highlighted several factors attributing to their neglect and underutilisation. To this effect, it is possible to conclude that NUCs are neglected due to several factors. Furthermore, from the study, it can be established that the smallholder farmers are able to allocate more area to crops which have several benefits than those whose benefits are limited. However, the lack of a ready market for NUCs is a major drawback in their adoption. The study also brings out the role of both public and private stakeholders in enhancing food security using NUCs through comprehensive research and development.

## 6.2 Recommendations

Based on the findings of the study, the following are the recommendations:

1. The Ministry of Agriculture and Livestock must intensify farmer sensitisation by extension officers on the importance of cultivating indigenous crops amidst climate variability to enhance food security. In this case, the extension officers must be knowledge brokers as well.

2. The National Food and Nutrition Commission (NFNC) and Ministry of Community Development and Social Services must come up with programmes which aim at value addition to NUCs so that the way of consumption is diversified. This can be done through formation of women's clubs where women can be taught different methods of preparing different dishes of NUCs to promote their consumption. Such clubs were common in the UNIP government in which women were imparted with several skills which included knitting and cookery. This will in turn enhance the cultivation of NUCs as they will be used in several dishes at individual farmer household level.

3. The Food Reserve Agency (FRA) must also include on their list of crops which they buy for National Reserve some of the NUCs such as cowpeas and Bambara nuts. These can later be used during the school Feeding programme which is taking place in the Ministry of General education. Therefore, with the provision of market for these crops, their production levels will be enhanced.

4. Zambia Agriculture Research Institute (ZARI) and private sector actors involved in seed breeding must include NUCs in seed breeding. This must be done through incentivising companies which will be involved in seed breeding for NUCs. This will enhance the maintenance and seed production of those crops, which are under threat of disappearing from the agriculture food system.

5. The Ministry of Agriculture and private stakeholders must train the smallholder farming households in seed preparation, maintenance and storage. This can be done through the community seed banks. This will enhance the maintenance of seeds for NUCs at both household and community level. This will then ensure their availability and a continuous supply of NUCs seed in the community which will in turn enhance their production.

6. The research recommends that an assessment be carried out to find out the ways in which the smallholder farming households consume NUCs.

7. The study recommends further research to find out what knowledge the community has regarding community seed banks which may offer a better option to empowering them with skills of preparing and maintaining seeds of NUCs to prevent their gradual disappearance from the agriculture food system.

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**List of Appendices**

**Appendix I – Semi structured Interview schedule for smallholder farming households**

**Start time: ……. Ending time:…….**

**THE UNIVERSITY OF ZAMBIA**

**SCHOOL OF NATURAL SCIENCES**

**DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES**

**Instruments used for data collection.**

An interview schedule for respondents on enhancing food security amidst climate variability among smallholder farmers. What role for Neglected and Underutilized Crops (NUCs) in Petauke, Zambia.

**Self-introduction**

I am Mwale Mabvuto, a post graduate student at the University of Zambia, Great East Road Campus. I am carrying out research on enhancing food security amidst climate variability among smallholder farmers. What role for Neglected and Underutilized Crops (NUCs) in Petauke, Zambia.

You have been selected randomly to take part in this research. Therefore, kindly assist me with the information I humbly request from you.

The information you will give is strictly for academic purposes. Therefore, all responses will be treated as confidential and your identity will be kept anonymous.

**Instructions**

Questions will be asked from the prepared interview schedule. You are requested to kindly give your answers in brief and specific to the point.

**Section A: Personal information**

Sex of the interviewee will be recorded prior to questioning and then, the following questions will be asked and answers recorded.

1. Sex of respondent (interview adult respondents). Tick appropriate (√)

A. Adult male. B. Adult female. C. Household head male. D. Household head female. E. Both

2. Age (record actual age)

……

3. Tribe of respondent

……

4. Marital status
   A. Married. B. Single. C. Divorced. D. Widowed.
5. What is your highest academic/ professional qualification you possess?
   A. No formal. B. Primary. C. Junior secondary. D. Senior secondary. E. Tertiary.
6. Number of years involved in farming. (Actual years)

……

7. Household size
   ……

8. Annual income for the household (estimate)

……

9. Economic wealth (through observation)
   A. Mud with grass thatched house. B. Mud with corrugated sheets house. C. Unburnt bricks with corrugated sheets house.

D. Burnt bricks with corrugated sheets house.

**Section B: Information on Knowledge on NUCs: (I) Production, use and storage and (II) Extent of cultivation.**

10. What crops do you (i) know? (ii) Grow? **(Tick appropriately (√))** (iii) How often is the crop grown, (iv) what is the size of the cultivated land? (v) How many kilograms do you produce? (vi) Who is in charge of crop? (vii) What do you do with the grown crops? (**Tick appropriately (√)). Record all your answers in the table provided as instructed.**

**Table 1: Crops known, grown, how often grown, cultivated area, quantity harvested, person in charge and uses of crop.**

| Crop | (i)Identified crop (√) | (ii)Crops grown (√) | (iii)Frequency (how often crop grown)(√) | | (iv) Size of land cultivated | (v) Quantity produced (KG) | (vi) Person Responsible for crop(√) | | (vii)Uses of crop (Tick appropriately (√)) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Every year | After 2 or more years | | | Male | Female | Consumption | Selling | Both | Animal feed |
| Maize | | | | | | | | | | | | |
| Cowpeas | | | | | | | | | | | | |
| Bambara nuts | | | | | | | | | | | | |
| Sorghum | | | | | | | | | | | | |
| Millet | | | | | | | | | | | | |
| Broad beans | | | | | | | | | | | | |
| Lentils | | | | | | | | | | | | |
| Common beans | | | | | | | | | | | | |
| Cassava | | | | | | | | | | | | |
| Pumpkins | | | | | | | | | | | | |
| Sweet potatoes | | | | | | | | | | | | |
| Ground nuts | | | | | | | | | | | | |
| Bananas | | | | | | | | | | | | |
| Horned melon | | | | | | | | | | | | |
| Water melon | | | | | | | | | | | | |
| Cucumber | | | | | | | | | | | | |
| Crenshaw | | | | | | | | | | | | |
| Sun flower | | | | | | | | | | | | |
| Soya beans | | | | | | | | | | | | |
| Okra | | | | | | | | | | | | |

11. (i) How many varieties do you know for each identified crop? (ii) Which variety do you prefer growing? (iii) What type of seed do you grow? **(Tick appropriately(√))** (iv)Why do you prefer growing the named varieties? (v) Why do you not grow the other varieties? **Record all your answers in the table provided as instructed.**

**Table 2: Preferred grown varieties, type of seed grown and reasons for growing named variety/ not growing the other variety.**

| Crop | Known varieties (by name) | | | | | | | (ii)Preferred variety grown | | | (iii)Type of seed grown | | (iv)Reasons for growing named variety | (v)Reasons for not growing the other variety |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Recycled seed(√) | Certified seed(√) | | |
| Maize | | | | | | | | | | | | | | |
| Cowpeas | | | | | | | | | | | | | | |
| Bambara nuts | | | | | | | | | | | | | | |
| Sorghum | | | | | | | | | | | | | | |
| Millet | | | | | | | | | | | | | | |
| Broad beans | | | | | | | | | | | | | | |
| Lentils | | | | | | | | | | | | | | |
| Common beans | | | | | | | | | | | | | | |
| Cassava | | | | | | | | | | | | | | |
| Pumpkins | | | | | | | | | | | | | | |
| Sweet potatoes | | | | | | | | | | | | | | |
| Ground nuts | | | | | | | | | | | | | | |
| Bananas | | | | | | | | | | | | | | |
| Horned melon | | | | | | | | | | | | | | |
| Water melon | | | | | | | | | | | | | | |
| Cucumber | | | | | | | | | | | | | | |
| Crenshaw | | | | | | | | | | | | | | |
| Sun flower | | | | | | | | | | | | | | |
| Soya beans | | | | | | | | | | | | | | |
| Okra | | | | | | | | | | | | | | |

12 (i). How do you grow the mentioned crops? **(Tick appropriately (√))**, (ii) if they practice rotation, then which crops are rotated? (iii) When do you grow these crop?

**(Tick appropriately (√))**, (iv) Why do you grow them in the mentioned season? **Record all your answers in the table provided as instructed.**

**Table 3: Method of growing preferred crops, growing season and reasons for growing them during that time of the year.**

| **Crops** | **(i) Method of growing the preferred crops** | | | **(ii)Crops rotated** | **(iii)Season the crop is grown** | | | **(iv)Reasons for growing the crop in that season** |
|---|---|---|---|---|---|---|---|---|
| | **Monocropping** (√) | **Intercropping** (√) | **Crop rotation** (√) | | **Rain season** (√) | **Dry season**(√) | **Both seasons**(√) | |
| Maize | | | | | | | | |
| Cowpeas | | | | | | | | |
| Bambara nuts | | | | | | | | |
| Sorghum | | | | | | | | |
| Millet | | | | | | | | |
| Broad beans | | | | | | | | |
| Lentils | | | | | | | | |
| Common beans | | | | | | | | |
| Cassava | | | | | | | | |
| Pumpkins | | | | | | | | |
| Sweet potatoes | | | | | | | | |
| Groundnuts | | | | | | | | |
| Bananas | | | | | | | | |
| Horned melon | | | | | | | | |
| Water melon | | | | | | | | |
| Cucumber | | | | | | | | |
| Crenshaw | | | | | | | | |
| Sun flower | | | | | | | | |
| Soya beans | | | | | | | | |
| Okra | | | | | | | | |

13. (i)How do these crops perform during the following (floods/ droughts and pests attack) (**Tick as appropriate (√),** (ii) how long do they take from planting time to consumption/ harvest. **Record all your answers in the table provided as instructed.**

**Table 4: Crops performance in adverse weather condition (floods/ droughts and pests attack)**

| Crop | Climate variation | (i) Performance of crop | | | | | (ii)Length of growing time (from planting to consumption/ harvest) |
|---|---|---|---|---|---|---|---|
| | | Very poor (√) | Poor (√) | Fair (√) | Good (√) | Very good (√) | |
| Maize | Drought | | | | | | |
| | Floods | | | | | | |
| | Pest attack | | | | | | |
| Cowpeas | Drought | | | | | | |
| | Floods | | | | | | |
| | Pests attack | | | | | | |
| Bambara nuts | Drought | | | | | | |
| | Floods | | | | | | |
| | Pests attack | | | | | | |
| Sorghum | Drought | | | | | | |
| | Floods | | | | | | |
| | Pests attack | | | | | | |
| Millet | Drought | | | | | | |
| | Floods | | | | | | |
| | Pests attack | | | | | | |
| Broad beans | Drought | | | | | | |
| | Floods | | | | | | |
| | Pests attack | | | | | | |
| Lentils | Drought | | | | | | |
| | Floods | | | | | | |
| | Pests attack | | | | | | |
| Common beans | Drought | | | | | | |
| Cassava | Floods | | | | | | |
| | Pests attack | | | | | | |
| Pumpkins | Drought | | | | | | |
| | Floods | | | | | | |
| | Pests attack | | | | | | |
| Sweet potato | Drought | | | | | | |
| | Floods | | | | | | |
| | Pests attack | | | | | | |
| Groundnuts | Drought | | | | | | |
| | Floods | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Pests attack | | | | | | |
| Bananas | Drought | | | | | | |
| | Floods | | | | | | |
| | Pests attack | | | | | | |
| Sunflower | Drought | | | | | | |
| Horned melon | Floods | | | | | | |
| | Pests attack | | | | | | |
| Gourd | Drought | | | | | | |
| | Floods | | | | | | |
| | Pests attack | | | | | | |
| Cucumber | Drought | | | | | | |
| | Floods | | | | | | |
| | Pests attack | | | | | | |
| Water melon | Drought | | | | | | |
| | Floods | | | | | | |
| | Pests attack | | | | | | |
| | Drought | | | | | | |
| Crenshaw | Floods | | | | | | |
| | Pests attack | | | | | | |
| Okra | Drought | | | | | | |
| | Floods | | | | | | |
| | Pests attack | | | | | | |

14. (i) What type of soil amendment do you do to enhance the growth of NUCs? **(Tick appropriately (√)),** (ii) Why do you carry out soil amendment? (iii) Why do you not carry out the soil amendment? **Record all your answers in the table provided as instructed.**

**Table 5: Type of soil amendment practiced by smallholder farmer households to enhance the growth of NUCs.**

| **Crop** | **(i) Soil amendment (tick appropriately)** | | | | | | **(ii)Reasons for carrying out soil amendment** | **(iii)Reasons for not carrying out soil amendment** |
|---|---|---|---|---|---|---|---|---|
| | **Inorganic fertiliser(√)** | **Organic fertiliser(√)** | **Insecticide (√)** | **Herbicides (√)** | **Inoculants (√)** | **N/A (√)** | | |
| Maize | | | | | | | | |
| Cowpeas | | | | | | | | |
| Bambara nuts | | | | | | | | |
| Sorghum | | | | | | | | |
| Millet | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Broad beans | | | | | | | | |
| Lentils | | | | | | | | |
| Common beans | | | | | | | | |
| Cassava | | | | | | | | |
| Pumpkins | | | | | | | | |
| Sweet potatoes | | | | | | | | |
| Groundnuts | | | | | | | | |
| Bananas | | | | | | | | |
| Horned melon | | | | | | | | |
| Water melon | | | | | | | | |
| Cucumber | | | | | | | | |
| Crenshaw | | | | | | | | |
| Sun flower | | | | | | | | |
| Soya beans | | | | | | | | |
| Okra | | | | | | | | |

15 (i) How do you preserve the crops? (ii) How do you keep them after preservation? (iii) How long can they stay after preservation? **Record all your answers in the table provided as instructed.**

**Table 6: Preservation and storage of NUCs and length of storage time practiced by smallholder farmer households.**

| Crop | (i)Preservation method | (ii)Storage (how they are stored) | (iii)Length of storage time |
|---|---|---|---|
| Maize | | | |
| Cowpeas | | | |
| Bambara nuts | | | |
| Sorghum | | | |
| Millet | | | |
| Broad beans | | | |
| Lentils | | | |
| Common beans | | | |
| Cassava | | | |
| Pumpkins | | | |
| Sweet potatoes | | | |
| Groundnuts | | | |
| Bananas | | | |

| | | | |
|---|---|---|---|
| Horned melon | | | |
| Water melon | | | |
| Cucumber | | | |
| Crenshaw | | | |
| Sun flower | | | |
| Soya beans | | | |
| Okra | | | |

16. (i) What Organisations are you working with in the cultivation of NUCs? (ii) If any, then what type of assistance do you receive from them? **(If none, skip the table and go to question 17). Record all your answers in the table provided as instructed.**

**Table 7: Role of stake holders' involvement in enhancing NUCs cultivation by smallholder farmer households.**

| **Name of Organization** | **Type of assistance rendered regarding crops** |
|---|---|
| | |
| | |
| | |
| | |

17. Mention the crops that you feel are neglected and underutilized?

……
……

18. Why do you think are neglected and underutilized?

……
……
……

19. Do NUCs have food security benefits with the change in climate?

A. Yes. B. No.

20. If YES to question above, then what are these food security benefits?

……
……

21. What challenges do you encounter during production, use and storage of NUCs?

……
……

22. In your view, what do you think can be done in order to enhance the cultivation of NUCs?

……
……

**Perception on climate variability**

23. Have you noticed any major change in weather (in terms of major change in temperature or rainfall) from year to year in the past 20 years?
    A. YES. B. NO.
24. If YES to question 23, then what is the change?

……
……
……

25. What has the impact been?

……
……

26. Anything else you may wish to contribute to our interview?

……
……

**End of the interview, thank you so much for your participation**

**Appendix II- Interview guide for Key informants**

**Start time: ……** **End time: ……**

**THE UNIVERSITY OF ZAMBIA**

**SCHOOL OF NATURAL SCIENCES**

**DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES**

**Instruments used for data collection.**

An interview schedule for key informants on enhancing food security amidst climate variability among smallholder farmers. What role for Neglected and Underutilized Crops (NUCs) in Petauke, Zambia.

**Self-introduction**

I am Mwale Mabvuto, a post graduate student at the University of Zambia, Great East Road Campus. I am carrying out a research on enhancing food security amidst climate variability among smallholder farmers. What role for Neglected and Underutilized Crops (NUCs) in Petauke, Zambia.

You have been selected purposively to take part in this research. Therefore, kindly assist me with the information I humbly request from you.

The information you will give is strictly for academic purposes. Therefore, all responses will be treated as confidential and your identity will be kept anonymous.

**Instructions**

Questions will be asked from the prepared interview schedule. You are requested to kindly give your answers in brief and specific to the point.

**Section A: Personal information**

Sex of the interviewee will be recorded prior to questioning and then, the following questions will be asked and answers recorded.

1. Sex

……

2. What is your highest academic/ professional qualification you possess?

A. Tertiary. B. Secondary.

3. What is your current position?

……

4. How long have you been in the position?

……

**Section B: Information on Role of stake holders in enhancing the cultivation of NUCs**

5. What agriculture programme is your institution currently involved in?

……
……
……
……

6. What crops do you promote in your program?

……
……
……
……
……

7. What criteria is used to pick the crops?

……
……
……
……
……

8. Why are you not promoting the other crops? (Neglected and Underutilized Crops).

……
……
……
……

9. Do you have any plans to include other crops in your programme (Especially those which are considered to be indigenous crops)?

A. Yes B. NO

10. If YES to question 10, then what crops would you include?

……
……
……
……

11. Why would you include them?

……
……
……
……

12. If NO to question 10, then why would you not include them?

……
……
……
……

13. What do you think are the benefits of promoting the cultivation of NUCs in enhancing household food security?

……
……
……
……

14. What role do you play in implementing the cultivation/ production, use, storage and marketing of NUCs?

**A. Production**

……
……

**B. Use**

……
……....

**C. Storage**

……
……
……
……

**D. Marketing**

**.....**
**.....**
**.....**
**.....**

15. Is there any government policy document relating to the promotion of cultivation of NUCs among smallholder farmers in enhancing household food security?

A. Yes. B. No.

16. If YES to question 16, then what does the policy state regarding NUCs?

……
……
……
……

17. If NO to question 16, then does the government have any plans to formulate the policy regarding the production, use and storage of NUCs among smallholder farmers?
    A. Yes. B. No
18. What could be some of the challenges faced by your office in implementing the cultivation, use and storage of NUCs?

……
……
……
……

19. What can be said about small holder farmers' attitude towards the cultivation of NUCs?

……
……
……
……

**End of the interview, thank you so much for your participation.**

**Appendix III: Key informant guide for FANSER representatives**

**Start time: ……** **End time: …….**

**THE UNIVERSITY OF ZAMBIA**

**SCHOOL OF NATURAL SCIENCES**

**DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES**

**Instruments used for data collection.**

An interview schedule for key informants on enhancing food security amidst climate variability among smallholder farmers. What role for Neglected and Underutilized Crops (NUCs) in Petauke, Zambia.

**Self-introduction**

I am Mwale Mabvuto, a post graduate student at the University of Zambia, Great East Road Campus. I am carrying out a research on enhancing food security amidst climate variability among smallholder farmers. What role for Neglected and Underutilized Crops (NUCs) in Petauke, Zambia.

You have been selected purposively to take part in this research. Therefore, kindly assist me with the information I humbly request from you.

The information you will give is strictly for academic purposes. Therefore, all responses will be treated as confidential and your identity will be kept anonymous.

**Instructions**

Questions will be asked from the prepared interview schedule. You are requested to kindly give your answers in brief and specific to the point.

**Section A: Personal information**

Sex of the interviewee will be recorded prior to questioning and then, the following questions will be asked and answers recorded.

1. Sex
2. What is your highest academic/ professional qualification you possess?
   A. Tertiary. B. Secondary.

3. What is your current position?

……

4. How long have you been in the position?

……

**Section B: Information on Role of stake holders in enhancing the cultivation of NUCs**

5. What is FANSER?

……

6. What is the aim of the organization?

……..…….

7. What kind of programmes is the organization implementing in Zambia?

……

8. In how many provinces is the organization working in?

…….……

9. In how many districts is the organization working in?

……

10. What was the criterion used for choosing the districts?

……

11. Which chiefdoms/ villages is the organization implementing its programmes in Petauke district?

……

12. What are the criteria for selecting the beneficiary households in your programme?

……

13. What crop varieties is the organization supporting the farmers with in your programme?

……

14. How did the organization come up with the mentioned crops?

……

15. Where the beneficiaries involved at any stage of selecting the crops given to them by the organization?

……

16. How have the beneficiaries received the programme?

……

17. Apart from crop seeds, what else does the organization help the beneficiaries with?

……

18. What challenges have you encountered during the implementation of the programme?

……

19. From the inception of your programme, have you noticed any crops that are neglected by the smallholder farmers?

……

20. Do these NUCs help in enhancing food security?

……

21. How do you promoted the cultivation of NUCs?

…….....

**END OF INTERVIEW**

**THANK YOU FOR PARTICIPATING.**

## Appendix IV. Eastern Province Crop Forecast Survey (2015/2020)

### a) Eastern Province Crop forecast survey in metric tons (2015/2016)

| Crop | 2015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 |
|---|---|---|---|---|---|
| Maize | 500,920.42 | 872,632 | 452,349.00 | 493,982 | 604,547 |
| Sorghum | 25.52 | 5 | 60.44 | 143 | 50.19994 |
| Rice | 2154.19 | 2,260 | 2,189.47 | 2,795 | 2,853 |
| Millet | 234.83 | 280 | 36.45 | 5 | 58.39463 |
| Sunflower | 43825.24 | 36,048 | 26,388.75 | 25,193 | 27,742 |
| Groundnuts | 31278.14 | 57,156 | 48,259.94 | 40,488 | 32,852 |
| Soyabeans | 27855.89 | 76,880 | 46,995.58 | 70,241 | 89,812 |
| Seed Cotton | 56701.52 | 45,757 | 47,592.16 | 47,894 | 15,236 |
| Irish Potato | 1392.81 | 469 | 160.04 | 561 | 504.0726 |
| Virgnia Tobacco | 570.15 | 1,496 | 2,523.59 | 3,313 | 2,490 |
| Burley Tobacco | 5574.90 | 6,128 | 10,766.75 | 7,896 | 2,499.129 |
| Mixed Beans | 1320.20 | 2,287 | 930.02 | 1,086 | 745 |
| Bambara nuts | 81.71 | 64 | 57.35 | 87 | 28.13128 |
| Cowpeas | 38.05 | 970 | 140.59 | 353 | 55.31181 |
| Velvet beans | 96.15 | 14,190 | | 6 | |
| Sweet Potatoes | 11,143.56 | 223 | 4,721.08 | 4,100 | 6,179 |
| Popcorn | 21.45 | | | | |

Source: Eastern Province Agriculture Office (2015- 2020)

**b) Number of households involved in crop production in Eastern Province (2016-2019)**

| Crop | 2016/2017 | 2017/2018 | 2018/2019 |
|---|---|---|---|
| Maize | 283,641 | 286,391 | 294,897 |
| Sorghum | 42 | 439 | 940 |
| Rice | 5,088 | 4,152 | 5,692 |
| Millet | 1,990 | 701 | 76 |
| Sunflower | 132,608 | 105,440 | 99,937 |
| Groundnuts | 189,394 | 209,991 | 192,240 |
| Soyabeans | 109,894 | 87,952 | 105,942 |
| Seed Cotton | 66,317 | 75,390 | 85,739 |
| Irish Potato | 624 | 333 | 632 |
| Virgnia Tobacco | 1,203 | 2,944 | 3,612 |
| Burley Tobacco | 5,054 | 6,509 | 6,749 |
| Mixed Beans | 9,651 | 6,382 | 7,166 |
| Bambara nuts | 571 | 692 | 1,346 |
| Cowpeas | 2,997 | 1,348 | 1,834 |
| Sweet Potatoes | 13,945 | 5,647 | 7,834 |
| Popcorn | 730 | | |

Source: Eastern Province Agriculture Office (2016- 2019)

### c) Area under production for selected crops in Eastern province (2015/2020)

| Crop | Hectares planted (2015/16) | Hectares Planted (2016/17) | Hectares planted (2017/18 | Hectares planted (2018/19) | Hectares planted (2019/20) |
|---|---|---|---|---|---|
| Maize | 287280.77 | 388,436 | 281,196.26 | 288,280 | 291,567 |
| Sorghum | 103.05 | 5 | 129.03 | 226 | 102.5876 |
| Rice | 1541.17 | 1,529 | 1,178.33 | 2,007 | 1,976 |
| Millet | 436.82 | 674 | 127.23 | 19 | 122.4252 |
| Sunflower | 81922.89 | 67,546 | 57,069.97 | 49,801 | 52,661 |
| Groundnuts | 68051.21 | 96,488 | 98,637.73 | 87,750 | 68,008 |
| Soyabeans | 33302.63 | 83,252 | 54,860.80 | 77,280 | 101,727 |
| Seed Cotton | 66346.40 | 54,740 | 57,990.08 | 61,313 | 23,420 |
| Irish Potato | 364.51 | 197 | 72.56 | 357 | 266.3081 |
| Virginia Tobacco | 323.36 | 757 | 1,472.06 | 1,870 | 1,836 |
| Burley Tobacco | 4339.37 | 3,983 | 7,063.84 | 6,410 | 1,725.011 |
| Mixed Beans | 2555.32 | 3,929 | 3,191.61 | 3,515 | 1,650 |
| Bambara nuts | 153.37 | 366 | 106.67 | 228 | 99.69161 |
| Cowpeas | 121.55 | 1,292 | 262.26 | 455 | 98.68814 |
| Velvet beans | 782.68 | 5,016 | | 5 | |
| Sweet Potatoes | 2568.42 | 5 | 1,781.61 | 2,005 | 2,286 |
| Popcorn | 26.32 | 243 | | 17 | |
| | | | | 13 | |

Source: Eastern Province Agriculture Office (2015- 2020)

**Appendix V: Petauke District Crop Production Area estimates (2012 – 2018)**

| Crop | Category | Number of Growers | | | Production | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Male | Female | Total | 2012/13 | 2013/14 | 2014/15 | 2015/16 | 2016/17 | 2017/18 |
| Maize | Small Scale | 38,809 | 11,770 | 50,579 | 28,051 | 30,347 | 30,352 | 28,352 | 60,695 | |
| Soya beans | Small Scale | 1,940 | 834 | 2,774 | 747 | 489 | 472 | 949 | 2,514 | |
| Ground nuts | Small Scale | 25,481 | 28,438 | 53,919 | 22,360 | 10,760 | 10,990 | 10,990 | 57,861 | |
| Mixed beans | Small Scale | 907 | 1,126 | 2,033 | 580 | 642 | 606 | 598 | 920 | |
| Sun flower | Small Scale | 13,471 | 12,073 | 25,544 | 16,750 | 26,137 | 26,500 | 31,500 | 28,196 | |
| Cotton | Small Scale | 9,051 | 6,776 | 15,827 | 10,043 | 10,786 | 10,360 | 30,802 | 13,024 | |
| Cassava | Small Scale | 276 | 124 | 400 | 1,200 | 661 | 409 | 420 | 490 | |
| Sweet potatoes | Small Scale | 2,994 | 1,810 | 4,804 | 510 | 268 | 187 | 210 | 681 | 371 |

Source: Petauke District Agriculture Office, 2020

## Appendix VI Petauke Met Station Rainfall data in millimeters (mm) (2000 to 2022)

| Year | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Annual Rainfall (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2000/1 | 0 | 7.5 | 246.9 | 240.2 | 217.4 | 183.7 | 267.7 | 4.6 | 4.6 | 0 | 0 | 0 | 955.2 |
| 2001/2 | 0 | 0.2 | 88.6 | 100.6 | 288.4 | 116.5 | 79.3 | 25.8 | 0 | 0 | 0 | 0 | 699.4 |
| 2002/3 | 0 | 1.5 | 52.4 | 361.5 | 284.0 | 214.5 | 209.0 | 32.2 | 0.9 | 0 | 0 | 0 | 1156 |
| 2003/4 | 3.8 | 28.1 | 31.5 | 11.7 | 235.1 | 203.4 | 111.3 | 104.1 | 0 | 0 | 0 | 0 | 728 |
| 2004/5 | 0 | 64.2 | 130.2 | 144.8 | 213.8 | 43.0 | 0 | 0 | 0 | 0 | 7.8 | 0 | 596 |
| 2005/6 | 15.8 | 0 | 37.1 | 166.4 | 235.2 | 114.9 | 161.0 | 19.9 | 7.5 | 0 | 0 | 0 | 757.8 |
| 2006/7 | 0 | 4.2 | 78.4 | - | 446.9 | 222.2 | 99.6 | 12.0 | 0 | 0 | 0 | 0 | 863.3 |
| 2007/8 | 0 | - | 235.9 | 87.0 | 260.6 | 160.2 | 73.5 | 0 | 0 | 0 | 0 | 0 | 817.2 |
| 2008/9 | 0 | 0 | 82.0 | 268.5 | 267.2 | 178.1 | 187.0 | 0 | 22.2 | 0 | 0 | 0 | 1005 |
| 2009/10 | 0 | 0 | 82.0 | 268.5 | 146.7 | 369.1 | - | 50.0 | 0 | 0 | 1.2 | 0 | 917.5 |
| 2010/11 | 0 | 0 | 58.7 | 241.4 | 262.3 | 95.2 | 164.5 | 26.3 | 0.9 | 0 | 0 | 0 | 849.3 |
| 2011/12 | 0 | 0 | 175.5 | 177.1 | 265.2 | 209.1 | 132.5 | 17.4 | 0 | 0 | 0 | 0 | 976.8 |
| 2012/13 | 0 | 37.8 | - | 125.6 | 158.3 | 156.5 | 104.5 | 5.6 | 0 | 0.2 | 0 | 0 | 588 |
| 2013/14 | 0 | - | 28.1 | 182.6 | 210.7 | 208.8 | 163.6 | 2.4 | 0 | 0 | 0 | 0 | 796.2 |
| 2014/15 | 0 | 0 | 2.2 | 187.1 | 298.7 | 147.4 | 171.6 | 32.8 | 0 | 0 | 0 | 0 | 839.8 |
| 2015/16 | 0 | 2.2 | 44.7 | 90.7 | 87.7 | 176.4 | 102.9 | 20.3 | 0 | 0 | 0 | 0 | 524.9 |
| 2016/17 | 0 | 0 | 135.4 | 280.5 | 241.5 | 293.7 | 99.9 | 22.0 | 4.7 | 0 | 0 | 0 | 1077.7 |
| 2017/18 | 0 | 0.5 | 131.1 | 140.0 | 40.2 | 286.8 | 127.8 | 0 | 5.1 | 0 | 0 | 0 | 731.5 |
| 2018/19 | 0 | 0 | 131.1 | 130.2 | 223.6 | 149.9 | 39.1 | 12.1 | 0 | 0 | 0 | 0 | 686 |
| 2019/20 | 0 | 8.0 | 83.6 | 191.6 | 276.4 | 294.5 | 43.0 | 0.4 | 0 | 0 | 0 | 0 | 897.5 |
| 2020/21 | 0 | 0 | 4.1 | 107.4 | 293.5 | 294.4 | 199.9 | 15.4 | 7.9 | 1.5 | 0 | 0 | 924.1 |
| 2021/22 | 0 | 6.4 | 20.8 | 107.4 | 356.5 | 130.9 | 60.3 | 29.2 | 0 | 0 | 0 | 0 | 711.5 |
| 2022/23 | 0 | 0 | 125.2 | 366.7 | | | | | | | | | 491.9 |

Source: Ministry of Green Economy and Environment, Petauke Met station, 2023