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FACULTY OF SCIENCE

Water Scarcity, Food Production and Dietary Choices of Rural Populations in Limpopo Province: A study of Musina Local Municipality.

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A research report submitted to the Faculty of Science, University of the Witwatersrand, in partial fulfilment of the requirements for the Degree of Master of Science by Coursework and Research Report.

Supervisor:

Prof Mulala Simatele

Johannesburg, 2018

DECLARATION

I, Zanele Mokgwathi, declare that this research report, apart from the contributions mentioned in the acknowledgements, is my own work, unaided work. It is being submitted for the Degree of Master of Science by coursework and research report to the University of the Witwatersrand. It has not been submitted before for any degree or examination at any other University.

_____

(Signature of Candidate)

……day of……2018

ABSTRACT

South Africa continues to experience major challenges such as increased poverty, high levels of unemployment and in recent years, drastic increases in food and fuel prices. In addition to these challenges, rural households in South Africa must contend with the challenges of water availability. The Limpopo Province of South Africa is one of the regions that has been negatively affected by both economic and physical water scarcity. For rural households in Limpopo, the lack of water does not only threaten food production but also threatens rural health, employment and livelihoods, thereby, increasing vulnerability to food insecurity and increasing poverty. In view of this, there is a need to understand and unpack the complex relationship between water availability and dietary choices in order to reduce the vulnerability of rural households to food insecurity.

This study sought to understand the impacts of water scarcity on the dietary choices of rural households in the Limpopo Province in Musina. This was achieved by exploring the different adaptive measures that households in Musina implement to cope with water scarcity. The primary aim of this research was to investigate the impacts of water scarcity on dietary choices of rural populations in Musina District, Limpopo. To achieve this aim, two secondary objectives were formulated. The first objective was to create an inventory of the impacts of water scarcity on livelihood choices. Second objective, to identify intervention entry points on building the adaptive capacity and resilience of rural households.

A review of the literature was undertaken to lay the foundation for key concepts such as water scarcity, food production and dietary choices. The literature study revealed that water scarcity is one the severe challenges that rural populations in Limpopo are faced with and it has a significant impact on food security.

To address the set objectives for this study, interviews were administered using a structured questionnaire as a guide. Only the household heads were interviewed, and the questionnaire consisted of open- and closed-ended questions. The respondents were selected by means of purposeful sampling technique and for analysis, only data collected from 175 usable interviews has been presented in this report. This study employed a mixed method approach as the core research methodology. The responses obtained were subjected to statistical analyses.

The research findings suggest that rural households in Musina experience challenges with accessing water. The contributing factors to this challenge include high water prices and poor

management of water infrastructure. Many households in Musina adapt to lack of water availability by buying water or walking to other villages in search of water. Water scarcity has an impact on food production and ultimately dietary choices. Households adapt to decreased food production and dietary choices by spending more money on food in order to ensure access. However, the respondents profile variables such as size of households, age and employment status of the household head were identified as contributing factors to vulnerability in the Musina location.

In conclusion, an adjustment/change in the free basic water provision policy is recommended. This is because water availability has numerous benefits for the people of Musina, especially in terms of food security, with subsequent linkages to all other dimensions of livelihoods. This study has added to the empirical body of water scarcity, food production and dietary choices in South Africa and the world at large.

KEYWORDS: Water scarcity; Food production; Dietary choices; Limpopo; Musina; South Africa

DEDICATION

This research report is dedicated to my birth mother, Rosina Mapula Mokgwathi and my lovely adopted mother, Mohlaho Sibasa Maake. You did not have enough funds to take me to school but somehow you managed to do it and I am a GROWN WOMAN because of your hard work, perseverance, words of encouragement, prayers and discipline. I love you very much and I owe everything to you.

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CHAPTER ONE
FRAMES OF REFERENCE

1.1. STUDY BACKGROUND

It is now widely accepted that the twenty first century is a water scarce era (Pittock & Lankford, 2010; Postel, 2000). Majority of the world now recognises water availability as a growing concern. Ayenew (2007) holds the view that the challenge of lack of available water is likely to increase significantly in the future unless appropriate measures are taken. Factors such as population growth, climate change, rapid economic development and water resource degradation are likely to exacerbate the problem (Pittock & Lankford, 2010; Postel, 2000). Overall, the effects of water scarcity are evident in most regions of the world such as East Africa, the Middle East, North Africa and parts of the Caribbean.

Water is critical for food production and as a matter of fact, agricultural production is driven by water input (Ebhuoma & Simatele, 2017; Musemwa *et al.*, 2013). Availability and access to freshwater is not only a basic need but also a very important part of poverty alleviation particularly in developing countries (Förch & Thiemann, 2004). This is because most rural households do not only use water for domestic purposes, instead, water is also used for agricultural activities such as subsistence farming which sustains the livelihood of many rural households (Pollard *et al.*, 2002). In addition, rural agriculture provides employment which generate income for rural households to sustains themselves. Therefore, water is directly linked to rural livelihoods in the developing world (Matshel *et al.*, 2013). Reuveny (2007) is of the view that water shortages threaten the food security of rural areas because of the dependence on agriculture which is water sensitive. The major source of surface water is rainfall and changes in precipitation can have significant impacts on water resources (Arnell *et al.*, 2001). The changes can relate to type, amount, frequency, intensity and duration. Water availability is sensitive to climate change and there is overwhelming evidence to suggest that water availability will be significantly modified by climate change extremes which will ultimately have a significant impact on agriculture (Ebhuoma & Simatele, 2017; Qureshi *et al.,* 2012).

One of the challenges that South Africa suffers from is water availability. This is because South Africa's water availability is very much linked to the precipitation cycle. Therefore, as a country, South Africa suffers a lot from lack of water availability and it is therefore, considered

to be a water scarce country with low and highly uneven rainfall distribution (Mukheibir, 2008; Hedden & Cilliers, 2014). The evaporation rate of South Africa's water resources is reported as four times higher than the world average therefor exacerbating the depletion of available water resources (Schreiner & Hassan, 2011). The challenges with water resources are worsened by the increasing costs of developing new water sources (Hanjra &Gichuki, 2008). However, with majority of the rural South Africans experiencing challenges with accessing water, one can argue that the impacts of depleting water resources will be most severe for rural populations than the urban populations. This is because rural households rely heavily on water availability to sustain their livelihoods (Rivenga & Cassar, 2002). Access to water secures access to a variety of other resources, food being the most important of all. Water availability is therefore essential for rural dwellers and the problem of water scarcity is therefore, a major threat to rural livelihoods.

1.2. PROBLEM STATEMENT

Water increases the livelihood options available to rural households and, it is thus indisputable that in most developing countries, livelihood options that are subject to water availability play a crucial role in sustaining rural livelihoods (Pollard et al., 2002). Therefore, the impacts of water shortages will have serious implications on poor rural households especially those in Sub-Saharan Africa (Stringer *et al.,* 2009). This is because the livelihoods of many rural households in Sub-Saharan Africa are subject to water availability and as a result, such households have a low adaptive capacity to extreme weather changes and climate change (Stringer *et al.,* 2009). It's also because food production and livelihoods in Sub-Saharan Africa is linked to agriculture which is highly dependent on the precipitation cycle (Stringer *et al.,* 2009). In view of this, the issue of depleting water resources and land degradation resulting from changing climate is expected to adversely affect the livelihoods of people in Sub-Saharan Africa, more especially the poor since it may have serious implications on food production (Boko *et al.,* 2007). In addition, the Intergovernmental Panel on Climate Change (IPCC) indicate that Southern Africa has the largest proportion of water scarcity-prone areas (IPCC, 2007). In addition, Southern Africa has been identified as a hotspot for climate change and therefore, one of the challenges that the region suffers from is food insecurity.

In the context of South Africa, Gbetibouo & Hassan (2005) argue that South African food crops would be negatively impacted by a projected reduction in rainfall. Benhin (2006) is of the view that in South Africa, food production is most vulnerable to climatic changes due to its high

dependence on climate variables such as precipitation and temperature. He further observes that decreases in available water resources will have a significant impact on food availability as a result of reduced food productivity (Benhin, 2006). Maize is a staple food for the majority of South Africans and future projected climatic changes are expected to have a significant impact on its production and distribution (Scholes *et al.,* 2015; Matjie, 2015). However, these impacts will be most severe for the poor populations in rural areas (Matjie, 2015). Scholes *et al.* (2015) argue that South Africa is a hot, dry country projected to get even hotter and drier with a relatively low coping capacity. Many South Africans are poor and living in under-serviced facilities hence limiting their adaptation options to water scarcity and land degradation due to climate change (Scholes *et al.,* 2015).

The following extract from Statistics South Africa (2016) is a worrying statement:

> *"A growing number of forecasts reveal that food prices might rise sharply in coming months. Survey data show which parts of the country are most vulnerable. Current data point to an agriculture industry that is struggling. During November 2015, in the midst of South Africa's worst drought in 23 years, Stats SA released gross domestic product figures showing three consecutive quarters of steep decline in agricultural activity[1]. In the third quarter of 2015, the sharp decrease was mainly a result of falling production in field crops, such as maize, sunflowers and sugar cane. The drought has forced South Africa to import maize to make up the shortfall. With rand weakness driving up the prices of other imports such as wheat[2], concern has grown over rising food inflation. Households that depend on grain-based products, and households already struggling to pay for food, are likely to be affected the most." (Statistics South Africa, 2016)*

Goldblatt (2010) argues that the estimated South African population in 2035 will be approximately 82 million people, calculated at an estimated increase of 2% per annum added to a population of 49 million in 2009. This means that, food production and imports will need to more than double to ensure that this projected population is food secure. However, it will be very difficult to ensure that South African households are food secure in future because at this present time South African households are food insecure. Part of the reason for this could be the high unemployment rate and increased poverty. According to the Department of Agriculture, Forestry and Fisheries (DAFF, 2012), a fifth of South African households have inadequate access to food and there is a need to carefully balance agricultural productivity and rural development with ecological sustainability in order to provide citizens with a mechanism for dealing with both food security and poverty. Overall, the information above demonstrates that South Africa's agricultural production will need to increase using the same or fewer natural resources (Goldblatt, 2010). This will however, be very challenging given the fact that South Africa is considered to be water scarce and water is the most critical resource for food production.

The Limpopo Province in South Africa has been identified as an area that is vulnerable to the impacts of the current and future water access challenges (Momba *et al.,* 2006; Palmer and Ainslie, 2002). This is because majority of the province comprises of rural villages that are highly dependent on agricultural production. In addition, most of these villages have been confirmed to be experiencing difficulties with accessing freshwater due to lack of water infrastructure as well as physical lack of water (Momba *et al.,* 2006; Palmer and Ainslie, 2002). However, with farming as the second largest employer in the province, the projected increase in water shortages not only threatens the people's ability to produce foods but also threatens their food security and livelihoods (including agricultural employment) (Cahill *et al.,* 2012). Tibesigwa *et al.* (2015, p2) observe that "food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life". However, many rural households in South Africa, particularly in the Limpopo Province, are food-insecure. Therefore, the projected increases in water deficits indicate a potential challenge for rural households particularly in the Limpopo Province. This is because majority of the households in rural Limpopo rely on farming (water dependent) to grow produce to supplement their food. Therefore, water scarcity is likely to expose rural households in Limpopo to increased food insecurity and poverty (Tibesigwa *et al.,* 2015; FA0, 2008). Furthermore, increased water scarcity will limit and compromise the livelihood options of households in Limpopo since farming is the main source of income for many people (Tibesigwa *et al.,* 2015). This will limit their dietary choices because it will affect their ability to access a variety of nutritious foods (Tibesigwa *et al.,* 2015).

In view of the above mentioned observations, this study was particularly interested in investigating the relationship between water scarcity, livelihood choices and dietary choices. ***The study investigated the impacts of water scarcity on livelihoods vis-à-vis DIETARY CHOICES, in Musina District.***

1.3. RESEARCH QUESTIONS

In view of the research focus above, the following questions were developed to guide the research process:

i) In what ways does water scarcity influence livelihood choices of poor rural communities in Musina?

ii) What adaptation strategies do poor rural households in Musina adopt to reduce the impacts of water scarcity on their livelihood choices?

iii) What policy framework exists, in which the adaptive capacity of poor people could be supported, in order to improve the livelihoods of poor rural communities in Musina?

1.4. RESEARCH AIM AND OBJECTIVES

The aim of this study was to investigate the relationship between water scarcity, livelihood choices and dietary choices. This was based on the premises that climate change results in waters scarcity and this threatens the livelihoods of people. It was also based on the premise that climate change results in land degradation which has implications on food production and ultimately affecting livelihood choices. Therefore, this study aimed to establish this relationship.

In view of the aim, the following were the objectives:

i) Create an inventory (record) of impacts of water scarcity on livelihood choices.

ii) Identify intervention entry points on building the adaptive capacity and resilience of rural households against water scarcity.

1.5. ETHICAL CONSIDERATIONS

According to Drew *et al.* (2008), research ethics refers to the moral obligation to protect participants from harm, unnecessary invasion of privacy and to promote the well-being of participants. In a research ethics context, harm can include psychological stress, personal embarrassment, humiliation or extreme physical pain that may have significant impact on the participants (Drew *et al.,* 2008). Based on these ground, the study questionnaire as well as the methodology were submitted to the Ethics Committee of the University of the Witwatersrand to determine whether they meet ethical requirements pertaining to humans (see Appendix A). This research was approved, and the ethics clearance number was GAES2017-01.

Participants were assured that their participation in the research was anonymous and as a result, participants were never asked for their names to ensure anonymity. Prior to the interview, participants were asked for consent to participate and they were informed that participation in the survey was voluntary. During the process, the researcher ensured that all the participants were aware that they had a choice to disclose or not disclose information on the questionnaire. The respondents were also assured that all the information obtained in this research would be treated with the highest level of confidentiality and that all the information was for academic purposes.

1.6. ORGANISATION OF THE RESEARCH REPORT

This report consists of six chapters. **Chapter 1** focuses on the frames of reference as well as the addressed research aims, objectives and questions. **Chapter 2** focuses on the literature review with a specific focus on water scarcity and food production. **Chapter 3** discusses the methodological considerations which is an outline of the methods employed in data collection and analysis. **Chapter 4** presents the empirical findings. An analysis and discussion of the results is outlined in **Chapter 5**. Lastly **Chapter 6** comprises of the conclusion and the recommendations for future studies.

CHAPTER TWO

THEORETICAL CONSIDERATIONS & LITERATURE REVIEW

2.1. INTRODUCTION

This chapter is dedicated to a discussion on theoretical considerations and literature review. It outlines some of the debates that have taken place within the discourse of water availability, livelihoods and food production. It is within this chapter where key concepts are defined and engaged with. It is important to note that literature review plays a key role in forming the foundation to the analytical framework that comes later in the discussion. Therefore, this chapter plays that role within this context. In view of this, the chapter is divided in the following order: the first section looks at the different concepts that will normally be applied in a study of this nature such as the concept of water availability and food production within the global context. The second section focuses on food production and water availability within an African context. Followed by a section focusing on water scarcity and food production within a South African context. The forth section address the issues of the interlink between water scarcity, food production and dietary choices. The final section is a summary that looks at the existing gaps in knowledge with a focus on South Africa hence justifying the need for this study.

2.2. WATER AVAILABILITY AND FOOD PRODUCTION: GLOBAL PERSPECTIVE

Water is a shared resource that interconnects the environment, food security, energy generation and many other sectors. It is the most widely distributed substance on earth and plays a vital role in human life as well as the environment (Flakenmark, 2007; Rijsberman, 2006; Oki & Kanae, 2006). Food and energy are the users of water. From a food perspective, water and energy are important inputs and from an energy point of view, water plus bio-resources (e.g. biomass from crops) are generally required resources for energy transformation (Brazilian *et al*., 2011). In addition, the supply of food and water require significant amounts of energy. This highlights the interactions between water, food and energy. However, Mendelson (2006) observe that this water resource is fast becoming scarce in most parts of the world because of the increasing demand across all users. Although globally there is an abundance of water, only a small portion of the water is suitable for human consumption (Oki & Kanae, 2006). This

ultimately translates in some regions of the world facing the challenge of water scarcity even though the earth generally has enough water.

Flakenmark (2007, p7) defines water scarcity as "a situation where there is insufficient water to satisfy normal human water needs for food, feed, drinking and other uses, implying an excess of water demand over available supply". Water scarcity can either be physical or economical. The general/usual water shortage is referred to as physical water scarcity and it can be because of various environmental conditions such as degradation of water resources or unfavourable climatic conditions (Flakenmark, 2007; Rijsberman, 2006). Economic water scarcity results from lack of access to water due to economic obstacles (Rijsberman, 2006). Economic water scarcity is often a result of old, damaged or inadequate infrastructure which contribute to poor water service delivery. Developing countries often have water physically available but economically scarce (Rijsberman, 2006). Water scarcity is prone in arid regions because of occurrence of frequent droughts and it is also likely in highly polluted areas.

On a global scale, the eminent water crisis resulting from depleting water resources is being recognized as a growing concern. However, the distribution of water scarcity related issues is disproportionate, with the major challenge commonly observed in developing countries. Kharraz *et al.* (2012) for example, argue that that water scarcity is prevalent in West-African and North-Asian (WANA) regions. Furthermore, Kharraz *et al.* (2012) report that water scarcity in the WANA regions has resulted in famine and drought, forced migration, open conflicts and loss of livelihoods. In another study conducted by Rijsberman (2006), physical water scarcity is a reported reality for densely populated arid areas such as Central and West Asia as well as North Africa. Rijsberman (2006) is of the view that the scarcity does not relate to water for domestic use but instead it relates to water for food production. There is overwhelming evidence that water scarcity results in rural populations being unable to ensure food security because of the reliance on subsistence agriculture (Kharraz *et al.*, 2012; Rijsberman, 2006). In a study by Dotse (2016), it was concluded that rural households in Ngqeleni were unable to reduce household food insecurity vulnerability because of water scarcity. With declining fresh water access recorded as affecting 2 billion people globally, it is believed that water scarcity will result in water related conflicts (Rijsberman, 2006).

Water is critical for food production and in fact, agricultural production is driven by water input (Ebhuoma & Simatele, 2017; Musemwa *et al.*, 2013; Qureshi *et al.*, 2012; Cooper *et al.*, 2008; Fischer *et al.*, 2007). The major source of surface water is rainfall and changes in precipitation

can have significant impacts on water resources (Arnell *et al.*, 2001). The changes can relate to type, amount, frequency, intensity and duration. Water availability is sensitive to climate change and there is overwhelming evidence to suggest that water availability will be significantly modified by climate change extremes which will ultimately have a significant impact on agriculture (Ebhuoma & Simatele, 2017; Qureshi *et al.,* 2012).

It is a widely held view that changing climatic conditions will likely exacerbate water scarcity in many parts of the world (Finalayson & Turral, 2007). The important thing for food security of many rural populations in the world are the future changes in water availability resulting from climate change. This is because the changes will have a profound impact on the natural resource base that agriculture depends upon. Climate change has already brought about observable changes such as declines in rainfall, increased drought frequencies and intensity as well as changing rainfall seasonality amongst others (Noah, 2015; Megersa *et al.*, 2014). There is a growing consensus that such trends will continue into the future unless drastic measures are adopted (Megersa *et al.*, 2014). In Europe, there has been observable increases in temperatures as well as changes in extreme weather events (Reidsma *et al.*, 2010). Webber *et al.* (2014) reported that most parts of Africa, for example, are likely to get warmer with decreased annual rainfall while East Africa is likely to have increased rainfall.

Nkhonjela (2017) is of the view that the impacts of changing climate conditions will be severe for the water industry. Water resource impacts are expected to take shape in the form of changes in frequency and severity of extreme events e.g. droughts and floods. Climate change is expected to exert increased pressure on ecosystems with far-reaching impacts on crop, livestock and fisheries productions (Campbell *et al.*, 2016). The most commonly reported impact of climate change is reduced rainfall (precipitation). The lack of water availability as a result of decreased rainfall has already resulted in the decrease of crop production in many parts of the world. A review by Chen *et al.* (2016), on the effects of climate change on agricultural productivity highlighted that Southern China would suffer negative crop yields because of increased water shortages and extreme weather events caused by climate change.

In another study conducted by Olesen and Bindi (2002), it was concluded that climate change may have positive effects on agriculture in Northern Europe. However, Southern Europe was reported to be at a disadvantage with possible increases in water shortages causing reduced crop yields. Similar findings were highlighted by Reidsma *et al.* (2010) in Southern Europe. The authors concluded that projected increases in temperature and water shortages reduced

crop yields as well as area for cropping. During the summer of 2003, Europe experienced an unlikely heatwave which has since been linked to current climate conditions (Heinemann *et al.,* 2017). The heatwave had a considerable impact on crop productivity. Heinemann *et al.* (2017) concludes that many parts of South America are expected to experience reductions in agricultural productivity associated with climate change induced water scarcity in the absence of adaptation.

Apart from water availability, food production is also dependent on good soils. However, it has been reported that land degradation remains a serious threat to agricultural productivity (Bindraban *et al.,* 2012; Huili *et al.,* 2013; Wessels *et al.,* 2004). Such that land degradation is considered as one of the main causes of stagnating productivity growth (Bindraban *et al.,* 2012). The term land degradation refers to a process whereby the soil quality reduces thus rendering the land less suitable for purposes such as crop production (Bindraban *et al.,* 2012). Causes of land degradation include erosion, nutrient depletion, soil contamination, compaction, salinization and soil sealing (Pimentel, 2006). Le *et al.* (2016) and Wessels *et al.* (2004) reported that at least a quarter of the global land area is faced with land degradation and this has serious implications on livelihoods of poor populations because of the reliance on land.

With fast increasing populations, land degradation poses a serious problem for world food supplies (Pimentel, 2006). Le *et al.* (2016) reported that about 3.2 billion people occupy degraded land areas, and this translates into the livelihoods of billions of people been negatively affected by land degradation. Huili *et al.* (2013) is of the view that changing climate conditions will worsen land degradation thus exacerbating food insecurity. This is because the expectation is for climate change to increase soil erosion thus aggravating soil degradation (Lal, 2006). The changes in precipitation because of climate change are expected to affect soil erosion rates. According to Blanco and Lal (2010) the effects are expected to be more severe in soils managed by smallholder farmers in developing countries because they are generally resource-poor. The high risk can also be a result of large areas which are already degraded as well as the fact that erosion strategies in developing countries are reported to be limited or non-existent (Blanco & Lal, 2010). Soil erosion reduces the water-storage capacity of soils by increasing water runoff. This has serious consequences on food production because the capability of soil to hold water and the fertility determines the productivity of the soil (Huili *et al.*, 2013; Blanco & Lal, 2010; Lal, 2006; Parry & Carter, 1988).

A study by Parry & Carter (1988), revealed that aside from water, crop yields may have been limited mainly by the levels of nutrients in the soil. Thus, suggesting that having sufficient water does not guarantee increased productivity. Bossio *et al.* (2010) investigated the link between water resource management and land management. The study was based on the premise that every land use decision is a water use decision. The findings revealed that agricultural water productivity gains can only be achieved when there is improved land use management. In another study by Khan *et al.* (2009) on China's water management and crop production. The study identified factors such as population growth, urbanisation, land use changes and water scarcity threating China's food security. It was revealed that links and interactions between water, food, environment and population will determine future food security as well as poverty reduction in China. The study concluded that there will be a new level of uncertainty in water management because of climate change.

Based on the explanations stated above, water scarcity and land degradation have a direct impact on land productivity in several ways such that in the worst-case scenarios, people may be unable to produce food to eat and starve because of the two challenges. The literature points out that there is a complex yet significant relationship between water scarcity, land degradation and food production. Water is critical in the relationship as a critical resource for crop production.

2.3. WATER SCARCITY AND FOOD PRODUCTION: AN AFRICAN CONTEXT

More than half of the African population live in rural areas and are faced with the growing challenge of water scarcity (Pelser, 2001). The African population is expected to reach 1.2 billion by the year 2020 (Love *et al.*, 2006). Many African countries have large numbers of rural populations highly dependent on rain-fed agriculture for food and livelihood, both in terms of commercial and subsistence. Agriculture is of tremendous importance for most of Africa given the widespread poverty in the continent and it is believed to be a means for reducing poverty and inequality (Diao *et al.,* 2006). Consequently, rain-fed agriculture remains the dominant source of staple food production and the livelihood foundation of most of the rural poor in Africa (Cooper *et al.,* 2008). However, 25% of the estimated population is projected to be undernourished. Moreover, the majority are living in the dryland areas of sub-Saharan Africa and 70% of the communities in this region are reported to be poor (Love *et al.*, 2006; Ryan & Spencer, 2001). The most vulnerable group is the smallholder farmers, particularly those in arid and semi-arid regions. This is because they generally farm on poor

quality sandy or loam soils with unreliable rainfall as the main source of water (Love *et al.*, 2006). In this context, stresses like water scarcity, land degradation, more frequent and prolonged droughts are expected to have negative impacts on food production and livelihoods (Noah, 2015; Basir & Schilizzi, 2013; Meade & Rosen, 2013).

Agriculture plays an imperative and effective role in ensuring food security as well reducing poverty in African countries (Musemwa *et al.,* 2013). A study conducted by Rosell & Holmer (2007) focused on farmers in the Ethiopian highlands who depend on rainfall dependent agriculture. Results from interviews highlighted that a more difficult farming situation had emerged during the past 40 years, largely due to deterioration of water resources in the face of reduced rainfall. The study concluded that there have been minor rainfall changes but greater rainfall variability which have had negative impacts on food production. In another study by Tambo (2016) on rural populations in west Africa. The author examined regional climate models to predict the impacts of decreased rainfall on crop production. The study concluded that the occurrence of decreased rainfall as well as increased temperatures will result in a decline in biomass production and grain yields. Furthermore, a focus on Ghana by Tambo (2016) revealed that a predicted 2.4% decrease in monthly rainfall and a 1°C increase in temperature will have severe impacts on farming. The study highlighted that changes in water availability because of climate variability will have substantial impacts on the poverty and food security levels in upper east region of Ghana. Households in this region are reported as having the lowest adaptive capacity. In Tanzania, for example, farmers have reported that over the past three decades the yield of maize per hectare has decreased by 50–70% and the yield of rice even more. The evidence points out that reduced soil fertility is the reason for decline in crop yields. In Pakistan, for example, wheat yields reduced during 2002-2003 because of water scarcity. This will affect the livelihood of Mediterranean farmers (Metzger *et al*., 2006; Schröter *et al.,* 2005).

There is overwhelming evidence to suggest that the poorest region in the world is sub-Saharan Africa (Adhikari *et al.*, 2015; Love *et al.*, 2006; Wessels *et al.*, 2004). Like other Africa regions, agriculture is of tremendous importance for many poor populations in the region. In addition, sub-Saharan Africa is not exempted from increased pressure on food production by rapidly growing populations (Adhikari *et al.*, 2015). However, the region's agriculture is characterized by low productivity such that yield of major crops is below the global average. It has been reported that water availability is the main limiting factor for productivity since the agricultural

system is rainfed. In addition, soil degradation through nutrient depletion also plays a vital role in the declining crop yield (Adhikari *et al.*, 2015; Love *et al.*, 2006; Wessels *et al.*, 2004).

Rural development has undoubtedly been affected by the shortage of water because smallholder farmers in sub-Saharan Africa have little access to water for irrigation which is of paramount importance for farming livelihoods (Love *et al.*, 2006). Lack of water has and will continue to cripple socio-economic status of communities through jobs losses in the agriculture and industrial production. In the face of changing climatic condition, the predictions indicate that sub-Saharan Africa will most likely experience significant reductions in precipitation. This is expected to have serious implication on already pressured food production system and these trends will result in further food shortages (Love *et al.*, 2006). Southern Africa (SA) is one region that has been shown to be highly vulnerable to climate related risk due to the region's low coping and adaptation capacity (IPCC, 2007). Over 60% of the region's livelihoods depend on agriculture in one way or the other (Cooper *et al.*, 2008). Agriculture is mostly practised under rain fed conditions (Twomlow *et al.*, 2008), thereby making crop production in SA particularly prone to climate change and variability (Ziervogel *et al.*, 2008).

In a study conducted by Zinyengere *et al.* (2013), the authors reviewed and consolidated results from 19 recent studies which quantitatively project the impact of climate change on crops for the 21st century in southern Africa. Results suggest that the aggregate impact of climate change on crops in southern Africa will be negative. Maize yields are projected to decline on average by 18%. The collective impact of climate change on all crop yields shows a median decline of −11% and −14% respectively. Another research by Conway *et al.* (2015) concluded that climatic changes in Sothern Africa would propagate into reduced water availability and therefore crop yields. This conclusion was based on majority of climate models which projected decreases in annual precipitation for southern Africa, typically by as much as 20% by the 2080s.

2.4. WATER SCARCITY, FOOD AND DIETARY CHOICES: SOUTH AFRICAN CONTEXT

South Africa is considered a water scarce country along with Egypt, Isreal, Malawi and Kenya (Mukheibir, 2008). The country's annual rainfall is 495mm which is about 60% of the world average (Hedden & Cilliers, 2014). South Africa, like many other countries in Sothern Africa has a highly uneven rainfall distribution with majority of the country receiving less than 500mm of annual rainfall while 21% receives less than 200mm annually (Hedden & Cilliers,

2014; Mukheibir, 2008). This results in water availability across the country being variable because of the seasonal rainfall. Schreiner and Hassan (2011) are of the view that South Africa's annual potential evaporation, which is approximately four times higher than the world average annual rainfall, simply makes matters worse. The country is well known for extended dry and wet conditions that create extreme temporal and spatial variability in water availability (Schulze, 2005; Tyson *et al.*, 1971).

In terms of water access, estimations suggest that 20% of the South African population do not have access to sufficient water supply (Kahinda *et al.,* 2007). By 2025 these conditions are expected to worsen as reported by the South African Department of Water and Forestry in 2002. This is because of a projected increase in water demand which is expected to exacerbate the water deficit challenge (Mukheibir, 2008). Increasing population growth and on-going industrial developments (particularly electricity generation) is the main cause of increased water demands in South Africa (DEA, 2011). This means that South Africa will continue to have a challenge of ensuring access to water for all always. However, the effects of water scarcity are expected to be most severe in the south-western, northern and central regions of South Africa (Basson *et al.,* 1997). Water use is not well documented in rural areas of South Africa and because of poor water supply and infrastructure, rural people often collect water from rivers, lakes as well as ground water resources (Mukhebir, 2008). However, with water quality as a major concern for South Africa, such unmanaged water resources place rural communities at risk of water scarcity and waterborne diseases.

In terms of food production, South Africa is regarded as a food secure country capable of producing sufficient food staples (IFSS, 2002; ITC, 2010). In addition, the country is also capable of importing food if necessary to ensure that the South African population meets their basic energy and nutritional needs. However, some authors argue that many rural households are in fact food insecure (Altman *et al.,* 2009). Dotse (2016) is of the view that rural households in Ngqeleni are food insecure and less resilient against water scarcity. Another study by Ubisi *et al.* (2017) revealed that rural households in Limpopo were food insecure because of a decrease in crop yields. Interestingly, South African agricultural production is characterised by a highly capitalised commercial sector as well as a subsistence sector (Baiphethi & Jacobs, 2009). May & Carter (2009) argue that the former apartheid homelands are areas with majority of the subsistence agriculture taking place. The general household survey of 2009 revealed inadequate or severe inadequate access to food in 20% of the South African households. It has been argued that household food insecurity in South Africa is a result of factors related to water

scarcity, poverty and unemployment (Altman *et al.,* 2009; Modirwa & Oladele, 2012; Tshuma & Boyana, 2013). Mwale *et al.* (2012) observe that not only is food insecurity widespread and persistent but it is also disproportionately evident in rural areas. Therefore, it is important to understand the baseline to improve the situation. Limpopo Province is a typical province characterised by large numbers of rural occupants. A study by Modirwa & Oladele (2012) reveals that South Africa food insecurity is not because of failure to produce at a national level but rather the failure to access the food sources by households and individuals.

In addition to water scarcity, land degradation is also believed to be one of the most severe and widespread environmental challenges in South Africa (Wessels *et al.*, 2004; Hoffman *et al.*, 1999). However, most of the land degradation appears to be evident in communal areas. These areas are populated by black people who are predominately engaged in crop production for subsistence or commercial purposes (Wessels *et al.*, 2004). Consequently, these areas today are characterised by high human populations, overgrazing, excessive wood harvesting and soil erosion.

South Africa, like many other countries in Sub-Saharan Africa is not exempted from the impacts of climate variability and change. There have been observations of changing climatic conditions in the form of increasing temperatures as well as changes in rainfall patterns. These have become cause for concern among poor rural South Africans because of the impacts on crop production. Predicted climatic changes include a general warming across the country with severe implications on water resources thus crop yields (Nkhonjela, 2017; Mukhebir, 2008). Temperature is expected to increase by approximately 1.5°C along the coast and 2-3°C inland of the coastal mountains by 2050 (Nkhonjela, 2017). It is believed that changes in climate will have significant implications for South Africa in terms of economic development given agriculture's contribution to the Gross Domestic Product (GDP) (Boko *et al.,* 2007). It is probable that, due to climate change, South Africa will face increases in mean annual temperatures and greater unpredictability of rainfall that is likely to exacerbate existing water shortages, very likely reduction of crop productivity.

In a study by Wessels *et al.* (2004) comparing the productivity of degraded and non-degraded rangelands in South Africa. The results revealed that land productivity in degraded areas was consistently lower than non-degraded areas. Maponya & Mpandeli (2012) reviewed the impacts of drought on food scarcity in Limpopo province. The study concluded that severe droughts in the province resulted in lack of water for irrigation. This had a negative impact on

agricultural productivity and hence resulting in food scarcity. Similar findings were also highlighted by Mpandeli and Maponya (2014). It was concluded that smallholder farmers in Limpopo are extremely vulnerable to the impacts of climate change such as increased water scarcity because of lack of financial resources, low level of resilience and high poverty levels.

2.5. WATER SCARCITY, FOOD AVAILABILITY AND DIETARY CHOICES – A SYNTHESIS

The collective opinion in literature is that one of the main global issues is the insufficient water availability for food. With global health dependent on food supply, shortages in food supply will result in nutrition deficit as reported by the World Health Organisation (WHO, 2014). Although there are many factors which contribute to this issue, reduced water availability and degraded soils comes out as the main factors. There is overwhelming evidence to suggest that water scarcity and land degradation have huge impacts on food production. This means that if people do not have water and lack fertile soils they will be unable to produce crops thus translating into food insecurity for an ever-growing population. This does not only mean food insecurity, but it can also contribute to other diseases.

The concept of food security consists of three pillars, namely food availability, food access and utilization (Bashir & Schilizzi, 2013; Masuku & Sithole, 2009). Food availability refers to the physical presence of sufficient food to meet collective requirements while access refers to ability to secure available food. Regardless of the differing definitions of food security, the combination and interactions of the pillars ensures food security (Vink, 2012). This means that if food is not readily available or accessible to all individuals and safe for utilization, food security will be compromised. In this study, availability and access will be discussed as a necessary component for dietary choices.

The first pillar of food security is food availability and it is based on the capability of a nation or household to produce enough food sources which are readily available (Drimie *et al.,* 2009). However, this pillar is dependent on food production as well as the satisfactory distribution of the available food (Jacobs, 2011). Food production can be on a national or household level, otherwise known as subsistence/smallholder farming. Subsistence farming is typically about producing food sources on a small-scale and it is regarded as an important avenue to ensuring household food security. Factors such as unemployment and poverty can affect the second pillar of food security namely food access. This is because unemployment and poverty can limit households' food access even if the availability is abundance (Pinstrup-Anderson, 2009;

Li & Yu, 2010). This is evident in most rural areas in South Africa particularly in Limpopo and Eastern Cape provinces (Victor, 2009). The allocation of available food sources plus the affordability of such foods and the preference of consumers will determine whether food access is sufficient or not. Financial resources play a vital role in ensuring food access such that households with insufficient finances cannot afford available food sources (FAO, 2011). The food security pillars are dynamic as they are influenced by factors such as water scarcity, increasing population growth, food production, markets and the overall state of the economy (FAO, 2011).

A study conducted by Hanjra & Qureshi (2010) on the impact of water scarcity on future food security, concluded that constant decline in water resources, climate change and energy shortages pose a threat to food security. In another study by Cline (2003), the impact of water scarcity on food production was examined. The author found that food production could be reduced by water scarcity with severe impacts on food and nutrition security. Similar findings were highlighted by Qureshi *et al.* (2013). The authors investigated the impact of water scarcity on global food security. The study concluded that water scarcity will have major implications on food security. Moreover, the study exposed that the future of food and nutrition security will be determined by population growth in addition to water scarcity.

Rodriguez *et al.* (2015) examined the impact of drought on food security among rural Mexican families. Like other studies, the results indicated that drought has a significant impact on food security. The United Nations Development Programme (UNDP) also highlighted similar findings. In 2007, a report by the UNDP concluded that food and nutrition security will not be worsened by lack of arable land but rather water scarcity which will limit food production therefore risking food security. There are several factors which pose major challenges to water scarcity and food production. These include land degradation, groundwater depletion, ecosystem degradation, fast growing population and water pollution (Hanjra & Gichuki, 2008). Hanjra & Gichuki (2008) analysed the impact of these factors on densely populated regions of the world such as the Middle East, India, China, Mediterranean and Pakistan. The study revealed that growing water scarcity has implications for hunger, poverty, climate change, ecosystem degradation, world peace and security.

A study by Molden (2007) investigated the link between food security, water entitlements, inequitable food distribution and poverty. The study concluded that food insecurity was worsened by the lack of water entitlements. Some authors have argued that under water scarce

scenario, the widening gap between the rich and the poor will pose risks to food security. Consequently, the growing water scarcity will translate in a decrease in crop yields therefore worsening food and nutrition security. Overall, the literature cited above has made one point clear: an important determinant of food security is water. Therefore, the constant decrease in water resources will have adverse impact on food and nutrition security.

2.6. GAPS IN KNOWLEDGE

A lot of work has been documented on water scarcity, land degradation and food production both locally and globally. Scholes *et al.* (2015) argue that the decrease in rainfall will result in farmers not having sufficient water for agricultural purposes hence causing further decline in food production with an increase in unemployment rates. The impacts of this scenario will be much higher on the livelihoods of the people who rely on agriculture to secure an income. Shackleton *et al.* (2008) are of the view that arable land offers South African rural people an option to trade in natural products hence generating income to sustain livelihoods. However, Shackleton *et al.* (2008) further argue that in the face of degrading land and water scarcity this safety net of rural people will be compromised.

There is an ever-increasing consensus that natural resources base such as water and land will be impacted by changing climatic conditions. As a result, there have been several studies examining the impact of changing climatic conditions on water, land and food. For example, a study by Ubisi *et al.* (2017) examines the effects of climate change on crop production and livelihoods in Limpopo. The study findings revealed that subsistence farmers perceived long periods of drought which presented an enormous stress for crop production. This resulted in low crop yields and high crop failures.

What is coming out from all the literature is the consensuses that water scarcity and land degradation have serious implications on food production thus food security. Furthermore, the literature highlights the impact of climate change on food production systems. In essence, previous published studies limit their arguments between water, land, climate change and food. Consequently, there have been separate investigations into the relationship between water scarcity and food production as well as those focusing on food production and land degradation.

To date, research does not go beyond this and talk about how then the impacts of water scarcity and land degradation on food production thus livelihoods affects dietary choices. The key thing that is not coming out which is relevant to this study is the focus on how climate change vis-à-vis water scarcity and land degradation affects dietary choices. As such, this is the basis for the

present study. It is important that we understand this relationship because dietary choices revolve around the nature of nutrition that households have, and this has knock-on effects on their ability for education/learning/national health/country's development etc. Amuna & Zotor (2008) is of the view that nutritional risk has a much greater impact in developing countries because it often contributes to increased infant and childhood mortality; and low birth weight. Reports by Rice *et al.* (2000) suggest that malnutrition is the most significant cause of mortality in children and this is more evident in poor rural areas such as those in South Africa. Thus, it is important to understand the relationship between water scarcity and dietary choices (nutrition security) because it has direct implications on human development. There is little empirical evidence in the literature that has combined the issues of water scarcity, food production and dietary choices. The results of the current study will therefore close the gap and contribute to the body of knowledge.

The study aims are examine and outline the link between water scarcity, food production and dietary choices at a household level in rural Limpopo. This will assist in creating a baseline data at the local level and to determine impacts of depleting natural resources at a household level.

CHAPTER THREE

METHODOLOGICAL CONSIDERATIONS

3.1. INTRODUCTION

This chapter is dedicated to discussing and exploring the various methodology employed in this study. It outlines the different methods that were used in data collection which forms the basis of this study. It is important to note that methodology by definition is a discussion of the underlying reasoning why particular methods were used. According to Kitchin and Tate (2000) the methodology used in research constitutes a set of procedures, which can be used to investigate a phenomenon or situation. In essence, this chapter will answer two specific questions: How was the data collected or generated? and how was it analysed?.

In view of this, this chapter is divided in the following order: the first section will discuss the research philosophy which outlines the researcher's philosophical position. This is important because the methodological procedures employed in the study were selected based on the researcher's epistemological point of view. The second section will focus on a brief recall of the general research aim and objectives followed by section three which will be discussing research design in detail.

3.2. RESEARCH PHILOSOPHY

According to Wahyuni (2012), the way data is collected, analysed and used rests in the research philosophy of the researcher. This is because the thinking and action of a researcher is guided and directed by his/her philosophical assumptions (Mertens, 2010) and as such, a researcher's worldview influences the final research outcome. There are always biased positions taken during a research process because a researcher is never neutral, and the position is based on personal philosophy. Therefore, it is important to always state the research philosophical position because it can affect the quality of work (Bahari, 2010).

Research philosophy is concerned with nature of knowledge, how knowledge is generated, understood, used and what is considered as acceptable knowledge (Bahari, 2010; Mertens, 2010). The approaches employed in research are based on different paradigms including: positivism, post-positivism, constructive-interpretivism and pragmatism (Bahari, 2010; Ponterotto, 2005). These paradigms or perspectives are used to conceptualise, guide and classify research.

One of these paradigms is Positivism. This paradigm believes that reality is stable and can be observed and described from an objective viewpoint without interfering with the phenomena being studied (Petty *et al*., 2012; Bahari, 2010). It is based on observation and measurement involving the collection of statistical data and reasoned analysis (Bahari, 2010). Advocates of this paradigm argue that observations should be repeatable, and the studied phenomena should be in isolation. Positivists researchers search for regularities and casual relationships between elements of the social world in an attempt to explain and predict the occurrences of the social world (Neuman, 2011; Bahari, 2010). According to Bahari (2010), quantitative methodology is employed in positivists research and it involves the collection of numerical data that uses precise statistical analysis.

In addition to positivism, there is Post-Positivism paradigm which is a successor of positivism ideology (Mertens, 2010). This paradigm agrees that knowledge is a result of the conditions in the social world and generalises the knowledge. Wahyuni (2012) is of the view that those who advocate for this paradigm are critical realists who understand that social reality must be framed in a particular context of relevant dynamic social structures or laws, which have created the observable phenomena in the social world. Often, post-positivist researchers use both qualitative and quantitative approaches in their research. According to Bahari (2010), qualitative research is one in which the researcher makes knowledgeable claims based primarily of participatory perspectives, individual experiences or both. Empirical materials such as case studies, life stories, personal experiences, interviews, observations which are meaningful to people's lives are employed in qualitative methodology (Wilson, 2010). Qualitative research emphasises words rather than quantification in the collection and analysis of data and this methodology offers an opportunity to discover and identify the presence or absence of a problem (Bahari, 2010; Du Plooy, 2009).

On the other hand, Constructive Interpretivism is a paradigm which believes that 'reality' is not objective and exterior but it is rather socially constructed and given meaning by people (Bahari, 2010). This means that it is highly subjective and there are many interpretations of reality. Authors argue that even though there is high subjectivity in this paradigm, the interpretations are in themselves a part of the scientific knowledge. Petty *et al.* (2012) are of the view that knowledge of this reality involves understanding the multiple views of people in a particular situation. A constructivist researcher is focused mainly on what people think and feel as well as how they communicate with one another and attempts to explain and understand why people have different experiences (Bahari, 2010). Constructionist researcher has the role

of appreciating/interpreting the varying constructions and meanings based on people experience. The research write-up involves quoting words from different respondents to reflect the different perspectives and voices (Petty *et al.,* 2012).

The final research philosophy in this study is Pragmatism. This paradigm combines all three ideological beliefs. Pragmatist researcher are of the view that there may be one reality, but it is interpreted differently by individuals (Griensven *et al*., 2014). Furthermore, the advocates of this paradigm argue that to get a better understanding of the social reality it is important to employ a mixed methodology (Wahyuni, 2012; Bahari, 2010). The focus of a mixed method approach is to collect and analyse data by combining both qualitative and quantitative data in a single and or series of studies (Griensven *et al.*, 2014; Creswell & Clark, 2011). Hesse-Biber & Levy (2008) argue that the benefits of this research methodology include the triangulation of techniques to offset each other's inherent weaknesses by using their respective strengths.

Overall, the researcher is most concerned with the adoption of a research philosophy which will enable the researchers to answer the relevant questions and objectives. After an examination of the different research philosophies, the researcher concluded that pragmatism is the most appropriate philosophy for this research. This means that mixed method approach would be applied therefore both qualitative and quantitative methods of research were employed. The primary data was obtained from a large number of households using semi-structured questionnaires. This was an added advantage for the researcher because it enabled the application of various statistical methods to analyse and interpret the data while at the same time enabling the participants to voice their opinions regarding the subject matter. The mixed method approach enabled the researcher to answer the research questions from different angles and in many forms.

3.3. RECAP OF RESEARCH AIM AND OBJECTIVES

Before discussing the research design, it is important to recap the general aim and general objectives of this study. The general aim of the study was to investigate and understand the relationship between water scarcity, livelihood options and food choices. This study is important because it will enable for understanding and contributing to the creation of an inventory on how this nexus exists.

The general objectives were as follows: the first objective was aimed at documenting the impacts of water scarcity on livelihood choices. The second objective was to capture the adaptation strategies employed by rural populations in Musina in the face of water scarcity.

3.4. RESEARCH DESIGN

Research design refers to the structure, plan and strategy chosen to enable the researcher to answer the research questions. It can also be defined as the format and theoretical structure under which the study was carried out (Mutambara *et al*., 2010). Overall, this section acts as the blueprint for the study as it guides data collection and analysis. Bryman (2004) argues that suitable research methods must be chosen at hand as well as research methods which are compatible with the study site. Babbie (2010) states that research design captures the plan from beginning of the process to the end. The design also indicates how the main parts of a research (e.g. measurements, samples or tools) employed get integrated into the research to address the research objectives or questions.

This research used both qualitative and quantitative research design in nature to explore the relationship between water scarcity, land degradation and dietary choices in rural Musina. The researcher used qualitative method to gain insights in local perceptions and opinions on the impacts of water scarcity and land degradation on food production of the local people. The researcher used semi-structured questionnaires. The reason for the qualitative method was because the researcher was interested in exploring the impacts of water scarcity and land degradation on dietary choices of rural populations in Musina. Structured questionnaires were employed to obtain quantitative data on household's food expenditure, demographic characteristics and other basic information. To quantify data in terms of statistics, percentages and tables, the researcher used quantitative method.

3.4.1. RESEARCH SITE DESCRIPTION

The chosen study site for this research was Musina local municipality. Musina local municipality is in the very North of Limpopo Province (23° 20'' 17' S, 30° 02'' 30' E), bordering Zimbabwe and Botswana (Fig. 1). Musina is the main entry point into South Africa from countries north of South Africa and factors such as declining economic conditions in countries such Zimbabwe have contributed to a drastic population increase since early 2000 within the municipality (StatsSa, 2011).

Musina covers a total area of approximately 7 577 km^2. The municipality has a population of 69 732 people accounting for 5.3% of the total district population (IDP, 2016). Musina local municipality largely consist of Africans (Black) (94%) and black females represent 49.5% of the total population. There are more than 20 000 households in Musina with an average household size of 3 persons per households (StatsSa, 2011). These households can be grouped

into three types, namely: Farms, Formal residential and Traditional residential. A proportion of 39.6% of the households are female headed and 8.86% of the households are regarded as agricultural households because of involvement in agricultural activities (StatsSa, 2011). In addition, most of the residents are aged under 20 years hence resulting in a high dependency ratio of 44.5% (StatsSa, 2011). A proportion of more than 26.4% of the households have access to piped water inside their households. This is an important figure because it suggests that majority of the households in Musina are forced to rely on alternative sources of water such as community taps. The main source of energy for cooking and heating is electricity but even so, there is an extensive use of wood for cooking and heating, 29.6% and 25.5% respectively (StatsSa, 2011). This indicates that many households still rely heavily on natural resources for their livelihood, which is typical of a rural economy. In the case of severe and prolonged drought, this section of the population will be the least resilient.

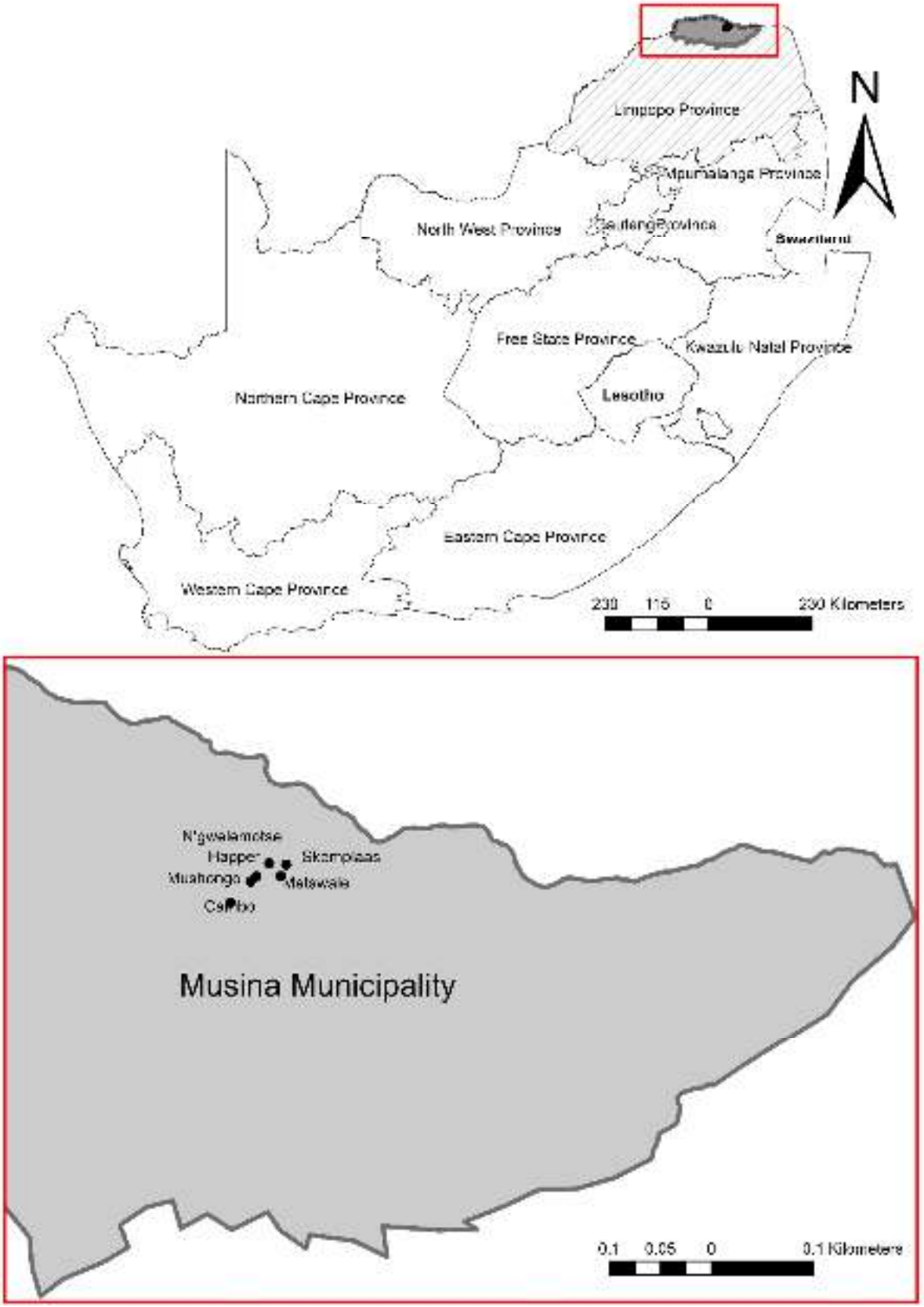


Figure 1: Shows the map of South Africa with the study site, Musina Local Municipality.

The majority of land in the municipality is used for agricultural purposes ranging from cattle farming, arable farming and game farming, the urban settlements only constitute up to 0.08% of land cover (IDP, 2014/15). Musina area comprises of a variety of soils types with great potential in terms of the different land uses. The first soil type is that of intermediate suitability for arable agriculture where climate permits while the second soil type is considered suitable for forestry or grazing but not suitable for arable agriculture and this type of soil is found along the Sand River and towards Limpopo River (IDP, 2014/15). The Eastern side of Musina consist of soils not suitable for agriculture or commercial forestry but are suitable for recreation and conservation. It is important to note that the rural settlements of Musina tend to be clustered and sparsely distributed outside the Eastern portion of the municipality and because of this distribution there is a great spatial imbalance between the East and Western areas of the municipality in terms of settlement and infrastructure. The fourth soil type in Musina is one deemed to be of poor suitability for arable agriculture.

In addition to understanding the soils of Musina, it is equally important to understand the climatic factors that need to be sufficient to sustain a viable agricultural production. Musina is known to be located in one of the warmest parts of South Africa. The climate of the area is characterized by mild, very dry winters, followed by hot wet summers (Kyei, 2011). Throughout the municipal area, maximum temperatures exceed 30°C while the Limpopo Valley is the warmest with maximum temperatures exceeding 33°C on average (IDP, 2014/15). Musina's rainfall is categorised within the rain shadow of the Soutpansberg with a rapid decrease from 800-1000mm in the mountains, to below 400mm in the area immediately north of Soutpansberg (IDP 2014/15). Rainfall largely occurs during the hot summer months (Kyei, 2011). Musina has been reported to be water stressed because of the increased pressure on water availability, accessibility and demand (Kyei, 2011). The vegetation type of the area is Mopane Bushveld which typically consists of Mopane trees, Baobab, various thorn species and long grass (Kyei, 2011).

The main contributors to the economy of Musina is Agriculture (35%) and Mining (30%) (IDP 2014/15). Most of the people in the municipality derive their livelihood through agriculture pursuits with this sector employing more than half of the employed population. Commercial and subsistence are the main agricultural occupation sectors and the Musina agricultural sector contributes 35% to the district thus confirming its importance to the local economy (StatsSa, 2011). At a municipal level, 18.7% of the population is unemployed and of this figure, 22.5% is the youth. There is high unemployment rate in the rural settlements because job opportunities

are not spread to also include people from the settlements in the eastern parts of the municipality, which are very rural in nature and not reaping the same benefits as the population in the urban area surrounding Musina town (IDP, 2014/15). Moreover, 12% of the population have 'no income' at all and this suggests that such households are the least resilient to external shocks such water scarcity (StatsSa, 2011).

3.4.2. STUDY POPULATION & SAMPLING PROCEDURE

An important aspect of research design is sampling design. Wild & Diggines (2009) argue that sampling design is a more cost-effective and less time-consuming way of research sampling aimed at the whole population. A complete design involves the researcher making multiple decisions concerning target population, sampling frame and methods as well as sample size of the study research. Welman *et al.* (2009) defines population as the full set of cases from which the sample is taken. A population can be individuals, groups, organisations, human products or their living conditions and a subset of the population studied for the research is called study sample/population (Welman *et al.,* 2009). It is important to select a study sample that is representative of the population in order to generalise the outcomes from the sample to the population (Wild & Diggines, 2009).

For this study, the study population comprised of individuals residing in Musina local municipality, in the Limpopo Province. Because of the size of the municipality and time constraints, the researcher purposefully chose to focus on Ward 1 of the municipality. This is because the ward consists of a large proportion of households engaged in farming activities hence their experience will be relevant for this study. The Ward has an estimated population of 13 364 with a total of 4 121 households (Census, 2011; IDP, 2016). To get a representative sample, the researcher concluded that a sample size of 5% of the total number of households in the ward would be representative. This conclusion was reached bearing in mind that this is a research report conducted in a limited time and with limited funds. Therefore, from the 4 121 households, only 5% of them were selected as the study sample meaning that 4 121*(5/100) = 206.05 households. The ward caters for many villages therefore the researcher selected six villages to focus on which are just outside Musina town. This is because the six villages represented a narrow margin of error. Therefore, to get sample size per village, the 5% sample size (206.05 households) was divided amongst the six villages thus 206.05/6= 34 households which were supposed to be sampled from each village. However, due to time constraints the

number was reduced from 34 to 30 households per village resulting in 180 households interviewed.

Apart from choosing the villages to sample, it was equally important to determine who will be sampled within these villages. Therefore, the study population was mainly household heads and particularly those involved in farming activities. To select target households, the research employed purposeful sampling. As noted by Palinkas *et al.* (2015), purposeful sampling is widely used in qualitative research for the identification and selection of information-rich cases for the most effective use of limited resources. Therefore, this technique was very fitting for this study. To identify the target households, the following procedure was followed: the researcher would drive into a village through the main road/street which was always either in the middle of the village or on the outside of the village therefore allowing for a full view of the village size. In each village, the researcher would start sampling the first household on the first street from the left hand side of the main road. From that household, the researcher then skipped four households after and interviewed the fifth household. This process would continue into the next street until the target Number of households was achieved per village. In the event that a household head was unavailable for an interview, the study would start the process of identifying households once again starting with the immediate neighbour. All the participants in this study were 18 years and older.

3.4.3. DATA COLLECTION TOOLS

Data collection is simply a technique used to collect empirical research data and this is how researchers access their information (Leedy, 1997). There are six common methods of data collection, namely: questionnaires, interviews, focus groups, tests, observations and secondary data. Leedy (1997) argues that primary data lie closest to the source of the ultimate truth and it is for this reason that this study uses primary data to get information directly from the rural households in Musina. Two main methods were used to collect this data, namely interviews and observations.

Interviews

Kitchin and Tate (2000) are of the view that interview is the most commonly used qualitative technique of collecting data. This research study relied heavily on interviews as a means of collecting data. Interviews were important because they were a means of gathering information on perceptions of water scarcity and how that impacts on livelihood options as well as food choices. In addition, the interviews were also used to gather information on the adaptive

strategies that are put in place to counter the impacts of water scarcity. In the process of conducting interviews, the researcher made use of an interview guide in the form of a semi-structured questionnaire. This is important because it provided structure for the interviews while also enabling the respondent to respond without limitations.

The interview guide was divided in four sections. Section one was focused on gathering basic demographic information of the household. Section two was meant to gain information about the farming/nonfarming activities of the household. The third section consisted of open ended questions with the intention of enabling participants to discuss household interactions with available water. The fourth and final section was meant to gather information about households' food expenditure and dietary choices. The preference was to interview heads of households but because of unavailability and other reasons, the researcher ended up interviewing whoever was in the house at the time of the interview.

3.5. DATA ANALYSIS

Data collection took place during the month of February 2017. The data was transcribed into Microsoft Excel 2010/13 for analysis once the data collection was complete. The data analysis involved organising the collected data in a way to answer the research questions and objectives as prescribed by Houser (2008). The raw data was firstly inspected and cleaned to ensure quality of analysis and interpretation. The respondents answers were checked for incomplete answers and possible errors. Once checking was completed, the respondents' answers were organised and coded in an excel sheet. The four sections were analysed differently depending on the format of the questions. Such that questions with open-ended answers were analysed qualitatively and several statistical analysis was used on the close-ended questions (quantitative).

3.5.1. DESCRIPTIVE STATISTICS

Rule & John (2011) argue that for explanation or evaluation of results to make sense, it is important to use descriptive analysis of the phenomenon and its context. Descriptive statistics in this research involved the report on demographic details of households, mean scores, median, mode and standard deviations. There was also an assessment of the normality of the data to determine the type of statistical analysis to subject the data. R version 3.4.2 was used for the descriptive analysis while Microsoft Excel 2010/13 was used to create frequency tables and graphs. The frequency graphs and tables indicated the impacts of water scarcity of households as well as the different coping mechanisms for households.

3.6. METHODOLOGICAL REFLECTIONS

The purposive sampling procedure was effective in ensuring that sampled households were not concentrated in one area of the village, but rather dispersed in parts of the village giving households a fair chance to voice their experiences. However, the researcher could not ascertain that the households' heads were available for interviewing hence at times the interviews were conducted with family members who were not necessarily heads of the household. This is because the researcher did not have the opportunity of returning to interview the head of the household. The advantage was that all the selected participants were very keen to participate hence there was no household needing to be skipped because of refusal to participate.

The researcher employed the assistance of one local person per village to help in guiding the researcher through the village. It appeared that most participants were very trusting of the researcher because of the presence of a local person and this made data collection much easier. The added advantage of a local person was that he/she would translate words which the researcher found difficult to pronounce or understand in the local language.

One of the challenges experienced during this study was juggling studies and family life. It was not easy spending sufficient time with my daughter while ensuring that the research does not fall behind. In addition, some of the interviews would take longer than expected because some of the participants would first narrate a story before answering the questions. Furthermore, some of the words were very difficult to translate from Venda to English hence taking longer to finish some interviews.

CHAPTER FOUR

EMPERICAL EVIDENCE

This chapter is dedicated to presenting the findings of this study. It is in this chapter where the questions that were asked in chapter 1 are being addressed and evidence provided. In view of this therefore, the chapter is structured around three research questions. The first section answers the question of the impacts of water scarcity on livelihood options in Musina. The second section focuses on documenting the adaptation strategies employed by rural populations in Musina and the third section looks at the policy framework that exist in order to build the adaptive capacity of rural households in Musina. In conclusion, the study will conclude with a section that sums up all the findings. However, before presenting the findings, it is important that the study gives context of the demographic factors obtained from the research site.

4.1. DEMOGRAPHIC FACTORS

A total of 180 interviews were conducted. However, five of the questionnaires were spoilt and consequently, only one hundred and seventy-five were usable. This represents a response rate of 97.2% on which the analysis of the data is based.

a) Gender

In society, male and female play very different yet important roles in agriculture and in most cases, there is a clear distinction in terms of labour divisions, roles and responsibilities. Therefore, for this study it was important to determine the gender dynamic in the research site and the survey results are presented in Table 1. Over half (54%) of those surveyed respondents were females. It is important to note that the 'Other' gender category refers to individuals who opted not specify their gender on the interview instrument. The results suggest that there are more female-headed households in the study site. Part of the reason here could be that most of the males in Musina had both permanently and temporarily migrated to nearby cities in search of jobs and or business opportunities.

Table 1: Gender dynamics of respondents

Gender	Number of households	Percentage
Female	94	54%
Male	68	39%
Other	13	7%

Gender	Number of households	Percentage
Total	175	100%

Source: Fieldwork based data 2017

b) Age

The age of a population is an important contributing factor to the sustainability of households in rural areas because it plays a key role in food production (Chambers & Conway, 1991). Therefore, it was important for this study to unpack the age distribution in the study site and the results are illustrated in Table 2. The results indicate that majority of the respondents were above 51 years of age (41%) followed by those between 40 and 50 years (28%). Based on these findings, it would suggest that the majority of people in Musina are senior citizens with very limited potential of being economically active.

Table 2: Respondents' age

Age groups	Number of households	Percentage
>51 years	72	41%
40-50 years	49	28%
29-39 years	38	22%
18-28 years	16	9%
Total	**175**	**100%**

Source: Fieldwork based data 2017

c) Employment Status

Apart from the age, it was also important to understand the employment status of the people of Musina. **Error! Reference source not found.** shows the distribution of the different employment status. Most of the surveyed respondents were unemployed (61%) and 33% reported to be employed. The results suggest that majority of the people in Musina have the time to engage in farming activities since they are not engaged in any employment activities.

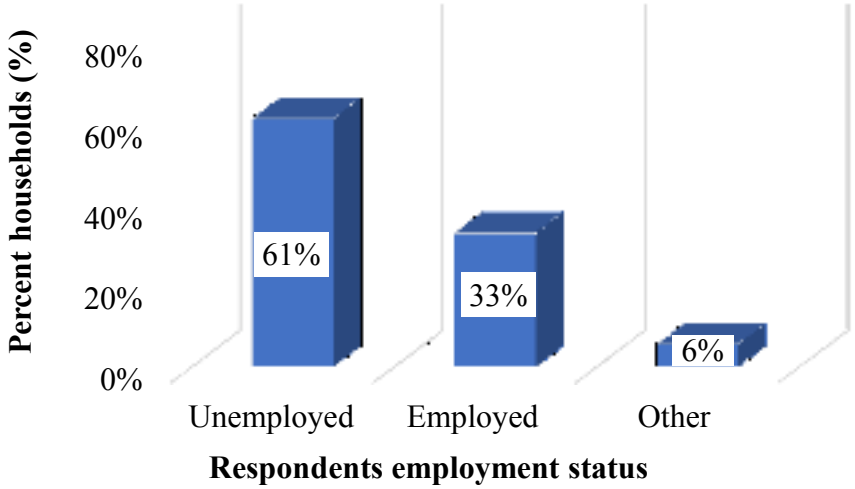


Figure 2: Respondents employment status

Source: Based on Table F1 (See appendix F)

d) Household size

Household composition and size are important factors which can influence dietary choices. **Error! Reference source not found.** shows the size of the household for respondents who participated in the survey. 39% of the respondents had between 1 and 3 members in the household while 35% of the respondents had between 4-6 members in the household. Based on the findings, most of the households in Musina comprises of a larger number of people implying more demand for food and water.

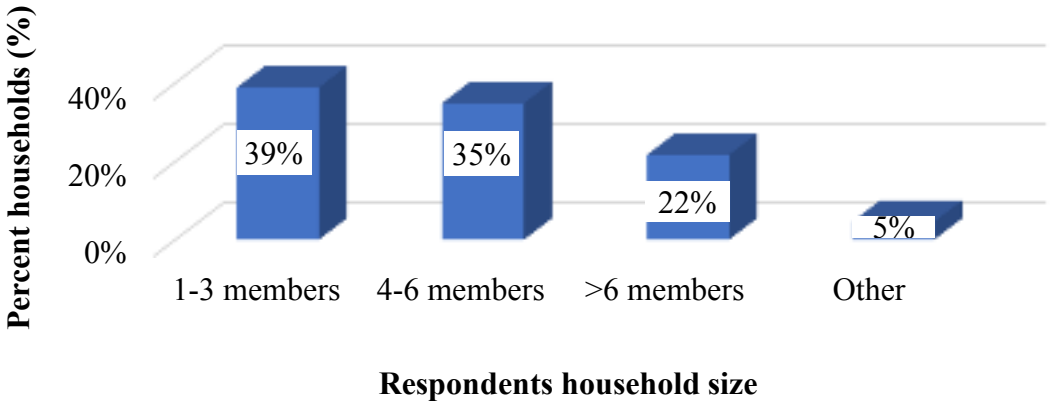


Figure 3: Household size

Source: Based on Table F2 (See Appendix F)

e) Engagement in farming activities

One of the important issues this study wanted to unpack was the impacts of water availability on food production in Musina and to understand this, it was pivotal for the researcher to assess the distribution of households that are involved in farming activities. Therefore, it was important to document the proportion of households who are actively engaged in agricultural production in Musina. Table 3 illustrates that in Musina, 55% of the respondents are actively engaged in farming activities.

Table 3: Engagement in farming activities in Musina

Type of response	Number of households	Percentage
Yes	97	55%
No	78	45%
Total	**175**	**100%**

Source: Fieldwork based data 2017

Having established that 55% of households in Musina engage in farming activities, it was therefore important to unpack the gender dynamics of the farmers in Musina. This is because gender is an important factor in determining access to resources and economic opportunities (Rust & Hansie, 2009). It is normally men who have all the decision making power in the use of resources, as well as access to resources such as land, agricultural inputs and water (Frank, 1998). Table 4 shows that majority of the people engaged in farming activities are women who are statistically presented as 52% whereas men are presented as 41%. As stated in the previous sections, the 'Other' gender category refers to individuals who opted not specify their gender on the interview instrument. The results suggest that the agricultural industry in Musina comprises of mostly women.

Table 4: Gender composition of farmers in Musina

Type of response	Number of households	Percentage
Female	50	52%
Male	40	41%
Other	7	7%
Total	**97**	**100%**

Source: Fieldwork based data 2017

f) Average age of farmers in the study location

Apart from establishing the gender composition of farmers in Musina, it was equally important to understand the ages of the farmers. This is because age contribute to a household's capacity to modify livelihood strategies in response to external factors such as lack of water availability. Therefore, an analysis of the respondents age shows that majority of the farmers in Musina are aged 51 years and older (49%) followed by those between 40 between 50 years (35%) as shown in Table 5. Only 2% of the respondents were aged between 18 and 28 years. The results suggest that it is mostly the senior citizens in the location that are interested in farming and part of the reason could be that the young people in Musina migrate to other areas in search of economic opportunities elsewhere. Senior citizens however, are generally weaker than the young generation therefore suggesting that the people who are engaged in farming activities in Musina generally do not cultivate larger fields thus affecting food production and supply.

Table 5: Average age of farmers in Musina

Age groups	Number of households	Percentage
>51 years	48	49%
40-50 years	34	35%
29-39 years	13	13%
18-28 years	2	2%
Total	**97**	**100%**

Source: Fieldwork based data 2017

4.2. WATER AVAILABILITY AND FOOD PRODUCTION IN MUSINA

The section below looks at the impacts of water availability on the food production and livelihood options for the people of Musina. This section will start by exploring the experiences of all the respondents and later focus only on those engaged in agricultural activities.

a) Water access challenges

One of the key issues that this study wanted to understand was how access to water impacts on households' food production vis-à-vis food choices. Therefore, it was important for this study to establish whether the people in Musina experience difficulties in accessing water. To determine this, the respondents were asked to indicate in the form of yes or no whether they experience challenges with accessing water. Table 6 illustrates that majority (69%) of the households in Musina have challenges with accessing water. It is important to remember that

water is a livelihood asset which plays a crucial role in rural livelihoods. Therefore, the findings suggest that the rural populations in Musina cannot expand their livelihoods since they do not have access to an important resource such as water and they are also at an increased risk associated with the lack of water availability such as food insecurity.

Table 6: Water access challenges in Musina

Type of response	Number of households	Percentage
Yes	121	69%
No	54	31%
Total	**175**	**100%**

Source: Fieldwork based data 2017

A further analysis of the gender dynamics in terms of who experiences water challenges more in the study site between male and female is reflected in Table 7. It is suggested that the majority of the people that experience water challenges are females who are statistically presented as 71% whereas males are presented as 24%. This implies therefore, that the majority of people in Musina that have difficulties in accessing water are females.

Table 7: Gender and water access challenges in Musina

Type of response	Number of households	Percentage
Male	29	24%
Female	86	71%
Other	6	5%
Total	**121**	**100%**

Source: Fieldwork based data 2017

Having established who experiences water challenges more between males and females, it was therefore important to identify the factors that make it difficult for the majority of the communities to have access to water. The respondents who said they experienced challenges with accessing water were requested to indicate the factors that hinder them from accessing water. Table 8 shows some of the challenges that exist within the study site. The majority (34%) of households in Musina reported that water is expensive to pay for while 28% of the households reported that water is physically unavailable. The results suggest that water

availability is a serious problem affecting the rural populations in the municipality and part of the reason here could be that majority of women do not have a disposable income to purchase water resources.

Table 8: Barriers to water access in Musina

Type of response	Number of households	Percentage
Water is expensive	41	34%
Water cuts (Periodic/Prolonged)	34	28%
Water source too far	21	17%
No rainfall	16	13%
Broken community taps	9	7%
Total	**121**	**100%**

Source: Fieldwork based data 2017

b) Link between water availability and food choices

After identifying the water access challenges that people in Musina experience, it was also very important to have an understanding of how the respondents view the relationship between water availability, food production and dietary choices. In trying to establish this, respondents were asked to indicate, by way of yes or no, whether they considered that there was a relationship between water availability, food production and food choices. These views are captured in Table 9. The results indicate that 73% of the respondents were of the view that there is a relationship between water availability and food choices. According to the respondents, the lack of water availability negatively affects their ability to produce foods and this has implications on food choices.

Table 9: Community perceptions of the relationship between water and food choices in Musina

Type of response	Number of households	Percentage
Yes	128	73%
No	21	12%
Don't Know	26	15%
Total	175	100%

Source: Fieldwork based data 2017

In addition to understanding households' perceptions of the relationship between water availability and food choices, there was a need to analyse further the gender dynamics with regards to who perceives this relationship more between male and female respondents. Table 10 shows the distribution of the responses based on 128 respondents who indicated that water availability has an impact on their food choices. Within this context, it is suggested that majority of the women in Musina are of the view that water shortages affect their food choices (57%). This implies that majority of females in Musina are particularly vulnerable to food insecurity compared to males as a result of lack of water. These findings suggest that women play a vital role of ensuring food access in households therefore resulting in women having to sacrifice their own food choices for the sake of the other household members particularly children.

Table 10: Gender and food choices in Musina

Type of response	Number of households	Percentage
Female	73	57%
Male	42	33%
Other	13	10%
Total	128	100%

Source: Fieldwork based data 2017

The 128 respondents were also requested to indicate/elaborate how water scarcity affects their food choices.

> *Most of the respondents were of the opinion that water scarcity affected **food production** therefor resulting in food shortages. Others said that water scarcity affected their **preference** because their most preferred foods have become unavailable in stores because of water scarcity. Some respondents said that their **budgets** were affected by water scarcity because food had become more expensive to buy. Some respondents reported that because of water scarcity their food **hygiene** was affected since they could no longer wash their food properly before cooking in an effort to save the little they have.*

The results suggest that water availability affects food supply in rural communities in Musina therefore affecting available food choices that households have.

c) Food production trends in the past five years

It is important to remember that one of the important issues this study wanted to investigate was how water deficits impacts on food production. In trying to establish this, the respondents who are engaged in farming activities were requested to indicate the production trends for the past five years. The information about the food production trends is illustrated in Table 11. Most of the respondents (58%) were of the view that production had decreased in the past five years. This was followed by 23% of the households who reported that food production had been the same for the past five years and only 19% of the households reported an increase in production. Looking at the findings, what is strongly suggested is that the lack of water availability has a negative impact on households' food production in Musina. Based on the findings, the decrease in food production implies an increased vulnerability to food security.

Table 11: Food production trends in Musina

Type of response	Number of households	Percentage
Decreased	56	58%
Same	22	23%
Increased	18	19%
Other	1	1%
Total	**97**	**100%**

Source: Fieldwork based data 2017

d) Drivers of reduced crop yields

Following the households' views of the food production trends in the past five years, there was a need to unpack what the respondents think is driving the changes in crop production. Therefore, respondents who indicated that their crop yields had decreased in the past five years were requested to specify what they think could be the main reason for the decrease and the results are outlined in Table 12. The results illustrate that 75% of the respondents were of the perception that decreased rainfall was the main reason for the declines in crop yield while 16% reported land degradation as the reason and only 9% said that their decreases in crop yields was attributed to a lack of resources. The results strongly suggest that the precipitation cycle is very much linked to food production in Musina and that farmers in the study site rely heavily on rainfall thus making them the least resilient to a decrease in water availability.

Table 12: Drivers of reduced crop yields in Musina

Type of response	Number of households	Percentage
Decreased Rainfall	42	75%
Land Degradation	9	16%
Lack of Resources	5	9%
Total	**56**	**100%**

Source: Fieldwork based data 2017

e) Food access across all villages

After establishing that households in Musina perceive a relationship between the availability of water resources and food production, it was also important to understand the dynamics in terms of food access in the past years. To address this, households were requested to rate their level of food access from 2012 to 2015 based on a Likert Scale. The results are reflected in Table 13. The results suggest that food access in 2012 was generally good across all the villages. The households indicated that they were able to access a variety of fruits and vegetable in 2012. However, the households reported that 2015 was a bad year because majority of the people in Musina were unable to access their most preferred foods.

Table 13: Food access across selected villages in Musina

Variable	Categories	Percentage of respondents (%)						Total average (%)
		N'gwelemotse	Mushongo	Cambo	Happer	Matswale	Skomplaas	
Food Access 2012	Bad	14	4	13	7	27	17	14
	Average	28	33	37	47	20	14	30
	Good	55	59	47	43	53	69	54
	Other	3	4	3	3	0	0	2
Food Access 2013	Bad	14	11	10	3	17	17	12
	Average	55	41	77	53	43	55	54
	Good	28	44	13	40	40	28	32
	Other	3	4	0	3	0	0	2
Food Access 2014	Bad	38	30	37	43	33	59	40
	Average	48	48	47	53	57	34	48
	Good	10	22	13	0	10	7	10
	Other	3	0	3	3	0	0	2
Food Access 2015	Bad	72	63	63	77	53	0	55
	Average	14	22	23	17	27	0	17
	Good	10	15	10	3	20	0	10
	Other	3	0	3	3	0	100	18

Source: Fieldwork based data 2017

A further analysis of food access between farming and non-farming households is shown below (Table 14). The results indicate that for every year (2012-2015) there were more non-farming households who perceived the years as having good food access. In 2012, for example, 59% of non-farming households reported the year as a good year in terms of food access while only 51% of farming households were of the same view. In 2015, 66% of farming households reported that year as bad food access while only 41% of non-farming households hold the same view. These results suggest that food access for farming households has been more average to bad.

Table 14: Food access for farming and non-farming households in Musina

Variable	**Categories**	**Percentage of respondents (%)**		**Total average (%)**
		Farmers	Non-Farmers	
Food Access 2012	Bad	11	17	14
	Average	36	22	30
	Good	51	59	54
	Other	2	3	2
Food Access 2013	Bad	11	13	12
	Average	59	49	54
	Good	29	36	32
	Other	1	3	2
Food Access 2014	Bad	33	49	40
	Average	56	38	48
	Good	9	12	10
	Other	2	1	2
Food Access 2015	Bad	66	41	55
	Average	22	12	17
	Good	6	14	10
	Other	6	33	18

Source: Fieldwork based data 2017

The table below illustrates the food access as perceived by both male and female respondents. It can be seen from the data that in any of the given years there are more male respondents who reported the years as having good food access (66%, 37%, 19% and 15% respectively for 2012-2015). What stand out in the table is that the proportion of female respondents who reported any of the years as having good food access decreases from 2012 (45%) to 2015 (6%). Although the male respondents' perception also decrease over the years the degree is not as

high as that of the female respondents. The results suggest that female headed households are at a relatively higher risk of not accessing sufficient food in future as a result of water scarcity.

Table 15: Food access and gender dynamics in Musina

Variable	**Categories**	**Percentage of respondents (%)**	
		Females	Males
Food Access 2012	Bad	20	6
	Average	33	26
	Good	45	66
	Other	2	1
Food Access 2013	Bad	18	4
	Average	53	57
	Good	27	37
	Other	2	1
Food Access 2014	Bad	45	35
	Average	49	44
	Good	5	19
	Other	1	1
Food Access 2015	Bad	55	53
	Average	17	18
	Good	6	15
	Other	21	15

Source: Fieldwork based data 2017

4.3. ADAPTATION STRATEGIES AGAINST WATER SCARCITY IN MUSINA

The lack of available water can be considered a stress for rural populations in Musina and this requires a response. Adaptation becomes important because it refers to practices, processes or structures used to offset or take advantage of stresses such as water scarcity. Therefore, it was important to understand the adjustments that rural households in Musina implement to reduce vulnerability to the deficit in water resources. The sections below detail the adaptation strategies employed by rural households in Musina. Before looking at the adaptation strategies it is important to show the distribution of their main sources of water.

a) Main water sources

To understand how the lack of water availability affects rural livelihoods in Musina, it was important to assess how households in the study site access water. Therefore, the respondents were asked to reveal their main source of water. Majority of the respondents rely on taps inside their yards (49%) followed by those who rely on community taps (34%) as their main source

of water (Fig. 4). This suggests that the government is responsible for water provision in the area.

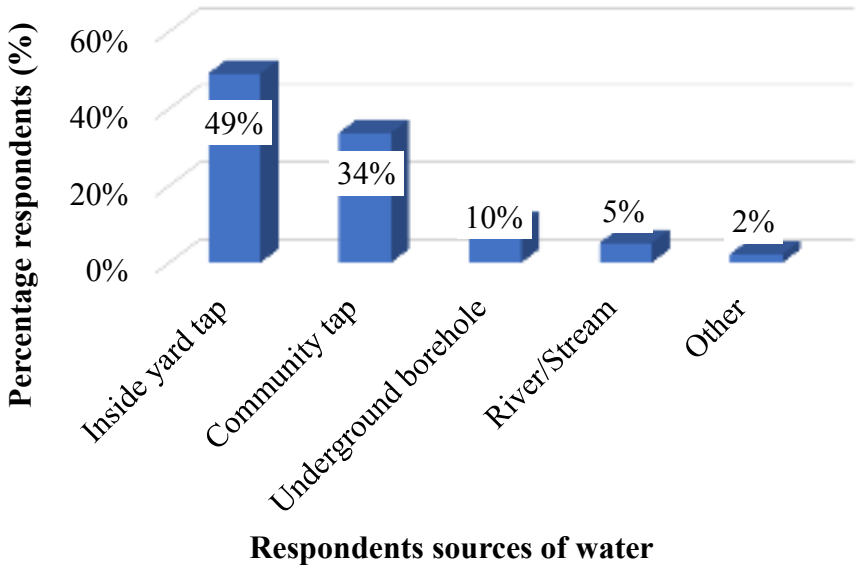


Figure 4: Main sources of water in Musina

Source: Based on Table F3 (See Appendix F)

b) Water sources in times of scarcity

Having gained insight on the main sources of water in Musina, the next step was to establish how households access water in times of water shortages. Therefore, the respondents were requested to indicate their adaptation strategy in times of difficulty with accessing water. Majority of the respondents pointed out that they depended on more than one source of water because their supply is unreliable. To ensure access to water during difficult times, respondents indicated that they store water in instruments such as buckets, bottles and jojo tanks. This implies that the main adaptation of the people of Musina against water shortages is water storage. This finding suggests that the people of Musina are at risk of suffering health issues associated with contaminants from their water storage and handling practices.

However, the 121 respondents (Source: Based on Table 6) who had indicated that they experienced challenges with accessing water were requested to name their alternative sources of water in times of difficulty. The results are outlined in Table 16. It is suggested that most of the people in Musina have to walk/drive (50% of the households) distances to access alternative water sources while others have to buy (34% of the households) water from other households.

A further 16% stated that they use unprotected wells as alternative sources of water. This implies that rural households in Musina are negatively impacted by the lack of water because they have to spend more time and money in trying to ensure continuous access of water. These findings suggest that women and young girls in Musina are at high risk of suffering from fatigue since they are often responsible for ensuring water access in rural households. This could have severe implications on the education of young girls in Musina because it means they have to use their study time to collect water instead of doing school work.

Table 16: Alternative water sources in Musina

Type of response	Number of households	Percentage
Walk/drive to other community taps in the village or other villages	61	50%
Buy from households with boreholes	41	34%
Unprotected wells	19	16%
Total	**121**	**100%**

Source: Fieldwork based data 2017

c) Farmers main source of water for crops in Musina.

Because of the insight that majority of the households in Musina are engaged in farming activities, it was then important to get an understanding of the main sources of water which households use for watering their agriculture produce. The result show that majority of the farmers in Musina rely heavily on the community tap (38%) and rainfall (31%) for their food production (Fig. 5). Respondents indicated that the community taps often have periodic water cuts e.g. 1 or 2 weeks. This implies that farmers in the study area do not have reliable sources of water for their crops except for those with boreholes.

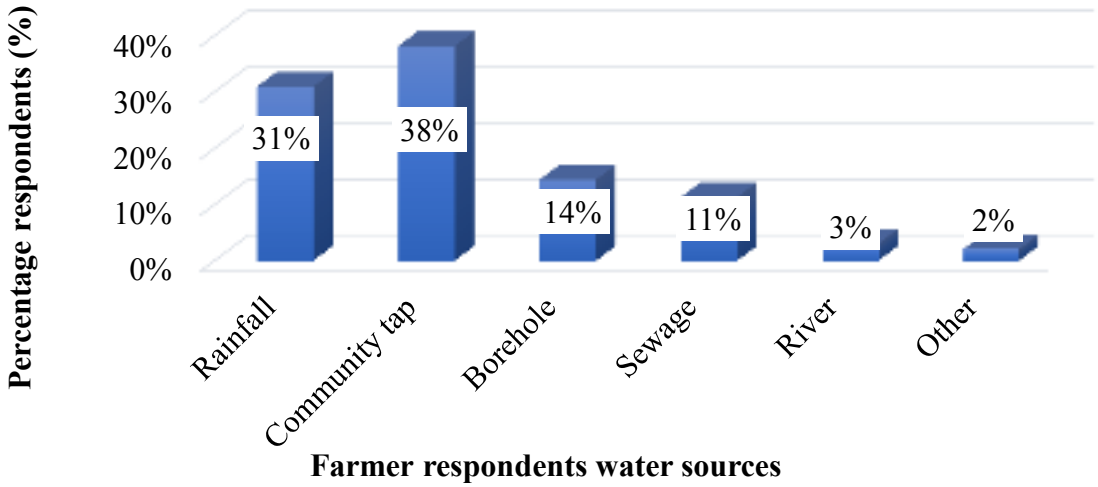


Figure 5: Main source of water for farming in Musina

Source: Based on Table F4 (See Appendix F)

d) Challenges with accessing water for farming purposes in Musina.

Apart from the challenges that the households in Musina experience with accessing water for domestic purposes, there may also be challenges with accessing water specifically for agricultural purposes. Therefore, the following section explores the different challenges that farmers in Musina experience in terms of accessing water for their crops. The respondents were asked to indicate in the form of yes or no if they experience challenges with water access for agricultural purposes. The responses obtained are shown in Table 17 which suggests that 69% of the 97 farming households experience challenges with watering their food crops. The results suggest that water challenges in the municipality do not only affect the domestic life of households but also have implications on agricultural production.

Table 17: Challenges with water access for farming purposes in Musina

Type of response	Number of households	Percentage
Yes	67	69%
No	30	31%
Total	**97**	**100%**

Source: Fieldwork based data 2017

Having identified that majority of farming households in Musina encounter challenges with accessing water for their agricultural produce, it was therefore important to determine the

barriers that make it difficult for them to get access to sufficient water resources. Table 18 illustrates some of the challenges that farming households in Musina experience. Majority (39%) of the households reported that water was expensive to pay for while 28% of the respondents reported that water was physically not available. Other households reported that there was inadequate rainfall (13%) whereas other households said that there was a lack of water infrastructure (7%). The results imply that water deficit is a serious problem affecting farmers in the study area and part of the reason could be the lack of financial capital to purchase water.

Table 18: Barriers to water access for farming purposes in Musina

Type of response	Number of households	Percentage
Water is expensive	26	39%
Physical water shortages	19	28%
Inadequate rainfall	9	13%
Lack of water pipes	5	7%
Water source too far	2	3%
Other	6	9%
Total	**67**	**100%**

Source: Fieldwork based data 2017

Because farmers in Musina have challenges with accessing water for their crops, it is therefore important to unpack the practices/strategies which they employ to overcome the stress of water availability. In trying to establish this, the households were requested to reveal how they respond to water availability challenges and the information is outlined in Table 19. The majority of the households said that they respond to challenges with accessing water for their crops by means of using greywater (48%) followed by 25% of farming households who resort to dry farming. Other households reported that they adapt by using drip irrigation (13%) to water their crops. The results suggest that the people of Musina do not have many livelihood options. Although faced with water access challenges, the farmers choose to find alternative ways of coping with the challenge by employing other means of watering their crops therefore ensuring continuation of farming activities. However, it is important to highlight that the most common adaptation strategy (use of greywater) could have negative impacts on soil quality and ultimately reducing soil potential of Musina soils in the future.

Table 19: Farmers adaptation strategies in Musina

Type of response	Number of households	Percentage
Use greywater (Bathwater and dishwater)	32	48%
Dry farming (Stop watering crops completely and rely solely on rain water and moisture in the atmosphere)	17	25%
Drip irrigation	9	13%
Grow plants with low-water needs	5	7%
Water at night only	4	6%
Total	**67**	**100%**

Source: Fieldwork based data 2017

e) Households monthly food expenditure

After establishing that the lack of access to water has implications on food production and household budgets in Musina, it was deemed necessary for this study to understand how much of the monthly income was affected by the changes. Households were therefore asked to give an indication of what percentage of the household monthly income was spent on buying food. The findings are demonstrated in **Error! Reference source not found.**. The results indicate that 48% of the households in Musina spend half of their household's income on food every month. This is followed by 31% of households in Musina who spend on average a quarter of the household income on food monthly. A further 21% of the households stated that they spend more than half the household monthly income on food. This implies that financial resources are a way of adapting to challenges with accessing water with households in Musina using more of their monthly household income to buy food in times of difficulty.

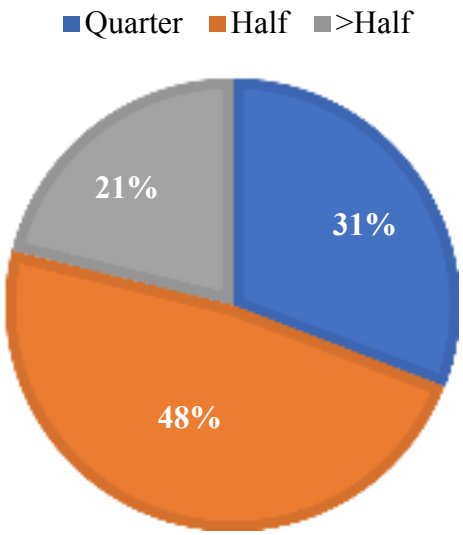


Figure 6: Households monthly food expenditure in Musina

Source: Based on Table F5 (See Appendix F)

f) Type of food choices during low rainfall years vs high rainfall years

Since households in Musina reported that water availability impacts on their food production capacity, it was important to unpack how the food choices differ between times of high water availability and times of low water availability. Therefore, households who are engaged in farming activities were asked to indicate the different food choices which they produce and have access to in years of high rainfall as well as in times of low rainfall. The responses are summarised below:

> *All the respondents indicated that they are able to cultivate their vegetable gardens and crop fields when there is sufficient rainfall. High rainfall provides them with their most important source of staple food which is maize meal as well as vegetables such cabbage, spinach, carrots, beetroot, potatoes, onions and they also get fruits such mangos, bananas, water melon and paw-paws to mention a few. The respondents also said that in low rainfall years they are unable to cultivate therefore forcing them to spend their little income to buy lots of tinned foods (fish, baked beans, spaghetti).*

This implies that increased water availability improves the food choices of households in Musina whereas limited water availability increases the risk of food insecurity.

4.4. POLICY FRAMEWORK AND ADAPTIVE CAPACITY

This section will explore the policy frameworks that are in place to build the adaptive capacity of the people of Musina. In South Africa, water is a human right and it is therefore the government's responsibility to ensure the provision of water to households. Therefore, the section below unpacks existing policies which are intended to enhance the adaptive capacity of households in Musina.

a) Distance from municipal water sources

Having established how vulnerable households in Musina are to water scarcity, the next step is to look at what the government (local municipality) has been doing to improve the adaptive capacity of households in Musina. Because municipalities are legally required to provide water sources within 200 meters of households, it was therefore important to understand the current distribution of municipal water sources in Musina. To establish this, the households were requested to indicate the distance they have to travel to access a municipal water source closest to their household. This information will highlight the level of compliance by the local municipality to the free basic water supply policy of 2000 in improving the adaptive capacity of households in Musina. The findings are illustrated in **Error! Reference source not found.**. The results show that the municipality complies with the water service policy by up to 84%. These results imply that the municipality has the water infrastructures in place for the households to access water.

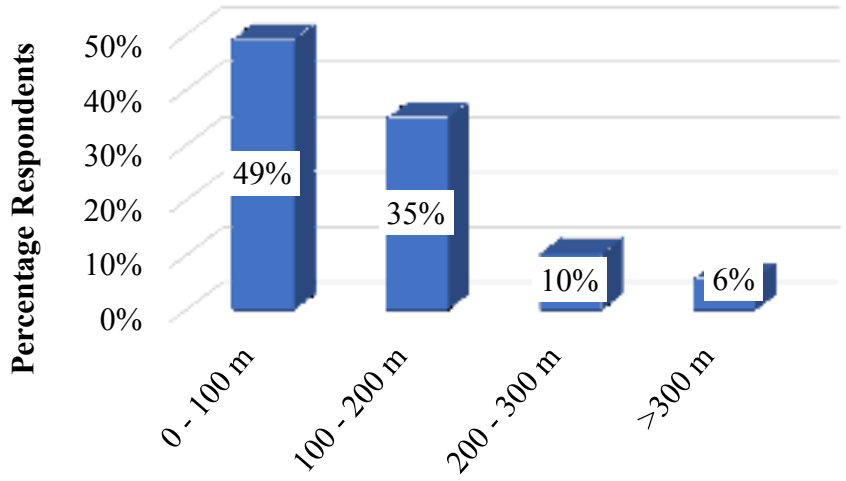


Figure 7: Households distance from municipal water source in Musina

Source: Based on Table F6 (See Appendix F)

b) Farmers assistance

Although there are municipal water infrastructures in Musina, it was important to understand whether the municipality renders assistance to farming households in times of water scarcity to continue with food production. To determine this, households were asked to indicate by form of yes or no whether they receive some kind of agricultural assistance from the municipality during difficult times. The results are outlined in Table 20. The results reveal that the farmers in Musina do not receive agricultural support and or assistance (90%) from the municipality during difficult times. This implies that farming households in Musina lack the necessary support therefore making them less resilient to water scarcity.

Table 20: Farmers agricultural support from the Musina Local Municipality

Type of response	Number of households	Percentage
No	87	90%
Yes	10	10%
Total	**97**	**100%**

Source: Fieldwork based data 2017

In view of the results provided, this chapter has presented the empirical evidence of the impacts of water scarcity on food production and dietary choices as well as livelihood options. The results reveal that challenges with accessing water in Musina have negative impacts on households' food production and food choices. From the findings, it is suggested that households in Musina are using different combination of adaptation strategies and portfolios to adapt to the impact of water deficits. The next chapter will focus on the implications of the findings.

CHAPTER FIVE

ANALYSIS AND DISCUSSIONS

5.1. INTRODUCTION

This chapter will explore the implications of the empirical evidence found in this study. The importance of this chapter is to describe and interpret the importance of the results while comparing with previous studies. Therefore, it is in this chapter where the objectives in chapter 1 are addressed and implications are discussed. In view of the important role that this chapter plays, it is structured in the following order: first section discusses the impacts of water scarcity on livelihood choices of rural people in Musina. The second section looks at ways in which the adaptive capacity of the people of Musina could be improved therefore building resilience. In conclusion, the study sums up all the implications before making recommendations in chapter six. Before discussing the implications of the results on the wider study objectives, it is importance to unpack the implications of the demographic factors on rural livelihoods and food production in Musina.

5.2. SOCIO-DEMOGRAPHIC INFLUENCE ON FOOD PRODCUTION

Socio-demographics contribute to food production and livelihood outcomes (Abu & Soom, 2016). These include factors such as age, gender, household size and employment status. For the purpose of this study, the age, household size and employment status of people in Musina are discussed.

One of these socio-demographic factors is age and it has an impact on households' food production. Kneuppel *at el.* (2009) argue that age plays a critical role in improving household food production and security. This is because age impacts on the labour supply for food production. Therefore, older household heads are expected to be less energetic than the younger household heads. Age often determines the farm size that can be cultivated, and the older household heads are not expected to cultivate larger farms compared to their young counterparts. It also determines the ability to switch from farm to off farm livelihoods. Younger household heads are better at seeking and obtaining off farm jobs than the older household heads. It is argued that as the household head gets older, the natural changes that may take place (physical/psychological/economic) increase the probability of food insecurity (Idrisa *et al.*, 2008; Duerr, 2007). Amaza *et al.* (2009) is of the view that age affects the rate at which a

household adopts innovative technology to improve agricultural production. However, this in turn has an impact on household productivity as well as adaptation strategies.

In view of this, the results from this study show that majority of the people in Musina are senior citizens and the findings also revealed that small holder agriculture in Musina is dominated by older women. This presents a problem because it suggests that rural households in Musina are not in the productive and active age. Therefore, they are expected to be generally weaker on the farms and at an increased risk of food insecurity because of reduced productions. Because of the age, the farmers in Musina are less likely to adopt new technologies that could improve agricultural production or switch from farm to off farm livelihoods particularly during difficult times. A study by Idrisa (2008) found that the age of farmers would significantly influence the decision making process with respect to adopting new agricultural technologies and other production-related decisions.

Another demographic factor is the household head employment status. This is important because employment yields earnings which then contributes towards the household monthly income (Abu & Soom, 2016). Therefore, the more a household head engages in employment, the higher the chance of earning and the greater the chance of being food secure. This study found that majority of the household heads in Musina are unemployed and engaged in farming activities. What is paramount in the above findings is that the rural households in Musina do not have the financial capital to buy sufficient food hence they resort to producing their own food. Ericksen (2007) is of the view that income (financial capital) is a direct determinant of food security. This means that food security may be a problem for households in Musina because of the high unemployment rate. Studies by Kuwornu *et al.* (2011) and Akerele *et al.* (2013) found that households who received high income from formal employment have greater probability of being food secure. Employment enables households to purchase sufficient food varieties thus widening dietary choices.

On the other hand, there is also household size as a demographic factor. Household size refers to the number of individuals residing in a household at a given time (Stats, 2012). This statistic is important because it determines the amount of food required to ensure food security (Abu & Soom, 2016). Therefore, an increase in the size of the household means an increased demand for food and water. Maxwell (1996) is of the view that large family size has significant relationship with increased risk of poverty. If you look at the information presented in **Error! Reference source not found.** in chapter 4, this study found that most of the rural households

in Musina had 1-3 individuals living in the households. These findings suggest that on average households in Musina do not have the sufficient labour power to work in the farms because of the limited number of household size. Therefore, food production is likely to be affected by this thus, exposing households in Musina to food insecurity and reducing livelihoods viability.

5.3. IMPACTS OF WATER AVAILABILITY ON FOOD PRODUCTION AND DIETARY CHOICES

The availability of assets and capabilities determines the livelihood strategies of households. Therefore, in the case of rural households, it is important to have access to sufficient water supply because of the heavy reliance on agricultural activities to sustain households' livelihood strategies. From the data presented in Table 6 in chapter 4, what is coming out is that majority of the people in Musina experience challenges with accessing water because of the purchase price of water which is expensive. This implies that there is economic water scarcity manifesting in Musina. The findings suggest that although there maybe water available, households are unable to access this because of lacking the financial capital to purchase the resource. On the other hand, some of the households in Musina stated that water cuts hinder them from accessing water on a regular basis. The water cuts could be as a result of water infrastructures which are in poor, unmaintained and damaged condition which is often the case in most rural areas in South Africa (Matshel *et al.*, 2013; Sullivan *et al.*, 2003). This finding implies that there is also physical water scarcity manifesting in rural Musina. However, this often results in villagers having to walk for distances to collect water from unsafe sources (Matshel *et al.*, 2013).

Looking at the information provided in chapter 4 under Table 16, what is paramount is that majority of the households in Musina adapt to water access challenges by walking or driving to other sections of their village or even other villages to access water while others choose to buy water from households with boreholes. The time and money spent on accessing water in Musina reduces the potential time and money that could be invested in ensuring rural sustainability of households in Musina. It could also be argued that the financial costs of accessing water in rural Musina is unbearably high considering the high unemployment rate (61%). Therefore, households in Musina appear to be at a disadvantage with limited capacity to diversify their livelihood activities because of the high amount of time spent travelling from one village to another in search of water (Crow *et al.*, 2012). However, in the broader livelihood terms, it is mainly women and girls at a disadvantage because they are often responsible for

water collection. The study found that 71% of the people in Musina who experienced challenges with accessing water were women. This means that women sacrifice their time and education to collect water (Ferguson *et al*., 1986). Similar conclusions were made by Ferguson *et al.* (1986) that women in Kenya, Machakos District, spent most of their time collecting water and as a result majority of them lost out on time for education. In addition, the women also suffered from ill-health that comes with such a task. In view of this, since education plays a key role in ensuring access to the economy and other livelihood resources, it means that women and young girls in Musina are at a disadvantage resulting in increased probability of being excluded from the labour force.

Considering the importance of agricultural production in rural livelihoods, it was expected that lack of water availability would have negative impacts on agricultural production and in turn having adverse effects on rural livelihoods in Musina. From the data that has been presented in this study particularly looking at chapter 4, what is coming out is that there is a connection between water availability and food production. It was identified, for example, that 58% of the farming households in Musina had reduced food production because of limited access to water resources Table 11. These results are in line with results from studies by Maponya & Mpandeli (2012) as well as Ubisi *et al.* (2017). Both studies concluded that the water scarcity in Limpopo has serious implications on agriculture in the province resulting in low crop yields and high crop failures. This finding is not unique to Musina, Thomas *et al.* (2007) writing in the context of Tanzania also found that smallholder farmers associated the decrease in their crop yields with a decrease in rainfall. Therefore, it can be argued that food production and security in Musina is under threat because of lack of water. From the findings, it is therefore important to start considering how to put systems in place that will ensure the households in Musina remain food secure.

Hubbard (1995) argues that water cannot be separated from food security in rural areas because of its key role in food production. The connection between water availability and food production determines livelihood measures which people adopt. This means that without mitigation measures water scarcity in Musina is bound to have negative impacts on the ability of households to produce sufficient food hence the decreasing food production and compromising food security. It was identified, for example, that 73% of the respondents identified the idea that water availability has an impact on their dietary choices. Similar conclusions were made by Ubisi *et al.* (2017) that smallholder farmers in Limpopo coped with decreased food production resulting from lack of water availability by changing their diets. The

World Health Organisation (WHO, 2014) reported that food supply is important to human need and contributes to good dietary requirements needed for growth as well as good health. Furthermore, a good and nutritious diet helps to prevent diseases and sicknesses. From the findings, it is suggested that households in Musina are vulnerable to food insecurity because of limited dietary choices thus appropriate policy interventions should be put in place. To reduce vulnerability of rural households in Musina to food insecurity, it is important to start considering a health policy that will ensure food security while improving livelihoods of households.

Majority of the households in Musina said that lack of available water affected their food preference because of preferred food becoming unavailable in stores on a regular basis. As a consequent of unavailability in stores, the people in Musina were of the view that the little that was available had become more expensive. Baiphethi & Jacobs (2009) argue that poor households in sub-Saharan Africa spend 60% - 90% of the household income on food. Therefore, subsistence agriculture is critical in reducing food insecurity as well as reducing the food expenditure in poor rural households. This study found that 48% of the households in Musina spend half of their households' income on food. This suggest that rural households in Musina ensure food access by drawing from financial resources. Financial resources seem to have been suggested as a way of adapting to the water availability challenge in Musina with people using more of their monthly household income to buy food in times of difficulty. However, in an area with 61% unemployment modifying livelihood strategies by taking from the financial resources puts a strain on already limited households' income. The main source of income for most households in rural South Africa is social grants (StatsSa, 2012). Because of this, financial resources of rural households are very sensitive to any increased pressure and this means that households in Musina feel the effects of decreased productivity as a result of water shortages.

Food access across all six villages was perceived as generally good in 2012 (Table 13). However, 2015 was considered a bad year in terms of food access. A comparison between farming and non-farming households in Musina reveal that on average more of the farming households reported 2015 as a bad year in terms of food access (Table 14). One of the reasons provided by respondents why 2015 was perceived as a bad was that in 2015 households could no longer afford to buy fruits and vegetables. In addition, households indicated that in 2015 their backyard gardens produced relatively decreased quantities of agricultural products compared to previous years. This suggest that farming households are relatively more

vulnerable to impacts of lack of water because of their reliance on agriculture to supplement household food access. These results suggest that water scarcity has far reaching impacts not just for households but also the wider community.

5.4. INTERVENTION ENTRY POINT TO BUILD ADAPTIVE CAPACITY AND RESILIENCE

Given the past and current water scarcity in the area, it was important to understand how households perceive and respond to water scarcity. Smit *et al.* (2000) and IPCC (2001) define adaptation strategies as the range of interventions in response to stresses such as water scarcity. The measures are intended to take advantage or manage the opportunities presented by the stresses. Maddison (2006) is of the view that adaptation occurs in two steps; namely: farmers perceive the change and secondly, action is taken in response to the changes through adaptation. Adaptive capacity on the other hand refers to households' capacity to cope with stresses and shocks (Bebbington, 1999). This definition is used as the basis for this section when discussing how households' adaptive capacity could be enhanced in the face of water scarcity.

South African rural areas are characterised by a legacy of inequality and discrimination in terms of resource allocation (Perret *et al.*, 2006). Because of this, rural populations continue to live in poor conditions with little to no running water. Water infrastructures in rural South Africa are often left in poor conditions (broken and unmaintained) resulting in economic water scarcity (Molobel & Sinha, 2011). Therefore, there is a need for water infrastructure development in rural area. This study identified that the people in Musina rely heavily on municipal water infrastructure such as taps inside their yards (49%) and community taps (34%). However, these people experience economic water scarcity because the study revealed that 34% reported that due to the expensive price of water they have challenges accessing water. These findings support the view of Molobela & Sinha (2011) that economic water scarcity is prevalent in rural South Africa hence the need for infrastructure development. The results suggest that, to build the adaptive capacity of the people in Musina, there is a need for the local municipality in Musina to enforce the necessary measures in ensuring that water infrastructures are kept in good condition at all times (well maintained and fixed when broken). In addition, there is also a need for the municipality to evaluate its water pricing process taking into account that majority of the rural occupants do not have sufficient financial resources to pay.

It is important to understand that the government's focus with respect to water provision has been on providing basic water to rural dwellers for domestic purposes only (Butterworth *et al.*, 2003; Mokgope & Butterworth, 2001). Butterworth *et al.* (2003) argue that the South African government paid very little attention to the fact that rural households also use water for production activities. This study found that the main source of water for farmers in Musina comes from community taps (38%). This finding supports Butterworth *et al.* (2003) argument because the results show that rural households in Musina use the same water infrastructures for their productive activities as well as domestic purposes. The free water basic policy of 2000 state that a household is entitled to 6 000 litres per month. The recommended daily water use of a person is 5 litres, while 3 500 litres is needed to meet the daily dietary requirements of a human being daily (Wenhold *et al.*, 2007). The people in Musina associated water scarcity with limited dietary choices. This serve as a clear indication of the disparity between the free basic water provision and the recommended water for food production only (Matshel *et al.*, 2013; Wenhold *et al.*, 2007). To enhance the adaptive capacity and resilience of the people in Musina, there is a need for a change in the maximum amount of free basic water provided to the rural households. This is because the current quantities appear to be insufficient in meeting the domestic as well as productive requirements for rural households in Musina and this should be of great concern for the municipality.

Diverse and unique combinations of livelihood assets and capabilities determines the type of adaptation strategy that households employ in response to water scarcity (Ellis, 2000, Bebbington, 1999). Therefore, households' adaptation strategies are not the same because assets and capabilities differ from household to household. This study revealed that some households in Musina adapt to the issue of water availability by buying water from households with boreholes (34%) while others walk/drive in search of water elsewhere (50%). These results suggest that majority of the households in Musina lack the financial asset and capabilities to buy water hence they opt to walk/drive in search of water. Therefore, suggesting that the high unemployment rate in the area makes it difficult for households to diversify their livelihood strategies.

Cohen & Moodley (2012) observe that unemployment reduces a household's capacity to respond to stresses such as water scarcity. Thus, suggesting that the adaptive capacity of the people in Musina is low with respect to water scarcity. Furthermore, the study established that majority of the people in Musina were senior citizens (51 years and older). This suggests a lack of labour power to participate in agriculture resulting in decreased food production and limited

dietary choices. This could be attributed to the lack of employment opportunities in rural areas which forces young people to move to urban areas in search of economic opportunities (Ainslie, 2005). As a result, one can argue that majority of the households in Musina are at an increased risk of food insecurity because of the little capacity to generate livelihood income given the age. It could be beneficial to centralise agricultural production in Musina into community projects. This would enable the municipality to deliver water regularly and in sufficient quantities (Nkosi *et al.*, 2014). In addition, community gardens have the potential of enhancing the adaptive capacity of rural households by increasing food security and by so doing, decreasing the amount of money spent on food monthly therefore increasing the household income surplus. In South Africa, Section (26) and (27) of the Constitutional Law enshrines that each individual is entitled to sufficient access of available, safe and sufficient food sources and water both on a national as well as household level (Du Toit, 2011; Pinstrup-Anderson, 2009). This means that such an intervention strategy would enable the government to comply with the law. In addition, such intervention should also be viewed as an economic activity for rural individuals because it has potential to offer youth with entrepreneurial skills.

In conclusion, this chapter highlights the key issues associated with water availability and rural households in Musina. The empirical evidence suggests that rural households in Musina are particularly vulnerable to food insecurity as result of reduced agricultural production. Socio-demographic factors such as high unemployment rate and age limits the adaptive capacity of the area. Potential intervention strategies include the establishment of community food gardens which have the potential of increasing food security while reducing household food expenditure.

CHAPTER SIX

CONCLUSION

The aim of this research study was to investigate and understand the relationship between water scarcity, livelihood options, food production and food choices in Musina, Limpopo. This study is important because it will enable for understanding and contributing to the creation of an inventory on how this nexus exists. In view of this, the following section gives an overall conclusion on some of the key findings in this study followed by a summary of policy recommendations and the last section focuses on future research focus.

6.1. KEY FINDINGS

This study has identified that there are more female-headed households in Musina and majority of the people in the study site are senior citizens above the age of 51 years. The investigation also found that generally households in Musina have low levels of employment (61%) and therefore, are most likely to depend on social grants. Furthermore, the results of this investigation show that households in Musina comprises of a larger number of people (4-6 and >6 members in a household) suggesting more demand for food and water. The relevance of subsistence farming in Musina is clearly supported by a total of 55% of the households indicating their involvement in farming activities and 52% were women. majority of the farmers in Musina are senior citizens aged 51 years and older (49%) followed by those between 40-50 years (35%) thus suggesting depleting or lack of labour force. One of the more significant findings to emerge from this study is that 69% of the households have experienced challenges with water access and supplementary results show that females (71%) are more prone to the challenges than male. Households in Musina are of the view that water is expensive (34%) and believed that the lack of water affects their dietary choices (73%). Farmers in Musina have observed decreased agricultural production in the past five years (58%). Households food access was generally good across the villages in 2012 but the opposite in 2015. The study has found that generally 49% of households in Musina rely on taps inside their yards as the main source of water followed 34% of households who rely on community taps.

The investigation probed the impacts of water scarcity on food production and livelihood options in Musina. The current data highlights the importance of water availability as a livelihood asset which plays a crucial role in rural livelihoods. Therefore, households in Musina have to walk/drive (50%) distances to access alternative water sources while others have to buy

(34%) water from households with boreholes. In addition to this adaptation strategy, households in Musina stated that they ensure food access by spending most of their households' monthly income on food. This however, puts a lot of pressure on the financial resources of rural households in Musina. Taken together, these results suggest that agricultural production plays a vital role in sustaining rural households in Musina and any decrease in production threatens the livelihoods of rural households in Musina. It is unfortunate that farmers in Musina do not receive support and or assistance (90%) from the municipality during difficult times therefore making them less resilient to water scarcity.

6.2. POLICY RECOMENDATIONS

There is a pressing need for interventions that will enhance the livelihoods in Musina to withstand the threats posed by lack of access to water. Therefore, this section will provide some policy recommendations for addressing water scarcity impacts on rural livelihoods in Musina. It is important to note that the recommendations are based on the findings of this study.

The results of this study indicate that the problem of water availability in Musina has contributed to a decrease in food production while increasing the risk of household food insecurity. This is because of the dependence on agricultural production for livelihood sustainability. It can be argued that because of the high unemployment, households in Musina do not have the capacity to effectively respond to water scarcity. In other words, general household livelihood resilience in Musina is low and thus, lack of water threatens most of the households in the municipality. In view of this, any intervention strategies intended to enhance the livelihood of households in Musina must maintain agricultural production. To maintain agricultural production and increase livelihood resilience of households in Musina, the following recommendations will be useful:

- The local municipality should consider centralising agricultural production into a few major community gardens rather than having households concentrate on individual household gardens. This would boost agricultural production and would also introduce economic opportunities for the youth. In this way irrigation water can be delivered to a few central points therefore agriculture would benefit the rural households in Musina and the employment opportunities will ensure an increase in the human capital of the area. Such community agricultural projects can not only supplement household food access, but it can also create opportunities for households to generate a financial income as well as increase available household income (Nkosi *et al.*, 2014).

- There is a need for local government to increase the maximum amount of water stipulated in the free basic water supply policy. Such intervention will ensure that there is sufficient supply of water therefore, reducing the set water cuts in rural areas. It is obvious that women in Musina are the custodians of farming knowledge in Musina therefore, if agricultural development and water scarcity interventions as support systems are to be designed, the dominance of the older women generation and their knowledge should be considered for future engagement of women in farming.
- There is also a need to increase support for farmers in Musina. Improved access to agricultural technologies that could improve production in times of scarcity are important.

6.3. LIMITATIONS OF THE INVESTIGATION AND RECOMMENDATIONS FOR FUTURE RESEARCH

This research has served its purpose of contributing to the body of literature on water scarcity, livelihoods, food production and dietary choices in rural Musina, South Africa. It has provided an understanding into how water scarcity impacts on dietary choices of rural populations in Musina, however there were limitations identified during the investigation which serve as a basis for future research.

The first limitation relates to the range of water-related activities whereby this study focused on only one activity namely crop farming. This research could be more informative if it had included other water-related activities because rural dwellers engage with a lot these activities to establish a livelihood. In addition, such a limitation hinders the research from conclusively establishing how water scarcity impacts on rural livelihoods. Therefore, further research should focus on the broad range of water-related activities which rural households engage in and how water availability affects them.

The second limitation relates to the study site chosen for the study. Only one local municipality in the Limpopo province was chosen to assess the impacts of water scarcity on dietary choices. Therefore, it is not possible to generalise these results to the entire province. Future research can be focused on other locations in the Limpopo Province in order to generalise the findings.

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APPENDICES

APPENDIX A: ETHICS CLEARENCE CERTIFICATE

Clearance number GAES2017-01

APPENDIX B: PARTICIPANTS INFORMATION SHEET

Dear: Sir/Madam

My name is Zanele Mokgwathi from the University of the Witwatersrand. I am completing a Masters degree in the School of Animal, Plant & Environmental Sciences. In my study, I want to learn how water scarcity and land degradation impacts on the ability of households to access food. I will be doing this to understand the relationship between climate change-induced water scarcity, land degradation, livelihood choices and dietary choices. I will need to interview households' heads in order to understand how water scarcity and land degradation has impacted food security of the household. The study will take place in various villages within Musina Local Municipality.

I am asking whether you would consider taking part in my research study. You have been selected because you deal first hand with making decisions for the household regarding what food. Therefore, you have in-depth knowledge on the impacts of water scarcity and land degradation on food security.

Your involvement in this study would mean that you will have to answer interview questions related to water, land and food for about half-an-hour to an hour.

I promise that:

- Participation in this study is entirely voluntary (You have the right to refuse to participate or withdraw).
- I will not record your name anywhere and I will only use code names instead e.g. H1 = Household 1, H2 = Household 2 etc. This will ensure confidentiality when reporting on the results.
- Please note that you will **NOT** be paid for the interview.

Your answers will form part of my Masters research report at the university, and a summary of my research can be provided to you on your request. Furthermore, after I have analysed the data and concluded my research I will come back to explain what I found, and also what the trends and important findings of the research are.

If you have any queries and/or questions please contact me:

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Your participation in my research will be highly appreciated.

Thank you for your time

Zanele Mokgwathi

APPENDIX C: CONSENT FORM

The researcher has explained the context of the study to me and I fully understand the aim of the research and my contribution towards it. I have been told that my identity will be anonymous and my responses will be kept confidential. I know that I can stop the interview at any time during the interview but I cannot withdraw once my responses are analysed for report writing. I do not have to answer questions that am not comfortable with. I have the contact details of the researcher in case I have any questions regarding the interview or the context of the study.

I agree to be interviewed

I agree to have my interview recorded: Y☐ ☐o

Participant's signature: Date:

APPENDIX D: PERMISSION LETTER: MAYOR

My name is Zanele Mokgwathi. I am currently registered for Masters Degree at the University of the Witwatersrand in School of Animal, Plant & Environmental Sciences. In my study, I want to learn how water scarcity and land degradation impacts on the ability of households to access food. I will be doing this to understand the relationship between climate change-induced water scarcity, land degradation, livelihood choices and dietary choices. I will need to interview households' heads in order to understand how water scarcity and land degradation has impacted food security of the household. The study will take place in various villages within Musina Local Municipality.

I hereby request your permission to interview the households' heads concerning how water scarcity and land degradation affects their livelihood choices specifically dietary choices. Your permission and support to conduct the research at your village will be highly appreciated.

This document is to certify that Zanele Mokgwathi has asked the chief of the village _____ for permission to interview the households.

The conditions:

- Participants acknowledge that their names will not be recorded or asked by the researcher. Furthermore, respondent codes will be used for pers. comm.
- Participants acknowledge that taking part is voluntary and they will not be forced.
- Participants are not forced to answer questions that they are not comfortable with.
- Participants can stop the interview at any time and refuse to answer any questions that they do not want to.
- Participants will **NOT** be paid for taking part in the interview.

I (Name)_____chief of _____ in _____

hereby grant Zanele Mokgwathi permission to conduct interviews in the village and interview the households with regards to the effects of water scarcity and land degradation on dietary choices.

Signature:_____ Date:_____

APPENDIX E: HOUSEHOLD QUESTIONNAIRE

Section A: Demographic Questions

House code_____				Date interview_____		Village name_____	
Gender?	M	F	Age ?	18 – 28 yrs	29 – 39 yrs	40 – 50 yrs	> 51 yrs
No. of years residing in this village?				< year	1 – 5 yrs	6 -10 yrs	> 10 yrs
House electrification?	Yes	No	Water source?	Borehole	Community tap	River	Other
Number of permanent house occupants			1 -3	4 – 6	> 6	Employed ?	Yes / No

Section B: Questions on farming

1. Do you practice farming?	Yes		No				
2. What type of farming?	Subsistence		Commercial				If no, reason:
3. How often do you farm?	A	V	S	R	N		
4. Harvest trends in past 5 years?	I		D		S		
5. Reasons for the trends:							
5.1. Decreased Rainfall	A	V	S	R	N		
5.2. Land Degradation	A	V	S	R	N		
5.3. Lack of Resources	A	V	S	R	N		

5.4. Other (Specify)	
6. List the crops which you often grow:	
7. In which year did you get the highest rainfall?	
8. In Which year did you get the highest crop yields?	
9. In which year did you get the lowest rainfall?	
10. In which year did you get the lowest crop yields?	

Section C: Water Availability Questions

11. What is the household's primary source of water?	
a) What is the alternative source of water in difficult times?	
12. What is the main source of water used for watering crops?	

a) What is the alternative source in times of scarcity?						
13. How far are you from the primary source of water?	Less than 100m	100-200m	300m	More than 300m		
14. Do you experience challenges with watering your crops?	Yes	No	Don't know			
	If yes, what are the challenges?					
15. How does water scarcity affect the crops you grow?						
16. Do you see any ways in which water availability/scarcity affect your food choices?	Yes	No	Don't know			
	If yes, how?					
17. How concerned are you about water scarcity in your area?	Extremely	Very	Moderate	Slightly	Not at all	Don't know

Section C: Diet Choice Questions

18. How has your food access changed in the past 4 years:				
2015	Good	Average	Bad	Explain: e.g. meals with less vegetables and more meat
2014	Good	Average	Bad	Explain:
2013	Good	Average	Bad	Explain:
2012	Good	Average	Bad	Explain:
19. In years of high rainfall which crops do you grow/buy to eat?				

20. In years of low rainfall which crops do you grow/buy to eat?				
21. How much of the total household income goes to buying food?		Quarter	Half	> Half
22. Why that amount?				
23. Which of these did you have to spend MORE money than you used to:	1= Fruits/ Vegetables	2= Maize meal	3= Meat	4= Bread
24. Why do you think that is?				

THANK YOU FOR YOUR PARTICIPATION.

APPENDIX F: TABLE SOURCES

Table F1: Respondents' employment status

Type of response	Number of households	Percentages
Employed	58	33%
Unemployed	107	61%
Other	10	6%
Total	**175**	**100%**

Table F2: Household size

No. of occupants	Number of households	Percentages
1-3	68	39%
4-6	61	35%
>6	38	22%
Other	8	5%
Total	**175**	**100%**

Table F3: Main water sources in Musina

Water sources	Frequency	Percentages
Inside yard tap	86	49%
Community tap	59	34%
Underground borehole	17	10%
River/Stream	9	5%
Other	4	2%
Total	**175**	**100%**

Table F4: Farmers alternative sources in difficult times

Alternative water sources	Frequency	Percentage
Rainfall	30	31%
Community tap	37	38%
Borehole	14	14%
Sewage	11	11%

Alternative water sources	Frequency	Percentage
River	3	3%
Other	2	2%
Total	**97**	

Table F5: Households food expenditure

Type of response	Frequency	Percentage
Quarter	54	31%
Half	84	48%
>Half	37	21%
Total	**175**	**100%**

Table F6: Distance from municipal water source

Distance from municipal water sources	Frequency	Percentage
0 - 100 m	86	49%
100 - 200 m	61	35%
200 - 300 m	18	10%
>300 m	10	6%
Total	**175**	**100%**