ANALYSIS OF WATER USE PRODUCTIVITY AMONG SMALLHOLDER HOMESTEAD FOOD GARDENING AND IRRIGATION CROP FARMERS IN THE NORTH WEST PROVINCE, SOUTH AFRICA

By

SELEKE CHRISTOPHER TSHWENE

Student number: 16969669

SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL EXTENSION

DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION
FACULTY OF AGRICULTURE, SCIENCE AND TECHNOLOGY
NORTH-WEST UNIVERSITY
MAFIKENG CAMPUS

SUPERVISOR: PROFESSOR O. I. OLADELE

DECEMBER 2014

DECLARATION

I, Seleke Christopher Tshwene, declare that the dissertation entitled " Analysis of water use productivity among smallholder homestead food gardening and irrigation crop farmers in the North West Province, South Africa", hereby submitted for the degree of Master of Science in Agricultural Extension has not previously been submitted by me for a degree at this or any other university. I further declare that is my own work in design and execution and that all materials contained herein have been duly acknowledged.

Signature

Seleke Christopher Tshwene

Date

14/04/2015

ACKNOWLEDGEMENTS

Many people have contributed immensely towards the completion of this study and I wish to thank them all. I extend gratitude to the following:

- My supervisors, Professor Oladimeji Idowu Oladele, for his guidance, constructive disparagement and intellect and for making me believe that everything is possible through determination. Without your support and encouragement, I would not have been able to travel this far. . When I was at the lowest point in the course of my studies, you assured me that there is a greener destination ahead of me and that hard work pays off.

- Mr Thato Mokoma and Queen Khetsi for assisting me during the data capturing process, guiding me on how to use the Statistical Package for the Social Sciences (SPSS) and in interpreting statistical terminologies. Thank you for your loyalty and encouragement and for the willingness to assist even when I was not around. You never complained and was willing to spend sleepless nights with me during the research journey. All district managers of agricultural local development centres as well as extension officers who participated in this study, without you, I will have nothing to tell.

- Mr Kebalepile Moeng, from DARD: information services –GIS unit, thank you for your technical support and assistance.

- My beloved fiancée, Ms Violet Mmamodikwe Pilane. You allowed me to steal your precious and valuable time for my studies. Thanks for your support and encouragement and for constantly asking me about the progress of my studies. May God bless you

- Last but not the least, God almighty for giving me the brain, strength, courage and ability to finish my studies. If you believe and trust in God, He will guide and never fail you in life.

- My late grandparents, Mr Christopher and Gotsemodimo Molosiwa, my father in-law, Mr Bomba Pilane may their souls rest in peace.

DEDICATION

I dedicate my work to my mother, Ms Gladys Tshwene, my brothers Keorapetse and Modise, to my sister Martha and her husband Leonard Dikhudu. A special dedication goes to my late grandparents, Mr Christopher and Mrs Goitsemodimo Molosiwa. I hope my studies make you even more proud of me.

ABSTRACT

The study analysed water use productivity among smallholder homestead food gardening and irrigation crop farmers in the North West province, South Africa. Home gardening and irrigation constitute the most important rural development investment strategies that can have direct impact on poverty and food security. Using a large sample size technique of n>30, 160 gardeners were selected for the study. Data was collected using a structured questionnaire and subjected to analysis using SPSS. Frequency counts and percentages were used to describe demographics. Multiple regressions were also used to identify determinants.

The independent variables were significantly related with an F value of 3.074, P < .05. Also, an R value of 0.506 showed that there is a strong correlation between socio-economic characteristics and water use productivity. The results further predicted R Square 26% of the variation in water use productivity. Five out of sixteen were significant, with three variables being significant at 5% (type of crop, social participation and market outlet) while two variables were significant at 10% (home food security and attitude).

Significant determinants of water use productivity were type of cropping (t =-2.443, P =.016), social participation (t =2.599, P = .010), marketing outlets (t = 2.810, P = .006), home food security (t=-1.777, P = .078) and attitude (t = -1.727, P = .086). The results imply that the higher attitude, marketing, home food security, social participation and type of crop, the higher the use of water productivity among farmers. However, insignificant determinants of water use productivity were farming experience (t = 0.571, p=0.569), education (t = -1.048, p = 0.296), land ownership (t = -1.416, p = 0.159) and age (t = -0.782, p = 0.436). The results imply that the lower the farming experience, education skill, land ownership and age, the lower the water productivity use among farmers.

Increasing agricultural productivity benefits the poor and landless through employment opportunities as majority of poor people lives in rural areas and derive their livelihood directly from agriculture, support for farming must be a high priority for rural development. Strengthening and upgrading rural education and training can have a positive result in addressing the knowledge, skills and information gaps that exit for farmers. Irrigation plays a pivotal role in improvement of rural livelihood, but often characterised by inefficient water use, high capital and recurrent cost, lack of sustainability and inequity in the distribution of land. Government and

other stakeholders including homestead gardeners in irrigation need a better understanding of the role of irrigation in improving the role of irrigation in improving and sustaining rural livelihood. The study among others recommend that home gardeners should be trained in the use of a wide range of irrigation systems, water management, marketing, general management, operation and maintenance of their plots and irrigation schemes and that there should be continuous monitoring by Departments such as the North West Department of Agriculture as it will provide response to farmers and assists them in improving their performance.

LIST OF ABBREVIATIONS AND ACRONYMS

ASGI-SA	Accelerated and Shared Growth Initiative of South Africa
GIS	Geographic information systems
NRC	National Research Council
MDG	Millennium Development Goals
WHO	World Health Organisation WHO/
UNICEF	United Nations International Children Emergency funds
UNESCO	United Nations Educational scientific and Cultural Organisation
WWAP	Water Assessment Programme
WWF	World Water Forum
NEPAD,	New Partnership for Africa's Development
NWA	National Water Act
DWAF	Department of Water Affairs and Forestry
USDA	United States Department of Agriculture
NWF	National Wildlife Federation
NNS	National Nutrition Survey
ALDEP	Arable Land Development Program
IKS	Indigenous knowledge systems
NMMDM	Ngaka Modiri Molema District Municipality
IDP	Intergraded Development Plan
SPSS	Statistical Package for Social Sciences
MUS	Multiple-use services
NWF	National Wildlife Federation
WRC	Water Research Commission

DARD	Department of Agriculture and rural development
ARDRI	Agricultural and Rural Development Research Institute
GSSP	Ghana Strategy Support Program
OECD	Organisation for economic co-operation and development
IIED	International Institute for Environment and Development
SSA	Statistic South Africa
IWMI	International Water Management Institute
HFIAS	Household food insecurity access scale
WP	water productivity

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CHAPTER ONE

1.0 ORIENTATION OF THE STUDY

1.1 INTRODUCTION

Agriculture is the backbone of the South African economy. About 80% of South Africa's population depend on agriculture for their livelihood. Economic growth and the rural poor are factors that are linked to agriculture and allow these developing areas to increase productivity and incomes. One of the key contributions of the agricultural sector is poverty reduction. Moreover, agricultural growth improves employment for poor rural people, increases the demand for consumer goods and services and stimulates growth in the nonfarm economy (OECD 2006). Over the past years, many rural farmers have been faced with serious challenges such as economic integration and this is affecting the socio-economic position of the rural poor.

The strategic importance of agriculture lies in its forward and backward integration with the rest of the economy, the establishment and maintenance of food security, the economic welfare of rural areas and stabilisation capabilities in relation to the balance of payments. In developing countries, rural development plays a crucial role in economic development and the alleviation of poverty. In spite of South Africa's plausible performance in terms of macro-economic stability and acceptable levels of economic growth over the past decade, the country's international competitiveness, mostly rated in terms of the strength of its institutional arrangements, has declined. In terms of equitability, South Africa has also performed poorly (Meyer *et al.*, 2009).

The authors suggest that in realising the weaknesses and failures of the economy and government policy in addressing the needs of the unemployed and poor sufficiently, former President, Thabo Mbeki pledged accelerated infrastructure investment in underdeveloped urban and rural areas in order to improve service delivery. In addition, agriculture is identified as one of the major sectors that can ensure the achievement of the Accelerated and Shared Growth Initiative of South Africa (ASGI-SA). Much of the world's poor population are found in rural areas and it is estimated to be around seventy percent (70%) while two out of three billion rural people reside in about four hundred and fifty million small farms. Changes in agricultural production have drastically occurred over the last decades with huge impacts in traditional agricultural patterns in terms of financial, communal or political power (Hazell, Poulton, Wiggins and Dorward, 2007).

A home garden is a small system of household plant production (Cherry and Di-Leonardo, 2010) and an unpopular aged-long food security strategy (Teitelbaum and Beckley, 2006) partly because of its wide variety of produce and its informal nature. Home gardening has become an important part of cultural heritage (Seaton, 1981) which denotes specific farming practices at different localities. It is therefore inappropriate to ascribe definite and effective cultural practices to the management, siting and ownership of home gardening because home gardening has been a way of life for centuries (Zerihun, Weyessa and Adugna, 2011).

Considering it cultural-based nature, the origin of home gardening is an initiation of new settlers as a means of survival (De Wolf, 1992) and therefore normally sited very close to the residence. Becker (1984) reported on the wide spread of "kitchen" gardens adjacent to dwelling places and that the commonly cultivated crops are vegetables, medicinal herbs and a few flowers. Home gardens satisfy immediate household food needs, the consumption of fresh farm produce and act as a direct transaction between the gardener and the consumer. The management of the garden is principally directed by the household head since the head locates the site and leads the construction of the house. However, the West Africa Regional Food for Peace Project (2004) maintains that there is dominance of women in West Africa in the management and ownership of home gardens.

1.2 BACKGROUND OF THE STUDY

Home gardening has contributed to food security in many ways, such as direct access to a diversity of nutritionally rich foods, increased purchasing power from savings on food bills and income from the sale of garden products, and fall-back food provision during seasonal lean periods (Akosa, 2011). Indigenous farming practice enhances the natural link between humans and their natural environment.

This farming practice adheres to ecologically friendly farming systems and fosters sustainability in ecological succession (IAASTD, 2009). The practice is viewed as a management strategy that employs the notion of reducing the cost of farm inputs and protecting the natural environment (National Research Council (NRC), 1989; Bruinsma, 2003).This system of farming also eliminates issues of social justice and equity associated with the production and distribution of food beyond the locality (Batterbury and Fernando, 2006) and therefore enhances food sovereignty. Individual farmers spend quality time in the gardens, paying particular attention to the survival of individual crops, maximizing each crop yield and the total farm output.

1.3 STATEMENT OF THE PROBLEM

Reducing world hunger by the year 2015 is one of the global priorities as set out by the Millennium Development Goals (MDGs) of the United Nations. Accomplishing national food security relies on appropriate policies that will ensure availability of adequate food either through local production (UN, 2005). Human population is largely increasing and the need for escalating food production to nourish the world's population of nine billion people by 2050 has enormous pressure on agricultural production systems (Oladele, 2012). According to Mwenge and Kahinda (2007), the government of South Africa is faced with tremendous challenges of providing rural areas with food, especially in dry areas.

Poverty and climatic conditions such as drought and floods, and economic and policy shocks increasingly threaten food security. Households which grow their own food are faced with difficult and unpredictable agricultural conditions and rising input prices. Poor nutrition and limited skills lead to increased vulnerability to disease and poor livelihood prospects. One response to this difficult situation or challenge is through the promotion of home gardens in rural communities (Mwenge and Kahinda, 2007).

Home gardening has the potential to improve the consumption of vegetables and fruits, improve child health care and nutrition, and improve household food security and income as well as women empowerment. It is believed that it also provides practical experience in food production and natural resource management. Through enhancing food nutrition and security, home gardening contributes to the alleviation of health and social impact of diseases. Effective home gardening in semi-arid areas like the North West province in South Africa needs an improved understanding of key factors impacting on land and water productivity which are imperative for a better informed and decision-making as well. The productivity of water used in agriculture is essential to meet the goals of food and environmental security. One of the technologies considered important in terms of ensuring household food security is through irrigation practice (Tekana and Oladele, 2011).

Increasing the productivity of water is critical in areas where water is a scarce resource since it promotes productivity in agriculture and plays a pivotal role in reducing environmental degradation and provision of food security (Rijsberman, 2001). Despite all its importance as stated above, emphasis in agriculture has been placed in large scale irrigation in terms of water use and production. In most studies, focus has usually shifted away from water use productivity in home gardening. This research therefore, analyses water use productivity among small holder homestead food gardening and irrigation crop farming in the North West province, South Africa.

1.4 RESEARCH QUESTIONS

The research questions asked were:

- What are the personal characteristics of rural small farmers engaged in home gardening and irrigation crop farming?
- What is the level of water use efficiency in home gardens?
- What is the level of return to water use in home gardening?
- What is the impact of home gardening and irrigation crop farming on household food security?

1.5 OBJECTIVE OF THE STUDY

The main objective of the study was to analyse water use productivity among smallholder homestead food gardening and irrigation crop farming in the North West province, South Africa.

1.5.1 Specific objectives

The specific objectives were to:

- Identify the personal characteristics of rural small farmers engaged in home gardening and irrigation crop farming;
- Determine the level of water use efficiency in home gardening;
- Ascertain the level of returns of water use in home gardening; and
- Determine the impact of home gardening and irrigation crop farming on household food security.

1.6 HYPOTHESIS

There is no significant relationship between farmers' personal characteristics, farm characteristics and water use productivity in home gardening and irrigation crop farming.

1.7 DEFINITION OF TERMS

1.7.1 Household food security

The access by all household members at all times, to adequate, safe and nutritious food for healthy productive life (FAO, 2003).

1.7.2 Home gardening

A home garden is a mixture of deliberately planted vegetation, usually with a complex structure and designed to produce natural products for the household or market (Kumar and Nair 2006).

1.7.3 Food security

A flexible concept when all people at all times, have access to sufficient, safe, nutritious food to maintain a healthy and active life. It includes physical and economic access to food that meets people's dietary needs as well as their food preferences. The three pillars or core determinants of food security are food access, food availability and food utilisation (FAO, 1996).

1.7.4 Irrigation

Irrigation means the action of applying water to land in order to supply crops and other plants with necessary water. Sometimes, nutrients may be applied through irrigation as well (Chait, 2013).

1.7.5 Water productivity

Abdullaev *et al.*, (2003) define water productivity as the physical accounting of water with yield or economic output to assess how much value is being obtained from the use of water and calculated by the equation (WP) = $\frac{output}{Q}$ where WP is the productivity of water in Kg/m^3 output indicating the production of the crop in kilograms. Water used by the crop Q is measured in m^3.

1.8 SUMMARY OF CHAPTER

This chapter has presented the introduction to the study, the background, statement of the problem alongside the objectives of the study. The research questions were highlighted and issues to be discussed in the study examined. The hypothesis was set out in the study indicating the significant relationship between variables.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 INTRODUCTION

This chapter explores the importance of water, homestead gardening and irrigation in communal areas of the republic of South Africa and other countries. It discusses the historical overview of water use productivity among homestead gardening. The importance of irrigation in people's lives in terms of its socio-economic implications and livelihood is also discussed. It also reviews the extent to which homestead gardening has been used as an agricultural project and tool in alleviating poverty.

2.2 INTERNATIONAL PERSPECTIVE ON WATER ACCESSIBILITY

According to WHO/UNICEF (2006), water access is classified as a universal need and a basic human right. It acts as an important element in human development, poverty alleviation and also as a crucial component of preventive healthcare. It is estimated that almost one in four people in developing countries lack access to improved water sources. Water is a universal solvent used for consumptive and productive purposes; it contributes positively to rural and urban livelihood in complex ways. In many instances, poor people do not have access to enough water for both productive and consumptive uses due to scarce or limited resources (Moldern *et al.*, 2007). Sometimes, water can be available but does not produce potential grains due to lower water productivity or lack of infrastructural investments. This is referred to as economic water scarcity and leads to poverty (Carter *et al.*, 2007).

Moldern *et al.* (2007) maintain that a third of the world's people receive water scarcity as a result of the rising demand by the population, continuous expansion of irrigation, growth in industries and lack of investment in machinery. Climatic changes and land degradation strain the environmental flow and there is a need to preserve the ecosystem (Janmaat, 2004). According to Boelens *et al.* (2005), the problem of water scarcity will intensify due to increasing population, the rising demand for water for agriculture and greater climatic variability. Increasing scarcity is likely to deepen current inequalities in access to water and a disadvantage to rural communities. For example, poverty in the high altitude Andean watershed has been increasing due to the fact that water is customarily used for hydro power projects or high profit users outside the area.

Lack of access to water is directly and indirectly related to poverty (Roy, Crow, 2004). Direct links are those that have to do with control over or with ownership of water resources while indirect links have to do with access to safe water. According to Modula (2000), low levels of access to improved water supply are mainly a result of poverty and have major adverse health effects on the population. Households with poor access to water stand a risk of being attacked by diseases. In Ethiopia, it has been estimated that 80% of household members suffer from water-related diseases (UNESCO-WWAP, 2003). Households whose members are affected by these diseases have to spend their resources taking care of the ill. This reduces the labour available for productive purposes and thereby accentuating poverty (UNESCO-WWAP, 2003).

According to UNESCO-WWAP (2003), a number of international ideas such as the 1981-1990 International Decade for Water Supply and Sanitation whose goal was to accomplish several coverage of improved water supply have been initiated due to global anxiety about improving water supply. In 2000, the second World Water Forum held in the Hague, elaborated more on the importance of providing safe water. Also, the UN general assembly emphasised the importance of improving water supply and set a target for the reduction by 2015 of the proportion of the population without access to safe water as one of the Millennium Development Goals (MDGs).

It has been noted that improved access to safe water is increasingly understood as satisfaction beyond basic needs. In rural areas, water is not only important for satisfying basic needs but for supporting critical household productive activities upon which their livelihoods depend. Some productive activities include watering vegetable gardens, livestock watering and other activities (Madulu, 2002; Makoni *et al.*, 2004).

The budget of most governments, NGOs and international donors and financing communities is spent on water lifting, storage and conveyance in order to bring water to homes and fields in rural and peri-urban areas in developing countries. The United Nations declaration of water as a human right ratified by governments in Bolivia (UN, 2010) further commits governments and donors to deliver water for domestic uses to all citizens for health. Organisations such as the World Bank, WHO, the International Fund for Agricultural Development of the United Nations and other financing organisation re-engage in agriculture and irrigation, with the stated aim of unlocking farmers' productive potential for food and income (NEPAD, 2003; World Bank, 2007).

Less rainfall and more extreme droughts and floods due climate changes reinforce the call for accelerating improvement in water lifting, storage and conveyance in order to protect the poor. The results of rural water projects are disappointing in most rural areas because there are few functional schemes and lack of maintenance of functional ones (Skinner, 2009).

According to WHO/UNICEF (2000, 2004, 2005 and 2006), there are many factors that determine access to water for households. Drinking water sources are defined as "improved and "not improved" types of water sources. "Not improved" water sources are used as alternatives for poor water qualities compared to "improved" water sources that are more likely to be polluted. WHO/UNICEF define "access to water" as households that can obtain their drinking water from an "improved" water source. Table 2.1 below shows different water sources.

Table 2.1: Types of water sources

Improved sources	Not improved sources
Household connection pipes	River /streams
Boreholes	Lakes/Dams
Rain water collection	Tanker truck provided water
Protected dug well	Unprotected dug well

WHO/UNICEF, 2000, 2004, 2005 and 2006

2.3 THE RIGHT TO WATER FRAMEWORK

884 million of the 6.7 billion people in the world do not have access to clean water (UNICEF, 2010). According to Kofi Annan (2001), the former United Nations Secretary General, "access to safe water is a fundamental human need and therefore, a basic human right. Contaminated water jeopardises both physical and social health of all people. It is an affront to human dignity".

According to the UN's (1992) committee on economic, social and cultural rights, an individual's right to water includes "sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use". The fulfilment of the right to water requires that the water be available, of sufficient quality and accessible. Having enough water for personal and domestic issues, including food preparation, sanitation and washing is defined as water availability. Water quality is defines as being free from substances like microorganisms, chemicals and other hazards that that threaten a person's health. Water accessibility is defined as physical and economic access to water. Thus, a person should have enough water for personal and domestic uses (availability) and it should be safe (quality) regardless of cost (accessibility) (UN, 1992).

Percentages of the population in India using improved water sources in 2006 stood at 89% (96% in urban and 86% in rural) compared to 81% (85% urban and 79% in rural) from 1990 to 1998 (United Nations Children's Fund, 2010). With regard to these improvements, it is likely that India will meet its aggregate level MDG target for clean water by 2015.

In India, there are threats to all the three elements of an individual's rights to water, a decrease in water availability, a lack of access to water, particularly in rural areas and a potential threat to water quality. The government of India has long recognised the lack of clean water as a problem. Under the Indian constitution, water and sanitation are the responsibility of each respective state within India, although the first national water supply and sanitation programme was introduced as part of the government's health plan between 1951 and 1965 (Government of India, 2006).

Most recently, India has been trying to address the problem of access to water by aggregating water supply and reducing unnecessary water use. Different institutions have encouraged a transition from government led supply given projects to decentralised projects driven by local demand. This has been applied to World Bank sponsored initiatives in India, beginning with the Karnataka project in the early 1990s and continuing with projects in Uttar Pradesh, Tamil Nadu, Madhya Pradesh and Maharashtra (Klees, Godinho and Lawson-Doe, 1999).

The concentration of export agriculture has put tremendous pressure on the already scarce water resources in the arid part of Mexico (Walsh, 2004 and 2009). In San Quintin, the production of water intense crops such as strawberries and tomatoes represent an ecological stress for a region with a mean annual rainfall close to 150 mm (Aguirre-Munoz *et al.*, 2001) compared to a national average of 774 mm (Browning-Aiken and Pineda Pablos in Press). According to Aguirre-Munoz *et al.* (2001), local growers selected regional aquifers to irrigate their lands. The main irrigation methods consisted in running water through the furrows. As water became limited, most growers shifted to drip irrigation. The intensification of production in the 1990s placed renewed pressure on the stressed water shed and water tables dropped about one foot per year (Lizarraga, 2008).

Like many other arid countries and regions in the world, Australia's agricultural production is threatened by water shortage with potentially serious economic and environmental consequences (Cooley *et al.*, 2009). The country is known to be one of the major food producers but with recent droughts, it's agricultural and food production has been reduced due to water scarcity (Goesch *et al.*, 2007). According to Quiggin and Chamber (2004), greater demands by non-agricultural uses and increased water scarcity have a major implication for agricultural production. Chiew *et al.* (2009) state that there is also a major concern that climatic change will reduce or change seasonal rainfall patterns. The combined effects are likely to be evident as declining food production, water allocation for irrigation and crop effective rainfall are reduced.

According to Faures and Santini (2008), the livelihoods of rural people in sub-Saharan countries are highly dependent on natural resources and water may be one largest constraint to expanding and diversifying livelihood activities. Water is a basic necessity and a productive asset. Provision of water in these areas is mainly to focus on meeting domestic needs suck as drinking, cooking, washing and bathing. Since the mid-1990s, there has been a growing interest in how domestic water for productive activities and is tied to rural livelihoods. Water is used for productive activities such as agriculture, gardening, raising livestock, pottery and other small scale commercial activities (Van Koppen *et al.*, 2009).

Multiple-use services (MUS) were used as an approach in improving the awareness of how water provided for domestic use should be used. This approach seeks to plan and manage water services with the aim of meeting people's water needs for multiple purposes (Smith *et al.*, 2010). Providing more water and creatively designing water services around productive activities can enhance people's livelihoods and contribute to a wider range of benefits than traditionally-designed systems (Smith *et al.*, 2010). Such additional productive systems include improved health, food security, income generation and women empowerment (Van Koppen *et al.*, 2009).

The productive use of water in livelihood diversification strategies remains relatively unexplored. Households with access to water for productive uses are able to diversify homestead production with small scale cultivation, kitchen gardens, animal raising or other small scale commercial services (Van Koppen *et al.*, 2009). According to Noel *et al.*, (2010), domestic water supply was used for many types of household-based enterprises such as vegetable cultivation, raising of pigs and small eateries. Almost 60-70% of rural poor are estimated to have access to small cultivable plots, often around their homesteads and engage in water-dependant small enterprises (Renwick *et al.*, 2007).

2.4 SOUTH AFRICA'S EXPERIENCE ON WATER REFORM

South Africa's National water act of 1998 (Act.36 of 1998) is widely regarded as an innovator to an international wave of reforms in the water sector, including the EU water framework Directive (EU, 2000) and Mexico's National water plan which embodies as set of guiding principles agreed at the 1992 International Conference on Water and the Environment (ICWE) in Dublin (World Bank, 1993, 2003). International norms differ from South Africa water reform. Goals of the legislation redress past inequalities in water use (World Bank, 2003).

The purpose of the National Water Act (NWA) is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways that take into account issues such as meeting the human and basic needs of present and future generations. It also seeks to promote equitable access to water, efficient, sustainable and beneficial use of water in public interest and also facilitating economic and social development among people (World Bank, 1993, 2003). According to the National Water Act, all water in South Africa is considered to be an 'indivisible national asset' and the Department of Water Affairs and Forestry (DWAF) is the custodian in the interest of the republic (DWAF, 1997).

2.5 THE CONCEPT AND CAUSES OF WATER SCARCITY IN SOUTH AFRICA

Water is not only scarce in arid and drought prone areas but also in regions where rainfall is abundant. This distresses the quantity of resources available and the quality of water due to degraded water resources. The sustainable use of water resource conservation, environmental friendliness and economic viability constitute priorities for agriculture in water scarce regions. New strategies are required mainly for irrigation management and practice since the agricultural sector is far ahead in demand for water. Water scarcity occurs as a result of various natural causes and man induced causes (Pereira, 1990).

According to Pereira, Cordery and Iacovides (2002), drought is nature induced with temporary imbalance in water availability consisting in lower average rainfall. The occurrence of drought is difficult to predict resulting in diminished water available. This is hazardous because it is a natural accident of almost unpredictable occurrence and disastrous due to the fact that it encourages the failure of precipitation causing serious disruption of water supply to the natural and agricultural ecosystem. Aridity is also a nature induced permanent imbalance in water availability consisting in low average annual rainfall resulting in overall low moisture and low carrying capacity of the ecosystem.

Desertification is caused by man and leads to permanent imbalance in the availability of water combined with damaged soils, inappropriate land use and deterioration of the carrying capacity of the ecosystem. This is associated with soil erosion and salinity. Although many definitions use desertification and focus mainly on land degradation and sometimes does not refer to water, when dealing with scarce water, it seems appropriate to define the term in relation to water and nature imbalances produced by the misuse of water and land resources. This therefore, draws attention to the fact that desertification, including land degradation, definitely cause water scarcity (Pereira *et al.*, 2002).

Water shortage is also man induced but temporary water imbalance including the over exploitation of ground water and reduced capacities of reservoir can consequently alter the carrying capacity in the ecosystem. Degraded water quality is often related to water shortage and like drought, encourages related impacts.

Desertification and water shortage are man induced and associated to problems such as land degradation due to soil erosion and salinization, over exploitation of land and water resources. Water quality requires policies that will lead in resolving the existing problem

Table 2.2: Causes of water scarcity

Duration	Nature produced	Man induced
Permanent	Aridity	Desertification
Temporary	Drought	Water shortage

Source: Pereira *et al.*, (2002)

2.6 ASSESSMENT OF HOME GARDENING IN THE LIVELIHOOD OF RURAL FARMERS

According to Nemudzudzanyi (2010), home gardens are classified as a type of domestic garden. The word domestic is derived from the Greek word "*domos*", which means "house". There are different types of home gardens and variations in terms of the purpose for which they are used. In most urban areas, home gardens are considered as comfort space around the yard. The difference between urban and rural gardens lies with the purpose and use. In most developing countries, their main purpose is to sustain livelihood and primary food production .A home garden is an intensively worked land use arrangement involving planned management of adaptable plants linked with agricultural crops within the yard of individual households (Fernandes and Nair, 1986).

To understand the basis of home food gardening, it is important to review its history and understand its evolution. Private, domestic gardens in residential areas represent substantial element of green space in many areas of the world (Gaston *et al.*, 2005; Mathieu *et al.*, 2007.). A home garden can be defined as the combination of thoughtful planted vegetation, usually with a complex procedure and planned to produce natural products for the household or the market (Kumar and Nair, 2006). Different plant species in a home garden can range from less than five to more than 100 (Vogl and Volg-Lukasser, 2003).

If home gardens are managed properly, they can be used for both money-making or survival purposes and can deliver from only a few to more than 100 products. Home gardening is not only important for exploring human-environment linkage but also to potentially improve the livelihood of people through improved management systems. According to Millat-e-Mustafa *et al.* (1996); Uddin *et al.* (2002); Ahmed and Rahman (2004), home gardens can act as a safety net in the provision of alternative livelihood opportunities for people during periods of frustration such as a bad crop year.

Keller (2003) defines home gardening as an area around the home where vegetables, annual and perennial plants and fruits are grown to meet family consumption requirements. Those that produce one to two varieties of vegetables, are scattered and seasonal, are considered as simple home gardens. Improved home gardens are those that have three to four varieties but are not productive throughout the year; and developed home gardens are those that produce at least three varieties of vegetables throughout the year.

2.7 HISTORY OF HOME GARDENING

During the early settlement period in the US, people's survival was based on their ability to cultivate their own food although producing an adequate amount was a challenge. Many struggled to flourish because of lack of food. Those who managed to survive did so by incorporating the now famous gardening triad of corn, beans and squash first cultivated by Native Americans (Becker, 1984; De Wolf, 1992).

In the eighteenth century, the character of home gardening changed due to the increase in the population of colonies. Growing occupational and residential specialisation meant that gardening was no longer a required activity of the entire population. However, many individuals continued with gardening for self-provision. Some people decided to engage in gardening more as a hobby and for relaxation than as a way of feeding themselves (Leighton, 1976).

The need and function of the home garden continued to evolve in the nineteenth century, with technological development and urbanisation being a critical force of change. The mass production of home preservation material (Becker, 1984) and the emergence of firms specialising in seed saving developed an impact on the character and scale of what was possible in home gardening (Tucker, 1993). The declining necessity of the garden as a survival strategy suggested that more people engaged in gardening used it for entertainment and leisure (Tice, 1984).

In urban communities, it was suggested that gardening enabled them to psychologically escape the hectic urban life for a few moments. It was an opportunity to show off their leisure time by growing exotic and expensive varieties of crops and plants (Tice, 1984). The increasing efficiency of market farming and space limitation of urban landscapes for home gardening was gradually becoming unnecessary in the urban landscape (Becker, 1984).

Food retail business grew during this period and destroyed the importance of home gardening as markets, trading posts and grocery stores began to develop in urban and rural communities (Baker and Izard, 1991). As the US entered the twentieth century, the practice of home gardening further declined with additional technological advances and even greater levels of urbanisation. Between 1910 and 1920, many people realised that they did not have enough time, space or desire to maintain home gardens and the art of home gardening started to fade (Lynd, 1929).

While the twentieth century witnessed a decline in home gardening, there was a resurrection during two historical moments referred to as 'war gardens' during World War I and 'victory garden' during the World War II. . The US department of Agriculture claims that during World War II, more than 20 million families planted a victory garden in 1943 (United States Department of Agriculture (USDA, 2011).

Bentley (1998) adds that these gardens functioned as a symbolic expression of patriotism and helped build community structures where they were planted. The US government encouraged households gardening during the periods of (Miller, 2004), assuming that the urban population no longer knew how to grow fruits and vegetables (Cole, 1993). Other levels of government including municipalities supported the use of gardens throughout the country (Miller, 2004).

2.8 CHARACTERISTICS AND FUNCTIONS OF HOME GARDENS

With a focus mainly on edible crops, home gardens contribute in sustaining basic household needs without generating environmental degradation (Nair, 2001; Watson and Eyzaguirre, 2002; Del-Angel-Perezand Mandoza, 2004). Research on the ecological functions of home gardens found out that they improve nutrient cycling (Kumar and Nair, 2004). The economic function of home gardening suggests that it is efficient and provides energy flows in terms of cash (Cai *et al.*, 2004) and contributes to food security through the generation of products for household consumption., It also contributes to household cash income through the commercialisation of surplus fruits and vegetables (Wezel and Bender, 2003).

According to Shillington (2008), home gardening provides an important space for social relations and contributes positively to household health other functions of home gardening includes its contribution to community development (Saldivar-Tanakaand Krasny, 2004), impact on social skills, food choice and nutritional knowledge of garden holders (Lautenschlager and Smith, 2007). It can be concluded that home gardening provides numerous benefits on the ecological, economic and social environment.

2.8.1 Gardens as significant space

Francis and Hester (1990) define gardens as a place with a distinct meaning. They are powerful settings for human life. There has been increased interest in examining the role of gardens, gardening practices, memories of past gardens and the gardening experience itself (Kiesling and Manning, 2010). Three major themes emerge from the literature.

2.8.2 Gardens and well-being

Gardens have established the connection between gardening and psychological well-being (Kuo and Taylor, 2004). Connection and access to nature have potential benefits for both physical and mental health (Frumkin, 2003), stress and cognitive functioning (Wells and Evans, 2003). Poverty deficient housing and crime, minimal contact with nature, the process of planting and observing how plants grow to maturity provide residents with significant calming relief from the concerns and challenges of daily living (Alanen, 1990). Gardens can also ease psychological strain.

2.8.3 Gardens and memories

According to Thompson (2005), gardens are containers of memory, of past landscapes, trees and plant past memories of favourite childhood gardens spill over onto present and ideal images of gardens .Certain plants carry special meaning and unlike gardens, are transferrable from home to home (Bhatti and Church, 2001). In some communities in England, ethnic minority groups took pleasure in growing fruit producing plants, such as olives and grapes, from their countries of origin (Rishbeth, 2004). For immigrants from war torn nations such as the Hmong from Laos, growing familiar fruits and vegetables, though enjoyable, was also touched with sadness, a recapitulation of the land and lives they had lost forever (Giraud, 1990).

2.8.4 Gardens and identity

Gardens can express personal, social, cultural and environmental identities (Kiesling and Manning, 2010). At the personal level, gardens can replicate an individual's creativity, originality, planting preference and gardening styles (Clayton, 2007). Gardens can express the gardener's relationship with the environment. For example, through the creation of an organic garden and the non-use of chemical fertilizers and pesticides (Kiesling and Manning, 2010). Although few researchers have made important contributions, research on home gardening is largely incomplete.

2.9 INTERNATIONAL PERSPECTIVE OF HOME GARDENING

2.9.1 Understanding the role of gardening in South America (United States of America)

In America, gardening is regarded as an important activity. A study at the National Gardening Association found that 78% of US households participate in home gardening while some carry out lawn gardening and garden activities (Butterfield, 2006). Although it is the most desired by many, this practice can have negative effects on the natural environment (Steignberg, 2006). Such practices involve planting invasive non-native species which may have negative impacts on the surrounding ecosystem. For example, using excessive water which can result in water shortageand administering of toxic chemicals (National Coalition against the misuse of pesticide, 2006). Based on the study of the US Environmental Protection Agency (2006), about 74% of US households used pesticides and fertilizers in 2001.

According to Pimentel (1991), numerous home gardeners tend to overuse pesticides than large scale farmers and it was estimated that around seven million bird species die each year due to the use of various pesticides. With regard to this a number; alternatives have been developed for home gardeners to adopt in terms of making their gardens more hospitable. Such practices include using native species of plants, reducing the use of toxic chemicals and the installation of ecologically diverse landscapes that provide food and shelter for wildlife (National Wildlife Federation, 2006).

2.9.2 Home Gardening In Asia (Philippines and India)

Philippines is one of the countries currently experiencing serious deficiencies of micronutrients, especially with Iron and Vitamin A (Soemantri *et al.*, 1985). Such deficiencies cause increase in morbidity and mortality, encourage growth deficits and reduce work productivity and economic input (World Health Organisation, 1995). The fifth National Nutrition Survey conducted in 1998 by the Food and Nutrition Research Institute of the government of the Philippines (FNRI) demonstrated that the prevalence of vitamin A deficiency was 8.2% among children aged 6 months to 5 yeasts and 7.1% among pregnant women (Department of Health, 2001).

Three strategies were later developed to control these deficiencies as follows: horticultural activities combined with health and education, protection of food products and distribution of high dose micronutrient supplements (vitamin A capsules and Iron tablets) (Darnton-Hill, 1997). The government focused on food protection but the programme did not cover the entire eligible population because of inconsistent supply (Dela Cuadra, 2002). Households faced with the crisis of increasing food prices may opt to change the quantity, quality and diversify their daily food consumption.

Even though previous studies concluded that fortification and supplementation were cost effective for controlling vitamin A in the Philippines (Solon *et al.*, 1979), recent studies have shown that it is a burden on government budget to sustain the on-going programme (Fielder *et al.*, 2000). Vegetables are regarded as the most economically efficient source of micro nutrients (Ali and Tsou, 2002). Due to the dietary deficiencies in the Philippines, diet improvement practices through home gardening were now developed (De Pee *et al.*, 1998). Home gardening is among the approaches recognised to increase production and consumption of vitamin A–rich foods and also has the potential to provide multiple nutrients (Chakravarty, 2000). However, few research works have been conducted to examine dietary improvements through home gardening in the Philippines (Bayani, 2000).

FAO (2000) found that about 230 different plant species are sheltering in 60 home gardens in Asian villages. Some of these traditional vegetable species have not been considered in modern society and yet were noted for good nutrition and medicinal purposes. A study of home gardening in humid Southern Kerela State of India demonstrated the increase in revenue from women's household gardens and contributing to improved children nutrition. In Southern India, men stopped gardening and women took over because gardening involves fetching water, which is regarded as a women's activity and unsuitable for men. Marketing of garden produce is also considered as a job for women as it is believed that it provides women with an opportunity to leave the house and socialise (Pacey, 1978).

2.9.3 AFRICA'S PERSPECTIVE ON THE IMPORTANCE AND USE OF HOME GARDENING

Agriculture is the main source of income for most rural people in Zimbabwe. The use of home gardens varies. Some use it for subsistence agriculture while others use it to grow crops for commercial purposes (Vogl *et al.*, 2004). In rural home gardens, gardeners usually grow medicines, vegetables and fruits (Kumar and Nair, 2004). The features of home gardens are year round production of food, decreasing production failure due to diversity of species, increased resource productivity over time and alternative production (Senanayake *et al.*, 2009). Home gardens can serve as source of cash and food as well as income for rural communities.

A wide range of products from trees and herbaceous plants cultivated in home gardens offers diversity to the diets of rural households and also serves as an important source of income through sale of surplus produce and cash crops (High and Schackleton, 2000). Owners use various forms of plant management strategies in home gardening activities (Thomas Van Damme, 2010). Plant management can be categorised into two main groups namely, cultivated and tolerated. Cultivated crops or species are managed and cared for by people during their lifecycle (Van den Eynden, 2004). They are sown as seeds then increased by means of stem, root cutting and transplanted from natural habitats (Thomas Van Damme, 2010). Tolerated are those that are intentionally spared during land clearing activities since they are useful to the household. Such species are maintained and protected in home gardens; some can be found growing in the wild.

Even though there has been little research done on food gardening in Zimbabwe, Mayori (2013) examined the use and management of home garden plants in Zvishavane district in Zimbabwe. Surveyed households in Zvishavane district possessed fenced home gardens adjacent to the homestead (71%) or next to the river (29%). Homestead gardens were clearly defined by a wooden fence or barbed wire. Cultivation was mainly done in an area of 154-520 m^2. Most people (93%) relied on bucket irrigation while only 9.7% had drip irrigation as the source of water. Rained irrigation is mostly considered as it plays a pivotal role in home gardening irrigation (Maroyi, 2013). Majority of households are educated up to secondary level and most home gardens are led by women since they remain at home while men are engaged in different jobs. Agriculture is the main source of income for most households (Maroyi, 2013).

Pacey (1978) states that during the hunger season, fresh home gardening vegetables can be cultivated so that the whole diet in the family could be better balanced. A number of developments in the vegetable industry and economy have resulted in high cost of energy and labour has contributed to an increased interest in home gardening. Due to price variations, vegetables are becoming too expensive; hence, home gardening can be used as a means to supply families and improve their dietary needs as well as provide additional tax-free income. Collum (1995) notes that fresh home vegetables have the upper hand in quality than those sold in the market and are readily available when needed.

In Botswana, home gardening is popular in Mochudi. The area is situated in the outskirt of Gaborone city where most husbands work and are employed (ALDEP, 1982). The majority of women remain at home while their husbands go to work. This is of great disadvantage to them since most women do not have access to land for farming resulting in high levels of poverty. Despite all the challenges, women are still projected to provide food for their families. The solution to this expectation was to engage in home gardening (ALDEP, 1982).

2.9.4 PERSPECTIVE ON THE IMPORTANCE AND USE OF HOME GARDENING IN (SOUTH AFRICA)

Food gardens are implemented in some developing countries with the aim of addressing food scarcity problems in vulnerable areas (Karaan and Mohamed, 1998; Moskow, 1999). South Africa has a large number of households with food insecurity problems and such interventions play a crucial role in trying to reduce the problem (Altman and Jacobs, 2009). Women are economically, socially and emotionally dependent on their husbands do not have independent decision-making powers. At the same time, however, they are key players in caring for the sick since they are the most reliable sources in caring and supporting their families (Gaede, Majeke and Modeste, 2006).

Interventions like food gardening and educating women reduce their dependence on men (Friedman, Kippax and Phaswana-Mafliyac, 2006). Francis (2002) maintains that in South Africa, "frugal populations are also highly stratified, with income and asset distribution tilted by class, gender, and ethnic identity. This stratification is bound up with inequalities of voice and power". Altman *et al.* (2009) suggest that there is a high prevalence of women engaged in subsistence agriculture in South Africa and that the gender-specific constraints they face are under-researched.

According to Du Plessis and Lekganyae (2012), women witness their daily interactions while men are perceived as the heads of families. Women are expected to remain subordinate to male authority. The authors maintain that since becoming involved in home gardening, women have been empowered by programmes directed at improving their literacy levels and strategies aimed at poverty alleviation. Their involvement in food gardening projects provided them with the opportunity to free themselves from the chains of poverty and deprivation: "*E ntshitse gare ga bodiidi le mohlako*" [It took me out of want and suffering].

Food gardens reduced poverty levels as women were able to take some food home to their children and at times, the gardens helped them obtain a small income from selling the produce (Du Plessis and Lekganyae, 2012). Food gardens also addressed aspects of structural powerlessness for women. Women themselves had power in the redistribution of vegetables taken from gardens to their homes. In other words, they controlled the allocation of these additional resources in their domestic spheres.

They gained a small victory over the delineation of priorities and of laying claim on what they have produced. In terms of economic empowerment, participation in the food garden project was beneficial to the women in terms of greater food security for their households, increased quantity and quality of foodstuff available for household consumption, savings in the food budget and modest income generation (Du Plessis and Lekganyae, 2012).

Du Plessis and Lekganyae (2012) state that policy interventions to promote the reduction of poverty in South Africa should consider the role of food gardens in rural and urban areas to change risk environments for the better. This should include the thought of equitable access to land, extension services and markets. Moreover, since the United Nations' Millennium Development Goals emphasise poverty reduction, the promotion of gender equity and sustained research as well as support for developmental interventions, such food gardens are thus required.

2.9.5 HOME GARDENING IN THE NORTH WEST PROVINCE, SOUTH AFRICA

Molebatsi *et al.* (2010) refer to home garden in Tswana language as "*Tshimo*" and define it as a model of sustainable resource management in South Africa but emphasise that gardens of indigenous culture as are known to be spontaneous and disorganised. People use home gardens for various reasons. Others use it for subsistence agriculture while others use if for commercial purposes in producing food (Vogl *et al.*, 2004).

In most rural areas, gardeners grow vegetables for medical, spiritual and ornamental purposes and fruits (Lamont *et al.*, 2004). Indigenous useful plants require less input in terms of monitoring growth and gardeners have the knowledge on how to cultivate and prepare these dynamic indigenous knowledge systems (IKS). For example, African leafy vegetables which grow fast and adapt well to unfavourable weather conditions, disease tolerant and can grow well in soils with limited fertility (Shiundu, 2002).

Table 2.3: List of useful plant species from Batswana home gardens in the North West province, South Africa

Species	Vernacular name	Plant use
Prunus persica (L.) Batsch	Peach	Fr
Vitis vinifera L	Grape	Fr
Bidens bipinnata L	Spanish Blackjack	Veg
Cucurbita pepo L.	Marrow	Veg
Citrillus lanatus (Thunb.) Matsum. and Nakai	Wild Watermelon	Veg
Vigna unguiculata (L.) Walp	Cowpea	Veg
Zea mays L	Maize	Gr
Cynodon dactylon (L.) Pers	Couch Grass	Or
Euphorbia inaequilatera Sond	Smooth Milkweed	Me

Plant use: Fr, Fruit; Gr, Grain; Me, Medicinal; Or, Ornamental; Ve, Vegetable

Source: Molebatsi *et al.* (2010)

In terms of the use of indigenous plant species and alien plants, Molebatsi *et al.* (2010) maintains that useful alien plants account for 60% of species found in Tswana home gardens. Such species are less preferable. These kinds of species have been recorded in most Tswana home gardens from rural areas (Davoren, 2009). Rural gardeners manage and use indigenous plants wisely (Zobolo and Mkabela, 2006) and alien species are normally well thought-out when there is a possibility of such species to be neutralised (Siebert *et al.*, 2010).

According to Head *et al.* (2004), several backyard food productions have lost their purpose due to the fact that most people are migrating to the cities. Kirkpatrick *et al.* (2007) support this argument by showing the decline in the percentages of productive vegetable and fruits micro gardens. Medicinal gardens in Tswana home gardens are very limited unlike in Zulu home gardens where micro home gardens with medicinal plants are the custom (Nemudzudzanyi *et al.*, 2010).

Accessibility of ornamental plants resistant to drought ushered the introduction of European practice within the Tswana culture (Davoren, 2009). Such species are available in peri-urban areas, mostly through urban home gardens indigenous knowledge systems (IKS) (Cillers, 2010) and are not completely foreign to the Tswana culture as they seem to appear even in remote areas (Molebatsi *et al.*, 2010).

According to various sources, little work has been done in terms of the layout of gardens in South Africa. Coetzee *et al.* (2007) state that micro gardens recognized for Tswana home gardens are similar to what was referred to as 'structural elements'. Molebatsi *et al.* (2010) conclude that Tswana home gardens are dominated by alien species and that there are five main plant use categories in Tswana home gardens. Grains dominate in rural areas and leafy vegetables in peri-urban areas and ornamentals are diverse.

2.10 OVER VIEW OF IRRIGATION AND ITS IMPORTANCE IN HOMESTEAD FOOD GARDENING

Irrigation refers to the artificial application of water to land for the purpose of enhancing plant production. This application reduces water deficit as a restraining factor in plant production and makes it possible to grow crops where climate is too dry for this purpose. It also increases crop yield where available soil water is a yield limiting factor during parts or all growing seasons (Reinders *et al.*, 2010). Irrigation water can be obtained from various sources and used by farmers in a group as an irrigation scheme.

The term irrigation scheme is an agricultural plan with multiple holdings reliant on a shared delivery system for access to irrigation water and may also include storage facilities. Reinders *et al.* (2010) refer to this term as a multitude of entities that correspond to the definition, when these entities share the same bulk conveyance systems. In South Africa, the term 'smallholder irrigation scheme' is commonly used to refer to irrigation schemes in which the land is held by Black people (Machete *et al.*, 2004). According to Vander Stoep (2011), smallholder irrigation schemes are of secondary importance in terms of land area and farmers' contribution. In 2010, smallholder irrigation schemes covered 47 667 hectares compared to the 1 675 822 hectares of registered irrigation land in 2008, with 1 399 221 hectares irrigated per annum.

The Government of the Republic of South Africa has submitted to supporting irrigation expansion by providing financial assistance to state irrigation schemes and irrigation board schemes. Several large state schemes were developed during the 1930s when the state was involved in severe droughts and economic despair. State irrigation schemes were created to increase food production, insure agriculture against drought, and establish new owner-operators in the farming sector as well as to create rural employment opportunities (Backeberg and Groenewald, 1995).

In the 20th century, South African politics was more in favour of whites (Beinart, 2001). Irrigation development was established for the settlement of white farmers (Bruwer and Van Heerden, 1995). Few small sized irrigation plots were owned by black farmers (Machete *et al.*, 2004). Smallholder irrigation schemes are regarded as of secondary importance in terms of land area and farmer participation in South Africa. In 2010, smallholder irrigation schemes covered 47 667 hectares compared to the 1 675 822 hectares of registered irrigation land in 2008, with 1 399 221 hectares irrigated annually (Vander Stoep, 2011).

The importance of smallholder schemes arises primarily from their location in former homelands, which continue to be poverty nodes (Vink and Van Rooyen, 2009). Irrigated farming in such areas has the capacity to contribute positively to food security and in the income of participating homesteads (Bembridge, 2000). The Water Research Commission (WRC) got involved in smallholder irrigation schemes, when from about 1990 onwards, it broadened its agricultural water focus from water as a production factor to water as a livelihood resource, against a backdrop of political changes in South Africa. Black irrigators farmed on about 100 000 hectares and half of this irrigated area was located in smallholder irrigation schemes (Bembridge, 1997) as part of their residential sites.

2.11 OVERVIEW OF SMALL HOLDER IRRIGATION SCHEMES IN SOUTH AFRICA

Irrigation is measured as one of the best technologies for ensuring household food security and for sustainable rural development within South Africa's largest semi-arid zone (Tekana and Oladele, 2011). Studies have indicated that in 2010, there were 302 smallholder irrigation schemes with a combined command area of 47 667 hectares in South Africa. Rivers are the principal source of water.

A total of 46 114 ha (96.7%) obtained its water from rivers. Smallholder irrigation scheme development in South Africa has a much longer history (Van Averbeke, 2008). However, in 2010, schemes constructed before 1950 no longer existed in their original form. One example was Taung in the North West province, which dates back to 1939 (Bembridge, 1997), but the original canal irrigation system has been replaced with an overhead system.

Table 2.4: Operational status of South African small holder irrigation schemes by province and irrigation system history

Province	Number of operational schemes by irrigation				Number of non-operational schemes by irrigation systems				
	Gravity fed surface	Pumped surface	Over head	Micro	Gravity fed surface	Pumped surface	Overhead	Micro	Total
Limpopo	49	9	30	13	12	5	41	11	170
Mpumalanga	3	0	4	0	1	0	11	0	9
North West	0	2	0	0	0	0	0	0	2
KwaZulu Natal	5	0	30	0	0	0	0	0	35
Free State	0	1	0	0	1	0	0	0	2
Northern Cape	0	2	0	0	0	1	0	0	3
Eastern Cape	4	0	46	1	0	0	0	0	67
Western Cape	6	0		0	0	0	0	0	8
Total	67	14	111	14	14	6	59	11	296

Source: Van Averbeke (2008)

2.12 IRRIGATION IN THE NORTH WEST PROVINCE OF SOUTH AFRICA

In 1939, the Taung irrigation scheme was launched by the South African government as part of the Vaal-Hartz scheme (Tekana and Oladele, 2011). The central government's withdrawal and homeland administration policy took over in the 1970s because political and administrative self-government of the Bantustan was encouraged. This saw the integration of the Taung Scheme into the Bophuthatswana homeland during the independent homeland era which lasted from 1970 until the 1990's and was an integral part of the economic development of the homeland. Irrigation development during the independent homeland era was characterised by modernisation, functional diversification and centralisation of irrigation management (Van Averbeke and Mohamed, 2006).

The ARDRI Report (2000) maintains that the Bophuthatswana government had to take proper control and supervision of the scheme with facilities and conditions of settlement and maintenance. The newly developed 1.7 hectares plots per farmer were irrigated by floods and around 200 farmers used the plots not for commercial purposes but to grow maize and pumpkin by preference. According to the Tomlison Commission, the 1.7 hectares irrigated holdings were adequate to "provide a family with a living that would satisfy them whereby the whole family will work on the scheme" (Tekana and Oladele, 2011). About 2 500 hectares of the land is under the centre pivot system and about 1000 hectares irrigated by the conventional sprinkler system.

2.13 THE EFFECTS OF IRRIGATION ON AGRICULTURAL PRODUCTIVITY

Irrigation water has increased food security of many agrarians and improved the standard of living in many parts of the word. Many children in developing countries lived in areas with shortage and enormous starvation with high rate of malnutrition. Due to this, there has been a number of reasons for the increase in food production. The role of water and its accessibility is also a major issue (FAO, 1999).

Historically, staple food production has been dependent on irrigation and irrigated production is estimated to account for 60% of worldwide agricultural output (Meinzen-Dickand and Rosegrant, 2001).The increased supplies of irrigation water have been instrumental in feeding the population of many developing countries in the last 50 years. Irrigation water has increased food security and improved living standard in many parts of the world. There have been a number of reasons for an increase in food production, including high yield varieties. However the role of water development in providing irrigation water to cropland has also been significant (Schoenggold and Zilberman 2005).

Schoenggold and Zilberman (2005) further indicated benefit of irrigation project as an expansion in the feasibility land base for agricultural production. Many region with high quality soils receive rainfall during the winter months when it cannot be used for crop production. For these areas, development of reservoir allow water to be stored during the rainy seasons of the year and then used for farming during dry period. Canals allow water to be transported from water rich to arid areas, where it can be used for crop production

According to FAO (1996) there is enormous evidence that irrigated lands leads to productivity, a hector of land that is irrigated is worth multiple hectors of rain fed cropland. In Asia, yields from most crops have increased 100-400 after irrigation. This has contributed to a decrease in food pricing. Irrigation allows farmers to apply water at the most beneficial times for the crop instead of relying on rainfall. A study conducted in India indicated that areas under irrigation have increased 30% from 1970–1985, from 31.1 million hectares to 41.8 million hectares, whilst food grain prices fell by 20% relative to the price index for all commodities. These reductions have had a positive impact on the real incomes of the urban and rural poor, who spend a large proportion of their income on basic foodstuffs (Evenson et al 1999)

Even though irrigation can be having a negative impact on the poor under some circumstances, agricultural irrigation has been regarded as a powerful factor for providing food security, protection against adverse draught conditions, increased prospects of unemployment for stable income and greater opportunity for multiple cropping and crop diversification. Accessibility to irrigation can enables farmers to adopt new technologies and intensify cultivation leading to increased productivity. Rural settings with irrigation water and land can have an important wealth generating function in agriculture (Hussain *et al* 2002).Access to good irrigation water has the potential to contribute to poverty reduction.it allows people agrarians in rural areas to increase their production and income and enhance opportunities to diversify their income base, reducing defenceless situation caused by season ability of agricultural production as well as external shocks.

According to Shah (1993) irrigation brings a range of benefits to individuals and households that economists sometimes distinguish between primary and spill-over effects. Primary effects includes, increased and more stable flow of income from farming made possible by increased intensity of cropping, improved yields and new farm enterprise or technology mixes whereas Spill-over effects indicate, Increased and more evenly spread farm labour opportunities and improved wage rates, reduced out-migration and increased return migration, Improved security against impoverishment, lower food prices and better nutrition throughout the year, Growth in non-farm employment, Greater urban-rural contact and new social networks and lastly More water for non-agricultural uses, including domestic uses that improve health.

Development of irrigated agriculture benefits land-owning households as they are able to increase their incomes from gains in productivity. One challenge in promoting irrigation for poverty reduction is to specifically target the rural communities. Such communities include those who neither own nor operate land, or whose major source of income is derived from agricultural wage employment, even if they own or rent small amounts of land. Carruthers (1996) argues that the reason why there should be more investment in irrigated agriculture is to increase food security and job creation to reduce migration in rural areas.

2.14 THE CONCEPT OF WATER USE PRODUCTIVITY

Kijne et al. (2003) explained the concept of water productivity (WP) as a vigorous measure of the ability of agricultural systems to convert water into food. While it was used primarily to evaluate the function of irrigation systems as 'crop per drop' it seems useful to extend the concept to include other types of livelihood support, such as mixed cropping, pasture, fisheries or forests Molden et al. (2010) define water use productivity as the physical mass of production measured against depleted or available water. They further indicate that productivity of water can be related to the economic value of the produce per unit volume of water. Viets (1962) further indicates that water productivity has a broader foundation than water use efficiency which only relates production of mass to process depletion such as evaporation for irrigated agriculture. Abdullaev et al. (2003) maintain that there are indicators that determine water productivity. Such indicators include the produce obtained and which is influenced by excellent agricultural operations, climatic conditions and soil standards. Another indicator is the water supply rate. If there is enough water supply rate, farmers are likely to produce more due to abundant water resources.

Over the past few years, the concept of productivity of water in agriculture has gained ground due to increasing scarcity of irrigation water from physical and economic perspectives, mostly locally and often also regionally. Several studies are available from the past which deal with water productivity of crops with respect to evapo-transpiration (ET) of crops. Oweis and Hachum (2002) examined water productivity influence of supplementary irrigation on pulses. Study by Saeed and El-Nadi (1998) in Shambat, Sudan, Utao and Idaho on forage crops showed improvement in physical productivity of water with supplementary irrigation. Rockström et al., (2002) provided evidence from Kenya and Burkina Faso to the effect that supplementary irrigation enhances water productivity (Kg/m3) of rain-fed maize and sorghum, respectively, remarkably with greater effect coming with fertilizer management; and from Tanzania to show that conservation tillage increases water productivity of maize.

2.14.1 Basic expression

Productivity is a measure of system performance expressed as a ratio of output to input. For agricultural systems, WP is a measure of output of a given system in relation to the water it consumes. Assessment may be required for the whole system, defined in time and space.

$$\underline{WP = Agricultural\ Benefit}$$
$$Water\ Use$$

2.14.2 Units used to determine water use productivity

Water Productivity represented in units of kg/m^3. If production is measured in kg/ha, water use is estimated as mm of water applied or received as rainfall, convertible simply to m^3/ha ($1mm = 10m^3/ha$). Alternative notations include food ($kcal/m^3$) or monetary value ($\$/m^3$). Water productivity is estimated for an agricultural system and defined within a given area and period of time. The purpose of WP is to permit rapid comparisons between water use systems in space and time. Water Productivity of 1.5 kg/m^3 might be considered 'good' whereas one of 0.5 kg/m^3 might be thought to be 'bad' Kijne et al. (2003). Estimates of WP for single activities are called partial WPs. Water Productivity of larger areas containing multiple land use requires integration of partial WPs for each activity contained within them.

2.14.3 Defining the time period and land area for estimation of water use productivity

Water productivity time period is estimated and determined by the cycle of agricultural production that drives the system.in this case it would at least comprise of one complete crop cycle, extended over a complete year to account for productive and non-productive water use. Valuation may be extended over several years to derive estimates of average, minimum or maximum water productivity within each season. In composite agricultural systems it may require assessment over several years to include all productive and consumptive phases. Cropping systems provide internal benefits in addition to yield such as soil nutrition, which may significantly influence water productivity in subsequent years Kijne et al. (2003).

It is important to define the boundaries of the system for which WP is to be estimated. This is determined by the definition of production system such as farm scale and the area for which water consumption can be defined (plot). Measurement of partial WP for a single crop at field or plot level is simplest. There is a difference between accuracy of measurement over small areas and representation of a larger hydrologic system. Such an assessment will represent only part of the benefits generated within a farming system. The effect of spatial scale on variation in water storage is also considered. Areas with high volumes of rainfall, WP will always vary spatially due varying water storage capacity Bouman (2006)

2.15 FACTORS AFFECTING WATER USE PRODUCTIVITY

2.15.1 Climatic conditions

A significant change in climate on a global scale will impact agriculture and consequently affect the world's food supply. More erratic rainfall patterns and unpredictable high temperature spells will consequently reduce crop productivity (FAO 2001). Most Developing countries will be particularly vulnerable. Land degradation, extreme geophysical events, reduced water availability (FAO 2004). Unless measures are undertaken to mitigate the effects of climate change, food security in developing countries in the tropics will be under threat.

Vegetables are the best resource for overcoming micronutrient deficiencies and provide smallholder farmers with much higher income and more jobs per hectare than staple crops (AVRDC 2006). The worldwide production of vegetables has increased over the past quarter century and the value of global trade in vegetables now exceeds that of cereals. Amongst vegetable crops, tomatoes are the most important horticultural crop worldwide and grown on over 4 million hectares of land area (FAO 2006). Tomato, cabbage, onion, hot pepper and eggplant are particularly important in Asia and Sub-Saharan Africa (Brown et al. 2005). Most vegetables prefer cooler temperatures, thus productivity is lowest in the hot and humid lowlands of Southeast Asia (Ali 2000). In Sub-Saharan Africa (excluding South Africa) and tropical Asia, average tomato yields are only about 10 - 12 MT/hectare, well below the yields in temperate regions (FAO 2006). Vegetables are generally sensitive to environmental extremes, and thus high temperatures and limited soil moisture are the major causes of low yields.

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2.5.2 Environmental constraints limiting vegetable productivity

Environmental stress is the primary cause of crop losses worldwide, reducing average yields for most major crops by more than 50% (Bray et al. 2000). Climatic changes influence the severity of environmental stress imposed on vegetable crops. Increasing temperatures and reducing irrigation water availability, are major limiting factors in sustaining and increasing vegetable productivity. Extreme climatic conditions will also negatively impact soil fertility and increase soil erosion. The response of plants to environmental stresses depends on the plant developmental stage and the length and severity of the stress (Bray, 2002).

- **High temperatures**

Temperature limits the range and production of many crops. High temperature conditions are often prevalent during the growing season and, with a changing climate, crops in this areas are subjected to increased temperature stress. High temperature stress disrupts the biochemical reactions fundamental for normal cell function in plants. It primarily affects the photosynthetic functions of plants (Weis & Berry 1988). High temperatures can cause significant losses in tomato productivity due to reduced fruit set, and smaller and lower quality fruits (Stevens & Rudich 1978). In pepper, high temperature exposure at the pre-anthesis stage does not affect pistil or stamen viability, but high post-pollination temperatures inhibit fruit set, suggesting that fertilization is sensitive to high temperature stress (Erickson & Markhart 2002). According to Hazra et al. (2007) the symptoms causing fruit set failure at high temperatures in tomato includes bud drop, abnormal flower development, poor pollen production, ovule abortion and poor viability.

- **Drought**

Drought is considered as the single most important factor affecting world food security and the catalyst of the great famines of the past (CGIAR, 2003). Inefficient water usage all over the world and inefficient distribution systems in developing countries further decreases water availability. Water availability is expected to be highly sensitive to climate change and severe water stress conditions will affect crop productivity, particularly that of vegetables. High temperatures and decreased precipitation could cause reduction of irrigation water availability and increase in evapotranspiration, leading to severe crop water-stress conditions Fruits and vegetables contain large quantities of water in proportion to their weight, Vegetables, being succulent products by definition consist of greater than 90% water (AVRDC,1990). Water greatly influences the yield and quality of vegetables drought conditions drastically reduces vegetable productivity. Drought stress causes an increase of solute concentration in the soil, leading to an osmotic flow of water out of plant cells. This leads to an increase of the solute concentration in plant cells, thereby lowering the water potential and disrupting membranes and cell processes such as photosynthesis.

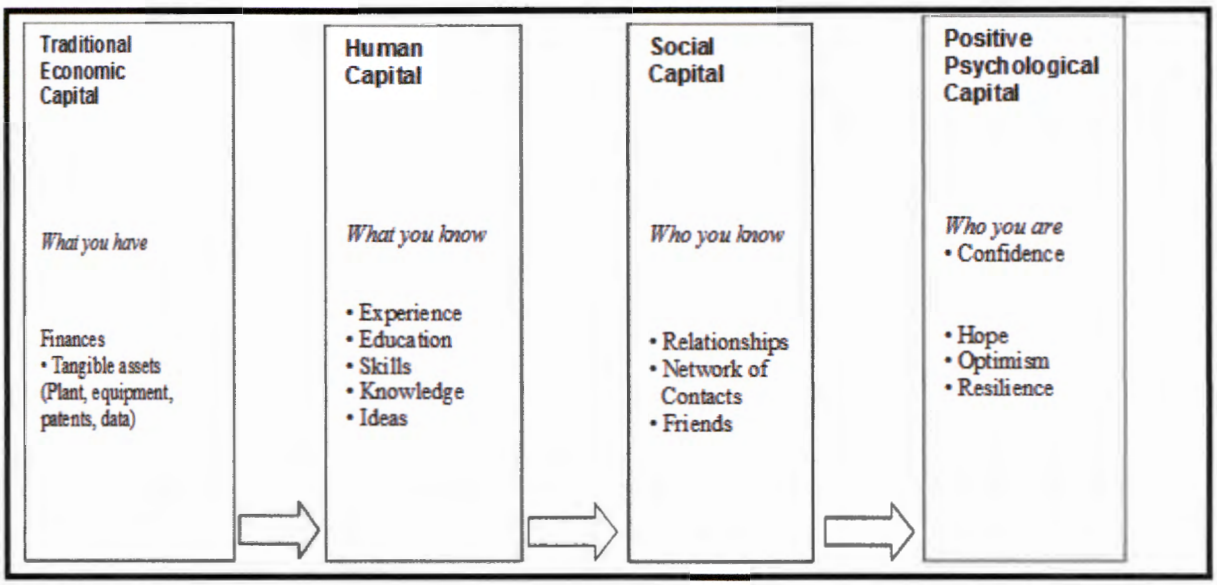
- **Flooding**

Most vegetables are highly sensitive to flooding and genetic variation with respect to this character is limited, particularly in tomato. Damage to vegetables by flooding is due to the reduction of oxygen in the root zone which inhibits aerobic processes. According to (Drew 1979) flooded tomato plants accumulate endogenous ethylene that causes damage to the plants. Low oxygen levels stimulate an increased production of an ethylene precursor, 1-aminocyclopropane-1-carboxylic acid (ACC), in the roots. The severity of flooding symptoms increases with rising temperatures; rapid wilting and death of tomato plants is usually observed following a short period of flooding at high temperatures (Kuo et al. 1982).

2.16 EXPANDING CAPITAL FOR COMPETITIVE ADVANTAGE

Through the rising acknowledgement of human resources as a competitive advantage in today's global economy, human capital and social capital are being touted in both theory, research, and practice. However, positive psychological capital has been virtually ignored by both business academics and practitioners. Avoiding a preoccupation with personal shortcomings and dysfunctions and focusing instead on personal strengths and good qualities, today's leaders and their associates can develop self-confidence, expectation, cheerfulness, and flexibility, thus improving both individual and organizational performance (Luthans. etal, 2004). Technological change and diffusion, rapid innovation, and deregulation have eroded these widely recognized barriers. In today's environment, which requires flexibility, innovation, and speed-to-market, effectively developing and managing employees' knowledge, experiences, skills, and expertise collectively defined as "human capital" has become a key success factor for sustained organizational performance.

Figure 2.1 Expanding capital for competitive advantage



Luthans et al. (2004)

2.16.1 Traditional economic capital

Traditionally, economic capital refers to financial and tangible assets such as plant and equipment for farmers (Luthans *et al.*, 2004). For gardeners, food security is the main concern, and their small production units are almost totally dedicated to home consumption. Their assets are poorly developed, and they have very limited access to services (credit) that would enable them increase returns to their assets. Many live in fragile ecosystems or less favoured regions with poor soil quality or without enough water supplies. The economic status of such farmers affects their income earning opportunities.

2.16.2 Human capital

Human capital is accumulated knowledge, created in the long-term process of human resources development. It begins in the early stages of life of an individual who wants to engage in agricultural activities. Improving human capital in agriculture is especially important where the shortage of trained human resources is a major limiting factor to development (Lindley *et al.*, 1996). Zubović *et al.* (2009) argue knowledge is recognised as a fourth economic pillar alongside those of land, labour and capital. Skills and intellectual acumen are often more critical than other economic resources such as land and labour and even capital because it is difficult to measure its levels.

2.16.3 Positive psychological capital

Luthans *et al.* (2004) note that with the rising recognition of human resources as a competitive advantage in today's global economy, human capital and, more recently, social capital, are being touted in both theory, research and practice. To date, however, positive psychological capital has been virtually ignored by both business academics and practitioners.

2.16.3.1 Confidence.

Confidence can be defined as having a firm trust in one's ability, having a sense of reliance or certainty. When making our decision or expressing knowledge ,opinions or beliefs about something we will have a feeling of confidence that accompany this.in this way we take confidence as being persons belief that a statement represents represent the best possible response and it describes a person's strength of belief about accuracy or quality of a prediction, judgment or choice (Sniezek,1992) .according to Bandura (1997), confidence as a positive psychological capital capacity has been demonstrated to have a strong positive relationship to work-related performance.

2.16.3.2 Hope

Commonly used in everyday language, hope has an impact and important positive contribution to positive psychological capital. Snyder et al. (1991) defined hope as a positive motivational state that is based on an interactively derived sense of successful by goal-oriented energy) and proper planning to meet goals. Adams et al. (2003) has indicated that there is considerable evidence of its positive impact on academic and athletic performance. Hope appears very similar to the other positive capacities, considerable theoretical and measurement analyses demonstrate its conceptual independence and discriminant validity.

2.16.3.3 Optimism

According Seligman (2002), optimism is perhaps more closely associated with overall positive psychology than the other constructs and like hope the term is commonly used, definition draws from attribution theory in terms of two crucial dimensions being permanence and pervasiveness. Optimists interpret bad events as being only temporary whereas while pessimists interpret bad events as being permanent. The opposite is true for good events, for which the optimist makes a permanent attribution ("I'm brilliant") and the pessimist a temporary attribution ("I have made a strong attempt on this". However permanence is more linked with time while pervasiveness has to do with space. For bad events, optimists make specific attributions while pessimists make universal attributions

2.16.3.4 Resilience

According to Luthans. *et al,*(2004), reliance is defined as the capacity or ability to bounce back from hardship or even dramatic positive changes in particularly relevant in today's turbulent business environment. Masten (2001), indicate that at first, resilience was thought to be quite rare in people but now there is evidence that it can come from "the from the everyday magic of ordinary, normative human resources" and "has profound implications for promoting competence and human capital in individuals and society." Coutu (2002) also indicate that there are common profiles of resilient people and are now recognized to be deep believers, having the ability to improvise and individuals who accept reality as it is. Excluding its application on stress resistance, only surface efforts have been administered to use resilience to promote how front-runners, associates and administrations can bounce back from hard times. However extensive research from clinical and positive psychology suggest that confidence, hope and optimism, reliance can contribute to positive psychological capital with a return of desired performance outcomes

2.17 Characteristics of Household Food Insecurity Access Scale (HFIAS) as a tool used to measure food insecurity

According to Coates, Swindale and Bilinsky (2007) The HFIAS is a tool used to assess whether households have experienced problems in food access in the preceding 30 days. The tool is composed of questions that ask about modifications households made in their diet or food consumption patterns due to limited resources to acquire food. It measures the severity of food insecurity in the past 30 days, as reported by the households themselves. The targeted population are normally the house hold responded targeted for the study and this study the focus was directed to homestead food gardeners.

The use of HFIAS allows the extent and severity of food insecurity at household level to be assessed and is a useful measure for comparing food access across different population groups. It can be used for monitoring and for evaluation of policies. This tool can also be used for the integration of food security information systems that monitors trends on a long term base. Such information can be interpreted at community, district and national level. The use of the tool at global level for comparison is theoretically possible as the questions it tasks are based on universal behavior. (Coates, Swindale and Bilinsky, 2007)

Swindale and Bilinsky (2006) indicated the relevance of this tool as it reflects the household experience of food access problems during the previous month. Growing prevalence of food insecurity as measured with the tool can identify seasonal food insecurity or an impending food crisis, and can be used to monitor changes in food security over time. The HFIAS is specific to food consumption aspects; it is not influenced by health and care aspects, as it refers to modifications of the diet pattern specifically due to lack of resources to access food. Therefore a change in the diet due to lack of health and/or care should not be captured by the scale. The extent at which it measures the socio economic situation and its evolution varies. Food insecurity measured by the HFIAS is linked to poverty level. . It is usually inversely correlated with Household Dietary diversity, i.e. households with low dietary diversity score are high for food insecurity. HFIAS allows assessment of food poverty - the inability to obtain healthy affordable food.

The tool is data derived from a nine item questionnaire on which the respondent is the in charge of food preparation or as head of the households who answers on behalf of all household members. Respondent has four possible responses depending on the regularity of occurrence. The results of food insecurity are based on the calculation of response and a classification of food insecurity. The positive qualities of this tool is that it is properly adapted to local context, the tool can be easily used and interpreted by local personnel, not time consuming and not offensive. HFIAS is a standardized tool that is based on universal behaviour in access to food. It is the correct and only tool that measures a household's direct experience of food insecurity (Coates, Swindale and Bilinsky, 2007).

According to Coates, Swindale and Bilinsky (2007) questions are asked with a recall period of four weeks (30 days).The respondent is firstly asked an occurrence question that is, whether the condition in the Question happened at all in the past four weeks (yes or no). If the respondent answers "yes" to an occurrence question, a frequency-of-occurrence question is asked to determine whether the condition happened rarely (once or twice), sometimes (three to ten times) or often (more than ten times) in the past four weeks.

Table 2.5 Household Food Insecurity Access Scale (HFIAS) Generic Questions

No.	Occurrence Questions
1	In the past four weeks, did you worry that your household would not have enough food?
2	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources
3	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources
4	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?
5	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?
6	In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?
7	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?
8	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?
9	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?

Coates, Swindale and Bilinsky, (2007)

2.18 SUMMARY OF CHAPTER

This chapter present an overview of irrigation in homestead food gardens, both in South Africa and on the international scene. The implication of South Africa water act on home gardening and the linkage between water use productivity and irrigation and household welfare were examined. The theoretical foundation for the study was laid and variables that have been used in similar studies in different parts of the world were isolated.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 INTRODUCTION

The aim of this chapter is to orientate the reader on the study area. It outlines the research design, the population of the study, sampling procedures such as sampling techniques and sample size. The data collection strategy and instruments used to collect data are discussed as well as the validity and reliability of results. Issues of ethical considerations and data analysis are also examined in this chapter.

3.2 STUDY AREA

The study was conducted in four districts of the North West province (Bojanala Platinum, Ngaka Modiri Molema, Dr Kenneth Kaunda and Dr Ruth Mompati).

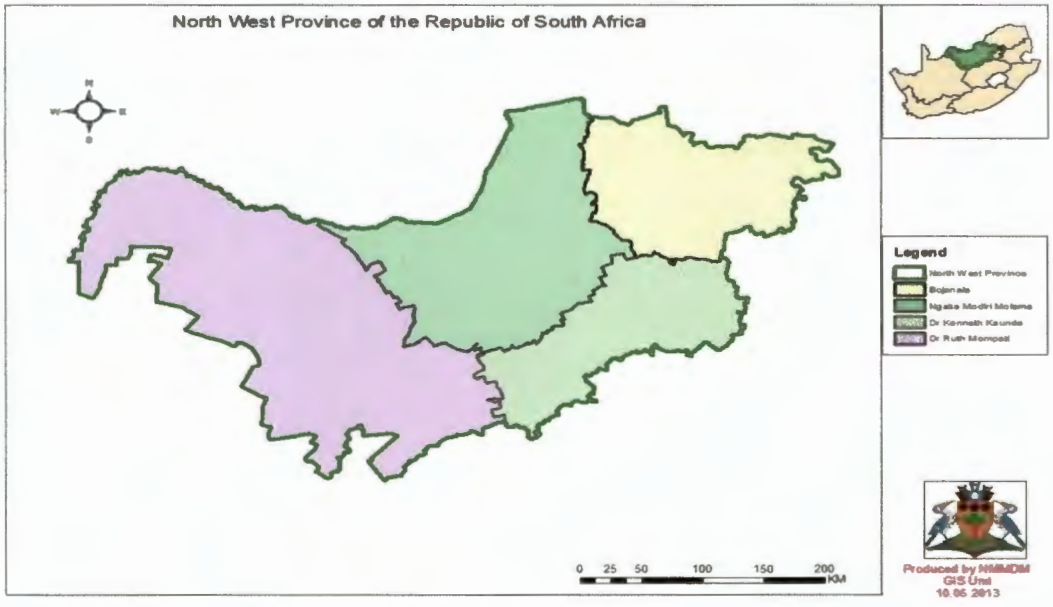


Figure 3.1: Map of the North West province (NMMDM, 2013)

3.2 DESCRIPTION OF THE STUDY AREA

According to the North West Parks Board, the surface area of the North West province of South Africa is 118,797 sq km (45,869 sq miles). It shares its international border with Botswana. Within the country, the province is bordered to the south by the Free State and the Northern Cape, and the northeast and east by Limpopo and Gauteng. The North West was created in 1994 through the merger of Bophuthatswana, one of the former Bantustans (or black homelands) and the western part of the Transvaal, one of the four former South African provinces. Most residents in the province are the Tswana people and speak Setswana as the home language. Smaller groups include Afrikaaners, Sotho and Xhosa speaking people. English is spoken primarily as a second language. Most of the inhabitants are Christians.
Mahikeng, formerly Mafikeng, is the provincial capital. Other major towns include Klerksdorp and Rustenburg. The province has two universities, one campus in Mahikeng referred to as the North-West University, Mahikeng Campus formerly called the University of Bophuthatswana in the early 1980s (founded in 1979) and the Potchefstroom University for Christian Higher Education (founded in 1869 and which became a constituent college of the University of South Africa in 1921 and an independent university in 1951.

3.2.1 Vegetation and climatic conditions

The North West province consists of flat areas of scattered trees and grassland. It has a variety of vegetation; some areas have mixed bush veld with plant species such as Sandvaal boom (*Terminalia Sericea),* Wlid Senga (*Burkea Africana*) and grass species such as Elephant grass (Eragrostis Pallens) while some have Sourish Mixed bush veld which consist of more acacia savanna with tall dense grassland. Another part of the province is covered with Kalahari thorn veld and shrub bush veld, vegetation of acacia species such as Camel Thorn (Acacia Giraffe) and common grasses that include species like Blue seed grass (*Eragrostis Lehmanniana*). There are few mountainous areas like The Magaliesberg mountain range in the northeast which extends over 130 kilometres (about 80 miles) from Pretoria to Rustenburg. The Vaal River flows along the southern border of the province.

3.2.2 Climate (temperature and rainfall)

Temperatures range from 17° to 31° C (62° to 88° F) in summer and from 3° to 21° C (37° to 70° F) in winter. Annual rainfall totals about 360 millilitres, with almost all of it experienced during the summer months, that is, between October and April.

3.2.3 Economic activities

The major economic activities of the North West Province are mining and agriculture.

3.2.3.1. Mining

Mining generates more than half of the province's gross domestic product and provides jobs for the local population and people from other provinces of the country and nearby countries like Botswana, Lesotho and Zimbabwe. Gold is mined in Orkney and Klerksdorp, uranium in Klerksdorp, Platinum in Rustenburg and Brits, and diamond in Lichtenburg, Christiana and Bloemhof.

3.2.3.2 Agriculture

The northern and western parts of the province have many sheep farms, cattle and game ranches. The eastern and southern parts are crop-growing regions that produce maize (corn), sunflowers, tobacco, cotton and citrus fruits. People in these regions are employed in farms and make a living out of it.

3.3 Dr Ruth Segomotsi Mompati district Municipality

The region is situated in the western part of the province with an altitude of 1,200 metres above sea level and annual average rainfall of 430 millilitres. The climate is dry. Summers are hot with temperatures ranging from 16 - 38 degrees Celsius. Dr Ruth Segomotsi Mompati occupies the western region of the North West province. It was previously known as Bophirima Region or Stellaland. The major town is Vryburg. The larger part of the region is still commonly referred to as Stellaland. Taung is the site of the discovery of the Taung Skull, one of the world's most important archaeological discoveries. The region is also affectionately known as "The Texas of South Africa" given its strong mining and agricultural economy. This district is divided into local municipalities as follows: Molopo, Kagisano, Naledi, Mamusa, Greater Taung and Lekwa-Teemane.

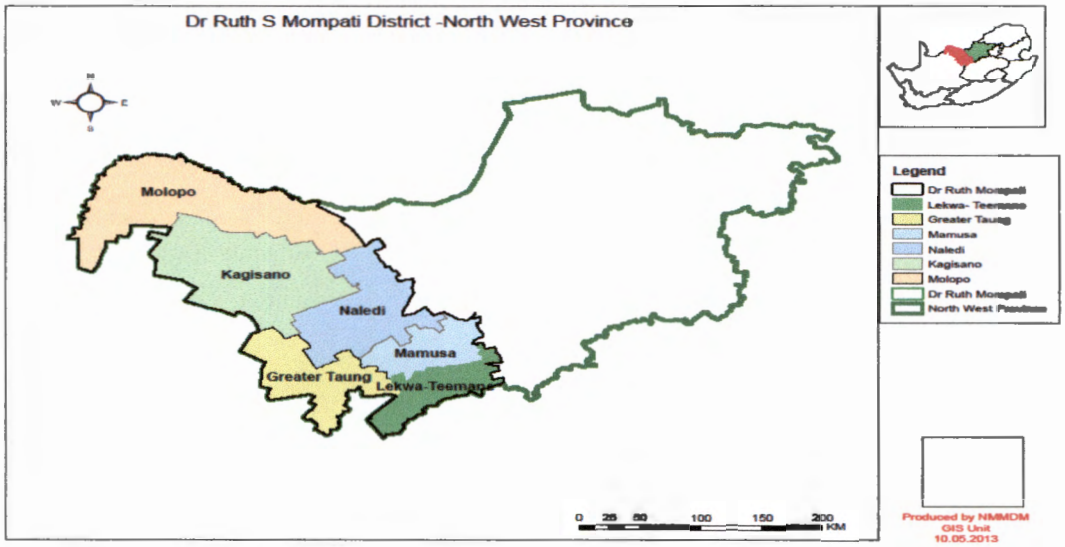


Figure 3.2: Map of the North West province showing Dr Ruth Segomotsi Mompati district (NMMDM, 2013)

3.4 Bojanala Platinum District Municipality

Bojanala is situated in the eastern part of the province and close to Gauteng. It is the most charming region of the province. Part of the district is covered in natural bushveld vegetation and added attraction includes the Magaliesberg Mountain. The region has well recognised game parks throughout the continent with the Big Five - lion, leopard, rhino, buffalo and elephant. There is a large variety of historical and cultural interests found in the area such as the German community of Kroondal that dates back to 1857, the indigenous Bafokeng, Bakgatla and Batswana tribes and other tribal traditions. Magaliesberg and Hartbeespoort regions have water activities, mountain sports, and hang-gliding, parasailing, abseiling, hiking trails, angling, yachting, ballooning, cable ways and leisure. There are a large number of arts, crafts and curio outlets, especially in the Hartbeespoort Dam and Rustenburg areas. Many form part of the Crocodile, Rustenburg and Magliesburg Arts and Crafts.

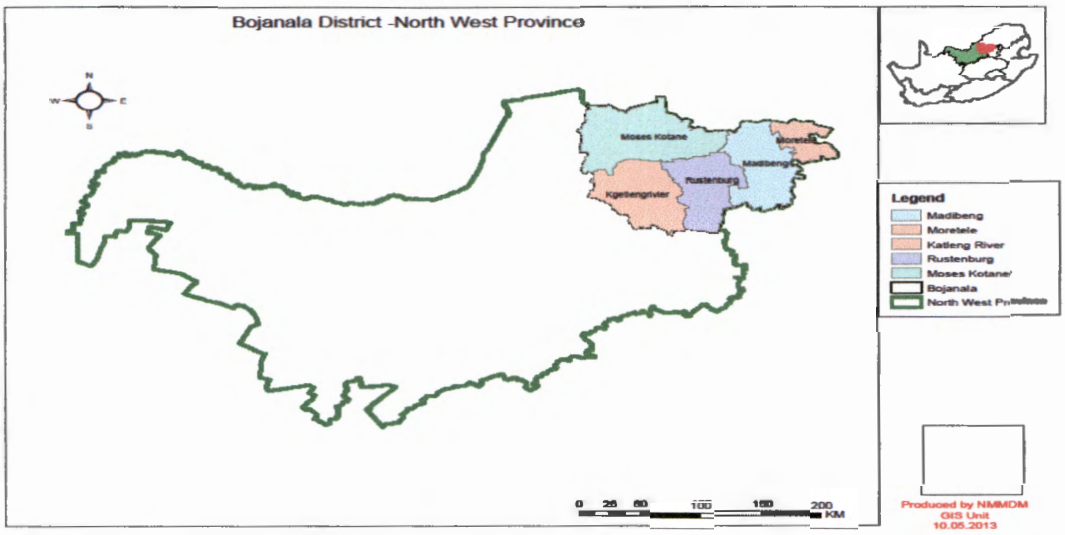


Figure 3.3: Map of the North West province showing Bojanala Platinum District (NMMDM, 2013)

This district is divided into local municipalities as follows: Madibeng, katleng-River, Moretele, Moses- Kotane and Rustenburg.

3.5 Ngaka Modiri Molema District Municipality (NMMDM)

Ngaka Modiri Molema is one of the four district municipalities of the North West province of South Africa. The slogan of the capital city is "The city of Goodwill". The district municipality (DC38) is situated centrally within the North West province. Ngaka Modiri Molema shares an international border with Botswana and the following district municipalities in the republic of South Africa; Bojanala Platinum District Municipality to the East, Dr Ruth Mompati District Municipality to the south and Dr Kenneth Kaunda to the south east.

Ngaka Modiri Molema is made up of five (5) local municipalities, namely, Mahikeng (North), Ditsobotla (East), Tswaing (South), Ratlou (West) and Ramotshere Moiloa (North East). The five local municipalities are subdivided into wards as follows: Mahikeng-28 wards; Ramotshere Moiloa-17 wards; Tswaing-13 wards; Ratlou-12 wards; and Ditsobotla - 19 wards. Popular languages spoken in the district are Setswana, English and Afrikaans (NMMDM IDP, 2011).

The district municipality has a total of 2,788.844 hectares of land equivalent to 26% of the total number of hectares in the North West province. Ramotshere Moiloa has the largest portion of land with 27% of the surface area. The smallest portion of land is covered by Mafikeng with 13% of land.

Centres of attraction in Ngaka Modiri Molema District Municipality include Madikwe Game Reserve, Disaneng and Letlamoreng dams, Henk Joubert Game Reserve, Kortkloof Cultural Village, Leopard Park Golf Course, Lichtenburg Game Breeding, Mafikeng Game Reserve and the Molemane Eye.

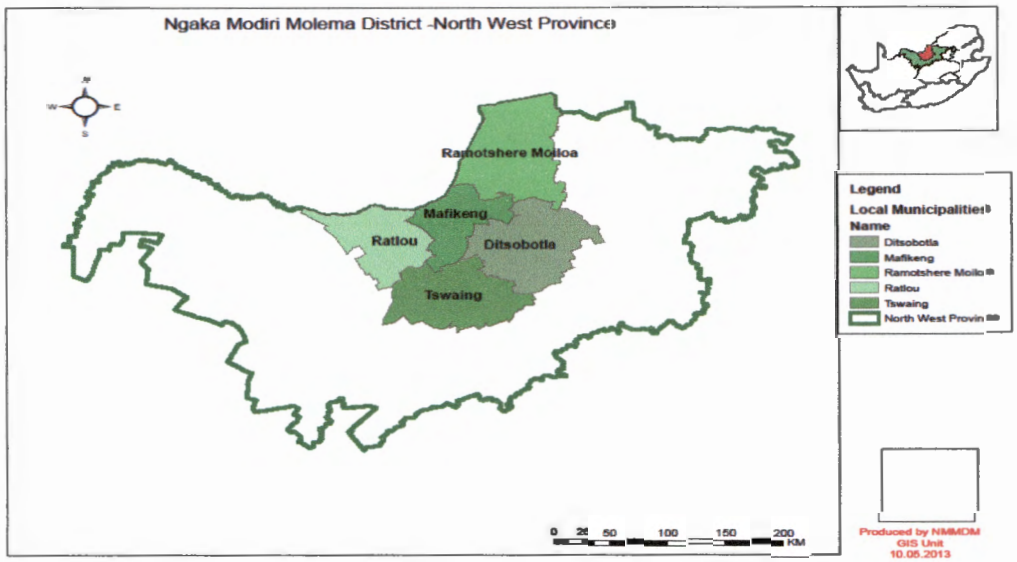


Figure 3.4: Map of the North West province showing Ngaka Modiri Molema District Municipality (NMMDM, 2013)

3.6 Dr Kenneth Kaunda District Municipality

Dr Kenneth Kaunda District Municipality is the smallest of all the districts. It comprises of the following local municipalities: Potchefstroom, Matlosana, Ventersdorp, Merafong City and Maquassi Hills. It is located in the south eastern part of the North West province.

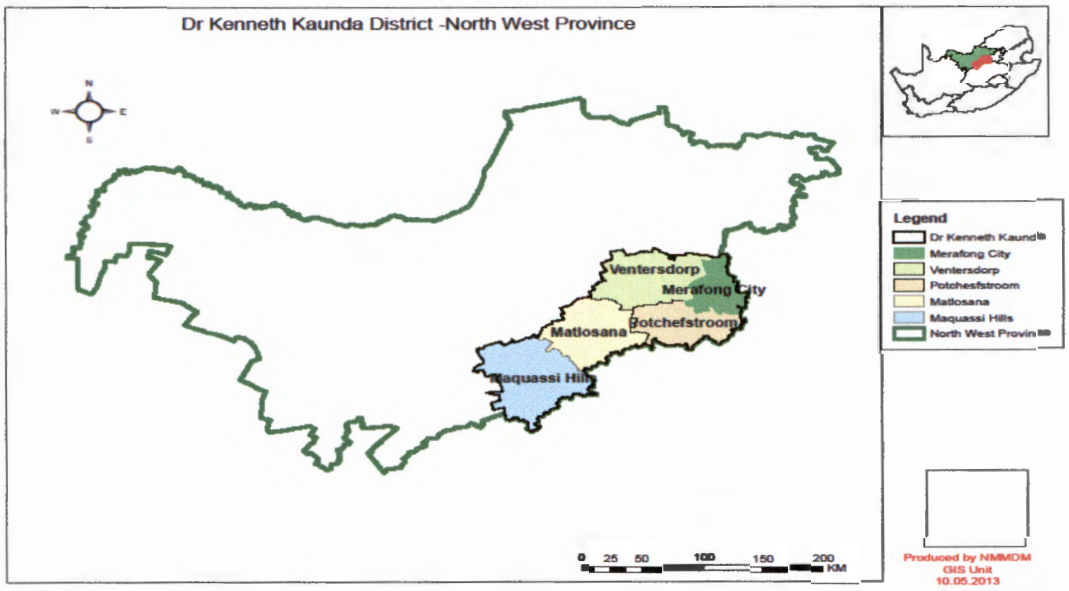


Figure 3.5: Map of the North West province showing Dr Kenneth Kaunda District Municipality (NMMDM, 2013)

The region has outdoor adventure areas which offer hiking trails, mountain biking trails, canoeing, white water rafting and mountain climbing. Lodges along the Vaal River afford some of the best angling and fly fishing opportunities in South Africa.

3.7 Research design

The research design used in this study was descriptive and quantitative. Bless and Higson-Smith (2000) define this approach as a study concerned about the condition that exists, processes that are prevailing, developments that are ongoing and trends that are developing. This study focuses on water security in homestead home gardening in the North West province. Furthermore, the approach was used to identify personal characteristics, water access, and educational level of farmers as well as farmers' perceptions towards home gardening.

3.8 Sampling technique and sample size

The sample was drawn from all households engaged in home gardening, especially participants who were willing to participate. A large sampling technique by (Howard and Kerlinger, 2000) of $n \geq 30$ was applied in order to select the farmers since the number of gardeners is not evenly distributed within the province. Participants were selected from all districts in the North West province. A total of 160 gardeners were selected for the study representing 40 per district

3.9 Data collection

Data was collected through a structured questionnaire which was developed based on the objectives and review of the relevant literature. Open and closed-ended questions were used to gather demographic information such as age, gender, marital status, educational level, number of dependants and house hold size. The second section of the questionnaire focused on capital assets such as natural, financial, physical and human capital used to measure the livelihood strategies used by farmers engaged in back yard gardening.

Natural capital included natural resources such as land and water. Financial capital was measured indicating the availability, adequacy and non-adequacy. Physical capital included infrastructure while human capital focused on knowledge and skill. The third section focused on socio economic status considering access to credit and incomes. Data was analysed using the Statistical Package for Social Sciences (SPSS) with frequency distribution for demographics and regression analysis.

3.10 Standardization and measurement units

During the administration of the questionnaire, the researcher realised that producers, harvesters of vegetable growers utilise different forms of measurement for their produce. They utilise bundles, beds and bags to estimate the size of the harvest. These types of harvests are not standardised and are based on value judgment by individuals. It was also noticed that the sizes of bundles, bags and beds vary from one area to another and depending on the type of vegetable. The weights and sizes of leaf root and stem vegetables were not the same. To be more scientific, it was necessary to standardise all measurements. A scale was used to get the sum of weights for vegetables and conversions made.

Table 3.1: Conversion rates in kg

Quantity sold / harvested	
Type of crop	**Units (Kg)**
Cabbage	2.266
Carrot	0.918
Beetroot	1.154
Tomato	0.650
Butternut	1.156
Onion	0.664
Lettuce	0.31
Cauliflower	0.584
Green beans	0.702
Green pepper	0.512

3.11 Ethical procedures of data collection

Permission to conduct the interviews in the study area was requested from community leaders and traditional heads. They were informed of the objectives of the study and respondents were assured of the confidentiality of the information provided. Participants were also informed that the information provided might be used for further research purposes and to develop policy guidelines in the study area. Respondents were treated with respect, dignity and the information was also treated with utmost confidentiality. Participation in the research was voluntary for respondents and interviews focused only on issues related to the research and no personal issues were discussed.

3.12 Method of data analysis

Data was sorted and analysed through the Statistical Package for Social Sciences (SPSS) version 18.0. Descriptive statistic such as standard deviation, mean, frequency distribution were used to describe the personal characteristics of respondent, tables, graphs and percentages were used to summarise the data and enhance the readability of the results. Multiple regression analysis was also used.

Model specification

Water Use Productivity (Y) = f (b_0+b_1, (Gender of household head)+ b_2, (Farming experience)+b_3, (Marital status of household head)+b_4, (Education) + b_5, (Religious belief) +b_6, (Land ownership) + b_7, (Type of crop)+ b_8), (Willingness to expand)+ b_9, (Attitude) +b_{10}, (Home food security)+ b_{11}, (Marketing outlets)+ b_{12}, (Social participation)

$Y = f(X_1, X_2, \ldots\ldots X_{10})$.....1

X_1 Gender of head of household

X_2 Farming experience

X_3 Marital status of head of household

X_4 Education

X5 Religious belief

X_6 Land ownership

X_7 Type of crop

X_8 Willingness to expand

X_9 Attitude

X_{10} Home food security

X_{11} Market outlet

X_{12} Social participation

Y= Water use productivity

3.13 SUMMARY OF CHAPTER

This chapter has described all the procedures for sampling, data collection and data analysis. The type of measurement the variables were subjected to and the analytical tools applied in the study were also discussed. An overview of water use productivity in back yard home gardening and linkage of poverty and household welfare were equally discussed. The theoretical foundation for the study were laid down and variables been used in similar studies in different parts of the world isolated. The next chapter presents the results and the discussion.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter presents the data obtained from the questionnaires administered to home gardeners in selected areas of the study. The data is presented and analysed according the research objectives presented in chapter one.

4.2 HOUSEHOLD CHARACTERISTICS OF HOME GARDENERS

Table 4.1 shows that respondents were between 30 and 40 years old and those between 51 and 60 represented 25.7% of individuals involved in home gardening. , The lowest age was 30 years representing 4.4 % of individuals involved in home gardening. This is a clear indication that people less than 30 years old are not involved in agriculture in great numbers. This finding is in line with that of the National Gardening Association (2011) that most gardeners are aged 45 and above , an indication that young people are continuously withdrawing from agriculture. According to Bhatti (2006), gardening activities are carried out by people aged between 45-75 years and the practice is more common in older neighbourhoods. Adekunle *et al.* (2009) found that in Nigeria, there are various reasons why the youth is not involved in agriculture. These factors include economic, social and environmental factors. Economic factors include scarce credit facilities, low farming profit margins and insurance. Social factors involve public perceptions and parental influence to move out of agriculture. Environmental issues address matters such as land degradation, inadequate land and poor harvesting. Seto (2011) suggests otherwise as his findings show that 42% of respondents involved in gardening are under the age of 39 followed by 40-59 representing 37%. This is an indication that it is not in all areas where older people are more involved in home gardening.

Table 4.1 also shows that 51% of respondents are female while 48.8% are male. This shows the low participation of men in home gardening. This is also in line with the finding of ALDEP (1982) who argues that as the majority of women remain home while their husbands go out to work in industries, their greatest disadvantage remain access to large land. The solution therefore is to participate in home gardening in order to reduce hunger by producing fresh home gardening vegetables for a better and balanced family diet. According to Keller (2003), more than 65% of the farming population in Cambodia are women and they play an important role in the provision of food security. They are regarded as nutrition keepers and masters in preparing food for their families. Keller (2003) also adds that if women are in charge of home gardens, there is a positive likelihood that vegetables produced will be used for household consumption. The findings of Oni, Maliwichi and Obadire (2013) in Limpopo show that male respondents (54%) and their female counterparts (46%) had almost equal participation in farming in the study area. This is mainly because most women in the community do not own land.

The educational levels attained by respondents are also presented in Table 4.1. The results indicate that most respondents have at least secondary education 48.1% and 41.3% have primary education. The reason may have been due to lack of schools or money related issues. Education is considered as one of the important aspects in knowing how to manage gardens. According to Mayori (2013), majority of households are educated up to secondary level. The findings of the National Gardening Aassociation (2009) indicate that even though the age of those involved is over 45 years of age, their educational level is higher representing 43% of college graduates and at least 21% of those who finished high school. The findings of Oni, Maliwichi and Obadire (2013) further indicate that education is not a major limitation to the participation in farming activities in the study area as almost all the farmers (98%) had acquired formal education. The farmers could read, write and correctly follow technical recommendations.

Table 4.1 below further shows that 46% of farmers in homestead food gardening are married, 4.4 % divorced and 12.5% widowed. Households ranging from 4-7 have the highest number of children which amount to 49.4% while households with more than seven have the least number of children at 5.6%. the findings are not contrary to those of the National Gardening Association (2009) which indicates that more respondents involved in home gardening are married with 64% and at least 16% widowed.

Table 4.1: Household characteristics of homestead gardeners

Variables	Frequency (%)
Gender	
Male	78(48.8)
Female	82(51.3)
Age	
less than 30	7(4.4)
30-40	41(25.7)
41-50	40(25)
51-60	41(25.7)
above 60	31(19.5)
Farming experience	
Less than 10	64(40)
10 to 15	46(28.8)
16 to 20	33(20.8)
Above 20	17(10.7)
Marital status	
Single	58(36.3)
Married	75(46.9)
Divorced	7(4.4)
Widowed	20(12.5)
Education	
Abet	15(9.4)
Primary	66(41.3)
Secondary	77(48.1)
Tertiary	2(1.3)

*** Figures in parentheses are percentages (%)**

4.3 house hold sizes and Area of land utelised among homestead food gardeners

Table 4.2 shows that 80.6% of the farm or garden sizes of respondents range from 0.1-1 hectares while 0.6% uses land larger than 2 hectares. In his study, Mayori (2013) found that home gardens were mainly carried out in areas of between 152-520 m^2. Based on the findings of the National Gardening Association (2009), the median food garden size is 96 square feet in area (8.9m^2) and the average food garden size is 600 square feet in area (55.7m^2). Tewabech and Ephrem (2014) found that the average size of home gardens range from about 500 m^2 to more than 2,500 m^2 (a quarter of a hectare), but in extreme cases, home gardens are as small as 20 m^2 and as large as 10,000 m^2. According to Barlow and Niek van Dijk (2013,) in Kwazulu Natal, Ugu District Municipality, inadequate irrigation infrastructure has limited the amount of land farmers can put under cultivation. On average, farmers have less than 0.1 ha of land under cultivation. While this land is generally enough to ensure household food security, it is not enough for them to be viable commercially. Faures and Santini (2008) support this finding by indicating that one of the constraints for using a smaller area may be shortage of water for irrigation which cannot meet a larger area for production therefore opting for small scale areas. The size of the harvest varies widely, but the aim of farmers is usually to produce enough to meet the consumption requirements of their households (Van Averbeke and Perret, 2004).

Table 4.2 also indicates that 1-3 members (78.8%) are active in homestead gardening while 4-7 members of a household are active representing 21.3 %. This indicates that only few people left in the villages are involved in home gardens. Table 4.2 also shows that 1-3 members (82.5%) of household are active in irrigation crop farming and only 14.7% for 4-7 households are not active in irrigation crop farming an indication that they rely solely on rainfall. This may be due to unavailability of resources to use and enough water to irrigate.

A study conducted by Oni, Maliwichi and Obadire (2013) revealed that more than half (54%) of the households had between 6 and 10 members and that about 63% of household members were involved in farming run as a family business. 17% were involved full time while 27% were part time.

Table 4.2: Household demographics and size of land among homestead food gardeners

Household size	Frequency (%)
Adult	
1 to 3	137(85.6)
4 to 7	22(13.8)
More than 7	1(0.6)
Children	
1 to 3	72(45)
4 to 7	79(49.4)
More than 7	9(5.6)
Male	
1 to 3	76(47.5)
4 to 7	80(50)
More than 7	4(2.5)
Female	
1 to 3	99(61.8)
4 to 7	57(35.6)
More than 7	4(2.5)
Number of dependants	
1 to 3	84(52.5)
4 to 7	62(38.8)
More than 7	14(8.8)
Size of homestead food gardens	
0.1 to 1	129(80.6)
1.1 to 2	30(18.8)
2.1 to 3	1(0.6)

*** Figures in parentheses are percentages (%)**

4.4 Amount of vegetables harvested in home gardens of the study area

Spinach is considered as the favourite crop for many customers within the range of home gardeners. From Table 4.3, 40% of gardeners harvest spinach ranging from 100-400 kg while 23.1% produce >800. Twenty percent harvest less than 100 with at least 16.9% harvesting between 400-800 kg. Production of cabbage shows that 62% of gardeners harvest less than one hundred kilograms while 37.3% indicated that they produce over eight hundred kilograms of cabbage with at least 0.6 % harvesting 100-400 kg.

Table 4.3 further shows that 61.3% produce less than 100 kg of carrot, only 27.5% produce 400-800 kg with a minimum percentage of 1.2% producing over 800kg. A larger percentage of tomatoes harvest is 70% with production less than one hundred kilograms, eighteen percent produce between 100-400 kg with at least 11.2% producing 400-800 kg. Production of butternut is not as common as other vegetables. This is indicated by the results that 88.1% of respondents harvest less than 100kg, 9.3% harvest 400-800 kg with only 2.5% harvesting over eight hundred kilograms.

Majority of respondents (68.1%) harvest less than 100 kg of onion while 20.5% produce 100-400 kg. Only 10.6% indicated that they produce 400-800 kg with 0.6% producing over 800 kg. Beans is more labour intensive, an indication that most gardeners are not very interested in planting beans. This is confirmed by the results in Table 4.3 which shows that 94.4% harvest less than 100 kg while 3.7% harvest 400-800 kg and at least 1.9% 100-400 kg. None of the farmers produce more than eight hundred kilograms.

From the Table 4.3, it can be concluded that the most cultivated crop in home gardening is spinach. This may be due to the fact that spinach is easy to maintain unlike beans and also because it is loved and enjoyed by many people.

Table 4.3: Amount of vegetables harvested in home gardens of the study area

Crop	<100	100-400	401-800	>800
Spinach	32(20)	64(40)	27(16.9)	37(23.1)
Cabbage	100(62.5)	1(0.6)	9(6.2)	50(37.3)
Carrot	98(61.3)	16(9.9)	44(27.5)	2(1.2)
Beetroot	112(70)	7(4.3)	34(21.2)	7(4.3)
Tomatoes	112(70)	29(18)	18(11.2)	1(0.6)
butternut	141(88.1)	0(0)	15(9.3)	4(2.5)
Onion	109(68.1)	33(20.5)	17(10.6)	1(0.6)
Green beans	151(94.4)	3(1.9)	6(3.7)	0(0)
Green Pepper	156(97.5)	3(1.9)	0(0)	0(0)

*** Figures in parentheses are percentages (%)**

4.5 Amount of vegetables consumed in home gardening of the study area

Table 4.4 shows that 43.3% of respondents consume spinach of 100-400 kg with 21% indicating that they consume over 800 kg of their produce. Cabbage consumption is at 26.6% for over 800kg with 62.5 kg consuming less than 100kg. Only 10.7% of respondents consume 400-800 kg. Sixty-one percent of gardeners consume less than 100kg of carrots with 18.7% consuming 100- 400 kg and at least 19.3% consume 400-800 kg.

The Table 4.4 further shows that 70% of respondents consume beetroot of less than 100 kg, 20.7% consume 400-800 kg and at least 5.4% consume 100-400 kg. Eighty eight percent of gardeners indicated that they consume less than 100 kg of butternuts, 9.5% consume 400-800 kg and at least 1.2% consume 100-400 kg. Consumption of onion for production less than 100 kg is at 68.1% of respondents. Only 24.3% consume 100-400 kg and 6.8% for 400-800 kg.

Table 4.4: Amount of vegetables consumed in home gardening of the study area

Crop	<100	100-400	401-800	>800
Spinach	32(20)	34(43.4)	24(15.2)	35(21)
Cabbage	100(62.5)	1(0.6)	17(10.7)	42(26.1)
Carrot	98(61.3)	30(18.7)	31(19.3)	1(0.6)
Beetroot	112(70)	9(5.4)	33(20.7)	6(3.7)
Butternut	141(88.1)	2(1.2)	15(9.5)	2(1.2)
Onion	109(68.1)	39(24.3)	11(6.8)	1(0.6)
Green Pepper	147(91.9)	13(8.1)	0(0)	0(0)

*** Figures in parentheses are percentages (%)**

4.6 Amount of vegetables sold from home gardening of the study area

Some gardeners sell their surplus in order to generate income to maintain their gardens and support their families. Table 4.5 shows that 43.5% of the gardeners sell spinach of 100-400%, 10.5% respondents sell over 800 kg and at least 15.2% sell 400-800 kg. It further indicates that twenty-five percent of gardeners sell over 800 kg of cabbage with 63.5% selling less than 100 kg. Sales of carrots between 100-400 kg stand at 18.7 % and 16.2% for 400-800 kg.

The market for beetroot is not much between 100-400 kg representing 5.4% and 400-800 with 20.7%. Only 70% is sold under production of 100 kg. Butternut of sales less than 100 kg amounts to 88.1% of respondents with only 9.5% indicating that they sell 100-400 kg. The highest selling production of onion is less than 100 kg with 68.1%. Onion market is not bad in 100-400 kg with 24.3%. Only 7.4% indicated that they sell 400-800 kg.

Table 4.5: Amount of vegetables sold from home gardening of the study area

Crop	<100	100-400	401-800	>800
Spinach	32(20)	69(43.5)	24(15.2)	35(10.5)
Cabbage	100(62.5)	1(0.6)	15(9.4)	40(24.8)
Carrot	98(61.3)	30(18.7)	26(16.2)	1(0.6)
Beetroot	112(70)	9(5.4)	33(20.7)	6(3.7)
Tomatoes	112(70)	0(0)	0(0)	0(0)
Butternut	141(88.1)	2(1.2)	15(9.5)	2(1.2)
Onion	109(68.1)	39(24.3)	11(7.4)	1(0.6)
Green beans	151(94.4)	13(8.1)	0(0)	0(0)
Green Pepper	156(97.5)	4(2.5)	0(0)	0(0)

*** Figures in parentheses are percentages (%)**

4.7 Source of water for irrigation in homestead food gardens

Majority of respondents (99.4%) do not use wells for irrigation with only 1% using wells.86.9% of gardeners stated that they do not use rain water tanks for irrigation. This means that they do not have storage facilities for water as tanks may be too expensive to install. Only 13.1% of respondents use rain water tanks. Rain water harvesting is only done by 29.4% of respondent. The findings by WHO and UNICEF (2000) are not contrary. They indicate that communities relying on wells as source of water tend to be poor and live in environments with associated high health risks and therefore, majority do not opt to use wells as a source of water for irrigation.

Table 4.6 indicates that 54.4% of respondents do not use tap water for irrigation. This may be due to the fact that they will be subjected to pay for water usage and at some point, it becomes expensive. Moreover, they are not producing enough for sale. Only 45.6% admitted to be using tap water for irrigation purposes. According to DWAF (2013), water users will not be billed by the Department if they are schedule 1 users in terms of the National Water Act (Act no 36 of 1998). These are non-commercial uses of water including domestic use, small-scale gardening and the watering of livestock. Such use will not invite tariffs for the water and the water will be supplied to water service providers free of charge but some government officials insist that those who use water for agricultural purposes must pay.

Table 4.6: Common sources of water for irrigation in homestead food gardens

Source of water for irrigation		
	No	Yes
Tap	87 (54.4)	73 (45.6)
Well	159 (99.4)	1 (0.6)
Rain water tanks	139 (86.9)	21 (13.1)
Rain water harvesting	113 (70.6)	47 (29.4)
Spring	159 (99.4)	1 (0.6)
Borehole	61 (38.1)	99 (61.9)

*** Figures in parentheses are percentages (%)**

4.8 Irrigation techniques used among homestead food garners

Table 4.7 shows that 74.4% are using sprinklers. When combined with others forms such as basin irrigation, they constitute 66.3%, watering cans with 68.8% and furrow 26.9%. All these techniques can be used concurrently to save time and cover enough space. Others prefer to use canals (66.3%). The system is in line with the sizes of the plots since most gardens are less than one hectare. According to Giddings (2004), most farmers prefer using irrigation methods which use less labour requires less maintenance required, that can allow easy establishment and maintenance of crops and is also suitable to most soil types.

Table 4.7: Common methods of irrigation used in homestead food gardens.

	Yes	No
Bucket/watering cans	110 (68.8)	50 (31.3)
Sprinkler	119 (74.4)	41 (25.6)
Furrow	43 (26.9)	117(73.1)
canal	106 (66.3)	54 (33.8)

*** Figures in parentheses are percentages (%)**

4.9 Access to employment opportunities and source of income of homestead food gardeners.

The results in Table 4.8 indicate that 95% of home gardeners are not employed. Only five percent stated that they are employed. The results further indicate that 91.3% of gardeners are not self-employed while 8.8% are self-employed Household source of income can be characterised in different ways such as farm and non-farm sources. Farm income includes income derived from the sale of farm produce and non-farmer sources include salaries, wages, remittances and other sources. Table 4.8 further shows remittance (55.6%) as the major source of income followed by wages (44.4%) and 22.5% from pension.

Cox *et al.*, (2001) maintain that gardeners are characterised by low income generation, small size land utilisation, lack of proper inputs and lack of resources. All these factors limit productivity and further increase the level of poverty. The findings by Ardinton and Laud (1996) correspond with other studies which indicated that remittance, wages, and pensions are more important sources of income for rural households than farming. Carter and May (1999) further indicate that farming plays an important role in alleviating poverty and in improving food security but on its own, it cannot be an adequate source of income for all farmers.

Table 4.8: Employment status and source of income of homestead food gardeners

Employment status		
	No	Yes
Employed	152 (95)	8 (5)
Self employed	146 (91.3)	14 (8.8)
Student	158 (98.8)	2 (1.3)
Source of income of the farmer		
	No	Yes
Wage	89 (55.6)	71 (44.4)
Pension	124 (77.5)	36 (22.5)
Remittances	72 (45)	88 (55)
Family business	159 (99.4)	1 (0.6)
Non-farm income	114 (71.3)	46 (28.8)

*** Figures in parentheses are percentages (%)**

4.10 Land ownership and type of cropping systems among homestead food gardeners

The results in Table 4.9 show that 50% of respondents use communal land for gardening while 49% of respondents use their personal land. Only one percent of respondents use leased land for production. Providing security of land is often seen as a precondition for intensifying agricultural production. According to Bembridge (2000), insecure land limits farmers' incentive in making long-term development investments on their land. Farmers feel that for them to be more productive, they should have land ownership rights so that they can rent or sell their land at any time and also for their children to be able to inherit the land. Rakuni (2002) also suggests that communal ownership would promote productivity only if communal ownership were secure.

Table 4.9 Land ownership and cropping system of farmers engaged in home gardening

Land ownership	Yes	No
Own land	79(49.4)	90(56.25)
Communal land	80(50)	80(50)
Leased land	1(0.6)	159(99.4)
Land reform	0(0)	160(100)
Rent	0(0)	160(100)
Cropping system		
Mono cropping	42(26.3)	118(73.4)
Double cropping	3(1.9)	157(98.1)
Mixed cropping	99(61.9)	61(38.1)
Crop livestock integration	0(0)	160(100)

*** Figures in parentheses are percentages (%)**

4.11 Common ways of receiving information by homestead food gardeners

Table 4.10 shows that the prominent sources of information among gardeners were radio (98.1%), Imbizo (95%), television (92.5%) and newspaper (73.3%). The use of these information sources may be due to the fact that there are several radio agricultural programmes that cover the information needs of farmers and also the fact that gardeners can afford these sources of information. This is in line with the findings of Tekana and Oladele (2011) who found that most farmers' access to information is through Imbizo.

Table 4.10: Common methods used to disseminate information among homestead food gardeners.

Sources of information		
	Yes	No
Television	148 (92.5)	12 (7.5)
Radio	157 (98.1)	3 (1.9)
Phone	46 (28.8)	114 (71.3)
Internet	9 (5.6)	151 (94.4)
News paper	118 (73.8)	42 (26.3)
Magazine	47 (29.4)	113 (70.6)
Computer	6 (3.8)	154 (96.3)
Imbizo	152 (95)	8 (5)

*** Figures in parentheses are percentages (%)**

4.12 Utilisation of vegetables among homestead food gardeners

Table 4.11 shows that most home gardeners (99.4%) use their produce for household consumption, for sale (98.1%) and gifts (27.5%). This indicates that home gardens are mostly used to provide for families in order to improve family nutrition as stated by Pacey (1978) that fresh home gardening vegetables can be used so that the whole diet in the family could be improved. Collum (1995) also maintains that home grown vegetables are of higher quality compared to those in the markets and are readily available. Ali and Tsou (2002) consider vegetables as the most economically efficiency source of micro nutrients. Chakravarty (2000) also agrees that indeed, home gardens increase the consumption of vitamin A.

High and Schackleton (2000) maintain that produce from home gardens offers diversity to household diet and further argue that it indeed serves as an important source of cash through the sale of surplus produce. Only 12.5% use crops to feed their livestock with the least response of 10% of respondents using crops for buttering, one of the oldest method of exchanging goods.

Table 4.11: Usage of vegetables produced by home gardeners

	Yes	No
Household consumption	159 (99.4)	1 (0.6)
Sales	157 (98.1)	3 (1.9)
Livestock consumption	20 (12.5)	140 (87.5)
Gifts	44 (27.5)	116 (72.5)
Buttering	16 (10)	144 (90)

*** Figures in parentheses are percentages (%)**

4.13 Access to Marketing outlets among homestead food gardeners

Majority of respondents (99.1%) indicated that they sell their produce to community members. Ninety eight percent of gardeners also agreed that they use pension pay point to market their produce. Respondent further indicated that clinics (16.3%) and schools (37.5%) are also marketing outlets. Only 2.5% sell their produce to supermarkets. Bachmann (2009) argues that any gardener who intends to sell his/her produce must develop a focused marketing plan before planting any crop. A market plan helps but does not guarantee that most of the produce will be sold. Bachmann (2009) further explains that tailgate method is one of the simplest methods of direct marketing. Vehicles are parked or driven on a road or streets loaded with produce with the hope that people will stop and purchase. There is little investment and cost involved in this method and it can be set up within short notice. However, in cities, one needs to set it up in partnership with the city government as some cities have regulations governing transient vendors.

The findings by Barlow and Niek van Dijk (2013) are not contradictory. They found that producers market their produce directly to their own communities or through formal cooperatives. If the produce does not meet the required standards of formal markets, the produce is recommended for informal markets. Bachmann (2009) further indicates that farmers' markets are excellent places for gardeners to sell their produce. The markets create wonderful podiums for farmers to meet with other people and develop steady customers which could lead to additional marketing channels.

Table 4.12: Zones at which homestead food gardeners market their produce

	Yes	No
Community (Tailgate)	159 (99.4)	1 (0.6)
Schools	60 (37.5)	100 (62.5)
Tuck shops	127 (79.4)	33 (20.6)
Clinics	26 (16.3)	134 (83.7)
Supermarkets	4 (2.5)	158 (98.7)
Hospices	110 (68.7)	50 (31.3)
Pension pay points	157 (98.1)	3 (1.9)
Farmers' markets	124 (77.5)	36 (22.5)

*** Figures in parentheses are percentages (%)**

4.14 Ability and willingness to expand backyard gardens/plots among homestead food gardeners.

Table 4.13 shows that 96.6% of gardeners are willing to expand. It also shows that 96.3% of respondents are willing to increase the number of crops. At least (57.6%) agreed that they are willing to increase the number of plots in different locations while only 42.5% confirmed that they are not willing to expand plots in different locations since home gardening has proven to be an effective approach to improved household food security. Keller (2003) findings reveal that most home gardeners in Cambodia are willing to expand.

Table 4.13: Capability and preparedness of home gardeners in expanding their backyard gardens/plots.

	Yes	No
Willingness to expand	153 (95.6)	7 (4.4)
Potential for plot expansion	153 (95.6)	7 (4.4)
Willingness to increase plot size	153 (95.6)	7 (4.4)
Willingness to increase the number of plots in different locations	92 (57.6)	68 (42.5)
Willingness to increase the types of crops produced	154 (96.3)	6 (3.8)

*** Figures in parentheses are percentages (%)**

4.15 Access to livelihood capital by homestead food gardeners.

A livelihood is made up of the capabilities, assets (stores, resources, claims and access) and activities necessary for a means of living. Livelihood is, therefore, broader than income and includes everything done to obtain a living (Rahman *et al.*, 2007).

Table 4.14 shows that 47.5% of farmers access financial capital through government, personal savings (42.5%) and 33.1% through regular remittance in order to sustain their projects while 66.9% do not have access to regular remittance. Table 4.14 also indicates that 15% of farmers access financial capital through banks while 85% do not have access, 11.3% of farmers' access livelihood assets through corporatives. Machete *et al.* (2004) maintain that one of the most crucial problems threatening the viability of home gardens is the absence of credit. Availability of credit is very important in the sense that it allows farmers to acquire necessary inputs in terms of quality and quantity and at the right moment. Spio (2002) points out that in South Africa, financial intermediaries have not been able to accommodate rural farmers because it is a risky, costly and a difficult task associated with high transaction costs.

Table 4.14 further shows that 75.6% of home gardeners have knowledge of gardening while 61.3% of home gardeners confirmed that they received training on how to handle crops, water and equipment. Agrawal (2008) argues that special skills and knowledge are critical for sustainable livelihood. For example, farmers need to know adaptation options to climate changes and this requires information on probable weather patterns. Farmers need knowledge in order to plan agricultural activities.

Physical capital is mainly about infrastructure. Physical capital boosts investment in home gardening and covers accessibility to roads, markets, water supply canals, electricity and storage. Table 4.14 further shows 38.1% have access to transport. It also reflects that 63.8% of home gardeners have access to storage. Senyolo *et al.* (2009) argue that access to markets is key for small farmers but the reliability and sustainability to output markets where they can sell their produce is a challenge and affects their livelihood.

Natural capital is mainly about natural resources such as land and water. To produce quality vegetables, land must be readily available and the soil must also be of good quality with water readily available. Table 4.14 shows that 82.5% of home gardeners have access to land for production with 90% indicating access to water. Oxfam America (2013) explains that the most important natural asset for enabling adaptation is access to and sustainable use of land and water.

Table 4.14 further reveals that 33.1% of home gardeners do not network with other farmers while majority (66.9%) prefer to be independent. 40.1 % of farmers have access to group memberships. There is also relationship of trust. 60.6% can rely on others while only 39.4% stated that they do not have any relationship of trust. Birner and Davis (2009) found that there is a need for agricultural services to support people engaged in agricultural production and facilitate their efforts in order to solve problems, create links to markets and other players in the agricultural value chain and also to obtain information, skills and technologies to improve their livelihoods.

Table 4.14: Access to livelihood assets by home stead food gardeners

Financial capital	Availability		Adequacy		
	Yes	No	No response	High	Low
Banks	24 (15)	136 (85)	131 (81)	7 (4.4)	22(13.8)
Cooperatives	18 (11.3)	142(88.8)	141 (88.1)	4 (2.5)	15 (9.4)
Money lenders	30(18.8)	130(81.3)	131 (81.9)	4 (2.5)	25 (15.6)
Saving	48(112)	112 (70)	118 (73.8)	11 (69)	31 (19.4)
Regular remittance	53(33.1)	107 (66.9)	105 (65.5)	4(2.5)	51(31.9)
Pensions	30 (18.8)	130(81.3)	128(80)	3(1,9)	29(18.1)
Relatives	45(28.1)	115(71.9)	118(73.8)	6(3.8)	36(22.5)
Personal savings	68 (42.5)	92 (57.5)	98(61.3)	13(8.1)	49(30.6)
Contractors	27(16.9)	133(83.1)	139(86.9)	3(1.9)	18(11.3)
Government subsidies	76 (47.5)	84(52.5)	87(54.4)	33(20.6)	40(25)
Human capital					
Training	98 (61.3)	62 (38.8)	80(50)	48(30)	32(20)
Vocational training	85 (53.1)	75 (46.9)	87(54.4)	33(20.6)	40(25)
Extension service	94 (58.8)	66 (41.3)	66(41.3)	43(26.9)	51(31.9)
Skills training	90 (56.3)	70 (43.8)	70(43.8)	46(28.8)	44(27.5)
Knowledge of gardening	121(75.6)	39 (24.4)	50(31.3)	76(47.5)	34(21.3)

Knowledge of vegetable production	114(71.3)	46(28.8)	39(24.4)	76(47.5)	45(28.1)
Record keeping	72(45)	88(55)	90(56.3)	24(15)	46(28.8)
Water management	120(75)	40 (25)	56(35)	48(30)	56(35)
Equipment handling	95 (59.4)	65 (40.6)	57(35.6)	45(28.1)	58(36.3)
Financial management	68 (41.3)	92 (57.5)	100(52.5)	21(26.3)	39(21.3)
Soil management	93 (58.1)	67 (41.9)	84(52.5)	22(26.3)	34(21.3)
Crop protection	71 (44.4)	89 (56.4)	82(51.3)	27(16.9)	51(31.9)
Physical capital					
Transport	61 (38.1)	99 (61.9)	96(60)	10(6.3)	54(33.8)
Water supply canal	72 (45)	88 (88)	94(58.8)	14(8.8)	52(32.5)
Markets	123 (76.9)	37 (23.1)	54(33.8)	35(21.9)	71(44.4)
Road accessibility	125 (78.1)	35 (21.9)	42(26.3)	36(22.5)	82(51.3)
Electricity	116 (72.5)	44 (27.5)	55(34.4)	23(14.4)	82(51.3)
Storage	58 (36.4)	102 (63.8)	99(61.9)	17(10.6)	44(27.5)
Natural capital					
Land	132 (82.5)	28 (17.5)	34(21.3)	39(24.4)	87(54.4)
Water	144 (90)	16 (10)	28(17.5)	43(26.9)	89(55.6)
Environment	130 (81.3)	30 (18.8)	37(23.1)	46(28.8)	77(48.1)
Biodiversity	56 (35)	104 (65)	101(63.1)	21(13.1)	38(23.8)
Relationship of trust	78 (48.8)	82 (51.3)	79(49.4)	20(12.2)	61(38.1)
Water use right	110 (68.8)	50 (31.3)	49(30.6)	50(31.3)	61(38.1)
Land tenure	106 (86.3)	54 (33.8)	57(35.6)	52(32.5)	51(31.9)
Social capital					
Networks	53 (33.1)	107 (66.9)	116(72.5)	24(15)	20(12.5)
Group membership	65 (40.1)	95 (59.1)	99(61.9)	18(11.3)	43(26.9)
Relationship of trust	97 (60.6)	63 (39.4)	66(41.3)	38(23.8)	56(35)
Access to wider institutions of society	79 (49.4)	81 (50.6)	81(50.6)	36(22.5)	43(26.9)

*** Figures in parentheses are percentages (%)**

4.16 Access to positive psychological capital among homestead food gardeners.

Table 4.14 presents psychological capital with 81.9% of home gardeners indicating that they are confident about what they are doing while 18.9% indicated that they are not confident. The results further indicate that 78.8% of farmers have the ability to mobilise while 21.3% of farmers do not have the ability to mobilise. 79.4% of farmers indicated that they have a strong positive relationship to work-related performance and 20.6% do not have a strong positive relationship to work-related performance.

Table 4.14 further shows that 88.1% of home gardeners are goal getters. This is an indication that farmers in rural areas are very serious with their work and work very hard in order to succeed in their business venture while 11.3% of farmers are not goal getters. The results further indicate that 88.1% of home gardeners are talented in terms of carrying out activities like food gardening and irrigation crop farming. Lastly, about 40.6% of home gardeners get easily fed up, especially when there is no positive feedback. This might lead them to a point where they give up and 59.4% of farmers keep striving even if they encounter challenges along the way.

Table 4.15: Homestead food gardener's access towards positive psychological capital.

Positive psychological capital	Availability		Adequacy		
	Yes	No	No response	High	Low
Confidence	131(81.9)	29 (18.9)	41(25.6)	80(50)	39(24.4)
Self-efficacy			41(25.6)	71(44.4)	48(30)
Individual's ability to mobilise	126 (78.8)	34 (21.3)	43(26.9)	72(45)	45(28.1)
Individual's ability to motivate	108 (67.5)	52 (32.5)	46(28.8)	74(46.3)	40(25)
Strong positive relationship to work-related performance	127 (79.4)	33 (20.6)	37(23.1)	81(50.6)	42(26.3)
Optimism					
Easily fed up	65 (40.6)	95(59.4)	107(66.9)	24(15)	29(18.1)
Giving up	24(15)	136(85)	125(78.1)	11(6.9)	24(15)
Discouraged easily	54(33.8)	106(66.3)	112(70)	12(7.5)	36(22.5)
Talented	141(88.1)	19(11.3)	31(19.4)	68(42.5)	61(38.1)
Goal getter	141(88.1)	19(11.3)	31(19.4)	74(46.3)	55(34.4)
Demotivated	64(40)	96(60)	85(53.1)	35(21.9)	40(25)

*** Figures in parentheses are percentages (%)**

4.17 Water use productivity status among homestead food gardeners

Table 4.15 shows that 11.5 kg/m^3 spinach harvested was produced by 78.848 m^3 of water and 27.1 kg of cabbage was produced by 38.532 m^3 of water. Carrots (7.3 kg) harvested used 40.29 m^3 of water; 9.2 kg beetroot harvested was produced by 31.995 m^3. Tomatoes (6.1 kg) harvested was produced by 31.505 m^3. Table 4.15 also shows that 6.5 kg of 500 potatoes harvested were produced by 0.765 m^3, butternut (9.6 kg) was produced by 13.335 m^3; onions (7.8 kg) harvested used 25.087 m^3. Green beans (6.4 kg) harvested was produced by 5.55 m^3, green pepper (2.9 kg) harvested was produced by 2.78 m^3, and 6.1 kg of lentils harvested was produced by 2.64 m^3 of water.Accoriding to Kijne et al. (2003) water productivity of 1.5 kg/m3 might be considered 'good' whereas one of 0.5 kg/m3 might be thought to be 'bad'.

According Speelman *et al* (2011), in monetary value, the aggregate average water value for the vegetable crops is 0.188 US$/$m^3$ if a value of zero is attributed to the cases with negative gross margins. This is lower than results of other studies. Hussain et al. (2007) reported values up to 0.37 US$/$m^3$ for high value crops in some African countries and Molden et al. (1998) stated that for vegetable production, water values are usually higher than 0.2 US$/$m^3$. Jordan and Bouhia (2001) in Morocco even found a value for vegetables respectively of 0.665 US$/$m^3$ and 0.686 US$/$m^3$.

Table 4.16: Total amount of household water use productivity n = 160

Crops(kg)	Quantity harvested (Mean)	Total water use water cubic (m^3)	Water productivity kg/m^3
Spinach	90680.8	78.848	11.5
Cabbage	104236	38.532	27.1
Carrot	29541.24	40.29	7.3
Beetroot	29496.24	31.995	9.2
Tomatoes	19172.556	31.505	6.1
Potatoes	500	0.765	6.5
Butternut	12837.38	13.335	9.6
Onion in	19591.3864	25.087	7.8
Green beans	3545.1	5.55	6.4
Green pepper	819.2	2.78	2.9

*** Figures in parentheses are percentages (%)**

4.18 Household food security among home gardeners

Table 4.16 shows that 33.1% of households of gardeners are not food secured while 66.9% indicated that their households are food secured. Aliber and Hart (2008) argue that South Africa is said to be producing enough staple food that can meet the basic nutritional requirements at national level but not in rural areas. According to the General Household Survey (2009), Statistic South Africa's report indicates that during 2008, the North West province had 80% food adequacy. The report further indicates that food access problems were mostly serious in the Free State. High unemployment rate, inadequate social welfare systems are the major contributors of food insecurity in rural areas.

Table 4.17: Household food security among homestead food gardeners

Household food security	
Not food secured	53 (33.1)
Food secured	107 (66.9)

*** Figures in parentheses are percentages (%)**

4.19 Results of multiple regression analysis determining water use productivity among homestead food gardening

The influence of socio-economic characteristics on water use productivity among homestead vegetable farmers. Water Use Productivity (Y) = f (b_0+b_1, (Gender of household head)+ b_2, (Farming experience)+b_3, (Marital status of household head)+b_4, (Education) + b_5, (Religious belief) +b_6, (Land ownership) + b_7, (Type of crop)+ b_8), (Willingness to expand)+ b_9, (Attitude) +b_{10}, (Home food security)+ b_{11}, (Marketing outlets)+ b_{12}, (Social participation). The results of the estimated model are presented in Table 18.

The independent variables were significantly related with an F value of 3.074, $P < .05$. Also, an R value of 0.506 showed that there was a strong correlation between socio-economic characteristics and water use productivity. The results further predicted R Square 26% of the variation in water use productivity. Five out of sixteen were significant, with three variables being significant at 5% (type of crop, social participation and market outlet) while two variables were significant at 10% (home food security and attitude).

Significant determinants of water use productivity were type of cropping (t =-2.443, P =.016), social participation (t =2.599, P = .010), marketing outlets (t = 2.810, P = .006), home food security, (t=-1.777, P = .078) and attitude (t = -1.727, P = .086). The results imply that the higher the attitude, marketing, home food security, social participation and type of crop, the higher the use of water productivity among farmers. However, insignificant determinants of water use productivity were farming experience (t = 0.571, p=0.569), education (t = -1.048, p = 0.296), land ownership (t = -1.416, p = 0.159) and age (t = -0.782, p = 0.436). The results imply that the lower the farming experience, education skill, land ownership and age, the lower the water productivity use among farmers.

Table 4.18: Multiple regression analysis relationship between socio-economic characteristics and water use productivity

	B	Std. Error	beta	t	sig
Constant	44.841	16.798		2.669	.008***
Gender of household head	-2.360	2.092	-0.089	-1.128	.261
Age of household head	-0.101	0.129	-0.100	-0.782	.436
Farming experience	0.118	0.208	0.064	0.571	.569
Marital status of household head	0.491	1.364	0.035	0.360	.719
Education	-1.759	1.678	-0.089	-1.048	.296
Religious belief	1.755	4.192	0.031	0.419	.676
Land ownership	-3.578	2.527	-1.138	-1.416	.159
Type of crop	-2.895	1.185	-0.348	-2.443	.016**
Willingness to expand	1.900	5.437	0.027	0.349	.727
Attitude	-1.225	0.710	-0.485	-1.727	.086*
Home food security	-1.999	1.125	-.711	-1.777	.078*
Market outlet	2.377	0.846	1.118	2.810	.006***
Social participation	1.849	0.712	0.398	2.599	.010**
Willingness to increase plots	-.146	.118	-.152	-1.237	.218
R	0.506				
R square	0.256				
F	3.074				.
P	0.000				

≤ = 0.01 = S^1 ≤ = 0.05 = S^5 ≤ = 0.10 = S^{10}

1% = 0.01 =* 5% = 0.05 = ** 10% = 0.10 = ***

4.20 SUMMARY OF CHAPTER

The chapter has presented the results of the study in terms of demographic characteristics of smallholder homestead food gardeners and irrigation crop farmers, source of water for domestic use, source of water for irrigation, employment status and source of income for farmers. The type of land ownership, types of crops, cropping systems of respondents, accessibility of information for smallholder homestead farmers and irrigation crop farmers, farmers' participation in agricultural organisations, methods of irrigation practised in homestead gardens were also presented and discussed. The impact of homestead food gardening and irrigation crop farming on the livelihood of smallholder farmers, constraints faced by smallholder homestead food gardeners and irrigation crop farmers, water use productivity among homestead food gardeners and the influence of socio-economic characteristics were also discussed in the chapter. The next chapter presents the findings, conclusion and recommendations of the study.

charts and graphs. The study has analysed water use productivity among small holder homestead food gardening and irrigation crop farming in the North West province, South Africa. One hundred and sixty (160) home gardeners were selected as representatives of home gardeners involved in home gardening in five district municipalities in the North West province.

5.2 FINDINGS OF THE STUDY

This study analysed water use productivity among small holder homestead food gardening and irrigation crop farming in the North West province, South Africa. The overall objective of the study was to analyse water use productivity among smallholder homestead food gardening and irrigation crop farming in the North West province, South Africa.

The study used primary data sources. Primary data was obtained by means of a survey using a structured questionnaire handed over to home gardeners. The reason for choosing this method is because it is time and cost effective given the geographic location of home gardeners and the size of the farms.

160 farmers were sampled as a representative of the larger group from which they were selected. Qualitative data analysis was done using the Statistical Package for Social Sciences (SPSS) version 18. Statistical method such as multiple regression analysis was used to determine determinants of household welfare.

Table 4.1 shows that more respondents have at least secondary education (48.1%) and 41.3% have primary education. Moreover, 46% of farmers in homestead food gardening are married, 4.4 % divorced and 12.5 widowed. Households range from 4-7 have the highest number of children representing 49.4% while households with more than seven have the least number of children at 5.6%.

CHAPTER FIVE

5.0 FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter presents the findings of the study, the conclusion and recommendations based on the results. Chapter 4 presented d the results obtained from questionnaires in the form of bar

In table 4.2, the results indicate that 85.6% of home gardeners have a minimum of 1 to 3 adults in their households, 13.8% have 4 to 7 adults and lastly, 0.6% has more than 7 adults. Moreover, the results further revealed that 80.6% of farmers occupy 0.1 to 1 hectare of land, 18.8% occupy 1.1 to 2 hectares and lastly, 0.6% occupies 2.1 to 3 hectares.

Table 4.3 shows that 40% of gardeners harvest spinach ranging from 100-400 kg while 23.1% produce > 800. Twenty percent harvest less than 100 with at least 16.9% harvesting between 400-800 kg. Production of cabbage indicates that 62% of gardeners harvest less than hundred kilograms while 37.3% indicated that they produce over eight hundred kilograms of cabbage with at least 0.6 % harvesting 100-400 kg. Table 4.3 further reveals that 61.3% produce carrot less than 100 kg, only 27.5% produce 400-800 kg with a minimum percentage of 1.2% producing over 800 kg.

A larger percentage of tomatoes harvest is 70% with production less than hundred kilograms, eighteen percent produce between 100-400 kg with at least 11.2% producing 400-800 kg. Production of butternut is not as common as other vegetables. This is indicated by results as follows: 88.1% of respondents harvest less than 100 kg, 9.3% harvest 400-800 kg with only 2.5% harvesting over eight hundred kilograms.

Majority of respondents (68.1%) harvest less than 100 kg of onion while 20.5% produce 100-400 kg. Only 10.6% indicated that they produce 400-800 kg with 0.6% producing over 800 kg. Beans are more labour intensive, indicating that most gardeners are not very interested in planting the crop. This is confirmed by the results in Table 4.3 which shows that 94.4% harvest less than 100 kg, while 3.7% harvest 400-800 kg and at least 1.9% 100-400 kg. None of the farmers produce more than eight hundred kilograms. 43.3% of respondents consume spinach of 100-400 kg with 21% indicating that they consume over 800 kg of their produce.. Cabbage consumption is at 26.6% for over 800 kg with 62.5 kg consuming less than 100 kg. Only 10.7% of respondents consume 400-800 kg. Sixty-one percent of gardeners consume less than 100 kg of carrots with 18.7% consuming 100- 400 kg and at least 19.3% for 400-800 kg.

Table 4.4 also shows that 70% of respondents consume beetroot of less than 100 kg, 20.7% for 400-800 kg and at least 5.4% for 100-400 kg. Eighty eight percent of gardeners indicated that they consume less than 100 kg of butternuts, 9.5% consuming 400-800 kg and at least 1.2% consuming 100-400 kg. Consumption of onion for production less than 100 kg stands at 68.1%. Only 24.3% consume 100-400 kg and 6.8% for 400-800 kg.

Table 4.5 shows that 43.5% of gardeners sell spinach of 100-400, kg 10.5% sell over 800 kg and at least 15.2% sell 400-800 kg. It further indicates that twenty-five percent of gardeners sell over 800 kg of cabbage with 63.5% selling less than 100 kg. Sale of carrots between 100-400 kg represents 18.7 % and 16.2% for 400-800 kg. This is not a good sign as production less than one hundred kilograms stands at 61.3% of respondents. The market for beetroot is not good enough and is between 100-400 kg and represents 5.4% and 400-800 with 20.7%. Only 70% is sold under production of 100 kg. The sale of butternut less than 100 kg amounts to 88.1% of respondents with only 9.5% indicating that they sell 100-400 kg. The highest selling amount of onion is less than 100 kg representing 68.1%. The onion market is not bad in the 100-400 kg representing 24.3%, only 7.4% indicated that they sell 400-800 kg.

In Table 4.6, the majority of respondents (99.4%) do not use wells for irrigation with only 1% using wells, 86.9% of gardeners stated that they do not using rain water tanks for irrigation. This is an indication that they do not have storage means of water as tanks may be too expensive to install. Only 13.1% of respondents use rain water tanks. In Table 4.7, the results show that 74.4% use using sprinklers. When combined with other methods such as basin irrigation, they represent 66.3%, watering cans with 68.8% and furrow 26.9%. All these techniques could be used concurrently to save time and cover enough space. Others prefer to use the canal system (66.3%) as it is in line with the sizes of the plots and since most gardens are less than one hectare.

In Table 4.9, 50% of respondents use communal land for gardening while 49% use personal land. Table 4.10 shows that the prominent sources of information among gardeners were radio (98.1%) Imbizo (95%), television (92.5%) and newspaper (73.3%). In Table 4.11, (99.4%) of home gardeners use their produce for household consumption, for sale (98.1%) and gifts (27.5%), about 99.1% of respondents stated that they sell their produce to community members. In Table 4.12, 98% of gardeners also agreed that they use pension pay points to market their produce. Respondent further indicated that clinics (16.3%) and schools (37.5%) are also marketing outlets. Only 2.5% of respondents sell their produce to supermarkets.

In Table 4.13, 96.6% of gardeners are willing to expand the size of their gardens. It also shows that 96.3% of respondents are willing to increase the number of crops. At least 57.6% agreed that they are willing to increase the number of plots in different locations while only 42.5% confirmed that they are not willing to expand plots in different locations. In Table 4.13, 47.5% of farmers' access to financial capital is through government, personal savings 42.5% and 33.1% through regular remittance in order to sustain their projects while 66.9% do not have access to regular remittance.

Table 4.14 further indicates that 15% of farmers access financial assistance through banks while 85% do not have access. 11.3% of farmers access livelihood assets through cooperatives. Table 4.14 also shows that 75.6% of home gardeners have knowledge of gardening while 61.3% of home gardeners confirmed that they received training on how to handle crops, water and equipment. Table 4.14 also confirms that 38.1% have access to transport and it is shown that 63.8% of home gardeners have access to storage. Table 13 reveals that 82.5% of home gardeners have access to land for production with 90% indicating access to water, about 33.1% of home gardeners do not network with other farmers while the majority (66.9%) prefer to be independent with 40.1 % of farmers having access to group memberships. In Table 4.14, there is relationship of trust among gardeners as 60.6% can rely on others while only 39.4% stated that they do not have any relationship of trust.

Table 4.16 presented the water productivity of each crop. 11.5kg/m^3 spinach harvested was produced with 78.848 m^3 of water; 27.1 kg of cabbage was produced with 38.532 m^3 of water. Carrots (7.3 kg) harvested used 40.29 m^3 of water; 9.2 kg beetroot harvested was produced with 31.995 m^3 of water. Tomatoes (6.1 kg) harvested was produced with 31.505 m^3. Table 15 also shows that 6.5 kg of 500 potatoes harvested were produced with 0.765 m^3, butternut (9.6 kg) was produced with 13.335 m^3; onions (7.8 kg) harvested used 25.087 m^3. Green beans (6.4 kg) harvested used 5.55 m^3, green pepper (2.9 kg) harvested used 2.78 m^3, and 6.1 kg of lentils harvested was produced with 2.64 m^3 of water. 33.1% of households of home gardeners are not food secured while 66.9% indicated that households are food secured.

Table 4.18 presented the results of multiple regression analysis. Significant determinants of water use productivity were Type of cropping (t =-2.443, P =.016), Social participation (t =2.599, P = .010), Marketing outlets (t = 2.810, P = .006), Home food security (t=-1.777, P = .078) and Attitude (t = -1.727, P = .086).

5.3 CONCLUSION

Homestead food gardening plays a pivotal role in the improvement of rural livelihood and is often characterised by inefficient water, high cost and lack of sustainability. Government and other stakeholders need a better understanding of the role of home gardening in improving and sustaining rural livelihood. It is necessary that productive resources must also be provided to small scale farmers accompanied by skills and resources in order for them to make optimum use of such resources.

Based on the findings and objectives of the study, the following conclusion could be drawn: The higher the age, education, farming experience, land ownership, type of crop, willingness to expand, attitude, home food security, market outlet and social participation, the higher the water use productivity. The availability of financial and human capital also contributes to higher water use productivity. Unavailability of natural and physical capital lowers the productivity of homestead food gardeners.

5.4 RECOMMENDATIONS

Recommendations proposed in this research are informed by the findings from the study of water use productivity among smallholder homestead food gardening and irrigation crop farmers in the North West province, South Africa. Based on these findings, the following recommendations are advanced:

- Home gardeners should be trained in the use of a wide range of irrigation systems, water management, marketing, general management, operation and maintenance of their plots and irrigation schemes;
- Home gardeners should be allowed access to natural resources such as land and water in order to improve their livelihoods and household welfare;
- Institutional support through technical and extension services should be strengthened in order to support home gardeners;
- Continuous monitoring by departments such as the North West Department of Agriculture is very crucial as it provides feedback to farmers and assists them in improving their performance.
- Training should be conducted in business management, specifically with regard to the choice of alternative crops and inputs.

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ANNEXURE 1

ANALYSIS OF WATER USE PRODUCTIVITY AMONG SMALLHOLDER HOMESTEAD FOOD GARDENING AND IRRIGATION CROP FARMERS IN THE NORTH WEST PROVINCE, SOUTH AFRICA

Questionnaire identification number	
Study area	
Respondent name	
Interviewers name	
Date of interview	

Personal characteristics and socio economic factors (Tick)

Household head race	Black	
	White	
	Coloured	
	Indian	

(Tick)

Gender	Male	
	Female	

House hold head age	
Farming experience	

(Tick)

Marital status	Single	
	Married	
	Divorced	
	Widowed	

(Tick)

Highest school level of the household	Abet	
	Primary	
	Secondary	
	Tertiary	
	None	

Religious belief (Tick)

Christian	
Hindu	
African	
Muslim	
Other (specify)	

Household size

Category	Number
Adult	
Children	
Male	
Female	
Total	

Number of dependents .....

Size of homestead food garden ..... (Ha)

Number of household members active in homestead garden	
Number of household members active in irrigation crop farming	

Source of water for domestic use (Tick)	Tap	
	Protected well	
	Unprotected well	
	River	
	Rain water tanks	
	Tap, river and rain water	

Source of water for irrigation (Tick)	Tap	
	Well	
	River	
	Rain water tanks	
	Rain water harvesting	
	Spring	
	Borehole	
	Dam	

Employment status (Tick)	Employed	
	Unemployed	
	Self employed	
	Student	
	Other (Specify)	

What is/are the source/s of income for the farmer? Make a tick

Sources	Tick
Wage	
Pension	
Remittances	
Family business	
Non-farm income	
Other (specify)	

Type of land ownership (Make a tick in the right block)

1. Own land ☐
2. Communal land ☐
3. Leased land ☐
4. Land reform ☐
5. Rent ☐

What type of cropping system does the farmer follow?

Mono cropping system	
Double cropping system	
Multiple cropping system	
Mixed cropping	
Crop livestock integration	

Do you have contact with the extension officer? Yes ..... No.....

Please indicate the sources of information

	Yes	No
Television		
Radio		
Phone		
Internet		

News paper		
Magazine		
Computer		
Public Participation (IMBIZO)		

Use of crops grown

Household consumption		
Sales		
Livestock consumption		
Gifts		
Buttering		

Marketing Outlets

Community		
Schools		
Tuck Shops		
Clinics		
Pick and Pay		
Choppies		
Shoprite		
Hospice		
Pension pay point		
Farmers Market		

Expansion of plot

	Yes	No
Are you willing to expand		
Do you have potential for expansion		
Are you willing to increase the size of the plot		
Are you willing to increase the number of plots in different locations		
Are you willing to increase the number of crops produced		

Farmers' participation to agricultural or social organizations

Organization	Organizational activities			Extent of participation		
	Meetings	Conferences	Workshops	Regular	Occasional	Never
AFASA						
Agricultural cooperatives						
YARD/BAYOFA						
Local community clubs						
NAFU						
WARD						
TAU						
Others						

Method of irrigation practiced in homestead gardens and crop fields	Bucket irrigation method	
	Sprinkler irrigation method	
	Furrow irrigation method	
	Flood irrigation method	
	Basin	
	Canal	
	Drip	

Resources used in homestead activities (Make a tick to indicate your answer)	List	Tick
	Trailer	
	Scotch cart	
	Tractor	
	Vehicle	
	Hand hoes	
	Shovels	
	Plough	
	Harrow	
	Wheel barrow	
	Sledge	

	Garden fork	
	Knap sack sprayer	
	Sickle	
	Spade	
	Rake	

Crop enterprises water use productivity, water use returns

Crops grown last season?	Area of production (Hs)	Quantity harvested? (kg)	Quantity sold	Quantity stored for consumption	Water source used in irrigation	Income Per unit	Water used Kg/m³
Maize							
Sunflower							
Spinach							
Cabbage							
Carrots							
Beetroot							
Tomatoes							
Potatoes							
Butternut							
Onion							
Lettuce							
Cauliflower							
Green beans							
Lucerne							
Green Pepper							
Lentils							
Kale							

Homestead activities carried out by smallholder farmers

Land clearing		
Ploughing		
Harrowing		
Nursery		
Transplanting		
Staking		
Planting		

Irrigating		
Ridging		
Weeding		
Fertilizer application		
Manure application		
Water control and management		
Irrigation/ water maintenance		
Spraying (pesticides)		
Harvesting		
Washing		
Trimming		

Attitude of smallholder farmers towards homestead food gardening and irrigation crop farming

	SA	A	U	D	SD
Homestead food gardening and irrigation crop farming enhance food security?					
Homestead food gardening and irrigation crop farming will increase adoption of newly improved production methods					
Expenditure on vegetables and other crops will be reduced					
Capacity building among farmers will be improved					
Access to markets will be improved					
Investment in agriculture will improve					
Homestead food gardening and irrigation crop farming will attract investors					
Employment will be generated					
Diversification of homestead food gardening and irrigation crop farming will be enhanced					
Sustainability of smallholder homestead food gardening and irrigation crop farming will be enhanced					
Homestead food gardening and irrigation crop farming enhances agricultural development					
Homestead food gardening and irrigation crop farming determine the impact on the livelihood					
Irrigation skills development will be stimulated					
Technical know-how will be improved					
Soil nutrients and structure will be improved					

Hint: Strongly Agree-SA; Agree-A; Undecided-U; D-Disagree; Strongly Disagree-SD

Household Food Insecurity Access Scale (HFIAS) Measurement Tool

Question	*Response options Code*
1. In the past four weeks did you worry that your household would not have enough food?	0 = No (skip to Q2)
	1 = Yes
1a.How often did this happen?	1 = Rarely (once or twice in the past four weeks)
	2 = Sometimes (three to ten times in the past four weeks)
	3 = Often (more than ten times in the past four weeks)
2. In the past four weeks, were you or any household member not able to eat the kinds of food preferred because of lack of resources?	0 = No (skip to Q3)
	1 = Yes
2a. How often did this happen?	1 = Rarely (once or twice in the past four weeks)
	2 = Sometimes (three to ten times in the past four weeks)
	3 = Often (more than ten times in the past four weeks)
3. In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q4)
	1 = Yes
3 aHow often did this happen	1 = Rarely (once or twice in the past four weeks)
	2 = Sometimes (three to ten times in the past four weeks)
	3 = Often (more than ten times in the past four weeks)
4. In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q5)
	1 = Yes
4 a How often did this happen	1 = Rarely (once or twice in the past four weeks)
	2 = Sometimes (three to ten times in the past four weeks)
	3 = Often (more than ten times in the past four weeks)
5. In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q5)
	1 = Yes
5 aHow often did that happen	1 = Rarely (once or twice in the past four weeks)
	2 = Sometimes (three to ten times in the past four weeks)
	3 = Often (more than ten times in the past four weeks)
6. In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7)
	1 = Yes
6 a How often did this happen?	1 = Rarely (once or twice in the past four weeks)
	2 = Sometimes (three to ten times in the past four weeks)
	3 = Often (more than ten times in the past four weeks)
7. In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q7)
	1 = Yes
7 a How often did this happen?	1 = Rarely (once or twice in the past four weeks)
	2 = Sometimes (three to ten times in the past four weeks)
	3 = Often (more than ten times in the past four weeks)
8. In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q7)
	1 = Yes
8 a How often did this happen?	1 = Rarely (once or twice in the past four weeks)
	2 = Sometimes (three to ten times in the past four weeks)
	3 = Often (more than ten times in the past four weeks)
9. In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (skip to Q7)
	1 = Yes
9 a How often did this happen?	1 = Rarely (once or twice in the past four weeks)
	2 = Sometimes (three to ten times in the past four weeks)
	3 = Often (more than ten times in the past four weeks)

Impact of homestead food gardening and irrigation crop farming on the livelihood of smallholder farmers

FINANCIAL CAPITAL	Availability		Adequacy	
	YES	NO	High	Low
Access to Credit from:				
Banks				
Cooperatives				
Money lenders				
Saving				
Regular remittance				
Pensions				
Relatives				
Personal savings				
Contractors				
Government subsidies				
HUMAN CAPITAL				
Training				
Vocational training				
Extension service				
Skills training				
Knowledge of gardening				
Knowledge of vegetable production				
Record keeping				
Water management				
Equipment handling				
Financial management				
Soil management				
Crop protection				
Any other (Specify)				
PHYSICAL CAPITAL				
Transport				
Water supply- canal				
Markets				
Road accessibility				
Electricity				
Storage				
NATURAL CAPITAL				
Land				
water				
Environment				

Biodiversity				
Trust relationship				
Water use right				
Land tenure				
Social capital				
Networks				
Group memberships				
Relationship of trust				
Access to wider institution of society				
Positive psychological capital				
Confidence				
Self-efficacy,				
Individuals ability to mobilize				
Individuals ability to motivate				
Strong positive relationship to work related performance				
Optimism				
Easily fed up				
Giving up				
Discouraged easily				
Talented				
Goal getter				
Demotivated				
Resilience				
Flexibility in adjustment				
Deep belief				
Ability to improvise				
Ability to adapt to significant change				
Ability to resist stress				

Constraints faced by smallholder homestead food gardeners and irrigation crop farmers

Marketing constraints **Choose by making a tick**		Tick
	Market information	
	Market price	
	Transportation	
	Processing	
	Preservation	
	Packaging	
	Lack of marketing skills	
Financial constraints	Lack of access to financial institutions	
	Lack of financial surety	
	Volatile interest rates	
	Lack of income	
	Low profit viability	
	Lack of financial skills	
Production constraints	High inputs cost	
	High implements cost	
	Lack of production skills	
	Lack of production knowledge	
	Climate change	
	Shortage of water	
	Pest	
	Water availability	

Entrepreneurial activities

Please indicate if you carry out any of these activities

Entrepreneurial activities			Willingness to engage in activities	
	Yes	No	Yes	NO

Product design				
Distribution/Sales/Service				
Manufacture new products				
Promotion				
Obtaining resources				
Research and development				
Protecting intellectual property				
Obtaining raw materials				
Identifying a market opportunity				
Drive and energy				
Self-confidence				
High initiative and personal responsibility				
Internal locus of control				
Tolerance of ambiguity				
Low fear of failure				
Moderate risk taking				
Long-term involvement				
Money as a measure not merely an end				
Use of feedback				
Continuous pragmatic problem solving				
Self-imposed standards				
Clear goal setting.				
High need for achievement				
Self-authority				
Independent thinkers				
Intuitive and resourceful working style				
Business failure is personal failure				
Belief in the ability to control outcomes				
Risk takers				
Self-motivated				
Dissatisfaction with present status of achievement				
Work experience				
Life path interruption				
Invention/ Creativity				
Technology changes				
Change in property				

New capital				
Unique Employees				
Perceive and recognize a fit				
Secure resources				
Secure markets				
Employ and develop capabilities				
Perceiving opportunity of Un-met market need				
Perceiving opportunity of Under-deployed resources				

Water Use security

Quantitative measure of water resources availability		
Quantitative measure of reliability of water resources		
Quantitative measure of rainfall variability		
Qualitative measure of water resources availability		
Qualitative measure of service reliability		
Qualitative measure of rainfall variability		
A1. % Population with access to piped water supply		
% Population with access to sanitation		
Time required for water collection activities		
Reports of conflict over access to water		
Ratio of domestic consumption to basic water requirements		
Quantitative measure of water quality		
Qualitative measure of water quality		
% Population reporting a change in soil fertility		
% Population reporting a change in tree cover		

4072
Desiree Street
Unit 12 Mmabatho
30 December 2014

CERTIFICATE OF LANGUAGE EDITING

The dissertation entitled

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Submitted by

SELEKE CHRISTOPHER TSHWENE (16969669)

For the degree

MASTER OF SCIENCE

(Agricultural Extension)

In the

Faculty of Agriculture, Science and Technology

Mafikeng Campus

North-West University

Has been edited for language by

Paul Nepapleh Nkamta (PhD; MA; PGCE; BA Hons)

Paul Nepapleh Nkamta (PhD)