

**EXPLORING FARMING SYSTEMS AND THE ROLE OF AGROECOLOGY IN
IMPROVING FOOD SECURITY, PRODUCTIVITY AND MARKET ACCESS FOR
SMALLHOLDER FARMERS**

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DECEMBER 2016

ABSTRACT

Most smallholder farming areas in developing countries including South Africa are inhabited by resource constrained farmers, many of whom lack appropriate technologies. The farmers have largely had little education and up to 80% of those involved in agriculture are women. Smallholder farmers in these areas engage in farming activities oriented at subsistence and/or selling of surplus as a survival strategy. Most farms in South Africa where smallholder farmers reside are found in poorly developed areas in former homeland areas presided over by traditional authorities. These areas are characterized by less productive soils and poor and erratic rainfall. These farmers face many challenges including water shortages and lack of irrigation. The land is exposed to increased land degradation, and often they lack finances and cannot afford basic inputs and implements for farming. As a result of these challenges, farmers' food security is affected. This study examined the smallholder crop production systems in these areas and explored the potential role of agroecology as a strategy to enhance their food security and markets access. Exploring farming systems which smallholder employs is important for providing a useful framework within which to examine agricultural development strategies and interventions impacting smallholder farmers in South Africa.

The research was conducted in KwaZulu-Natal, Swayimane area under uMshwathi Local Municipality which is located within the uMgungundlovu District Municipal area (29°25'S; 30°34'E). A sample of 80 smallholder farmers was purposively selected for the study. About 300 farmers in Swayimane practiced agroecology, 26% of those were interviewed for the study. The aimed to establish whether smallholder farmers applied agroecological principles or conventional farming. Primary data was collected using structured questionnaires and key informant interviews. Focus group discussions were also conducted to generate detailed information on which farming system was incorporated in their farms and whether agroecological principles can enhance productivity on their farms.

The sample consisted of 64% women and 36% men. In terms of age, most participants 36.3% fell between the ages of 46-60. Also most of the farmers attended secondary school 63.7%. The results show that different types of farming systems were practiced in the area. Smallholder farmers were practicing conventional farming, organic farming with conventional farming and agroecological principles in farming. The farming systems practiced were mostly affected by shortages of water.

Farmers were forced to diversify their crops to those which are drought resistant which affected their profits as there was no established market for such crops. In addition, their food security was affected as there was less diversity of crops produced as a result of the water shortages. In employing these production systems, findings revealed that smallholder farmers considered yields, economic benefits, social and environmental factors when evaluating different farming systems to use in their farms. Hence farmers diversified their farming system by cultivating drought tolerant crops.

In terms of agroecology, farmers were aware that agroecology is not a relatively new concept in South Africa as these methods were also applied by their forefathers. However as much as farmers were aware and also applied agroecological concepts and principles to their farming practices, many still used industrial fertilizers in a large part of their farms and a few farmers used organic farming. Farmers acknowledged that some agroecological principles including organic farming were very helpful as they are environmentally friendly. Despite benefits of practising agroecological methods of farming, farmers were still somewhat reluctant to converting from using conventional to agroecological methods of farming because of the perceived difficulties associated with practicing some of the methods of agroecology. The most commonly mentioned disadvantages included low yields from producing food using organic fertilizers and lower profits made from selling such produce because the yields were much less compared to those produced conventionally.

With regards to market access farmers argued that markets demand consistency and quality. Hence farmers were not selling food produced organically because of low yields and the longer time it takes to mature. Accessing markets also comes with lots of institutional and social challenges which farmers find it hard to deal with and resorted to selling in informal markets. However, such produce was regarded by farmers as being healthy and methods of producing were less harmful to the environment, hence some farmers allocated smaller land portions to produce organic food products for household consumption.

Results also showed that training farmers in terms of using agroecology was important as those who have attended training were applying some of the methods in their farms. However, the trainings given to farmers did not yield the expected outcomes as farmers were still somewhat reluctant to changing their methods of farming. Hence as part of the recommendations for training

smallholder farmers should be on practical on-farm training and should involve practical work. This type of on farm training could be more beneficial than sitting and listening in the training room. The training given should involve relevant stakeholder in the community including the Department of Agriculture. For the future, the research be expanded to include two study sites for comparison purposes, perhaps another province to see whether the results would be similar so that one can then give a reliable recommendations as to what really is the suitable farming methods for small farmers to employ.

Keywords: Farming systems, Agroecology, Smallholder farmers, Food security, and Market access.

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DECLARATION

I **Thobeka Mkhize** declare that:

- The research reported in this dissertation, except where otherwise indicated is my original research.
- This mini dissertation hereby submitted to the University of Kwa-Zulu for the degree of Master of Science in Agriculture (Food Security) has not been submitted by me for a degree at this or any other university
- This is my own work in design and that all material contained herein has been duly acknowledged.

Signed: _____

T. Mkhize

Date

As Research Supervisor, I agree to the submission of this mini-dissertation for examination.

Signed: _____

Dr. J.M. Chitja

Date

As Research co-supervisor, I agree to the submission of this mini-dissertation for examination.

Signed: _____

Dr. A. Odindo

Date

ACKNOWLEDGEMENTS

First, I would like to say thank you God Jehovah for all that you have done for me thus far and going forward.

Thank you to the following people who have contributed to this achievement:

- I would like to thank Dr J Chitja for her supervision and support throughout the course of the project. Thank you for believing in me and for seeing the potential in me. I enjoyed working with you.
- I would also like to thank Dr. Odindo for his co-supervision.
- I would like to thank the community of Swayimane for participating in the study; the Zimele organization for making the research a success; Sbonelo Ntombela and Nduduzo Cele who helped me with data collection; and Kwazi Zuma for helping me to analyse my data.
- I would also like to thank Denver for always helping when I needed him and for the words of encouragement. Also Dr. Vhongai Murugani with proof reading the work.
- Lastly, I would like to thank my family for encouraging me to never give up, and for their support throughout this time. I would also like to thank my friends for their words of motivation when the going got tough.

DEDICATION

I dedicate this mini-dissertation to my grandparents and aunt who have been supporting me throughout the course of my studies. I pray that Jehovah keeps them long enough to reap the fruits of their work. My late mother Thandi Mkhize, all was inspired by the desire to make you proud even in your absence. I love you all.

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LIST OF ACRONYMS

AWM	Agricultural Water Management
CA	Conservation Agriculture
CCAFS	Climate Change Agriculture and Food Security
CTIC	Conservation Technology Information Center
E. coli	<i>Escherichia coli</i>
FAO	Food and Agriculture Organization
ITB	Ingonyama Trust Board
IAC	Inter Academy Council
IFAD	International Fund for Agricultural Development
IFAMA	International Food and Agribusiness Management Association
IPM	Integrated Pest Management
KZN	KwaZulu-Natal
NGO	Non-Government organization
PDF	Portable Document Format
PRA	Participatory Rural Appraisal
RWH	Rain Water Harvest
SA	South Africa
SAEES	School of Agricultural, Earth and Environmental Sciences
SPSS	Statistical Package for Social Sciences
SWOT	Strength, Weakness, Opportunity, Threat.
SSFMI	Small-scale Farmer-Managed Irrigation
Stats SA	Statistics South Africa
UKZN	University of KwaZulu-Natal
USDA	United States Department of Agriculture
WFP	World Food Programme

WH	Water Harvest
WHL	Woolworths Holdings Limited

DEFINITION OF TERMS

- Farming systems

Groups of individual farms that share generally similar resource bases, enterprise patterns, livelihood styles, and constraints, and for which similar development strategies would be pertinent (Carmona *et al.* 2010).

- Agroecology

The application of ecological insights to agricultural systems in the entire food system, encompassing ecological, economic and social dimensions (Tomich *et al.*, 2011).

- Food security

The availability of nutritionally adequate and safe foods, and an assured ability to acquire acceptable foods in the socially acceptable ways including, physical and economic access, at all times, to be the sufficient, safe and nutritious food to meet the dietary needs and the food preferences for an active and healthy life (Thiengkamol, 2011).

CHAPTER 1

THE RESEARCH PROBLEM AND ITS SETTING

1.1 Introduction

Most households in rural South Africa are classified as poor, with the highest total counts for households thus classified being in Kwa-Zulu Natal (KZN), Limpopo and Eastern Cape (Stats SA, 2008). These provinces are also characterized by high rates of unemployment: 33% in KZN, 40% in Limpopo and 37% in Eastern Cape. Rural populations in these provinces are in most cases directly dependent on agriculture for their own food security (Stats SA, 2011). Statistics South Africa also shows that the provinces with highest number of households directly engaged in agriculture are KZN, Eastern Cape and Limpopo, in that order (Stats SA, 2011). However, the farming on which these populations largely depend is affected by several challenges. Binam *et al.* (2004) argue that the most pressing problem for smallholder farming is finance for basic inputs. Access to and costs of inputs such as seeds, implements and chemicals are critical issues for small farmers and directly affect their potential income from farming (Binam *et al.* 2004). Another challenge is increasing land degradation, which creates additional costs for fertilizers and supplementary feeds that small farmers often cannot afford (Siegel & Alwang, 2005). In their paper on emerging issues for smallholder organic farmers in South Africa, Thamaga-Chitja & Hendrick (2008) also cite lack of information and skills as further challenges in smallholder and rural farming.

In the African context, it has been asserted that each 1% increase in agricultural productivity in Africa reduces poverty by 0.6% (Forum for Agricultural Research in Africa, 2007). Hence, “a smallholder-led growth strategy can make a very significant impact on food security and poverty decrease” (Williams *et al.* 2008; Altieri 2009). Research shows that, with the necessary support, smallholder agriculture can contribute significantly to poverty and hunger alleviation by raising agricultural productivity and rural incomes (Machethe, 2007). Furthermore, policies must confront the problems faced by smallholder farmers as they are primary producers.

In smallholder farmers agriculture crops are grown under a wide range of production systems. In some cases, these include technological interventions such as soil tilling, protective or curative

pest and weed control with agrochemicals, and application of mineral fertilizers for plant nutrition. Other systems have a predominantly ecosystem approach which is both productive and more sustainable. In Africa, a wide range of farming systems exist, and although it is not possible to single out one or two systems that predominate, the top six systems together provide 80% of all food production (Inter Academy Council report). It is thus not feasible to identify which system offers the best opportunities for improvements. Examples of farming system types for improving sustainability are, first, organic cropping systems which is driven by a philosophy of using biological processes to achieve high soil quality, control pests, and provide favorable growing environments for productive crops (National Research Council, 2010). Second, alternative livestock production systems, in this system farmers take advantage of opportunities for greater on-farm cycling of nutrients, seek to mimic natural patterns of animal behavior. Third, perennial agriculture systems and management-intensive rotational grazing (National Research Council, 2010). Fourth, conventional farming, also known as industrial agriculture, refers to farming systems which include the use of synthetic chemical fertilizers, pesticides, herbicides and other continual inputs, genetically modified organisms, concentrated animal feeding operations, heavy irrigation, intensive tillage, or concentrated monoculture production (Czarnecki, 2011). The Food and Agriculture Organization (FAO) argues nonetheless that farming systems should be underpinned by three technical principles:

- Simultaneous achievement of increased agricultural productivity and enhancement of natural capital and ecosystem services.
- Higher rates of efficiency in the use of key inputs including water, nutrients, pesticides, energy, land and labor.
- Use of managed and natural biodiversity to build system resilience to abiotic and economic stresses (FAO, 2011).

Magombeyi *et al.* (2012) show that smallholder farming systems are characterized by low yield and high risks of crop failure and food insecurity. Many smallholder farmers in South Africa do not achieve good yields because the fertilizer supply is inadequate, the range of fertilizers is limited, and delivery is unreliable (Magombeyi *et al.* (2012). Inappropriate applications can be

counterproductive, and the non-availability of nutrients at certain stages can reduce the beneficial effects of previous applications (FAO, 2011).

Research shows that farming systems that can improve sustainable crop production, can bring a range of productivity, socio-economic and environmental benefits to producers and to society at large while simultaneously helping to ameliorate climate change and protect ecosystems. The systematic application of agroecological principles is precise for small and large farms anywhere in the world to address the new Triple Green Revolution challenge. This refers to green for productive use of green water (rain); green for intensification and enhanced food production; and green for sustainability and building water resilience in watersheds and river basins (Gomez *et al.* 2013) Africa stands out as one of the most vulnerable of the three water scarce world regions, where food production and human livelihoods rely on limited, highly variable, unreliable and unpredictable rain.

Agroecology is defined as the form of agriculture which integrates natural, regenerative process, minimizes non-renewable inputs, involves locally adapted practices and encourages biodiversity. It has strong historical roots in traditional farming systems globally, partly because of its low-cost inputs requirements. Wezel *et al.* (2013) adds that there are different practices of agroecology, which involves increasing efficiency or substitution. The different agroecological practices are natural pesticides; crop choice and rotations; intercropping and relay intercropping; agroforestry; direct seeding into living cover crops or mulch; organic fertilisation, split fertilisation, reduced tillage, drip irrigation, biological pest control, and cultivar choice (Wezel *et al.* 2013).

Dobermann and Nelson (2013) argues that improved performance regarding the application of agroecology may mean increased productivity and profitability, enhanced use of local resources, maximized returns from external inputs, improved stability and diversity yields, reduced greenhouse gas emissions, enhanced ecological resilience and environmental service provision. The only agricultural systems that will be able to confront future challenges are agroecological systems that exhibit high levels of diversity, integration, efficiency, resilience and productivity (Gimenez & Patel, 2009).

With regards to market access, in systems under population and market pressure, some farms in a farming system may successfully intensify and even specialize to produce for the market, whereas others may regress to low-input/low-output systems. Moreover, in any one location within a farming system, different farms are likely to be at different stages of development because of differentiated resource bases, household goals, capacity to bear risk or degree of market access, (Inter Academy Council, 2004).

1.2 Importance of the study

Exploring and analyzing the farming systems within which the smallholder and subsistence farmer live and work can provide useful strategies which can be applied towards the reduction of poverty and hunger affecting many lives. In Latin America and the Caribbean there are many NGOs involved in promoting agroecological initiatives that have demonstrated a positive impact on the livelihoods of small farming communities in various countries (Altieri *et al*, 2012). Farmers adopting agroecological models achieved significant levels of food security and natural resource conservation.

Given the benefits and advantages of such initiatives, two basic questions emerged: (1) why these benefits have not disseminated more widely and (2) how to scale-up these initiatives to enable wider impact? (Altieri, 2012). This study will not focus on how to scale-up agroecological initiatives, however, it will advocate for engaging supportive policies into agroecology for development of smallholder farming which could result into improved livelihoods.

The study will provide the scientific evidence and increase farmers' appreciation for agroecology. Research shows that rural incomes cannot substantially be increased by exclusive emphasis on subsistence food crop production; rather, more market-oriented production systems are needed (Llazo, 2013). Moreover, population growth combined with new technology options and/or market opportunities can induce farmers to diversify and intensify farming systems. Therefore, a study that seeks to integrate these three strategies which are: to analyze farming systems, investigate agroecology as a strategy that can enhance food security and market access for smallholder farmers is of great importance. Furthermore, as strategies towards enhancing food security and reduction of poverty amongst smallholder farmers, all role players including universities needs to be

involved to disseminate the agricultural knowledge and information and make it readily available to smallholder farmers (Berdegue & Escobar, 2009).

1.3 Research objectives

The study investigated the farming systems in which smallholder farmers in Swayimane, KwaZulu-Natal operate, through an analysis of socio-economic aspects which the farmers consider when choosing a farming system to employ when farming. Furthermore, the study sought to investigate the contribution of agroecological practices like organic farming, mulching, composting or kraal manure, conservation tillage and integrated pest management to current rural livelihoods. The economic viability of existing farming systems and food security was also investigated. Finally, the study considered whether farmers' perceived agroecologically produced food as potentially marketable as this is an important aspect for development of smallholder agriculture.

1.4 Specific research questions

These research objectives can be narrowed down to three specific questions which are:

1. What are the practices used by smallholder and subsistence farmers to maintain high crop productivity and factors associated with the choice and intensity of these practices?
2. Can the application of agroecological practices or concepts impact on high level of productivity and sustainability?
3. Is there a potential market for agroecologically produced crops?

1.5 Study assumptions

It was assumed that respondents (farmers and agro-facilitators from Zimele organization) were trained to use some methods of agroecology and would be knowledgeable about the practical aspects of agroecology; agroecological methods including mulching, conservation tillage, organic farming, composting or kraal manure usage and integrated pest management.

1.6 Hypothesis

Farming systems used by smallholder farmers are not fully suitable to the farmers in the context and the application of agroecological concepts in smallholder farming can enhance productivity and food security.

1.7 Study limits

KwaZulu-Natal Province is very large; the research could not cover the whole province because of time and of resource limitations. This research is based on one geographical area, this restriction limits the ability to generalize the results to other areas. The research only focused on exploring the farming systems that are practiced by farmers in Swayimane and its relevance to market access, it did not include fieldwork.

1.8 Dissemination of research results

The researcher has already presented the findings at the School of Agriculture, Earth and Environmental Sciences' research day, South African Association for Family Ecology and Consumer Sciences and the International Federation for Home Economics Africa Region in February 2016. One journal article will also be prepared for publication. The full study will also be in the dissertation sections of University of KwaZulu-Natal (UKZN) library which is also availed online in a PDF format.

1.9 Structure of the dissertation

The mini-dissertation is organized into five chapters. Chapter one presents an introduction to the research problem, the importance of this study, the research problem, research objectives, specific research questions, study limits and study assumptions. The second chapter presents a review of literature on farming systems, role of agroecology among smallholder farmers and lastly considers productivity and market access for smallholder farmers. Chapter three describes the methodology used to collect and analyze the data. The results and discussions are presented in chapter four. Lastly, chapter five is the summary of the research, conclusions and recommendations for future research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Food security and sustainable farming have been the focus of domestic and international policy initiatives, such as the Millennium Development Goals (United Nations, 2004; 2005; 2007). Nevertheless, challenges remain with Asia and the Pacific having 578 million of the world's hungry, Africa with 239 million and Latin America with 53 million people hungry (WFP, 2016). Several strategies have been employed by governments in different countries to address food insecurity. Food security covers four pillars which are food availability, food access, food utilization and food stability (FAO, 2006). If one of the four pillars is compromised, then food security status is also compromised. This includes the ability to produce own sufficient food through agriculture and the ability to access markets to purchase and sell food items (Alkon & Norgaard, 2009). The literature review explores the current food security situation of smallholder farmers through exploring and analyzing the production systems within which the smallholder and subsistence farmers live and work. Garrity *et al.* (2012) states that “the description of the major farming systems provides a useful framework within which to examine agricultural development strategies and interventions”. Furthermore, this review discusses agroecological principles as one of many interventions to address food insecurity. Lastly the review also looks at the challenges facing smallholder in accessing markets.

2.2 What is a farming system?

A farming system is defined as a population of farm households, of varying farm sizes, which have similar patterns of livelihood, consumption, constraints and opportunities; and for whom similar development strategies and interventions would be appropriate. Often, such systems share similar agro-ecological and market access conditions (Garrity *et al.* 2012).

Dixon (2012) argues that the functioning of any farming system is strongly influenced by the local external rural environment, including local institutions, land, labour and input markets and information linkages. In fact, it is important to include closely-linked aspects of local institutions

into the analysis of the farming system. The farm household boundaries are thus defined by the limits of the sphere of household decision-making, for example, including decision making and income flows connected to off-farm work activities (Dixon *et al.* 2012).

2.2.1 Dominant production systems and their linkages

Poor performance of soil largely due to poor land management practices including; continuous cropping, intense nutrient removal, inadequate mineral and organic matter replenishment and soil erosion; is an important factor affecting the sustainability of any cropping system and its future productivity (Chinangwa, 2006). Projections indicate that, in the next 30 years, production from irrigated land in the sub-Saharan Africa could increase substantially, with most of the increase coming from yield increases on existing irrigated land (Tilman, *et al.* 2002). But Agricultural Water Management (AWM) is generally perceived as a key step towards improving low yielding smallholder farming systems in sub-Sahara Africa.

Furthermore in 2007, the South African government accepted the Biofuel strategy which makes provision for 2% of annual fuel needs to be supplied by biofuels within the next five years, this raised a concern about its effect on food prices, food availability, the environment and agricultural sector as whole (Chakauya, 2009). The adoption of biofuel may have an impact on food security for smallholder farmers because poor people spend large proportions of their budgets on basic foods, and thus they are especially vulnerable to food price increases (IFAD, 2008).

In Africa, there is a wide range of farming systems, and although it is not possible to single out one or two systems that predominate, the literature discusses three types of farming systems which are commonly used in smallholder farming. The next section provides an overview of common trends affecting the farming systems

2.2.1.1 Irrigated Farming System

There are different types of irrigation, which one can use depending on the source water and distribution method (Ramachandran, 2010). In Sub-Saharan Africa, public sector irrigation schemes have generally been expensive to construct and maintain and their performance has been disappointing (Kay, 2001). Not only have production increases been lower than anticipated, the

systems have often been unsustainable, due to low output prices and high operation and maintenance costs. The irrigated farming system is thus quite complex. In many cases, irrigated cropping is combined with rain-fed cropping. Although, it is impossible to distinguish between full and partial water control, crop failure is generally not a problem, but livelihoods are vulnerable to water shortages (IAC, 2010).

Small-scale Farmer-Managed Irrigation (SSFMI) has been more successful and holds the promise of being sustained by farmers. Although Sub Saharan Africa has the lowest proportion of its cropped area under irrigation in the developing world, construction of new irrigation schemes is often more expensive than elsewhere (Dixon *et al.* 2012). For new irrigation schemes to be economically viable, farmers must be able to grow and market high-value crops such as vegetables, and this is only feasible in proximity to markets.

2.2.1.2 Mixed Farming System

Mixed farming systems can be classified in many ways, based on land size, type of crops and animals, geographical distribution and market orientation, (Obasi *et al.* 2016). Two major categories of mixed farming are discussed here. The categories are, mixing within crops and/or animal integrated systems. Mixed farming is probably the most non-threatening agricultural production system from an environmental perspective because it is, at least partially, a closed system (Ryschawy, 2015). The waste products of one enterprise (crop residues), which would otherwise be loaded on to the natural resource base, are used by the other enterprise, which returns its own waste products (manure) back to the first enterprise. Because it provides many opportunities for recycling and organic farming and for a varied, more attractive landscape, mixed farming is the favorite system of many agriculturalists and environmentalists (Dixon *et al.* 2012).

Mixed farming systems provide farmers with benefits such as an opportunity to diversify risk from single crop production, to use labor more efficiently, to have a source of cash for purchasing farm inputs and to add value to crops or crop by-products (Sadati, 2010). This production method is good for smallholder farmers as it offers highest return on farm business, as the by-products of the farm are properly utilized. Enhancing productivity and profitability of certain crops and livestock and food security. Additionally, if farmers are keeping both livestock and crops on the farm, the

system provides milk, meat and vegetables for household consumption and the surplus is sold on the market which is good for farmers' food security (CCAFS, 2015).

(i) Mixed cropping

As part of the indigenous knowledge farmers in Africa have been practicing mixed cropping (Olukoya, 2006). Even at the level of the individual farm unit, farmers typically cultivate 10 or more crops in diverse mixtures that vary across soil type, topographical position and distance from the household compound (IAC, 2010). Research shows that mixed cropping has several advantages which includes maximizing possible use of the land under cultivation since the crops require different soil depth for their nutrient supply, protects the soil from erosion as each harvested plant is replaced by a new one, and increases yield through the interaction of supplementary crops (Ogen, 2006).

(ii) Animal Integrated

Integrated farming system refers to agricultural systems that integrate livestock and crop production (Obasi *et al.* 2016). The integrated farming system could be crop-fish integration, livestock-fish integration, crop-fish-livestock integration or combinations of crop, livestock, fish and other enterprises. In an integrated system, livestock and crops are produced within a coordinated framework (Gupta, Rai & Risam, 2012). The waste products of one component serve as a resource for the other. For example, manure is used to enhance crop production; crop residues and by-products feed the animals, supplementing often inadequate feed supplies, thus contributing to improved animal nutrition and productivity (Gupta, Rai & Risam, 2012). Combining crops and livestock also has the potential to maintain ecosystem function and health and help prevent agricultural systems from becoming too brittle, or over connected, by promoting greater biodiversity, and therefore increased capability to absorb shocks to the natural resource base (Kassam *et al.* 2009). This could be why smallholder farmers are encouraged by policy and research to employ this method in their production systems (Kayisi & Tsedu, 2011). Evidence is increasing that integration of livestock into diverse cropping systems can produce important benefits (Sulc & Tracy, 2007). For example, the farmers' ability to feed crops to livestock, this enables them to capture and potentially recycle nutrients back to farm fields. This reduces the

amount of purchased fertilizers, and enhances desirable soil attributes, such as organic matter, water-holding capacity, and soil structure (Schiere *et al.* 2002; Entz *et al.* 2005; Hendrickson *et al.* 2007).

2.2.1.3 Rain-fed farming system

This type of farming system relies on rainfall for water. It provides much of the food consumed by poor communities in developing countries (Tow *et al.* 2011). Productivity in the rain-fed farming is determined by the amount and distribution of rainfall. In the year 2015 in South Africa, the World Food Programme (WFP) said maize production was estimated to have dropped by a third compared with last year, putting it on track for a harvest of about 10 million tons, its worst in eight years. This tonnage was largely produced by commercial farmers, as data on smallholder farmer yield is often unavailable even though smallholder farmers are said to be the drivers of many economies in Africa (DAFF, 2012). Thus, the potential of smallholder farmers remains unrealised. The decrease in maize production had a negative impact on household food security as most of the South African population consume maize and its products almost daily. Moreover, smallholder farmers are more vulnerable to drought because they are concentrated in less favorable climate regions, lack resources and rely on own production for household food security (Agri SA, 2016). The issue of shortage of rain affects both small and commercial farmers, which in turn has an impact on food prices and food security in general. In addition, the levels of productivity, particularly in parts of sub-Saharan Africa and South Asia, are low due to degraded soils, high levels of evaporation, droughts, floods and a general lack of effective water management (International Water Management Institute, 2010). The rain-fed system is said to be not suitable in future as it will be under pressure to help supply the 70% increase in food production by 2050 as water available for irrigated agriculture is increasingly limited (Rockström, 2007). The only way to manage dry-spells in rain-fed agriculture is through investments in field-scale water and addition of micro-irrigation components in rain-fed.

2.3 The socio-economic determinants of farming systems for rural farmers

The socio-economic aspects that plays a role in a farmer's decision to make a choice as to which farming system to adopt when farming are discussed in this part of literature.

A variety of constraints such as available production technologies, biophysical or geophysical constraints, labor and input market constraints influence farmer decisions to farmer decision-making and adoption of land use practices (Bowman & Zilberman, 2013; Deressa *et al.* 2009). Economists assume that farmers make choices to improve their utility, or well-being. Farmers, in particular, tend to pursue activities that increase their income, reduce their financial and physical risk, reduce labor requirements, and are convenient or enjoyable (Bowman & Zilberman, 2013). Population growth combined with new technology options and/or market opportunities can induce farmers to diversify and intensify their farming systems. Depending on the natural resource base and management systems, intensification can either sustain and improve productivity over time, or degrade the natural resource base and therefore lower production potential over time (Bowman & Zilberman, 2013). That is why monitoring of progress in production system practices and their outcomes will be essential.

Relevant socio-economic indicators include farm profit, factor productivity, the amount of external inputs applied per unit of output, the number of farmers practicing sustainable intensified systems, the area covered, and the stability of production (Ochieng, 2015). The relevant ecosystem service indicators are: satisfactory levels of soil organic matter, clean water provisioning from an intensive agriculture area, reduced erosion, increased biodiversity and wildlife within agricultural landscapes, and reductions in both carbon footprint and greenhouse gas emissions. Consumer attitudes and willingness to pay (i.e., the maximum amount a consumer would be willing to pay for a good or attribute) for differentiated crops or attributes, such as organic or local production or pesticide-free varieties, also affect the agricultural systems that emerge in response to the demands of a changing market (Bowman & Zilberman, 2013).

2.4 The case for smallholder farmers

Historically, the segregation brought about by apartheid laws disadvantaged smallholder farmers in South Africa (Van Koppen *et al.* 2009). These farmers often have poor access to productive land with reliable water resources due historical segregation which led to land dispossession

(Schreiner *et al.* 2004). Smallholder farmers are often grouped as farmers who farm for household consumption, cash sale and even animal fodder. They participate in lower risk farming and frequently have a lower ability to access the farming markets because of their limited exposure (Denison & Manona, 2007).

The research shows that agriculture and food security in the livelihoods of South African households and the dietary intake of most households is closely linked to productivity and the diversity of food production in the country (Benson, 2015). However, agriculture is characterized by the following: the industrial-sized growing of a single plant, or "monoculture", genetically engineered crops, and repeated toxic chemical infusions of pesticides and the application of inorganic fertilizers. These harm people and the farming ecosystems they depend on, including the use of limited monoculture species has led to a loss in the diversity of agricultural species (Altieri *et al.* 2012).

Female smallholder farmers face the added burden as many poor communities depend on women to grow most of the food they eat. Women, who dominate small-scale farming in communities may benefit from agroecology. Agroecologically based agriculture is economical, making use of available resources, thus women who often do not have access to financial resources can have a debt free livelihood (Kayisi & Tsedu, 2001). Smallholder organic farming has been topical particularly in Africa as organic farming principles are like those of traditional African farming and are therefore easier to implement and allow farmers to build onto their indigenous knowledge (Thamaga-Chitja & Hendriks, 2008). However, education and skills remain a limiting factor for smallholder farmers to practice licensed organic farming. Moreover, conservation agriculture can result in yield benefits in the long-term, but in the short-term – and this may be up to 15 years' yield losses or no yield benefits are just as likely, especially if starting from degraded soil conditions (Rusinamhodzi *et al.* 2011).

2.5. Training smallholder farmers

Generally entrepreneurs must be open-minded and in possession of the following skills: record keeping, banking, labour management, the ability to choose a profitable enterprise and production method for that enterprise (Khapayi, & Celliers, 2016). Agricultural production methods are

dynamic and require a farmer who is current with developments and changes. Education can help farmers to attain these skills. Hence, knowledge is another factor which is important and can help smallholder farmers to avoid risks.

The key point made by Ojiem *et al.* (2006) is that even if a technology makes perfect scientific sense and has benefits for the environment, people will not automatically adopt it. Technologies are influenced not only by scientific factors but also by cultural and social factors. Taking these factors into account requires working together with farmers in their embedded 'socio-ecological niches' on production technologies. This requires effort to be put into social, institutional and organizational structure as well as science.

2.6 Agroecology and smallholder farmers

The application of ecological insights to agricultural systems in the entire food system, encompassing ecological, economic and social dimensions, (Tomich *et al.* 2011). Agroecology reclaims the idea that an agricultural system must be viewed as an ecosystem (Frehaut & Rupani, 2010). It is not a new concept to farmers as it is managed by linking traditional knowledge, sustainable agriculture, and local food system experiences (Altieri & Rogé, 2009). The principles of agroecology include diversification, the use of renewable resources, minimizing toxic compounds, the conservation of resources such as soil, water, energy, and capital, managing ecological relationships, valuing health and culture, and an overall holistic approach to agriculture (Altieri & Rogé, 2009). It also includes making better use of natural resources (land, water, and biodiversity) and technologies. Combining natural, community and human capital, with appropriate technologies and inputs can eradicate harm to the environment. Agroecology utilizes the knowledge and expertise of farmers, thus creating space to solve problems by working together. Fertilizer prices are also higher for smaller farmers buying in small quantities. The cost of transport for a small grower buying a few bags could be R10 extra a bag, but for a big farmer placing a large order the transport cost might only be an extra R1 a bag (Goldblatt, 2010). Furthermore, the cost of transporting the fertilizer could even exceed the base cost of the fertilizer.

Lack of knowledge and information about the costs and benefits of adopting new technologies or conservation practices or lack of knowledge about how to implement such technologies or

practices will also affect a farmer's propensity to adopt them (Chavas *et al.* 2010, Chavas & Kim 2010).

2.6.2 Agroecological and related practices used by smallholder farmers

2.6.2.1 Conservation tillage

Conservation tillage is any method of soil cultivation that leaves the previous year's crop residue (such as corn stalks or wheat stubble) on fields before and after planting the next crop, to reduce soil erosion and runoff (USDA, 2010). The Conservation Technology Information Center (CTIC) defines conservation tillage as any tillage and planting system that leaves at least 30 percent of the soil surface covered by residue after planting (Garcia-Torres *et al.* 2013).

Unlike conventional tillage, such as moldboard plowing that leaves the soil surface bare and loosens soil particles, making them susceptible to the erosive forces of wind and water, conservation tillage practices reduce erosion by protecting the soil surface and allowing water to infiltrate instead of running off (Ewert *et al.* 2015).

Conservation tillage practices are grouped into three types: no-till, ridge-till, and mulch-till, however, no one method is suitable for all soil types. Decisions on which method to use should be based on the severity of the erosion problem, soil type, crop rotation, latitude, available equipment, and management skills. Derpsch (2008) reports that adoption of conservation agriculture by smallholder farmers in South America has been slow compared to that on large and more mechanised farms. Empirical evidence in southern Africa has shown variation in the farmers' adoption rate of Conservation Agriculture (CA) technologies (Mazvimavi *et al.* 2008). Some farmers have adopted the complete package, others only partially while others have completely dis-adopted. Among the farmers who continue to practice CA, many have modified the package and generally adopted some components of the technology while leaving out other recommended practices (Mazvimavi & Twomlow, 2009). In the study conducted in Zimbabwe the empirical results from multinomial logit analysis showed that the choice of CA adopted is positively influenced by farmer's formal education, access to extension services, labour and animal draught power availability and land size (Mavunganidze *et al.* 2013). It was further established that the farmer's decision to adopt components of CA was also conditioned by age (Mavunganidze *et al.*

2013). The area under Conservation Agriculture (ha) in South Africa is estimated to be 377 000 ha (Thiombiano, 2009). Some of the barriers mentioned by Thiombiano (2009) include insufficient enabling policy environment to boost sustainable land management and scale up success stories of projects and community's efforts. A study that was done in the Eastern Cape and KwaZulu-Natal regarding the implementation of Conservation Agriculture (CA) including mulching among smallholder farming results showed appreciation for CA by farmers. Smith (2015) with Grain SA argued that many CA farmers in these areas changed from conventional methods because they were continually experiencing poor production results. Instead of abandoning farming altogether farmers chose to implement the more sustainable farming methods they had learned from the likes of Grain SA, Mahlathini Organics and other organisations (Smith, 2015). Moreover, for successful promotion of CA, it is important that agricultural extension officers and CA farmers share their knowledge in a practical and encouraging way (Rusinamhodzi *et al.* 2011; Smith, 2015).

2.6.2.2 Water harvesting

Water harvesting is the collection of runoff for productive purposes (Rockstrom, *et al.* 2010). Instead of runoff being left to cause erosion, it is harvested and utilized. In the semi-arid drought-prone areas where it is already practiced, water harvesting is a directly productive form of soil and water conservation (Sivanappan, 2006). The benefit of water harvesting is not only to secure and increase crop production in semi-arid regions where rainfall is normally high enough for crop production or to make crop production possible in regions where rainfall is normally not sufficient, but also to stop soil erosion and to recharge aquifers tapped for irrigation (Mirza *et al.* 2013). The harvested runoff can involve different forms of surface runoff (sheet, rill, gully and stream flow) and the storage is either done in various structures like tanks, reservoirs or dams, or directly in soil or sand (Rockstrom, 2003). For smallholder farmers' food insecurity is often linked with water scarcity, poverty and stressed ecosystems (FAO, 2009). Thus, increasing the crop water productivity in smallholder farming is key since the productivity is often low but has the largest potential to be enhanced. An encouraged approach to enhance water productivity in smallholder agriculture is to adopt water harvesting (WH) and conservation technologies such as tied ridges and contour bunds, micro-basins, mulching, runoff harvesting, and other conservation farming

technologies (Rockstrom *et al.* 2004; Zehnder *et al.* 2009). Both yields and reliability of production can be significantly improved with this method.

A study that was conducted in Ethiopia on water harvesting, revealed that farmers who took training on how to use and manage water harvesting were more skilled in selecting sites for Water Harvest Techniques (WHT) and selecting crops based on crop water-requirement than farmers who did not take training (Wakeyo & Gardebroek, 2013). Hence training smallholder farmers regarding the practice of water harvesting increases probability of adoption (Noltze *et al.* 2012).

2.6.2.3 Mulching

Mulching is an old practice in agricultural fields, it is a protective covering, usually of organic matter such as leaves, straw, or peat, placed around plants to prevent the evaporation of moisture, and the growth of weeds (Patil *et al.* 2013). Mulches are either organic or inorganic. Organic mulches are those derived from plant and animal materials (Chalker-Scott, 2007). Those most frequently used include plant residues such as straw, hay, peanut hulls, leaf mold and compost, wood products such as sawdust, wood chips and shavings and animal manures (Grundy *et al.* 2007). Organic mulch properly utilized can perform all the benefits of any mulch except for early season soil warming. However, natural mulch materials are often not available in adequate quantities for commercial operations or must be transported to the place of use (van Dijk *et al.* 2015).

Mulching reduces the deterioration of the soil by preventing the runoff and soil loss, minimizing weed infestation and controlling water evaporation (Bhardwaj *et al.* 2012). Thus, it facilitates the increased retention of soil moisture and helps to control temperature fluctuations, and to improve the physical, chemical and biological properties of soil, as it adds nutrients to it and ultimately enhances the growth and yield of crops (Bhardwaj *et al.* 2012; Muhammad *et al.* 2009). Furthermore, mulching boosts the yield by 50-60 per cent over no mulching under rain-fed conditions (Patil *et al.* 2013).

2.6.2.4 Composting and manure

Compost

Considering the increasing costs of fertilizers together with degrading soils, there is a greater need for the integration of livestock and crop production as another way to improve soil fertility (Hilimire *et al.* 2013). For smallholder farmers, the costs for are even higher because they are getting fertilizers from towns to the villages. Farmers may find it beneficial to use compost and animal manure in substitution of industrial fertilizer. In a study that was conducted in Malawi, compost was found to be an effective means for substituting industrial fertilizer for smallholder farmers (Mustafa-Msukwa *et al.* 2011). Weeds, grasses and any other plant materials, wastes from cleaning grain, cooking and cleaning the house and compound, making food and different drinks, particularly coffee, tea, home dry grass, hay and straw left over from feeding and bedding animals may be used to make a compost (Mustafa-Msukwa *et al.* 2011) . Animal bedding is very useful because it has been mixed with the urine and droppings of the animals.

Animal Manure

The use of cow dung is very popular in smallholder farming as it reduces inputs costs and increases the profits (Ayoola & Makinde 2008). It is argued that the use of animal manure is not only economical beneficial but it is also one of the methods used for sustainable agriculture as these manures provides large amounts of macro and micro nutrients for crop growth and eco-friendly alternative to industrial fertilizer (Amos *et al.* 2015). Industrial fertilizers used in conventional farming are associated with soil degradation, nutrient imbalance and increased soil acidity (Makinde *et al.* 2001). In a study that was done in Nigeria to evaluate the performance of vegetable and maize using cow dung, it was found that the use of cow dung had significant effects on the growth and yield performance of maize (Amos *et al.* 2015). Additionally, dung and droppings from all types of domestic animals, including from horses, mules, donkeys and chicken, from night pens and shelters, or collected from fields (FAO, 2011). Chicken droppings are important to include because they are rich in nitrogen. However, for South African smallholder especially in the rural areas the use of chicken droppings is not popular. A study conducted in KZN established

that many farmers were not accustomed to using chicken manure as fertilizer because most farmers had no experience with chicken manure and so lacked knowledge on the usefulness of this manure and its management (Mkhabela & Materechera, 2003). The same study also showed that the farmers believed that too much chicken manure would ‘burn’ their crops. Another difficulty associated with the application of animal manure is the bad offensive smell from it. Moreover, the insufficient poultry manure limits smallholder farmers from using it as the manure can only be obtained in farm situations where intensive commercial poultry production exists in high proportion (Lanyasunya *et al.* (2006); Mkhabela & Materechera, 2003).

2.6.2.5 Integrated pest management

In agroecological practices farmers manage pests through a variety of means. Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices (Uneke, 2007). IPM programs use existing, comprehensive information on the life cycles of pests and their interaction with the environment (Damos, 2013). This information, in combination with the available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment (Damos, 2013). Preventative strategies including sanitation, rotation, and variety selection are made well in advance to carefully avoid expected pests. Although several natural pesticides are available for organic crops, producers are obligated to use all possible cultural and biological means of pest management first, before applying any pesticides (Isman, 2006).

African smallholders have proved less willing to embrace IPM, in particular, there has been limited success with IPM for staple food crops. The problem lies less with the lack of appropriate extension, training, or technology but with the need for IPM in smallholder farming systems under current conditions. The main production problem facing smallholders is not crop losses from pests but low average yields, reflecting the high cost of the new seed-fertilizer technology and declining soil fertility.

2.7 Productivity in smallholder farming.

Productivity is defined in several ways by different scholars. This study adopts the definition by Serres (2012). Productivity is defined as a “measure of the amount of agricultural output produced for a given amount of inputs, such as an index of multiple outputs divided by an index of multiple inputs e.g., the value of all farm outputs divided by the value of all farm inputs” (Serres, 2012). Additionally, productivity is intimately linked with knowledge, technology, organization, governance skills and needs to be considered in the current frame of globalization, competition and profit maximization. This part of literature discusses productivity in smallholder farming.

Although Smallholder farmers dominate farming in Africa the productivity of their land and labour is often very low, thus their financial return are low and they live in poverty, (Collier & Dercon, 2009). The productivity of smallholder farming is more important especially in rural areas, to eradicate poverty and ensure food security since there are more people who are illiterate and unemployed (Abdu-Raheem & Worth, 2011). Most rural areas in South Africa are not ideal for agriculture due to various reasons which include: climate and weather, soil type, level of education, poor infrastructure, lack of support from government in agriculture, lack of knowledge and sources of water.

The current global food system is dependent upon commercial industrial agriculture, which is environmentally destructive, detrimental to human health, and putting smallholder farmers across the world out of business (Weis, 2007). By trying to produce food cheaply and efficiently, industrial agriculture is destroying the life support systems on which humans depend (Oloko, 2016). The earth can no longer bear the brunt of human-induced environmental damage. It also puts small-scale farmers at an economic disadvantage by forcing them to rely on expensive external inputs. An agroecological approach to food production, in contrast, values diversity. Agroecology integrates scientific knowledge on environmentally sound farming practices with traditional knowledge. It conserves biodiversity while at the same time empowering smallholder farmers to define their own food systems (Wynberg *et al.* 2012). By combining socio-economic and ecological considerations into the design of food systems, agroecology is an approach that allows farmers to meet our food needs without compromising the ability of future generations to meet theirs (Francis *et al.* 2013; Wolfenson & Rome, 2013).

Research shows that agroecological practices can improve productivity in smallholder farming (Milder *et al.* 2016). Whereas the yields of individual crops in agroecological fields are not necessarily higher than those obtained through input-intensive farming, the total agricultural output is larger because farmers rely on a diversified pool of crops and livestock (Milder *et al.* 2016). Therefore, diversified crops could lead to improved market access for smallholder farmers thus improving income and food security for smallholder farmers. The agroecological approaches look at the entire agroecosystem and at the multiple relationships within it, rather than addressing each component separately as with most conventional agricultural research.

2.7.1 Productivity and agroecological practices.

The close relationship between farming and environmental sustainability suggests that due to their relatively minor use of chemicals in farming compared to larger farms, smallholders are considered the guardians of ecological and environmental sustainability at the local level. Smallholder farmers also typically rely on traditional knowledge when predicting the weather (Nyong *et al.* 2007). However, doing so has become increasingly difficult due to climate change as seasons, floods, and storms follow a more irregular pattern and the frequency of water stress, soil erosion, and infestations has increased. Experts at COP17 in Durban, South Africa have recommended the adoption of new ways of farming, such as agroecology as this farming practice encourages farmers to use locally produced seeds, manure and natural ways of controlling pests, as opposed to exotic seeds and chemicals (Kayisi & Tsedu, 2001). Nowadays, the importance of natural factors has been depleted while the dynamic factors like technology and socio-economic factors have come forward. Yet, people have minimal control over the physical environment such as rain, duration and intensity of sunlight, soil quality and timing of water availability. There is, therefore, no single goal that can be set for all situations in terms of highest productivity.

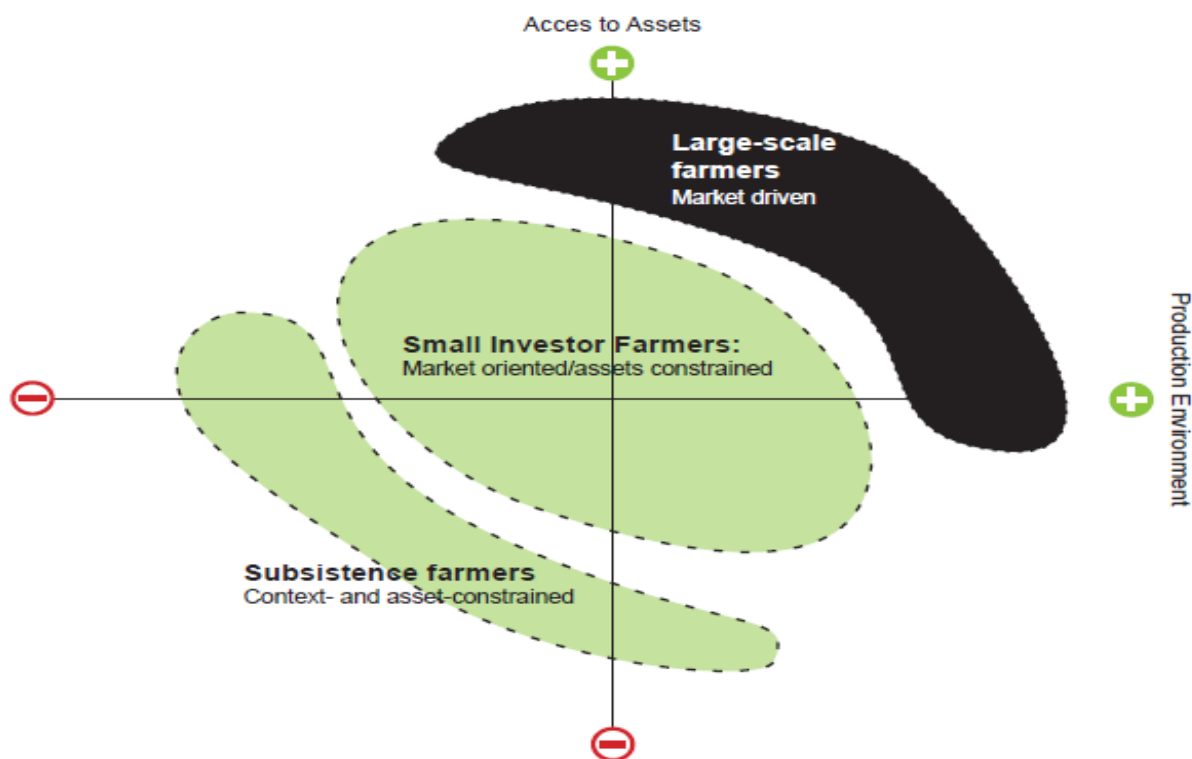
However there has been some ongoing debate as to whether agroecological methods or specifically organic farming can be able to feed the whole world. Research shows that it is often reported that organic yields are low in the first years after conversion and gradually increase over time, owing to improvements in soil fertility and management skills, this was also supported by analysis of

organic performance improvement in studies that lasted for more than two seasons or were conducted on plots that had been organic for at least 3 years (Martin *et al.* 2004).

In another study, a comparison of soil characteristics during a 15-year period found that soil fertility was enhanced in the organic systems, while it decreased considerably in the conventional system. Nitrogen content and organic matter levels in the soil increased markedly in the manure–fertilized organic system and declined in the conventional system (Martin *et al.* 2004). Make the link with smallholder farming’s practices, that agroecology may lead to more yields for farmers thus improving market access, overcoming low volumes.

2.8 Smallholder farmers and markets.

Markets are very important in reducing poverty and improving livelihoods of households. Market participation is important amongst smallholder farmers because their households derive benefits such as income and open opportunities for rural employment which then helps in the development of the economy of the country. At the national level, Lyster (2000) identified that market participation is important both for sustainable agriculture and economic growth and for the alleviation of poverty and inequality. Research shows that agriculture contributes a very high percentage in the growth of the economy of different countries; however, smallholder farmers are still having challenges in accessing the markets (Salami *et al.* 2010). This part of literature explores different factors that contribute towards the inaccessibility of markets by smallholder farmers.



Source: Berdegue, J.A., G. Escobar (2002)

Figure 2.1 Access to assets and production environment by farmers.

Figure 2.1 shows that subsistence farmers are context and asset constrained whereas, small investor farmers are market and asset constrained and large-scale farmers who have largely overcome constraints in the production environment using technology are market driven (Berdegue & Escobar, 2002). In South Africa, less developed rural economies and smallholder farmers find it difficult to participate in commercial markets due to a range of technical and institutional constraints, (Fraser, 2012). Factors such as poor infrastructure, lack of market transport, dearth of market information, insufficient expertise on grades and standards, inability to have contractual agreements and poor organizational support have led to the inefficient use of markets argues (Fraser, 2009). Chitja & Mabaya (2015) have reported that smallholder farmers face countless constraints in production, institutional arrangements and in accessing markets.

In agricultural production and marketing, smallholder farmers are still falling behind in the use of improved technology (Aker, 2011). New techniques are often required to upgrade agricultural

commodities for markets that demands high quality standards (Lee *et al.* 2012). New production techniques are often necessary to increase productivity as well as to ensure that the commodity meets market demands, however smallholder farmers are frequently reluctant to adopt new technologies because of the possible risks and costs involved.

When smallholder farmers are faced with high transaction costs, they will either stop participation in marketing or resort to other means of marketing such as spot markets. The use of spot markets may not be as rewarding to the farmers as formal markets are, mainly due to traders' opportunistic behavior. Opportunistic behavior is whereby the produce by smallholder farmers are bought at a lesser price than the market price because it is known that they desperately need someone to buy their produce (Seabright, 2010).

The smallholder farmers are likely to accept new practices when they can rely on external resources for maternal and technological inputs. The introduction of new technology will not be successful unless it is initiated within a well-managed and structured farming operation. Private agribusiness will usually offer technology more diligently than government agricultural extension service because it has a direct economic benefit in improving farmers' production (FAO, 2001).

Machingura, (2007) pointed out that smallholder farmers lack facilities including road and transport infrastructure, storage infrastructure and have poor telecommunication networks. Lack of such facilities usually constrains the farmers' supply response to any incentives in both agricultural production and marketing. For this reason, institutional development must be accompanied by technological changes to sustain market participation among smallholder farmers.

2.8.1 Potential markets and organic produce for smallholder farmers.

Organic and agroecological production may offer a solution to smallholder agricultural challenges which emanate from increased input costs and inaccessible markets. Organic farming refers to the type of farming that is done without the use synthetic chemicals such as pesticides, fertilizers, fungicides and insecticides or genetically modified seeds (Winter & Davis, 2006). Due to food safety and environmental quality concerns, policy makers worldwide are attaching more importance to the production and consumption of such food products (Forman *et al.* 2012). Thus, the consumption of food produced without the use of chemical fertilizers and pesticides is

encouraged as it could enhance the prevention of some of the health hazards associated with the consumption of conventional foods (Huber *et al.* 2011; Palupi *et al.* 2012; Winter & Davis, 2006).

In South Africa, the indigenous farming systems that were used in the past could be referred as organic farming, although the farmers were unlicensed (Chambers, 2011). These farming methodologies did not utilize any biocides. The production methodology was dependent on the natural resource base. Organic farming methods combine scientific knowledge of ecology and modern technology with traditional farming practices based on naturally occurring biological processes (Wezel *et al.* 2009). Organic farming methods are studied in the field of agroecology. Agroecology is used as opposition to current agriculture practices with claims to stand for agricultural systems that are more beneficial to farmers and society than existing ones. Also, many of the practices promoted under the heading “agroecological farming” are already existing best practices, such as crop rotation or soil fertility management, which can be applied in a variety of contexts and farming systems (Altieri, 2002). Moreover, like organic farming agroecology integrating traditional knowledge with scientific practices, and taking on landscape-level approaches are all key elements in ensuring that agriculture supports food security, sustainability and rural livelihoods (Wezel *et al.* 2009).

With regards to the potential of such produce in the markets especially for smallholder farmers, research shows that the organic movement is gaining momentum in South Africa as seen by the increased availability of natural, organic and free range products in supermarkets (Mhlophe, 2015). Woolworths and Pick 'n Pay are pioneers in this field- responsible for introducing first free range eggs in 1991 and organic broiler meat in 2007. Besides supermarkets, weekend markets also known as farmers' markets are mushrooming in affluent suburbs, especially in Gauteng and the Western Cape (Chikazunga, 2012).

2.8.2 Certification as barrier to market access for smallholder farmers

It is not easy to make a distinction between organic products and conventional products especially at the market. Therefore, there is an inspection which is called certification that is done at the farm to assure consumers that the product is organic. Certification is important in organic farming because it; (i) creates a respectable and credible image for the sector, (ii) serves as an instrument

for development of the local market and, (iii) serves as a tool for assisting organic producers in accessing export markets through equivalence agreements (Rundgren, 2006).

However, for many South African farmers the system of certification remains difficult to attain since there are currently no uniform national organic certification standards or legislation (DAFF, 2011; Thamaga-Chitja & Hendriks, 2008). In addition, the process of certification is very expensive for poor smallholder farmers as the costs were said to vary between R9000 and R15 000 per annum in 2008 (Thamaga-Chitja & Hendriks, 2008). High certification costs act as barriers to new entrants in the sector, wishing to access retail or export markets.

In contrast with agroecology, the practices of certified organic agriculture are codified in a clearly defined and transparent set of standards (Wibbelmann, 2013; Organic Research Center, 2014). This has the advantage that certified organic producers can receive a price premium in the marketplace and be trusted as being part of a body that shares and controls a transparent set of standards. There are however also advantages to avoiding codification: it keeps some options open, protects the breadth of the social movement associated with agroecology, encourages freeform thinking, and avoids attempts to push sustainably produced products into a high-value niche market. Agroecology has considerable resonance with other sustainable agriculture concepts, principles and practices that also offer alternative structures to the mainstream paradigm of industrial agriculture (De Wit & Iles, 2016).

2.8.3 Consumer behavior and agroecologically produced food

Consumer behavior also plays a big role towards acceptance of products produced using agroecological practices by farmers in rural communities. Consumer behavior is defined as the study of psychological, social and physical actions when people buy, use and dispose products, services ideas and practices (Solomon, 2006). Olson & Peter (2008) add that consumer behavior is a dynamic process because of the continuous changes in ideas, perceptions and activities of consumers as an individual or in a group. With regards to consumer behavior and issues of importance when choosing food, Weatherell (2003) argues that people consider the price, convenience, ease of preparation and access to food as major concerns. In addition, people want to consume organic products for better health conditions or maintaining the present situation,

moreover preventing and treating illnesses or food allergies is another health-related attribute, (Zanoli *et al.* 2004).

Production and marketing strategies are determined by consumer beliefs, attitudes, responses to organically grown products and the willingness to pay a premium price. Because organic products are credence goods, consumers may not know whether a product is produced using organic or conventional methods unless they are told so (Giannakas, 2002). Because of that consumer behavior plays a big role in the acceptance of organic food by people.

People's knowledge is affected by the type and quality of information made available to consumers. Advertisements, processing, awareness of certifications and labels, all play a crucial role in knowledge enrichment. Thus, knowledge and awareness are critical in the consumers' behavior towards organic produced food (Yiridoe *et al.* 2005). In addition, demographic characteristics are also important factors for purchasing behavior, which can explain the purchase of organic products. Individual socio-demographics include economic characteristics (i.e. personal or household income) and are commonly included as determinants of choice. If an individual cannot clearly differentiate between organic food and conventional food products, a price premium on the organic food product can confuse and affect the individual's purchasing decision. Consumers' age, education, family size, marital status, and children in household, along with product attributes, affects their attitude and preference to buy the products. Consumers' attitudes, towards the health attributes and towards the environment, are the most important factors that explain consumers' decision-making processes for organic food products (De Magistris & Gracia, 2008)

Inventing a new approach to growing food sustainably and in harmony with nature so that South Africa's farms will be able to provide enough food for future generations without compromising quality or adding to the cost, Woolworths created a brand on similar lines called Farming for the future (Woolworths Holdings Limited, 2015). Farming for the Future is a holistic approach that manages the entire farming process systematically. It is based on building and maintaining the soil, because, farmers require good soil to produce good food (WHL, 2015). Healthy soil is better able to retain water, so it needs less irrigation and water use is reduced (Moe & Rheingans, 2006). It also needs fewer chemical interventions, thus farmers only use synthetic fertilizers or herbicides when needed. This system has ripple effects because if fewer chemicals are used there will likely

be less chemical run-off, which, along with less soil erosion and loss of top soil, helps maintain water quality and biodiversity. Farmers also use integrated pest management principles to reduce reliance on chemical pesticides and herbicides and encourage biodiversity (WHL, 2015). All these practices employed in the Farming for the Future are methods of agroecology.

The first three years' audits from Woolworths involving 15 of the largest fruit and vegetable growers, who were supplying 37% of Woolworths fresh produce and using a total area of about 45 000 hectares, showed remarkable results (WHL, 2015). The results showed a 20% reduction in the use of synthetic fertilizers; a 34% increase in compost use per kg produce produced; a 3% increase in soil carbon; and water was reduced by 720.9 million m³. Although the country had optimal rains, some of this reduction – which represents a 16% drop in water usage – was a result of optimizing irrigation, cultivating practices, introducing compost and upgrading old systems (WHL, 2015). Sustainable pest management techniques, such as integrated pest management, has resulted in a substantial initial decrease – in the region of 50% – in the usage of pesticides and herbicides, as well as an increase in biodiversity. There was also an 18% reduction in fossil fuel use; a 32% increase in recycling and a 13% decrease in solid waste material going to landfills. This steered to healthier soil and resulted to less chemical run-off into the freshwater systems (IFAMA, 2014). Farming for the Future enables Woolworths to offer their customers quality produce that has been grown sustainably, at an affordable price. This is strategically important in that it differentiates Woolworths as a brand at a time when consumers are looking for responsibly and ethically sourced products and greater transparency from retailers (IFAMA, 2014). Moreover, such initiative helps in enhancing the food security of the customers, current and future. The initiative also advocates for the likelihood of the customers to accept agroecologically produced foods.

2.9 Summary

This chapter discussed different farming systems used by smallholder farmers. Three production systems were discussed, that is irrigated, rain-fed and mixed farming. The factors that determines which farming system to use and linkages between the farming systems were discussed. Furthermore, a description of agroecology and the reasons why some farmers chooses to practice

it in their farms over conventional farming were discussed. Its benefits, which are its being environmentally, economically and socially advantageous were also shown to contribute to it being a preferred smallholder farming method. Moreover, where it has been employed it played a huge role in enhancing food security.

Furthermore, the literature looked at market access and the challenges which smallholder farmers encounter to access markets. Market access was also explored with regards to produce from agroecology. It was argued that farmers who practice agroecology can access markets as practices and approaches of farming through agroecology are gaining acceptance by consumers as they are environmentally friendly and good for health. Another notable factor which was discussed in literature was the need for training in smallholder farming as one factor which can help with acceptance of new technologies including agroecology.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The research was aimed at exploring the farming systems used by smallholder farmers and the application of agroecological methods in improving food security. The research was conducted in the Swayimane area, KwaZulu-Natal, South Africa (29°25'S; 30°34'E). Key informants including tribal authority were interviewed prior to the main study to gather information on the community and the livelihoods. The authority to the community was given by the Gcumisa Tribal Authority. The study was given ethical approval by the University of KwaZulu-Natal (HSS/0350/015M). Participatory Rural Appraisal (PRA) tools were used to conduct the study. Groups of farmers were chosen from those who are practicing agroecology and those practicing conventional farming. This was done to get an insight as to whether the farming systems used by conventional farmers and those used by the farmers that practice agroecology as smallholder farmers were the same and to what extent were they different. The differences were explored in relation to productivity, market access and food security status. This chapter outlines the research design, the data sampling techniques and the sample size. Data collection procedures adopted in the study are presented as well as the methods used to analyze the data.

3.2 Description of the study area

The study was conducted in Swayimane under uMshwathi Local Municipality which is located within the uMgungundlovu District Municipal area. It is to the north of Msunduzi Municipality (Pietermaritzburg/ Capital City of KwaZulu Natal).

3.2.1 Wards and Traditional Authorities

Within the boundaries of UMshwathi municipality, there are eight traditional lands falling under the following traditional Authorities: Madlala H.D; Gwamanda B.G; Zondi M (deceased); Ngubane T.D (deceased); Ndlovu M.M; Ntanzu B; Mthuli M.Z and Gcumisa N.P. There are certain parts of the land that falls under the Ingonyama Trust Board (ITB) and some parts unquantifiable

state land. The sample for this research was purposively selected from under the Gcumisa traditional authority.

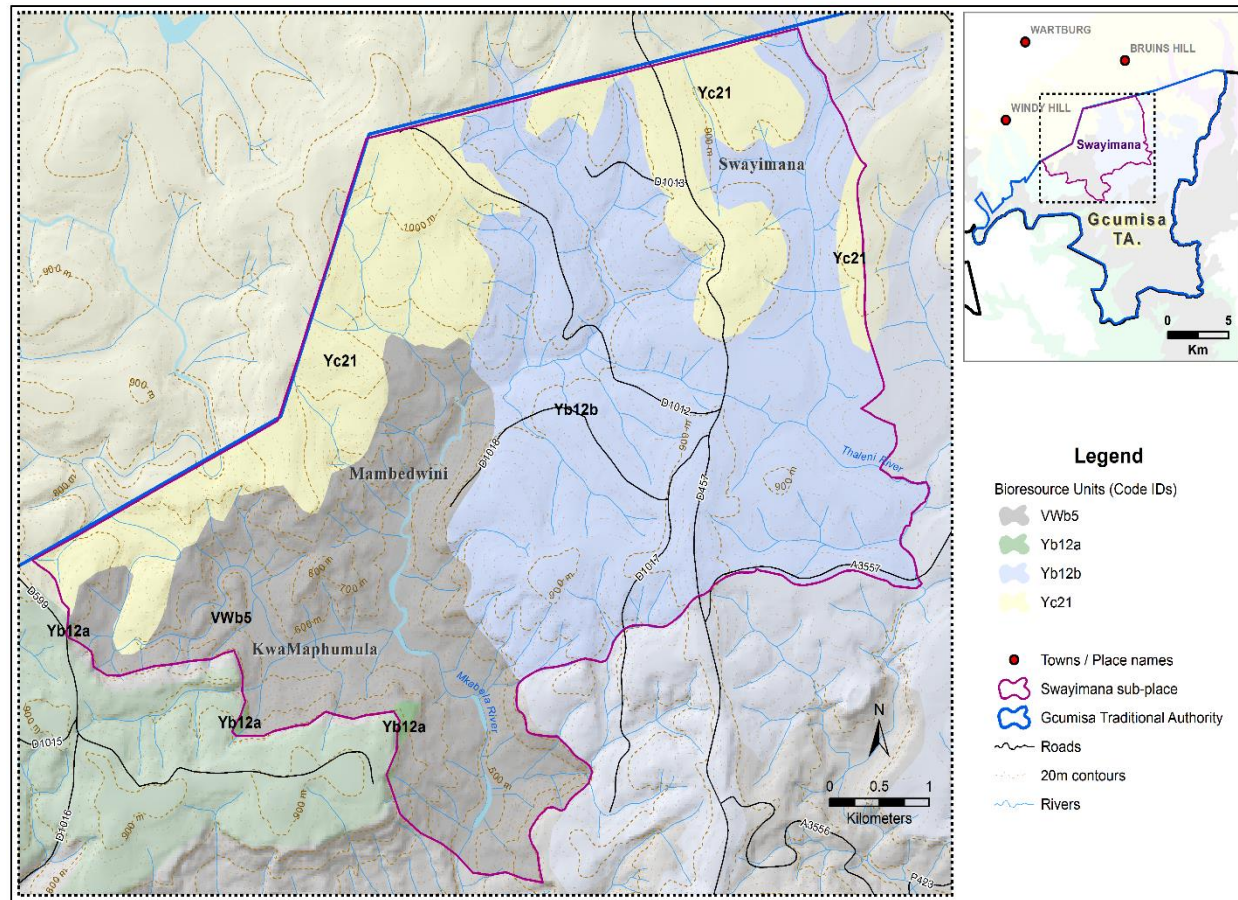


Figure 3. 1: Map of Swayimana area

3.2.2 Socio economic profile of the area

Statistics South Africa (2011), shows that the Municipality has 106 374 people living in approximately 23 732 households. Of the total population, approximately 33% are 14 years or younger and 62% of the population is between 15 and 65 years and the remaining 5% of the population are over 65 years which means a large percentage of the population is within the working age (Stats SA, 2011). However, that is not the case as the level of unemployment in the municipality is very high with a percentage of 24, 9% (Stats SA, 2011). In terms of gender, 53% of the population is female and the remaining 47% is male. There is a high level of poverty in the traditional rural areas. The traditional areas are characterized by small-scale and subsistence

farming, informal trade and dispersed settlements with scattered pilot projects of co-operative sugarcane farming (Stats SA, 2011).

Umshwati Municipality displays a high level of agricultural potential, of interest is the high to relatively good land potential in the Ntanzi, Mthuli and Gcumisa tribal areas. Swayimane is considered as a semi-arid area with an annual rainfall of 730 mm (September, 2015). The most commonly produced crop in the area is sugarcane with less maize, potatoes, beans and leafy vegetables.

3.3 The research design

For this research, a mixed method approach was employed which is a combination of qualitative and quantitative methods. The mixed research method approach was suitable because of the complexity of the study as it included a variety of data (Driscoll *et al.* 2007). However, research shows that the analytic process of combining qualitative and survey data and by quantitative data can be time consuming especially when working with a bigger sample (Driscoll *et al.* 2007). Furthermore, mixed research methods were used to ensure the reliability of the research (Eysenck, 2004). A survey was used because there is no active intervention on the part of the investigator that may produce researcher bias (Kothar, 2004). In addition, survey design may be utilised to study characteristics in a population to investigate probable solutions of a research problem. It is impartial; there is no bias in the selection of units participating in the research (Kothar, 2004). For the current study impartiality in choosing the participants was important to generate the different farming systems employed in the community by smallholder farmers for success of the study. However, the person who responds to a survey is aware of being studied and can be responsible for biased data.

3.4 Sampling technique and sample size

A sample of 80 smallholder farmers were purposively selected for the study. Purposive sampling produces a sample where the included groups are selected per specific characteristics that are important as related to the specific study objectives (Teddlie & Yu, 2007). Purposive sampling

may be used where simple random sampling may not yield a desired sample, for example in a case where a researcher is targeting a group of people in a community (Burton, 2000). The characteristic which is of importance in this study was whether the farmer practiced agroecology or conventional farming. Zimele, a non-profit organization which focuses on projects which aims to empower women in impoverished areas including small holder farmers in such areas. The organization worked with 300 farmers around the Swayimane area, however, only some of these farmers had received training on agroecological principles, as some were focused on different methods of farming. The other farmers were involved in animal production while others focused on crop production. The number of farmers trained in agroecological principles was small as it was only limited to those farmers who were involved in crop production. Hence 80 farmers were chosen, 40 were from the group that practiced conventional farming and another group was farmers that practiced some methods of agroecology. This was done to make a comparison as to the production systems used by the two groups of farmers. Other reasons were to identify whether the production systems employed by farmers in the two groups were sufficient in terms of enhancing food security productivity.

Farmers that practice agroecology were members of the Zimele. These farmers were chosen because they have received training on applying methods of agroecology when they farm. A comparison between them and conventional farmers in smallholder farming, within the same geographical area of Swayimane was made. For the purposes of the research purposive sampling was employed to obtain the objectives of the research more specifically the one which deals with the practice of agroecology among smallholder farmers in the study area. Observation was employed to observe the farming practices to strengthen the research reliability. The questionnaire was written in English, a face to face technique was employed to ensure that participants understood the questions and to ensure no question was left unanswered.

3.5 Data collection

Primary data was collected using structured questionnaires and key informant interviews. During the collection of data farmers were asked to respond to a questionnaire which contained both open ended and closed ended questions. The questionnaire was translated to local language to improve

the understanding between the enumerators and participants. Focus group discussions (FGD) were also conducted to generate detailed information on the topic at hand as recommended by Shandasen & Rook (2007). Transect walk was done to explore and observed farming systems of the study area.



Figure 3.2 Enumerator interviewing a farmer

For this research focus group discussions were conducted prior to the survey. This was done to facilitate the questionnaire design. Conducting focus group discussions is said to be applied to anticipate non-response or refusal problems in hard to reach populations and to explore ways to

minimise these potential sources of sampling bias, (Wolff 1993). Also with the current research most rural farmers are illiterate, the concepts used in agroecology may be difficult to understand. There was then a need to begin with focus groups discussions to minimise non-response and avoid prompting the respondents to particular answers during quantitative data collection.

Focus groups are conducted with a group size of 8-12 participants for a period between 60-90 minutes. However, with the current research participants were more than the required numbers. There were 15 and 18 participants for the first and second groups respectively. This was because the focus group discussions were conducted during the farmers' regular meetings as members of the cooperative. It then became a challenge for the researcher to exclude others from the discussions. However, farmers were made aware that the focus group discussions only required 12 participants or less, those who wanted to be excused were allowed to do so which no one did.

3.6 Data processing and analysis

Data from questionnaires was coded and captured using the SPSS version 21. Different statistical analysis including frequencies, means, cross tabulations were used to analyze data. Table 3.1 shows the specific objectives and the corresponding analytical method that were used. The type of data that was collected to answer the objectives is also shown in Table 3.1.

Table 3.1 Data collection and analysis for each sub-problem

Sub problem	Tool of data collected	Data to be collected	Method of analysis
Exploring the practices used by smallholder and subsistence to maintain productivity and factors associated with the choice and intensity of these practices?	Survey and transect walk to complement each other	Level and number of agricultural practices in which the farmers use.	Summary and frequency
	Key informant	Farming practices applied by the community, their strengths and linkages	
Can the application of agro ecological practices or concepts impact on productivity and sustainability?	Survey Transect walk	Farmers knowledge of agroecology	Theme analysis
	Ranking	The impact of agroecology as opposed to the conventional farming.	Comparative analysis
Is there a potential market for agroecological produce?	Survey Key informant	The farmers' current market situations. Analysis of favorable and unfavorable factors in the markets	SWOT analysis

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

The purpose of the study was to explore the farming production systems used by farmers in Swayimane area to enhance food security. Furthermore, the study was aimed at investigating whether smallholder farmers in the area were aware of agroecological methods which can be applied in smallholder farming which are both environmentally friendly and economically viable. This was to be done by examining two of the many aspects which play a big role in achieving food security of smallholder farmers. The two aspect which are also complementary were productivity and market access of the existing farming systems. To respond to the main research problem, the study was narrowed into three objectives that were as follows:

- (i) What are the practices used by smallholder and subsistence farmers to maintain productivity and challenges associated with the choice and intensity of these practices?
- (ii) Can the application of agroecological practices or concepts impact on productivity and sustainability?
- (iii) Is there a potential market for agroecologically produced crops?

The results and discussions are presented per the objectives of the research. However, the section begins with presenting the characteristics of the participants that have a bearing on the results presented.

4.2 Demographics and socio economic considerations

4.2.1 Gender

The results showed that there were more women compared to men in the study area (Table 4.1). These results show distribution which was expected as it is established that most primary producers are women especially in smallholder farming (FAO, 2011). However most rural women in developing countries live in areas governed by traditional authorities where women are treated as secondary citizens (Toulmin, 2009). In such places, culture allows women and men to do certain

jobs in the household and farm (Ambuda & Klerk, 2008). Men are expected to work to earn money, hence when they engage in agriculture, it is not done with the goal of addressing food insecurity within the household, but as one way in which they are generating income for themselves. Men are also in agriculture because of the incentives that are derived from practicing, in parts of Africa, there is evidence that as gardens become more profitable, men intervene to take over the management and marketing functions.

Table 4.1: Respondents Demographic data

Characteristics	Frequency	Percentage (n=80)
Sex		
<i>Male</i>	29	36.3
<i>Female</i>	51	63.7
Age		
<35	10	12.6
36-45	23	28.8
46-60	29	36.3
>60	18	22.6
Marital status		
<i>Single</i>	26	32.5
<i>Married</i>	33	41.2
<i>Divorced</i>	1	1.3
<i>Widow/widower</i>	20	25.0
Education		
<i>No formal education</i>	6	7.5
<i>Primary</i>	22	27.5
<i>Secondary</i>	51	63.7
<i>Tertiary education</i>	1	1.3
Employment status		
<i>Full time</i>	8	10
<i>Part time</i>	9	11.3
<i>Unemployed</i>	37	46.3
<i>Pensioner</i>	26	32.5
Average income		
<i>Below R800 (ZA)</i>	26	32.5
<i>R801- R 1500 (ZA)</i>	39	48.8
<i>R1501- R3500 (ZA)</i>	8	10
<i>Above R3500 (ZA)</i>	7	8.7

4.2.2 Age of the farmers

Age group of sampled farmers was categorized into four groups; age range from 18-35; 36-45; 46-60; and greater than 60 years. Most farmers fell in the age range of 46-60 by 36% followed by 28% of farmers who fell in the age range between 36 and 45 (Table 4.1). About 22% of farmers were 60 years and older. The statistics show that smallholder farming in the Swayimane area is generally practiced by older people, with only about 10 % of farmers who fell in the age range between 18 and 35 and this could be because of most of the youths may be employed in the formal sector and other informal sectors as most of them view agriculture as for older people.

4.2.3 Marital status

In an African setting marriage plays a big role with regards to decision making. Household head which is the male is the one who makes the decisions. Also with the current study the marriage factor was investigated because the study anticipated to investigate the reasons behind choosing a certain farming system. Results shows that about 42% of the participants belonged to the married category. Nadasen (2012) reported that in most cases the women residing in male headed households are implementers of the household heads plans. When the farmers were asked, who makes decisions related to farming, farmers pointed out that it depended on the nature of the decision. Decisions regarding acquiring land and leasing it are made by the male. But decisions which included the type of crops to be planted were made by women and sometimes they had to consults with the male.

4.2.4 Education of the farmers

The level of education of a farmer does not only increases his farm productivity but also enhances his ability to understand and evaluate new production techniques (Pannell *et al.* 2006). Results shows that a large percentage of the farmers fall within secondary education with 63.7%. Tertiary education, on the other hand, was very low with only one farmer who attained it. However, having secondary level education is an advantage to the farmers as there is a chance to improve the capacity of performance in the agricultural operations as most farmers are able to read and write. It was also observed that farmers preferred the study to be conducted in isiZulu which was their

mother tongue. This poses a disadvantage to smallholder farmers as formal business transactions are generally negotiated in English. Furthermore, it is expected that education would aid the farmers to interpret instructions on the use of agrochemicals, adopt modern agricultural technologies and take wise decisions on farming operations (Davis *et al.* 2012).

4.2.5 Land size distribution of the farmers

Demographics regarding land distribution shows that farmers have small landholdings for farming. As shown in Table 4.1, most farmers own land which is between 1 hectare and less than 2.5 hectares. Only 15% of the farmers have land which is greater than 2.5 hectares. This shows that farming was limited by the availability of land. In addition, the diversity of crops grown by the Swayimane farmers is negatively affected by size of their land. Furthermore, the process involved in acquiring land from the traditional authorities is not easy especially for women. In South Africa, the main property rights system in rural areas where smallholder farmers are located is the communal land rights which has no individual title and thus cannot be used as collateral in formal financial institutions (Thamanga-Chitja *et al.* 2010).

4.2.6 Employment and income of the farmers

Results show that about 46% of the farmers were unemployed with 49% of them earning an income between R800 and R1500 per month. These results in Table 4.1 shows high level of unemployment amongst farmers.

4.3 Typologies of Production Systems

Results with regards to the production systems used show that farmers in Swayimane practiced three kinds of farming. The three types were conventional farming, mixed conventional with organic farming and farms which practiced some agroecological concepts. Both the Zimele trained farmers and those who were not trained in terms of agroecology farmers used relatively similar ways of farming in the area. Also with regards to the crops produced and the seasons in which those crops are produced it showed similar results amongst all farmers interviewed. Farmers in the

area were practicing the “normal way of farming” which they use chemical fertilizers to grow their crops. Farmers sometimes practice some methods of agroecology. They argued that before there were no chemical fertilizers and that these methods were the ones that were used. This showed that they were aware that methods of agroecology including organic farming are not a relatively new concept in South Africa as these methods were also applied by their forefathers. As much as they were aware of some of the agroecological methods of farming and practiced some of these methods, a large portion of their farms was grown using chemical fertilizers and only a small portion was used for practices like organic farming. They are still somewhat reluctant to using them because of the “perceived” difficulties that comes with the agro-ecological methods.

4.3.1 Conventional farming

The conventional farming system was the dominant system in the study. All farmers were practicing this method of farming including those who were trained with agroecologically based farming principles. Farmers referred to this method as a “normal way of farming”. This showed that farmers have relied more on modern ways of farming over traditional methods of farming. Historically smallholder farmers relied more on the environment to improve their productivity by using agroecological based production (Kremen & Bacon, 2012). However, it was observed that this method of farming had constraints which could be addressed if farmers had used traditional farming principles. Constraints including expensive fertilizer and seeds which were reported by participants could have been addressed by farmers. Research shows that fertilizers are applied in order to supply the plants with nutrients like nitrogen, phosphorous, calcium, and potassium which helps with proper growth. But if the soil lacks these elements the plant cannot function properly and produce the food necessary. Hence farmers relied on fertilizers to produce food. However, if farmers relied on organic fertilizers financial constraints would be limited. Moreover chemical fertilizers can harm the environment if not used correctly (Godfray *et al.* 2010; Cornish, 2010). There is a need for farmers to send a soil sample to a laboratory for baseline testing. By testing their soil, farmers would know which nutrient and how much to apply to the soil. If too little is added, crops will not produce as much as they should. If too much is added, or at the wrong time, excess nutrients will run off the fields and pollute streams and groundwater (Cornish, 2010). However, to a certain extent the educational level of the farmers may be a limiting factor regarding

the correct application of fertilizers in the farms. There is thus a need to train farmers on the traditional farming ways so to address some constraints brought about modern ways of farming in the area.

4.3.2 Mixed conventional and organic farming

On the other hand, it cannot be said that indigenous knowledge of farming is completely not used in the area. Most farmers revealed that they are mixing the conventional farming with some approaches of agroecology. Mixing included using organic fertilizers in their farms to grow crops. Farmers said they sometimes use cow dung instead of chemical fertilizers. Cow manure was mixed with soil and applied as fertilizer. They collected this from the cow kraal and they selected the one which has stayed for quite some time. Farmers argued that fresh cow manure was not good for the crops because it can be too strong and can destroy the crops. Fresh cow manure can contain dangerous bacteria, such as *E. coli*, which are destroyed during the composting process and the ammonia in fresh manure can cause strange growth patterns and "burn" delicate plant roots (Phipps, 2014). They added that they collected dry cow dung in the veld and used it for controlling the moles (imvukuzane) in their farms. The dry dung was collected, burnt and while still burning, put it in the hole of mole. It is believed that this chases the moles away. Results in the Table 4.2 shows the response of the farmers when they were asked about pesticides and fertilizers effect on the environment. Generally, farmers seem to believe that these factors do not harm the environment. However, this is very contradictory as they are of the opinion that food produced using fertilizers is not as healthy as the one produced using organic methods (refer to Table 4.3).

4.3.3 Agro-ecological farming

4.3.3.1 Agro-ecological practices used by farmers.

Results showed that agroecology is relatively not understood by farmers in the Swayimane area. Farmers who practiced agroecology were mostly those who were members of the Zimele organization. Farming and crop production is highly technical, it requires one to be equipped and empowered for a farmer to make a living from it (Noltze, 2012). Because farmers from Swayimane were not equipped to use agroecological methods results showed that they had some negative

perceptions towards the application of some of the methods. Below are some of the agroecological practices which were used by farmers in the study. This part of the results continues to show some of the perceptions that farmers held with regards to applying some of the agroecological methods in their farms.

Organic farming

Participants were said that they practised agriculture to generate income, it was not only for the benefit of the household (Rao & Qaim, 2011). If farmers adopted the organic farming completely there was going to be less yield. When farmers grow for instance their cabbages using organic farming they come out in small sizes which are hard to sell to people as people prefer bigger sizes of cabbages. Farmers did not understand that organic management methods can maintain and improve the structure of the soil in long term and demonstrate a clear on-site sustainability advantage over the conventional systems (Ghorbani, 2008).

Research shows that when growing cabbages organically the soil must have a lot of organic matter because growing cabbages withdraw a lot of nitrogen from the soil (Masley, 2009). So, the farmers need to build organic fertilizers into the soil when they plant. It has also been reported that organic yields are low in the first years after conversion and gradually increase over time, owing to improvements in soil fertility and management skills (Masley, 2009). This was also supported by analysis of organic performance improvement in studies that lasted for more than two seasons or were conducted on plots that had been organic for at least 3 years (Martin *et al.* 2004). In *this* study of Swayimane, the smaller yields and sizes of produce could be a result of the farmers being within the first three years of conversion. The concept was introduced to the farmers in 2014 thus, it is possible that soil organic matter, insect diversity and farmer experience were not yet fully developed. Studies comparing organic and conventional cropping systems have found that yields of crops in full organic production may be somewhat lower than that of conventional production by approximately 5-10%. They add that organic crop yields were much higher than conventional during drought years. This could be due to several factors of concern with organic farming including crop variety, weather conditions, production methods, and grower expertise (Jacobsen, 2011).

However, farmers understood that the food produced organically is healthier. They allocated a small portion which was for their households' consumption only. This is supported by Zanolli *et al.* (2004) who shows that people prefer consuming organic products for better health conditions or maintaining the present situation. They add that preventing and treating illnesses or food allergies is another health related attribute. Farmers also argued that crops produced in the organic way takes longer periods compared to using chemical fertilizers to grow.

Pest management

Farmers says there is a plant called *umsuzwane* (*Lippia javanica*) which is used as pest controller. Accessing this plant is not difficult for farmers as it grows in open veld. The use of this plant as pest control is indeed correct as the study conducted in Kenya showed that *L. javanica* was reported to have pesticidal effects on aphids, ticks, antestia bugs and red spider mites on rape. In addition, this plant also contains toxic substances against many microbes and insect pests (Mwanauta and Mtei, 2014). The farmers also used other methods including the use of products that can be found within the household, those included dishwashing liquid, garlic, water and oil (all mixed). Farmers argue that using these kinds of pest management products is far cheaper than buying the chemical products.

Mulching

Farmers had knowledge about mulching, they made use of the leaves from the trees in their yards and covered the soil surface to retain soil moisture. When grass was cut in the yard they no longer waited for it to dry so that it will be burnt, but was taken to cover the soil surface of where they grow their crops. Mulches are used as a soil covering, for a variety of reasons, including weed prevention and control, heat trapping and moisture preservation (Campbell, 2012). However, for farmers in the study the main reason they were using the mulches was for preventing evaporation. The use of mulching was not only beneficial for crops but also helps in keeping their homes clean. They acknowledged that methods of agroecology like mulching were very helpful as they helped the soil to retain moisture which is good to grow plants especially during dry seasons. The use of such agroecological methods affirmed what Alteri (2002) argued that farmers in used some methods of different farming systems in order to cope with extreme weather events and

climatic variability as these farmers live in harsh environments in the regions of Africa (Alteri & Koohafkan, 2008). Moreover, the practice of these methods showed that smallholder farmers consider yields, economic, social and environmental factors when evaluating the benefits of different farming systems.

Table 4.2. Understanding of agroecology among farmers

Question	Theme	Quotes
What is your understanding of agroecology?	Quality	<i>"Food produced does not have chemicals"</i>
	Indigenous Knowledge	<i>"These methods were applied in the old days by our parents and they used to provide good yields."</i>
		<i>Crops takes long period to grow</i>
What is the difference between crops produced using methods of agroecology and crops produced conventionally?	Quantity	<i>"Crops produced without chemical fertilizers sometimes don't grow, if they do they are in less yield"</i>
		<i>"Crops produced organically are healthy".</i>
		<i>Food produced in the backyard is healthier than food bought in supermarkets.</i>
What are the benefits of practicing agroecology in enhancing food security?	Economic viable	<i>"We spend less money spent on fertilizers and pesticides because we only buy for the bigger plots but for small plots on the back yard we use organic farming".</i>
	Environmentally Friendly	<i>"Less harmful to the soil and water"</i>
		<i>Animals drinking water in the rivers are not exposed to chemicals fertilizer and pesticides usage.</i>

4.3.3.2 The extent of the knowledge of agroecology.

Table 4.2 summaries the most important findings from the focus group discussions in relation to the farmers understanding of agroecology. The response from farmers show that farmers understand that agroecology is not a relatively new concept in farming as the methods were used in the olden days. The farmers also understand that using agroecology in their farming system can save them money. This similar to what was reported by Tirado (2009) who found that the use of

organic fertilizers, generally cheap and locally available, makes ecological farming more secure and less vulnerable to external inputs' accessibility and price fluctuation. Farmers argued that when agroecology was practiced in the olden days it used to produce good yields. However, in the modern days it is hard to practice such methods as yields that results are not as good of compared to yields of crops produced using conventional methods of farming.

4.3.3.3 Perceptions of agroecology

The respondents, were presented with 7 factors which have a bearing on the practice of agroecology on their farms. These factors are in Table 4.3, respondents were asked to rate the given factors using a Pearson scale. As presented in the table the factors include food prices, grower profits, taste of food, healthiness of food, quality of food, public's health and water quality. Results shows that respondents agree that taste, quality and healthiness of food would increase very much as all range from 60 % and above. However, with regards to profits, respondents argue it would be reduced. These statistics are supporting the arguments which they made during focus groups discussions.

Table 4.3. Perceived effect of practicing agroecology by farmers (n=80)

If agroecology is practiced, how will the following factors be affected	Increases Very much (%)	Increases Small (%)	No Difference (%)	Reduces Small (%)	Reduces Very much (%)
Food price	53.8	22.5	10	7.5	6.3
Grower profits	23.8	22.5	10	22.5	21.3
The taste of food	63.7	21.3	3.8	7.5	3.8
Healthiness of food	68.8	20	2.5	6.3	2.5
Quality of products	63.7	18.8	2.5	7.5	7.5
Public's Health	68.8	22.5	7.5	1.3	0
Water quality	61.3	15	22.5	1.3	0

Farmers growing crops for their family consumption were more likely (5.745) to practice agroecology compared to those who produce for market. The odd ratios showed that reason to grow crops ($P>0.05$) and gender were strongest predictors for farmers practising agroecology or not. Zimele affiliated farmers were likely to practice agroecology as compared to the other farmers.

Table 4.4: odds ratio for farmers practising agroecology (n=80)

Predictor	Odds Ratio	L	U	significance
Respondent affiliation (Zimele vs Non Zimele)	0.868	0.164	4.585	NS
Gender (Female vs Male)	0.964	0.315	2.952	NS
Age (< 45 vs > 45)	0.413	0.096	1.777	NS
Marital Status (Married vs Single)	0.805	0.272	2.381	NS
Education (< grade 7 vs > grade 7)	0.194	0.043	0.887	*
Employment Status (employed vs unemployed)	0.814	0.228	2.899	NS
Household Income (above 800 vs less 800)	0.154	0.046	0.517	*
Land (more than hectare vs less than hectare)	0.37	0.069	1.987	NS
Grow to sell (yes vs no)	5.745	1.263	26.122	*

4.4 Production systems and challenges

4.4.1 Water shortage

Shortage of water was the main factor which restricted farmers in the area to plant more than what they currently planted. South Africa has been experiencing and still is experiencing shortages of water. The sector which is mostly affected is farming since water is one element which makes farming possible. The farmers in Swayimane were not exempted from of water shortage. Under

normal circumstances the farmers said they irrigated their gardens at least three times a week. They used about 3x25L of water per day, which amounted to about 225L of water for irrigation per week. However, this method was labor intensive since farmers had to go fetch water in the river as some did not have tap water at their households.



Figure 4.1 Small plot for cabbages and spinach

Table 4.1 shows that most farmers 58.9% were old, thus fetching water from the river could be a challenge. Figure 4.1 shows a big container by the plot where the water was kept after fetching it from the river. The farmers argued that because this irrigation system was labor intensive, they chose not to produce many crops like cabbage and spinach that require frequent irrigation. If they produced them, they were not for selling but for household consumption. Figure 4.1 shows how small the plot was for such crops. However, this is a disadvantage for small farmers since such crops are in demand in the market. For South Africa, staple food crops and farming activities familiar to the farmers such as maize, vegetables and fruits are seen widely as the most promising products for agribusiness ventures in rural areas (Mkhabela, 2007).

A large part of the land used for farming was used to grow maize compared to other crops. The planting season of maize was said to be between September and December since it is a rainy season. Participants argued that they would like to grow maize even in winter season like commercial farmers since there is less competition in the market. However, for them that is impossible since they depended largely on rain to grow it and maize requires a lot of water in order to grow. A yield of 3 152 kg/ha requires between 350 and 450 mm of rain per annum. At maturity, each plant will have used 250 l of water in the absence of moisture stress. South Africa does not yet have a structured system of dealing with food security disasters, such as droughts or floods (FAO, 2006). These disasters, which occur at regular intervals, can substantially threaten the food security position of agriculture-based households (FAO, 2006). Because water availability during the growing season is the single most important factor in maize production in South Africa, it is essential that soil tillage be aimed at optimising infiltration and minimising evaporation. It can produce from 80 to 100 tons/ha green material and 16 to 21 tons/ha of dry material within a relatively short period (100 to 120 days). It is therefore one of the most efficient grain crops in terms of water utilisation. Maize is usually produced under full irrigation to obtain the highest yields. The study attempted to find out how the farmers dealt with problem of water shortage which was facing the country.

4.4.2 Water management

Water shortage was one of many challenges in reducing food security and malnutrition (Wenhold *et al.* 2007). This was also observed in the present study area (see Figure 4.2) which shows a plot of maize which is supposed to have been ploughed but due to shortages of water, the recommended time had already passed. However despite the high levels of water shortages results revealed lack of knowledge regarding water management practices amongst participating farmers. These findings indicate the need for water management practices for farmers to start acknowledging and value practices available to them. Furthermore, it supports the finding that instead of isolating agriculture as a production system, it should be viewed it as an integrated multiple-use ecosystem. Table 4.5 below shows the results for different water management techniques that can be applied in smallholder farming and the extent of their application by the respondents.



Figure 4.2 plot used to grow maize

Table 4.5: Knowledge extent of water management techniques (n=80)

Water Management Practice	Knowledge of practice, but do not use	Water management practice used on the farm	Wants to know more about the practice
Bunds	22.5%	2.5%	75%
Mulching with straw or leaves	36.3%	35%	28.7%
Mulching with plastic	33.8%	6.3%	60%
Swales	33.8%	17.5%	48.8%
Contour planting	31.3%	61.3%	7.5%
Collecting Used Household (Grey) Water	51.2%	45%	3.8%
Collecting Roof Water	22.5%	77.5%	0.0%

Results showed lack of knowledge regarding different practices which can be applied to cope with water shortages. Out of all practices presented to the participants, the farmers only used two practices on their farms. Those were contour planting and collecting roof water. However, for farmers to only be practicing collecting roof water and neglecting other water management practices was a disadvantage since the practice depends on rainfall. When farmers were asked why they were not collecting used household (Grey) water since they were aware of it, they argued that water from bathing cannot be good for growing food since it is dirty and food was for consumption. In the box below were some of the responses which farmers gave to the question as to why they were not using grey water for irrigation although they were aware of it. However, it was noted that farmers who were members of the Zimele organization although it was not all of them were aware that while grey water may look “dirty,” it was a safe and even beneficial source of irrigation water

Box 1

Responses given by farmers as to why they do not use grey water for irrigation

- *Surely one cannot use water that they were using to bath to bath to water crops which are for consumption, it's unhygienic!*
- *Water used has soap, so it can have a negative effect on the crops.*
- *When I wash dishes I prefer using water for rinsing the dishes than the one with soap to water crops.*

4.4.3 Coping Strategies regarding shortages of Water

The coping strategies according to these results represents the change of farming practices which farmers applied as results of rain and water as their main input to growing crops. These cropping strategies are presented in the figure below. Figure 4.3 shows that most farmers did not change their farming methods due to water shortage. About 29% said that they stopped producing certain crops especially those that require irrigation to mature at the early stages of growth. They did this

because they were afraid of crop failure and loss. However, 16% of the farmers said that they were waiting for the rain before planting their crops. Data was collected in early December which is the period in which farmers are actively involved in farming, but due to water shortages because of rain it was clear that farmers had not yet began preparing to plant. This was examined through transect walks. About 4 % of the farmers believed that the possible benefits of mixed cropping were to balance input and outgo of soil nutrients, to keep down weeds and insect pests, to resist climate extremes (wet, dry, hot, cold), to suppress plant diseases, to increase overall productivity and to use scarce resources to the fullest degree. The most common mixed crops identified was maize and beans, and maize with pumpkins.

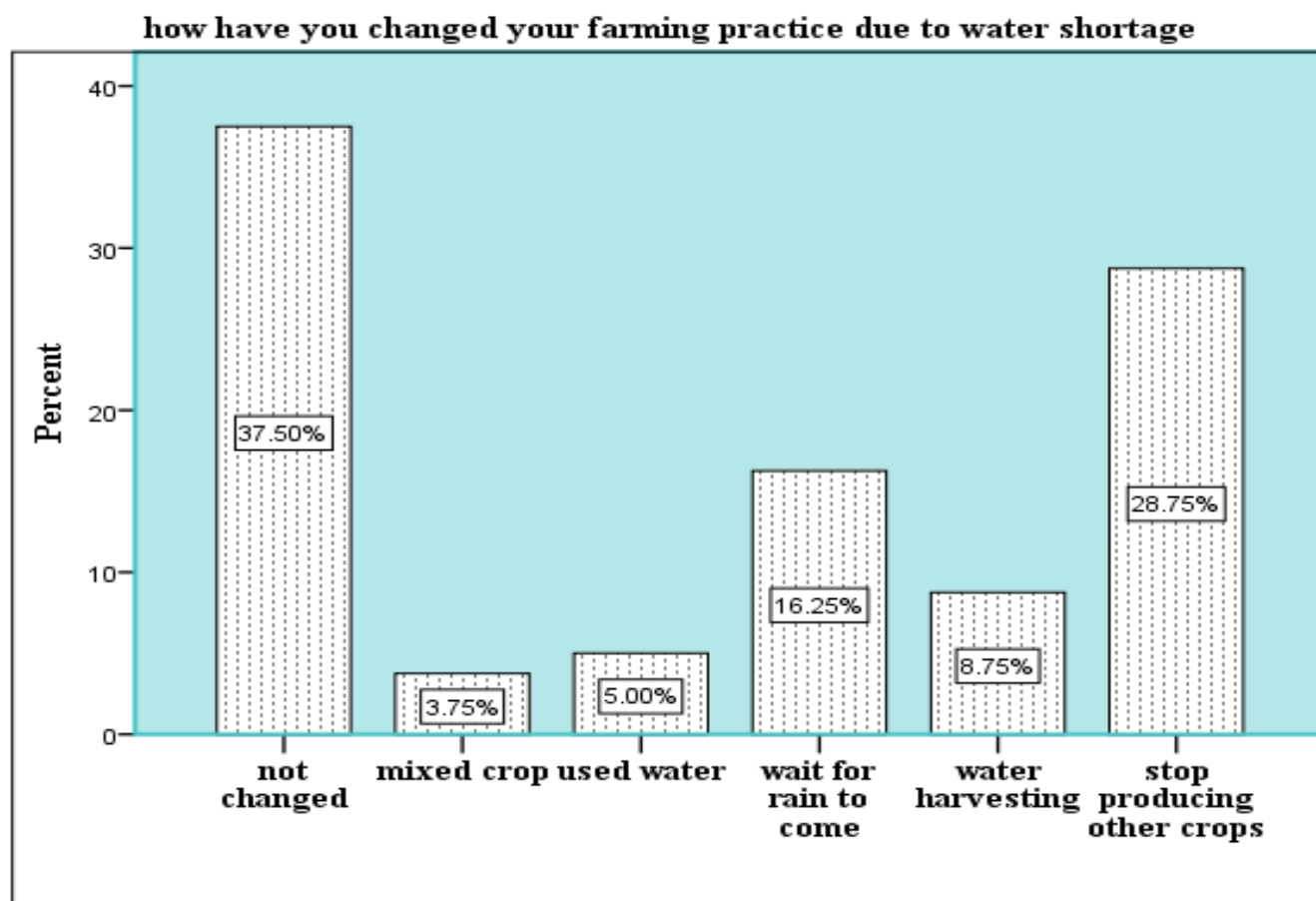


Figure 4. 3: Adaptation to water shortages

In terms of the participants that were members of the Zimele who were trained on some methods of agroecology, results showed that many fall under those who did not change their farming methods due to water shortages. This might be the result of some practices like mulching and water harvesting which farmers have already been trained by the Zimele organization to use in their farms. Mulching management techniques can reduce evaporation and modify soil temperature, and reduce weed infestation, and thereby may lead to increases in yield, and possibly water use efficiency (Qin *et al.* 2015). Results showed that 9 farmers from those who were not trained waited for the rain while the Zimele members only 4 farmers resorted to waiting for the rain to begin planting. These results showed the importance of giving smallholder farmers training to cope with unforeseeable natural disaster like drought. Furthermore, this is clear indication of the need to train farmers with agroecological methods of farming as this helps with food security at large since farmers still manage to produce crops even under unfavorable conditions.

4.4.4 Lack of crops diversity

Farmers in the area had limited crop diversity. Results shows that maize was the most popular crop that the farmers grow. Almost all the participants reported that they grow maize. Farmers also reported that they grow crops like beans, taro, potatoes and sweet potatoes. These crops were mostly planted because farmers could generate some income from these crops because they were marketed directly to the local community. However, crops like cabbages, spinach, carrots, onions, tomatoes and beetroot farmers were difficult to sell in the community as most community members preferred to buy the produce from bigger local supermarkets. Farmers mentioned the lack of irrigation system that was required to produce such crops as mentioned before. Farmers resorted to growing them for family consumption only so that they limit the use of water as such crops require irrigation frequently during their early stages of growth. Storage facilities was also mentioned by farmers as another challenge which prevented them from producing these crops. From observing the diversity of crops produced by small farmers in the area it was evident that access to water was a limiting factor for small farmers. The production of sweet potatoes and taros was in line with what Motsa *et al.* (2015) argued ‘Sweet potato is a drought tolerant crop with the potential to enhance food and nutrition security, especially for subsistence and small-scale farmers in South Africa’.



Figure 4.4 Production of sweet potatoes as drought resilient crop

4.4.5 The use of fertilizers in production

The use of chemical fertilizer was very popular amongst participants. The use of fertilizer was statistically related to the employment status of the participants using chi-square. As presented in the Table 4.7 below, the result shows that the statistics did not bear the hypothesis that those who were not employed would not use or used limited application of fertilizer in their farms. The two variables were significantly not related (chi-square = 3.616, $df = 3$, $p > 0.05$). This finding was a disadvantage for farmers since their level of unemployment was high. Farmers reported that they buy one bag of fertilizer for R450. That amount of expenses incurred increased when one included the money spent going to buy those fertilizers. Moreover, this had negative impacts on both the environment and household food security. Lundqvist *et al.* (2008) argued that the dependence and overuse of synthetic fertilizers, pesticides and herbicides reduces long-term soil fertility, causes soil erosion, pollutes water supplies, poisons fragile ecosystems, exposes farmers and farm workers to toxins, and contributes to climate change through greenhouse gas emissions (Lundqvist *et al.* 2008). In the long run such practices have a negative impact on the farmers' food security

and ability to adapt to change. As a result, farmers were expected to use limited fertilizers and use more alternative like composts on their farms.

Table 4.6 Application of fertilizer and employment status (n=80)

DESCRIPTION		CATEGORY	EMPLOYMENT STATUS				TOTAL
			Employed full time	Employed part time	Unemployed	pensioner	
DO	YOU	Yes	8	8	36	26	78
APPLY							
FERTILIZER		No	0	1	1	0	2
			8	9	37	26	n=80

4.5 Improving market access

This research asserted that improving productivity with regards to production systems for smallholder farmers is a sustainable solution for achieving food security. Also through improved and sustainable farming systems small farmers will be able to compete in the market. The key barriers which are preventing participants to access and practice effectively in the market are similar. In addition, farmers argue that there is no market where they can sell to generate income. This goes back to the issues of consumer behavior and market access as it had been argued in the literature that for smaller scale farmers to supply supermarkets or wholesalers they need a certain size of production, high quality products, and consistency in quality and supply, requirements which they find difficult to consistently meet, (Louw, 2007).

Table 4.7 Theme analysis for market access

Question	Quotes	Discussion
What do you understand about market access?	<p><i>"It is a place where one can take their produce for selling"</i></p> <p><i>"In Swayimane we need a central place where we can all take our produce"</i></p>	Farmers interpreted market as formal place where they can take their produce and believed that this would bring them buyers.
Where do you sell your produce?	<p><i>"Competition is high amongst farmers because we produce similar crops at the same period of time and one ends up having too much surplus and sometimes goes to waste".</i></p> <p><i>"Local people don't buy from us because they produce their own food similar to the ones produced for selling by us"</i></p> <p><i>I take my produce to Durban where I have established myself customers, which I am sure they will buy my produce.</i></p>	Value adding of the produce was lacking from the farmers. Some of the produce went to waste because the only way they could get rid of it was through selling it in the market.

For organic produce, farmers argue that they do not grow to sell but only for their household consumption. Farmers argued that they only sell food produced conventionally because they become ready to be sold quicker which helps them to be regular in the market. The farmers had observed that organic produce took longer to mature. When farmers were asked whether they ever tried selling food produced organically, they said they have only tried with the local community which they rejected or tried buying the produce at lower prices because of the size of the product which they compare with the one produced using chemical fertilizers as it has been discussed.

4.5.1 Improvements related to production and market access

When farmers were asked to respond to the question within the market access section which asked them what improvements they feel would deliver the greatest benefit. The respondents mentioned

that limited agricultural production inputs, training and land as major challenges in gaining access to markets and surplus and selling of it thereof. However different farmers preferred different arrangements. For example, the elderly farmers mentioned that they did not have the problem selling their produce at their homes because of the risks which they associated with going to the markets including the price fluctuations. These farmers argued that it would not be easy for them to sell for formal market as there are too many processes involved which were beyond their capabilities including the language barrier as they are illiterate. So, it would be beneficial for some farmers to go for formal markets as other prefer selling their produce at their farms. Below are some of the improvements that would be of benefit mentioned by the farmers.

4.1.5.1 Road and transport infrastructure

Most of the farmers pointed out the limitation of transport infrastructure as the biggest challenge to access market for farmers in the Swayimane area. This is because the road and route are not easy to travel using even for cars. When hiring a car, it must be of a certain kind which is good to deliver goods without them being damaged. So, farmers resorted to selling to the informal markets which included local community and sellers who came and buy from farmers at their farms.

Farmers argued that they needed fertilizers to increase their yields and quality of their produce. Fertilizers are said to be very expensive and can only be afforded if bought in bulk then individually purchasing them as they also inclusive of transport expenses. Water is another production input which is a requirement for farmers to improve their household food security and market access. Where farmers have enough water for irrigation, there would be an increase in harvests significantly and potentially increase the money farmers earn (Namara *et al.* 2010).

4.5.1.2 Tractor availability and expense

Farmers added that there were inconveniences brought about by hiring a tractor during the planting season. Inconveniences caused by the availability of the tractors when one needed them. Farmers that owned smaller plots of farming land argued that they were given less priority by the owners of the tractors because they did not pay as much as those owning bigger plots. Farmers felt there was a need for the community to have ownership of tractors provided by the Department of

Agriculture. However, some farmers argued that previously there were tractors provided to the community by the Department of Agriculture, but the system in which they were serviced to the farmers was not effective as they ended up not functioning. One factor which negatively influenced the use of those tractors was the dynamics of gender within the community, men had more authority over the usage than women. This is common in the communities controlled by traditional authorities where men are prioritized over women. Women contribute tremendously to agricultural output but unfortunately, they hardly benefit from agricultural incentives and innovation because of economic suppression and traditional practices which undermine the constitutional provisions on the equality of men and women (Mabundza *et al.* 2014). Furthermore, respondents felt that the tractors were too expensive considering that most farmers were not employed. When farmers approached the planting season, there was a high demand for the tractors which resulted in some planting after the recommended planting time. Also, due to high demand of tractors some farmers resorted to using hoes especially and hired people to help. All these factors compromised the quality of the yield of the farmers which in turn affected the ability compete in the market with other farmers.

4.5.1.3 Pricing

Farmers argued that they priced their produce according to local standards, these prices were different from those of formal markets. This showed that farmers themselves were not confident about the quality of their produce as they sold theirs with the lower price than those of the local formal supermarkets. The prices were decided by the farmers in unity, however it was argued that there is some level of disloyalty amongst farmers. When traders come to buy farmers sometimes changed prices so that they get rid of all the produce while others still had them. This was happening mainly in the selling of maize as all farmers produced it, there was a high competition of getting markets for it.

4.5.1.4 Record keeping

Farmers did not do record keeping, this made it difficult for the researchers to see how much farmers were losing or gaining in terms of productivity. Farmers were also reluctant to say how much they made from the crops they produced. However, they made it clear that they were not

satisfied with the profit they made considering the time, money and energy they put in producing the crops. These results shows that there was a strong need for more training to cover areas of record keeping so that farmers can be able to trace their progress. Through such training farmers would be able to link agriculture and their financials and not separate the two since it is their source of income and means of livelihood. In addition, when the farmers want to apply for a loan records would provide them with some source of projected income.

4.5.1.5 Training

Farmers value training provided to them. But there is no proper way of evaluating the training given to them, for instance whether the trainer is an extension officer who has the necessary skills of agroecology. Also, whether the training is on farm training as smallholder farmers are mostly illiterate meaning training which involves practical work on farm is more beneficial than seating and listening in the training room. Some of the training given to farmers did not yield the expected outcomes due to limited resources to train the farmers. When workshops are done they only benefit those that are representing groups because they are the ones who are directly taught by the trained facilitator. The others are then given the information through the leader or the person chosen of the farmers group who had attended a particular workshop. Furthermore, the training which a few selected individuals attend brings about segregation within farmers' groups because it is the leaders of groups who chooses which farmer to attend a particular training based on their own criteria of selection. This then caused hatred between those selected and those not. Even the leaders were suspected of being biased in their choosing.

4.6. The analysis for understanding the Strengths, Weaknesses, and for identifying both the Opportunities and the Threats facing smallholder farmers.

The SWOT analysis shows that farmers in Swayimane have got advantages as farmers in smallholder agricultural production which they can use to strengthen their farming activities. Advantages including the availability of NGO's (Zimele) and being part of cooperatives as part of the community. Even the farmers that are not yet part of the NGO's must make use of such opportunities available to them. This can help with the availability of trained labour as well as

improved hand tools help to foster good agricultural practices and agriculture production (Mushobozi & Santacoloma, 2010). Moreover, agricultural cooperatives help in the provision of four essential services to the cooperative's members: farm guidance, input supply services, credit services and market services (Prakash, 2005).

Table 4.8 SWOT analysis for improving market access and productivity

Strengths	Weaknesses
<ul style="list-style-type: none"> • Zimele- the availability of the private organization like Zimele is good for the community as it teaches them new farming systems to use which are environmentally friendly and cheaper. 	<ul style="list-style-type: none"> • Knowledge- farmers lack knowledge of the available market. • Pricing – there is no loyalty amongst farmers regarding pricing the common crops produced.
Opportunities	Threats
<ul style="list-style-type: none"> • NGO's- farmers needs to be part of NGO's working with the community as there training provided to them through them. • Cooperatives- farmers needs to be members of cooperatives since there is vast sharing of knowledge. Through cooperatives farmers are able to minimize expenditures when buying production inputs. • Local markets- there is available markets for farmers locally, however there needs to be a system to use to regulate pricing. 	<ul style="list-style-type: none"> • Production Resource shortages- lack of water limits crop diversification and amount of produce to access markets regularly and effectively. High costs of buying production inputs including seeds and fertilizers. High costs of renting a tractor made it even harder to produce crops to their full potential. • Informal markets- produce are sold for cheaper prices to informal markets due to constrains. • Storage facility

CHAPTER 5

SUMMARY AND RECOMMENDATIONS

5.1 Recap of the research objectives and methodology

The study set out to look at the farming systems which smallholder/scale farmers in Swayimane use to enhance their food security and the suitability of the systems. It further looked at the role of agroecology as another strategy that can be used by smallholder farmers to enhance productivity and market access. This was done by looking at two groups of farmers. Farmers who were assumed to practice agroecology and were members of the Zimele organization which trains their farmers on the use of the methods of agroecology. Another group was chosen from farmers within the study area who were not the Zimele members. The survey was a mix of both qualitative and quantitative data collection methods. A questionnaire was used to collect quantitative data and focus group discussion was employed to collect qualitative data. The results presented were responses to the study objectives and in relation to the farming systems, agroecology and market access. The following conclusions are made from research conducted.

5.2 Conclusions

The findings revealed that farmers from both groups that were selected, those who have been trained to use agroecology and those who have never received any training that the production systems employed are similar. They are using rain-fed farming, followed by mixed crop farming. It was found that there are challenges with the production systems used especially in relation to water shortages. Farmers are faced with water shortages which influences their yield as they may start planting when it is after the recommended dates. Farmers did not value the agroecological approaches in the community. This was revealed in the perceptions they had of these approaches. Moreover the extension officers were also not in these practices and therefore failed to support farmers accordingly. The ploughing units which they use for agroecology produce are small because of the lack of confidence in these approaches. The variety of crops produced is also affected by water availability due to rain shortage. Farmers are forced to produce crops that require

limited water to grow. There is less crop diversification amongst farmers in the area. This has a negative impact on their profits and prices which farmers can charge for their crops. The way in which this can be improved is through development with regards to water access for these farmers. Farmers are faced with challenges regarding market access. They cannot meet the required standards for markets which include consistency and quality due to lack of resources. Moreover road and transport infrastructure poses another challenge for farmers as they cannot access markets easy to buy or sell. Farmers argued of inconveniences brought by hiring a tractor which at times resulted in some farmers planting after the recommended times.

5.3 Recommendations for policy

Farmers need to develop strategies to deal with risks when there are higher chances of failure. The current strategies which they are using may be effective but they also compromise the farmer's food security as they turn to grow some crops and not others. In this regard, Department of Agriculture Forestry and Fisheries could help farmers with training in terms of agroecology as practice which they can use in dealing with risks associated with changing environment. Farmers also needs tractors to help with the ploughing. Most of the farmers are old which makes it hard for them to plough using their hands, the local municipality needs to consider providing smallholder farmers with tractors at least during the summer season where most of the farming is done. Also on the point of being elderly empowerment projects should take into considerations that it is not possible for all farmers to participate in bigger and formal markets because of the processes involved. So, there is a need for empowerment projects which meet the needs of those farmers.

Appropriate systems should ideally evolve from the experience of traditional techniques, where these exist, as this would make it easier for illiterate smallholder farmers to grasp and use. They should also be based on lessons learned from the shortcomings of previous projects which calls for evaluation of different projects including those made by private organizations. Above all it is necessary that the farming systems are appreciated by the communities where they are introduced. Without popular participation and support, projects are unlikely to succeed, so there is a need of involving higher authorities of the community including the chief when projects are introduced so that they would have an impact.

5.4 Recommendations for improvement of the study

A study of this nature where the researcher is comparing a certain group of participants in this case being the conventional farmers and those employing some principle of agroecology, a larger number of participants is needed to ensure the reliability of the results. Due to time constrain the research could not practically compare the two groups and the effectiveness of the recommended methods of farming. For improvement of the study it is recommended that the study is done over two seasons, summer and winter to strengthen the recommendation with regards to which method of farming is suitable for the farmers. Furthermore, the study needs to practically choose a group of farmers who practice agroecology methods and be practically present to oversee whether proper precautions are being followed by farmers when practicing agroecology. This is to ensure that reliability of the results found by the research. Lastly improvements may also be employed regarding the study area, two study sites need to be selected for comparison purposes, perhaps another province where similar activities would be conducted to see whether the results would be similar so that one can then give a reliable recommendations as to what really is the suitable farming methods for small farmers to employ.

REFERENCES

- Abdu-Raheem, K. A., & Worth, S. H. (2011). Household food security in South Africa: evaluating extension's paradigms relative to the current food security and development goals. *South African Journal of Agricultural Extension*, 39(2), 91-103.
- Agri SA (2016). "A rain drop in the drought". Report to the multi-stakeholder task team on the draught Agri SA's status report on the current drought crisis.
- Aker, J. C. (2011). Dial "A" for agriculture: a review of information and communication technologies for agricultural extension in developing countries. *Agricultural Economics*, 42(6), 631-647.
- Alkon, A. H., & Norgaard, K. M. (2009). Breaking the food chains: An investigation of food justice activism. *Sociological Inquiry*, 79(3), 289-305.
- Aliber, M., & Hart, T. G. (2009). Should subsistence agriculture be supported as a strategy to address rural food insecurity? *Agrekon*, 48(4), 434-458.
- Altieri, M. A. (2002). Agroecology: the science of natural resource management for poor farmers in marginal environments. *Agriculture, ecosystems & environment*, 93(1), 1-24.
- Altieri, M. A. (2009). Agroecology, small farms, and food sovereignty. *Monthly review*, 61(3), 102.
- Altieri, M. S., & Rogé, P. (2009). The ecological role and enhancement of biodiversity in agriculture. *Agriculture, biodiversity and markets: livelihoods and agroecology in comparative perspective*. Earthscan, London, 15-32.
- Altieri, M. A., & Koohafkan, P. (2008). *Enduring farms: climate change, smallholders and traditional farming communities* (Vol. 6). Third World Network (TWN).
- Altieri, M. A., Funes-Monzote, F. R., & Petersen, P. (2012). Agroecologically efficient agricultural systems for smallholder farmers: contributions to food sovereignty. *Agronomy for Sustainable Development*, 32(1), 1-13.
- Ambunda, L., & de Klerk, S. (2008). Women and custom in Namibia: A research overview.

- Andersson, J. C. M., Zehnder, A. J. B., Jewitt, G. P. W., & Yang, H. (2009). Water availability, demand and reliability of in situ water harvesting in smallholder rain-fed agriculture in the Thukela River Basin, South Africa. *Hydrology and Earth System Sciences*, 13(12), 2329-2347.
- Ayoola, O. T., & Makinde, E. A. (2008). Performance of green maize and soil nutrient changes with fortified cow dung. *African journal of plant science*, 2(3), 019-022.
- Bationo, A., Vanlauwe, B., Kimetu, J., Kihara, J., Abdoulaye, M. S., Adamou, A., & Koala, S. (2005). Increasing land sustainability and productivity through soil-fertility management in the West African Sudano-Sahelian zone. *Nutrient and water management practices for increasing crop production in rainfed arid/semi-arid areas*, 53.
- Benson, T. (2015). Association between irrigated farming and improved nutrition in farm households in Malawi. *Agrekon*, 54(3), 62-86.
- Berdegúe, J. A., & Escobar, G. (2002). *Rural diversity, agricultural innovation policies and poverty reduction*. Overseas development institute (ODI). Agricultural research & extension network (Agren).
- Binam, J. N., Tonye, J., Nyambi, G., & Akoa, M. (2004). Factors affecting the technical efficiency among smallholder farmers in the slash and burn agriculture zone of Cameroon. *Food policy*, 29(5), 531-545.
- Bowman, M. S., & Zilberman, D. (2013). Economic factors affecting diversified farming systems. *Ecology and Society*, 18(1), 33.
- Burton, G. 2000: 'Answers as interactional products: two sequential practices used in research interviews', in (ed.) P. Drew. *Heritage Talk at field work*, Cambridge: Cambridge University Press, 212-34.
- Campbell, S. (2012). *Mulch it!: a practical guide to using mulch in the garden and landscape*. Storey Publishing.

- Carmona, A., Nahuelhual, L., Echeverría, C., & Báez, A. (2010). Linking farming systems to landscape change: an empirical and spatially explicit study in southern Chile. *Agriculture, ecosystems & environment*, 139(1), 40-50.
- Chalker-Scott, L. (2007). Impact of mulches on landscape plants and the environment-a review. *Journal of Environmental Horticulture*, 25(4), 239.
- Chakauya, E., Beyene, G., & Chikwamba, R. K. (2009). Food production needs fuel too: perspectives on the impact of biofuels in southern Africa. *South African Journal of Science*, 105(5-6), 174-181.
- Chambers, R. (2011). Complexity, Diversity and Competence: Toward sustainable livelihoods from farming systems in the 21st century.
- Chavas, J. P., & Kim, K. (2010). Economies of diversification: A generalization and decomposition of economies of scope. *International Journal of Production Economics*, 126(2), 229-235.
- Chikazunga, D. (2012). Alternative food markets and opportunities for smallholder farmers in South Africa. Available from <http://www.plaas.org.za/blog/alternative-markets-smallholders> (Accessed 25 June 2016).
- Chilonda P., Machethe C & Minde I. (2007). Poverty, Food Security and Agricultural Trends in Southern Africa. ReSAKSS Working Paper No.1.
- Chinangwa, L. L. R. (2006). Adoption of soil fertility improvement technologies among smallholder farmers in southern Malawi. *Master's thesis, Department of International Environment and Development Studies, Norwegian University of Life Sciences (UMB)*
- Chirwa, E. 2012. Factors Influencing Smallholder Commercial Farming in Malawi: A Case of NASFAM Commercialisation.
- Climate Change Agriculture and Food Security, (2015). How mixing crops and livestock on the farm can help support climate adaptation. Available from <https://ccafs.cgiar.org/blog/how-mixing-crops-and-livestock-farm-can-help-support-climate-adaptation> (Accessed 28 August 2015).

- Collier, P., & Dercon, S. (2009). Background paper for the Expert Meeting on How to Feed the World in 2050. *African agriculture in*, 50.
- Cornish, P. S. (2010). A postscript to “Peak P”—an agronomist’s response to diminishing P reserves. In *Food Security from Sustainable Agriculture, Proceedings of the 15th Agronomy Conference* (pp. 15-18).
- Czarnecki, J. J. (2011). Food, law & the environment: Informational and structural changes for a sustainable food system. *Utah Envtl. L. Rev.*, 31, 263.
- DAFF. (2011). National Policy on Organic Farming. In: Department of Agriculture Forestry and Fisheries (ed.). Cape Town, South Africa: DAFF publishers.p.1-30.
- DAFF, (2012). A framework for the development of smallholder farmers through cooperatives development. Available from [www.nda.agric.za/.../FRAMEWORK-%20OF%20SMALL%20FARMERS%20\(2\).pdf](http://www.nda.agric.za/.../FRAMEWORK-%20OF%20SMALL%20FARMERS%20(2).pdf) (Accessed 25 June 2016).
- Damos, P. (2013). Current issues in integrated pest management of Lepidoptera pest threats in Industrial crop models. *Lepidoptera: Ecology, Behavior and Management*, 45-86.
- Davis, K., Nkonya, E., Kato, E., Mekonnen, D. A., Odendo, M., Miiro, R., & Nkuba, J. (2012). Impact of farmer field schools on agricultural productivity and poverty in East Africa. *World Development*, 40(2), 402-413.
- De Magistris, T., & Gracia, A. (2008). The decision to buy organic food products in Southern Italy. *British Food Journal*, 110(9), 929-947.
- Denison, J., & Manona, S. (2007). *Principles, approaches and guidelines for the participatory revitalisation of smallholder irrigation schemes*. Water Research Commission.
- Deressa, T. T., Hassan, R. M., Ringler, C., Alemu, T., & Yesuf, M. (2009). Determinants of farmers’ choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global environmental change*, 19(2), 248-255.
- Derpsch, R. (2008). No-tillage and conservation agriculture: a progress report. *No-till farming systems. Special publication*, (3), 7-39.

- De Wit, M. M., & Iles, A. (2016). Toward thick legitimacy: Creating a web of legitimacy for agroecology. *Elementa: Science of the Anthropocene*, 4(1), 000115.
- Dobermann A. & Nelson R. (2013) Opportunities and Solutions for Sustainable Food Production Background paper for the High-Level Panel of Eminent Persons on the Post-2015 Development Agenda.
- Driscoll D L.; Appiah-Yeboah, A; Salib P; and Rupert D J., (2007) "Merging Qualitative and Quantitative Data in Mixed Methods Research: How To and Why Not". Ecological and Environmental Anthropology (University of Georgia). Paper 18.
- Entz, M. H., Guilford, R., & Gulden, R. (2001). Crop yield and soil nutrient status on 14 organic farms in the eastern portion of the northern Great Plains. *Canadian Journal of Plant Science*, 81(2), 351-354.
- Ewert, F., Rötter, R. P., Bindi, M., Webber, H., Trnka, M., Kersebaum, K. C., & Semenov, M. A. (2015). Crop modelling for integrated assessment of risk to food production from climate change. *Environmental Modelling & Software*, 72, 287-303.
- Eysenck, M. W. (2004). Research methods: Data analysis. *Psychology: An International Perspective*.
- FAO (2011). SAVE and GROW: A policymaker's guide to the sustainable intensification of smallholder crop production. Available from <http://www.fao.org/docrep/014/i2215e/i2215e.pdf> (Accessed 23 February 2014).
- Forman, J., Silverstein, J., Bhatia, J. J., Abrams, S. A., Corkins, M. R., De Ferranti, S. D., & Campbell, C. C. (2012). Organic foods: health and environmental advantages and disadvantages. *Pediatrics*, 130(5), e1406-e1415.
- Forum for Agricultural Research in Africa (2007). The challenges of agricultural research and development. Available from <http://fara.org/about-us/background/> (Accessed 17 February 2014).

- Francis, C., Lieblein, G., Gliessman, S., Breland, T. A., Creamer, N., Harwood, R., & Wiedenhoft, M. (2003). Agroecology: the ecology of food systems. *Journal of Sustainable Agriculture*, 22(3), 99-118.
- Frehaut B, Rupani S (2010), Surplus People Project: Agro-Ecological Farming Available from <http://www.spp.org.za/agro-ecological-farming/> (Accessed 17 February 2014).
- Garcia-Torres L., Benites J, Martínez-Vilela A., Holgado-Cabrera A. (2013) Conservation Agriculture: Environment, Farmers Experiences, Innovations, Socio-economy, Policy.
- Garrity, D., Dixon, J., & Boffa, J. M. (2012). Understanding African farming systems. *Australian International Food Security Centre, Canberra*.
- Ghorbani, R., Wilcockson, S., Koocheki, A., & Leifert, C. (2008). Soil management for sustainable crop disease control: a review. *Environmental Chemistry Letters*, 6(3), 149-162.
- Giannakas, K. (2002). Information asymmetries and consumption decisions in organic food product markets. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, 50(1), 35-50.
- Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., & Toulmin, C. (2010). Food security: the challenge of feeding 9 billion people. *science*, 327(5967), 812-818.
- Goldblatt, A. (2010). Agriculture: Facts & Trends, South Africa. In *World Wildlife Forum*.
- Gómez, M. I., Barrett, C. B., Raney, T., Pinstrip-Andersen, P., Meerman, J., Croppenstedt, A., & Thompson, B. (2013). Post-green revolution food systems and the triple burden of malnutrition. *Food Policy*, 42, 129-138
- Grundy, A. C., & Bond, B. (2007). 9 Use of Non-living Mulches for Weed Control. *Non-chemical weed management: principles, concepts and technology*, 135.
- Gupta, V., Rai, P. K., & Risam, K. S. (2012). Integrated crop-livestock farming systems: A strategy for resource conservation and environmental sustainability. *Indian Research Journal of Extension Education, Special Issue*, 2, 49-54.

- Huber, M., Rembialkowska, E., Średnicka, D., Bügel, S., & Van De Vijver, L. P. L. (2011). Organic food and impact on human health: Assessing the status quo and prospects of research. *NJAS-Wageningen Journal of Life Sciences*, 58(3), 103-109.
- IAC Report (2010) African agriculture production systems and productivity in perspective International Water Management Institute.
- IFAD (2008). Challenges and opportunities for smallholder farmers in the context of climate change and new demands on agriculture in Conjunction with the Thirty-first Session of IFAD's Governing Council, February 2008.
- International Food and Agribusiness Management Association (2014). Woolworths Farming for the Future Volume 17 Special Issue B. Available from <https://www.ifama.org/resources/Documents/v17ib/King-Thobela.pdf> (Accessed 18 September, 2015).
- Isman, M. B. (2006). Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. *Annu. Rev. Entomol.*, 51, 45-66.
- Kassam, A., Friedrich, T., Shaxson, F., & Pretty, J. (2009). The spread of conservation agriculture: justification, sustainability and uptake. *International Journal of Agricultural Sustainability*, 7(4), 292-320.
- Kayisi D. & Tsedu T. (2011). Africa: Women encouraged to practice agro-ecology available from <http://www.genderlinks.org.za/article/africa-women-encouraged-to-practice-agro-ecology-2011-11-30> (Accessed 16 September 2015).
- Khapayi M., & Celliers, P. R. (2016). Factors limiting and preventing emerging farmers to progress to commercial agricultural farming in the King William's Town area of the Eastern Cape Province, South Africa. *South African Journal of Agricultural Extension*, 44(1), 25-41.
- Kothar, C. R. (2004). Education Research Methodology. *Methods and Techniques*, New Delhi: New Age International (P) Ltd.

- Kremen C., Iles A. and Bacon, C.M. (2012). Diversified Farming Systems: An agroecological, systems-based alternative to modern industrial agriculture. *Ecology and Society* 17(4): 44.
- Lanyasunya T. P., Rong Wang H. , Abdulrazak S. A., Kaburu P.K., Makori J.O., Onyango T.A. and Mwangi D. M. (2006). Factors Limiting Use of Poultry Manure as Protein Supplement for Dairy Cattle on Smallholder Farms in Kenya. *International Journal of Poultry Science* 5 (1): 75-80, 2006.
- Lee, J., Gereffi, G., & Beauvais, J. (2012). Global value chains and agrifood standards: challenges and possibilities for smallholders in developing countries. *Proceedings of the National Academy of Sciences*, 109(31), 12326-12331.
- Llazo E. (2013) Small Scale farming and agricultural product marketing in Albania. *Folia Pomer. Univ. Technol. Stetin.* 2013, *Oeconomica* 306 (73), 135–144.
- Louw A., Chikazunga D., Jordaan D., & Biénabe E. (2007). Restructuring food markets in South Africa: Dynamics within the context of the tomato subsector. Department of Agricultural Economics, Extension and Rural Development University of Pretoria, South Africa.
- Lundqvist, J., de Fraiture, C., & Molden, D. (2008). *Saving water: from field to fork: curbing losses and wastage in the food chain*. Stockholm, Sweden: Stockholm International Water Institute.
- Mabundza, R., Dlamini, C. S., & Nkambule, B. (2014). Gender mainstreaming in smallholder agriculture development: A global and African overview with emerging issues from Swaziland. *African Journal of Agricultural Research*, 9(42), 3164-3170.
- Machingura, C. (2007). *An analysis of factors that can be used to identify successful smallholder farmers a case study of Mbhashe and Ngqushwa* (Doctoral dissertation, University of Fort Hare).
- Magombeyi S.M. Morardet S., Taigbenu A.E & Cheron C (2012). Food insecurity of smallholder farming systems in B72A catchment in the Olifants River Basin, South Africa. *African Journal of Agricultural Research* Vol. 7(2), pp. 278-297.

- Makinde, E. A., Agboola, A. A., & Oluwatoyinbo, F. I. (2001). The effects of organic and inorganic fertilizers on the growth and yield of maize in a maize/melon intercrop. *Moor Journal of Agricultural Research*, 2, 15-20.
- Masley S., (2009). Growing cabbage in home gardens. Available from <http://www.grow-it-organically.com/growing-cabbage.html> (Accessed 23 February 2015).
- Mavunganidze, Z., Madakadze, I. C., Mutenje, M. J., & Nyamangara, J. (2013). Factors affecting the choice of conservation agriculture practices adopted in smallholder cotton farmers in Zimbabwe.
- Mazvimavi K, Twomlow S. (2009). Socioeconomic and institutional factors influencing adoption of conservation farming by vulnerable households in Zimbabwe. *Agric. Syst.* 101:20-29.
- Mazvimavi K, Twomlow S, Belder P, Hove L. (2008). An Assessment of the Sustainable Uptake of Conservation Farming in Zimbabwe. Global Theme on Agro ecosystems Report No. 39, P.O. Box 776, International Crops Research Institute for the Semi-Arid Tropics, Bulawayo, Zimbabwe. P. 60.
- Mhlophe, B. (2015). *Antecedents of Consumer Purchase Intentions towards Organic Food Produces: A Case Study of the Johannesburg Municipality* (Doctoral dissertation, University of the Witwatersrand, Johannesburg).
- Milder, J. C., Majanen, T., & Scherr, S. J. (2016). Performance and potential of conservation agriculture for climate change adaptation and mitigation in Sub-Saharan Africa.
- Mirza B. B., Shabbir A. S., Gary S. S. (2013). Making rainfed agriculture sustainable through environmental friendly technologies in Pakistan: A review. *International Soil and Water Conservation Research* Volume 1, Issue 2, Pages 1-87.
- Mkhabela, T. (2007). Linking farmers with markets in Rural South Africa: Rural Development and poverty alleviation through supply chain management.
- Mkhabela, T. S., & Materechera, S. A. (2003). Factors influencing the utilization of cattle and chicken manure for soil fertility management by emergent farmers in the moist Midlands

- of KwaZulu-Natal Province, South Africa. *Nutrient Cycling in Agroecosystems*, 65(2), 151-162.
- Moe, C. L., and Rheingans, R. D. (2006). Global challenges in water, sanitation and health. *Journal of water and health*, 4(S1), 41-57.
- Motsa, N. M., Modi, A. T., & Mabhaudhi, T. (2015). Sweet potato (*Ipomoea batatas* L.) as a drought tolerant and food security crop. *South African Journal of Science*, 111(11-12), 1-8.
- Mushobozi, W. L. & Santacoloma, P. (2010). Good Agricultural Practices (GAP) on horticultural production for extension staff in Tanzania. Rome: FAO.
- Mustafa-Msukwa, A. K., Mutimba, J. K., Masangano, C., & Edriss, A. K. (2011). An assessment of the adoption of compost manure by smallholder farmers in Balaka District, Malawi. *South African Journal of Agricultural Extension*, 39(1), 17-25.
- Mwanauta W.R, Mtei KA, Ndakidemi P.A. (2014). *Prospective Bioactive Compounds from Vernonia amygdalina, Lippia javanica, Dysphania ambrosioides and Tithonia diversifolia in Controlling Legume Insect Pests. School of Life Sciences and Bioengineering, The Nelson Mandela African Institution of Science and Technology, Arusha, Tanzania.*
- Nadasen, P. (2012). Citizenship rights, domestic work, and the fair labor standards act. *Journal of Policy History*, 24(1), 74-94.
- Namara, R. E., Hanjra, M. A., Castillo, G. E., Ravnborg, H. M., Smith, L., & Van Koppen, B. (2010). Agricultural water management and poverty linkages. *Agricultural water management*, 97(4), 520-527.
- Noltze, M., Schwarze, S., & Qaim, M. (2012). Understanding the adoption of system technologies in smallholder agriculture: The system of rice intensification (SRI) in Timor Leste. *Agricultural systems*, 108, 64-73.
- Nyong, A., Adesina, F. & Elasha, B.O. (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation and Adaptation Strategies for Global Change*, 12(5), pp.787-797.

- Obasi, P. C., Nwaiwu, I. U., Korie, C. O., & Tim-Ashama, A. (2016). Evaluation of productivity and profitability of mixed farming enterprises in Imo State, Nigeria.
- Ochieng, J. (2015). *Market Orientation, Rural Out-migration, Crop Production and Household Food Security: The Case of Smallholders in Central Africa* (Vol. 6). Kassel University press GmbH.
- Ogen, O. (2006). Traditional farming and indigenous knowledge systems in Africa: perspective from the Ikale-Yoruba experience. *Indilinga African Journal of Indigenous Knowledge Systems*, 5(2), 157-166.
- Ojiem, J. O., De Ridder, N., Vanlauwe, B., & Giller, K. E. (2006). Socio-ecological niche: a conceptual framework for integration of legumes in smallholder farming systems. *International Journal of Agricultural Sustainability*, 4(1), 79-93.
- Oloko, M. (2016). *Indigenous Food Systems: A viable alternative to food security* (Doctoral dissertation, University of Winnipeg).
- Organic Research Centre (2014). Agroecology and organic farming – natural partners or complete strangers? Available from www.organicresearchcentre.com/manage/authincludes/.../ORCBulletin117_web.pdf (Accessed 15 March 2015).
- Palupi, E., Jayanegara, A., Ploeger, A., & Kahl, J. (2012). Comparison of nutritional quality between conventional and organic dairy products: a meta-analysis. *Journal of the Science of Food and Agriculture*, 92(14), 2774-2781.
- Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. *Animal Production Science*, 46(11), 1407-1424.
- Patil, S. S., Kelkar, T. S., & Bhalerao, S. A. (2013). Mulching: A Soil and Water Conservation Practice. *Res. J. Agri. Forestry Sci*, 1(3), 26-29.
- Peter J.P and Olson J.C (2008). *Consumer Behaviour and Marketing Strategy*, 8th International edition, McGraw-Hill Companies Inc, New York.

- Phipps, N. (2014). Cow Dung Fertilizer: Learn The Benefits Of Cow Manure Compost. Available from <http://www.gardeningknowhow.com/composting/manures/cow-manure-compost.htm>. (Accessed 11 September 2014).
- Prakash, D. (2005). Agricultural Extension Services Provided by Cooperatives. New Delhi: IFFCO Foundation.
- Qin, W., Hu, C., & Oenema, O. (2015). Soil mulching significantly enhances yields and water and nitrogen use efficiencies of maize and wheat: a meta-analysis. *Scientific reports*, 5.
- Ramachandran V, (2010), Benefits of Irrigation in Agriculture. Available from <http://www.brighthub.com/environment/scienceenvironmental/articles/75536.aspx>. (Accessed 11 September 2014)
- Rai, M., Reeves, T. G., Pandey, S., & Collette, L. (2011). Save and grow: a policymaker's guide to sustainable intensification of smallholder crop production. *Rome: FAO*.
- Rao, E. J., & Qaim, M. (2011). Supermarkets, farm household income, and poverty: insights from Kenya. *World Development*, 39(5), 784-796.
- Rockstrom, J., Karlberg, L., Wani, S.P., Barron, J., Hatibu, N., Oweis, T., Bruggeman, A., Farahani, J. and Qiang, Z., 2010. Managing water in rainfed agriculture—The need for a paradigm shift. *Agricultural Water Management*, 97(4), pp.543-550.
- Rockström, J., & Barron, J. (2007). Water productivity in rainfed systems: overview of challenges and analysis of opportunities in water scarcity prone savannahs. *Irrigation Science*, 25(3), 299-311.
- Rundgren, G. (2006). Best practices for organic policy: what developing country governments can do to promote the organic sector. *Prepared under the Capacity Building Task Force (CBTF) Project Promoting Production and Trading Opportunities for Organic Agricultural Products in East Africa*. New York and Geneva: United Nations.
- Ryschawy J. (2015). EIP-AGRI Focus Group Mixed farming systems: livestock/cash crops starting paper. Available from https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/fg16_starting_paper_2015_en.pdf (Accessed 23 May 2016).

- Sadati, S. A. (2010). Exploring the solutions for overcoming challenges facing peasant farming system in Iran. *Journal of Agricultural Science*, 2(4), 244.
- Salami A., Kamara A. B, Brixiova Z. (2010). Smallholder Agriculture in East Africa: Trends, Constraints and Opportunities, Working Papers Series No 105 African Development Bank, Tunis, Tunisia.
- Schiere, J. B., Ibrahim, M. N. M., & Van Keulen, H. (2002). The role of livestock for sustainability in mixed farming: criteria and scenario studies under varying resource allocation. *Agriculture, ecosystems & environment*, 90(2), 139-153.
- Seabright, P., 2010. *The company of strangers: A natural history of economic life*. Princeton University Press.
- September, L. (2015) Growth parameters, maize silage and Bambara groundnut grain yield in an intercropping system. Master of Science in agriculture (crop science) University of KwaZulu-Natal Pietermaritzburg South Africa.
- Serres M. (2012) Agricultural productivity, resources, and related terms. Michel Serres Institute for resources and public goods. Available from <http://institutmichelserres.ens-lyon.fr/spip.php?article39> (Accessed 23 August 2014).
- Shamdasani P N & Rook (2007). Focus Group Theory and Practice Vol 20.
- Sivanappan R. K. (2006). Rain Water Harvesting, Conservation and Management Strategies for Urban and Rural Sectors. National Seminar on Rainwater Harvesting and Water Management.
- Smith, J. A. (Ed.). (2015). *Qualitative psychology: A practical guide to research methods*. Sage.
- Solomon M R (2006). Consumer behavior: buying, having and being. 7th edition. Pearson Prentice Hall, New Jersey, USA.
- Statistics South Africa (2008). Poverty Profile of South Africa: Application of the poverty lines on the LCS 2008/2009.

- Sulc, R. M., & Tracy, B. F. (2007). Integrated crop–livestock systems in the US Corn Belt. *Agronomy Journal*, 99(2), 335-345.
- Teddlie, C., & Yu, F. (2007). Mixed methods sampling: A typology with examples. *Journal of mixed methods research*, 1(1), 77-100.
- Thamaga-Chitja, J. & Hendriks, S. L., (2008). Emerging Issues in Smallholder Organic Production and Marketing in South Africa. *Development Southern Africa*. 25(3):317 - 326.
- Thamaga-Chitja J.M & Mabaya E., (2015). Institutional innovations linking small-scale farmers to produce markets in South Africa. In: *Innovative Institutions, Public Policies and Private Strategies for Agro-Enterprise Development*. Ralph D. Christy, Carlos A. da Silva, Nomathemba Mhlanga, Krisztina Tihanyi, and Edward Mabaya, Editors. World Scientific Publishing Co. Inc, Singapore.
- Thiengkamol, N. (2011). Development of a Food Security Management Model for Agricultural Community/Developpement DU Modele DE Gestion DE LA Securite Alimentaire Pour Le Milieu D'agricole. *Canadian Social Science*, 7(5), 162.
- Thiombiano L., & Meshack M., (2009). Scaling-up Conservation Agriculture in Africa: Strategy and Approaches. Addis Ababa, Ethiopia: Food and Agriculture Organization of the United Nations (FAO) Sub Regional Office for Eastern Africa.
- Tirado, R. (2009). Defining ecological farming. *Greenpeace Research Laboratories Technical Note*, (4).
- Tiziana de Magistris, Azucena Gracia, (2008) "The decision to buy organic food products in Southern Italy", *British Food Journal*, Vol. 110 Iss: 9, pp.929 – 947.
- Tomich, T. P., Brodt, S., Ferris, H., Galt, R., Horwath, W. R., Kebreab, E., & Micheltore, R. (2011). Agroecology: a review from a global-change perspective.
- Toulmin, C. (2009). Securing land and property rights in sub-Saharan Africa: the role of local institutions. *Land use policy*, 26(1), 10-19.

- Tow, P., Cooper, I., Partridge, I., & Birch, C. (Eds.). (2011). *Rainfed farming systems*. Springer Science & Business Media.
- Uneke, C. J. (2007). *Integrated pest management for developing countries: a systemic overview*. Nova Publishers.
- Van Dijn, E. A., Grogan, K. A., & Borisova, T. (2015). Determinants of adoption of drought adaptations among vegetable growers in Florida. *Journal of Soil and Water Conservation*, 70(4), 218-231.
- Van Koppen, B., Sally, H., Aliber, M., Cousins, B. & Tapela, B. (2009). Water resources management, rural redress and agrarian reform. Development Planning Division. Working Paper Series No.7, DBSA: Midrand.
- Wakeyo, M. B., & Gardebroek, C. (2013). Does water harvesting induce fertilizer use among smallholders? Evidence from Ethiopia. *Agricultural Systems*, 114, 54-63.
- Weatherell, C., Tregear, A., & Allinson, J. (2003). In search of the concerned consumer: UK public perceptions of food, farming and buying local. *Journal of rural studies*, 19(2), 233-244.
- Wenhold, F. A. M., Faber, M., van Averbek, W., Oelofse, A., Van Jaarsveld, P., van Rensburg, W. J., & Slabbert, R. (2007). Linking smallholder agriculture and water to household food security and nutrition. *Water SA*, 33(3).
- Weis, A. J., (2007). *The global food economy: The battle for the future of farming*. Zed Books.
- Wezel, A., Bellon, S., Doré, T., Francis, C., Vallod, D., & David, C. (2009). Agroecology as a science, a movement and a practice. A review. *Agronomy For Sustainable Development*, 29(4), 503-515.
- Wibbelmann, M., Schmutz, U., Wright, J., Udall, D., Rayns, F., Kneafsey, M., Trenchard, L., Bennett, J. and Lennartsson, M., (2013) Mainstreaming Agroecology: Implications for Global Food and Farming Systems. Centre for Agroecology and Food Security Discussion Paper. Coventry: Centre for Agroecology and Food Security.

- Williams B., Mayson D., Rick de Satgé, Shelley Epstein and Semwayo T., (2008). Extension and small holder agriculture Key issues from a review of the literature
First draft: 16th June 2008.
- Winter, C.K. and Davis, S.F., (2006). Organic foods. *Journal of Food Science*, 71(9), pp.R117-R124.
- Wolfenson, K. D. M., & Rome, A. (2013). Coping with the food and agriculture challenge: smallholders' agenda. *Food and Agriculture Organisation of the United Nations, Rome*.
- Wolff, B., Knodel, J., & Sittitrai, W. (1993). Focus groups and surveys as complementary research methods. *Successful focus groups: Advancing the state of the art*, 118-136.
- Woolworths Holdings Limited, (2015). Good business journey report. Available from http://www.woolworthsholdings.co.za/investor/annual_reports/ar2015/whl_2015_gbj.pdf (Accessed 17 February 2016).
- World Food Programme, (2016). Crop and Food Security Assessment Mission (CFSAM). Available from <http://www.wfp.org/food-security/assessments/crop-food-security-assessment-mission> (Accessed 23 August 2016).
- Wynberg, R., van Niekerk, J., Williams, R., & Mkhalihi, L. (2012). Securing Farmers' Rights and Seed Sovereignty in South Africa.
- Yiridoe, E.K., Bonti-Ankomah, S. and Martin, R.C., (2005). "Comparison of consumer's perception towards organic versus conventionally produced foods: a review and update of the literature", *Renewable Agriculture and Food System*, Vol. 20 No. 4, pp. 193-205.
- Zanoli, R, Baehr M, Botschen M, Laberenz H, Naspetti S, Thelen E, (2004). The European Consumer and Organic Food. *Organic Marketing Initiative and Rural Development vol 4*, Aberystwyth, UK.
- Zehnder, A. J. B., Jewitt, G. P. W., & Yang, H. (2009). Water availability, demand and reliability of in situ water harvesting in smallholder rain-fed agriculture in the Thukela River Basin, South Africa. *Hydrology and Earth System Sciences*, 13(12), 2329.

APPENDICES

Appendix 1: Survey face-to-face interview questionnaire

All the information provided here will be treated as **STRICTLY CONFIDENTIAL**. Please note that respondents may withdraw their participation at any time, should they wish to do so.

Name of participant.....

Date:

Section A: Demographics

1. Gender

0= Male	1= Female

2. Age

0= Less than 35 yrs.	1= From 36-45 yrs.	2= From 46-60 yrs.	3= Greater than 60 yrs.

3. Marital Status

0= Single	1= Married	2= Divorced	3= Widowed

4. Are you the household head?

0= Yes	1=No
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5. Level of education

0= No Formal education	1= Primary	2= Secondary	2= Tertiary

6. Employment status

0= Employed full time	1= Employed part time	2= Unemployed	3= Pensioner

7. Income per month

0= Below R800	1= R801 – R1500	2= R1501-R3500	3= Above R3500

8. Means of land ownership

0= Allocated	1= Inherited	2= Borrowed	3= Rental	4= Bought

9. Total hectares of the land

0= Less than.1 ha	1= greater than 1 and less 2.5ha	2= Greater than 2.5

10. How large of a family garden area and farm area (square meters or ha) do you plant?

Farm for sale of crops: _____

Garden for family use: _____

Section B: Farming System

11. Which production system is practiced in your farm?

Irrigated	
Mixed crop	
Rain fed	

12. Do you practice livestock farming?

13. If yes is there a significance of both cropping and livestock farming?

14. Which crops do you grow in your farm?

Types of crops	Tick below	Growing season		How much is produced per hector
		Summer	winter	
Cabbages				

Maize				
Potatoes				
Sweet potatoes				
tomatoes				
Onions				
Pumpkins				
Other(mention)				

15. Where do you get water for use in farm?

16. How much water is used per week?

17. Which crops have you not been able to plant on time this year, due to water shortage?

18. How have you changed your farming practices based on water shortage?

19. Please indicate your use or awareness of these water management practices:

Water Management Practice	I have knowledge of this, but do not use	I do this practice on my farm	I want to know more about this
Bunds			
Mulching with straw or leaves			
Mulching with plastic			
Swales			
Contour planting			
Collecting Used Household (Grey) Water			
Collecting Roof Water			

20. Do you apply fertilizer to grow crops in your farm?

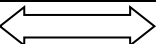
21. If yes how much money do you spend on fertilizers?

Section C: Agroecology

22. Which statement do you most agree with (tick one)

- ☐ Long-term environmental sustainability is my highest priority
- ☐ Long-term economic sustainability is my highest priority goal
- ☐ Long-term optimization of environmental and economic sustainability is my primary goal

23. To what extent do you think the following factors harm the environment?

	Not at all  Very large extent				
	1	2	3	4	5
Pesticides used in farming					
Fertilizer use in farming					

Key code* Scale of 1 to 5, where 1 means not at all and 5 means a very large extent

24. If agroecology is practiced in your farm and those around, how do you think the following factors can be affected?

	Increases Very much	Increases Small	No Difference	Reduces Small	Reduces Very much
Food price					
Grower profits					
The taste of food					
Healthiness of food					
Quality of products					
Public's Health					
Water quality					

25. Which agro ecological method is practiced in your farm?

Integrated pest management	
Organic	
Conservation tillage	
Water harvesting	
Livestock integration	

Mulching	
Composting \ kraal manure	

26. Why that particular agroecological practice? (From above)

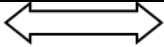
27. Have you ever received any training of agroecological practices?

Yes	No

28. If yes from where, private /extension officer

Extension officer	Private organisation (NGO/ Company)	Other

29. To what extent do you think the provided training was helpful?

Not at all  very large extent				
1	2	3	4	5

Key code* Scale of 1 to 5, where 1 means not at all and 5 means a very large extent

30. What are the reasons farmers practice agroecology? (Can tick more than 1)

Knowledgeable about it	
Market availability	
Lower inputs costs	
Larger yield	
Higher selling price	
Other	

31. What is preventing farmers from practicing agroecology? (Can tick more than 1)

Lack of knowledge	
Lack of markets for organic produce	

Higher labour costs	
Lack of support from agricultural extension	
More time required	
Increased risk of loss	
Other	

Section D: Market Access

32. Do you grow to sell?

Yes	
No	

33. If yes where do you normally sell the produce?

Local community	
Local supermarkets	
Other (mention)	

34. Do you know of any market for agroecologically produced foods?

Yes	
No	

35. If yes where?.....

36. Do you sell throughout the year?

Yes	
No	

37. When selling, do you run out of produce or there is always a surplus?

38. What are the key barriers in accessing market successfully?

39. What improvements do you feel would deliver the greatest benefit?

Appendix 2: Focus Groups

Appendix 2: Guide for Focus group discussion

1. What are some of the practices used by the farmers in the study area?

- Difficulties that comes with the choice?
- How do they deal with them?
- What are the strengths of the chosen practice?

2. What are the limiting productivity factors?

For the farmers who have knowledge of agroecology practices

3. What is the extent of their knowledge about agroecology practices like?

- Conservation
- Mulching
- Zero tilling
- Water harvesting
- Livestock integration
- Integrated pest management

4. Who introduced them to it?

5. Since you have started applying it, have you seen any change?

6. Is there a growing market for their produce?

7. How do they market it?

- Do they say it does not have chemicals
- Is it fresher/ cleaner for consumers?

8. Is there a demand for it in the market?

Appendix 3: Ethical Clearance certificate



28 May 2015

Ms Thobeka Mkhize 208510096
 School of Agricultural, Eartyh and Environmental Sciences
 Pietermaritzburg Campus

Dear Ms Mkhize

Protocol reference number: HSS/0350/015M

Project title: Exploring farming systems and role of agroecology among small farmers in improving productivity and market access

Full Approval – Expedited Application

In response to your application received on 16 April 2015, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol have been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....
Dr Shenuka Singh (Chair)
 Humanities & Social Sciences Research Ethics Committee

/pm

Cc Supervisor: Dr Joyce Chitja & Dr Alfred Odindo
 Cc Academic Leader Research: Professor Onesimo Mutanga
 Cc School Administrator: Ms Marsha Manjoo

Humanities & Social Sciences Research Ethics Committee

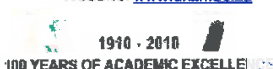
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