

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

The horticulture industry in Kenya plays an important role in food security, employment creation, and poverty alleviation (Agricultural Sector Coordination Unit [ASCU], 2011). The sector contributes enormously to food security and household incomes to a majority of Kenyan producers who carry out one form of horticultural production or another and it employs over six million Kenyans both directly and indirectly thus improving on their livelihoods (Ministry of agriculture, 2010a). However the potential for horticultural production in the Arid and Semi-Arid Lands (ASALs) of Kenya has not been fully utilized to be of help to the communities living in those regions (Ministry of Agriculture, 2010b). This is because farming in Kenya is mainly rain fed and the arid and semi arid regions lack of sufficient rainfall to support sustainable rain fed farming (Ministry of Agriculture, 2010b).

Generally the arid and semi arid regions of the world are vulnerable to frequent and often severe droughts due to unreliable and erratic rainfall that these regions receive leading to massive crop failures and therefore lack of food security (International Center for Agricultural Research in the Dry Areas [ICARDA], 2013). These regions are some of the world's poorest regions facing severe challenges to sustainable development with the biggest challenges being lack of food security, water scarcity, land degradation, and climate change (International Center for Agricultural Research in the Dry Areas [ICARDA], 2009). The situation is further complicated by climate change which is causing rainfall variability making it an urgent agenda globally to develop strategies for sustainable crop production in the arid and semi regions (Food and Agriculture Organization of the United Nations [FAO], 2011).

Majority of occupants in the arid and semi arid regions are low income smallholder farmers whose livelihoods depend directly or indirectly on agriculture but lack resources to invest in meaningful agricultural activity (FAO, IFAD and WFP, 2013). Also more than 70 percent of the lands that these communities depend on for agricultural production suffer from soil and terrain constraints which impair farming activities (Food and Agriculture Organization of the United Nations [FAO], 2011). Therefore for agriculture to be able to address the challenges of food security and poverty in these dry lands, strategies must be put in place which will address the high poverty levels among the small farmers, the environmental degradation which is already

being experienced in these regions and climate change which is worsening the farming conditions (International Center for Agricultural Research in the Dry Areas [ICARDA], 2013). This means that current farming practices being used by farmers in the dry regions will have to be revised not only to address crisis in food security being experienced in the regions but also to address fundamental questions of relationships among production, social, environment and economic situations facing farmers in the dry regions all over the world (International assessment of agricultural knowledge, science and technology for development [IAASTD], 2009).

To address challenges to farming in dry lands of the world the International Center for Agricultural Research in the Dry Areas (ICARDA), which is the global agricultural research center working with countries in the world's dry areas, together with its partners have for more than three decades been developing a range of improved technologies for sustainable farming suited to small scale farmers in environments with scarce water and highly variable climates (ICARDA, 2010). According to ICARDA these practices are tailored to local conditions to address hunger and poverty in order to improve rural livelihoods and facilitate equitable, environmentally, socially and economically sustainable development in the dry land regions.

Sustainable farming approaches have emerged a priority for world leaders towards achieving sustainable development (FAO, 2011). Agricultural sustainability centers on the need to develop agricultural technologies and practices that are accessible to and effective for farmers, and that lead to both improvements in food productivity and positive side effects on environmental goods and services (National Research Council of the National Academies, USA, 2010). Sustainability is emphasized to be a necessary basis for efforts aimed at building lasting prosperity and the adoption of sustainable farming practices is one of the targets of the new global development agenda for the period beyond 2015 which is currently being shaped (FAO, IFAD and WFP, 2013).

It is for this reason that a major study of the future of food and farming up to 2050 has called for substantial changes throughout the world's food system to make it more sustainable so that it can simultaneously raise yields, increase efficiency in the use of inputs and reduce the negative environmental effects of food production (FAO, 2011). According to FAO the study recommends the adoption of sustainable crop production practices which use the ecosystem approach where inputs, such as land, water, seed and fertilizer are used to complement the natural processes that support plant growth, including pollination, natural predation for pest control, and the action of

soil biota. Sustainable farming practices have been found to simultaneously raise yields, increase efficiency in the use of inputs and reduce the negative environmental effects of food production (United Nations Environment Programme [UNEP], 2012).

Around the world sustainable farming practices have been found to offer small farmers and their families multiple benefits by enhancing their productivity, reducing production costs, building resilience to stress and strengthening their capacity to manage risk (SARE, 2004; CARDA, 2010; ICARDA, 2013;FAO, 2011 (Babu and Blom, 2014). The principles and management practices used to achieve agricultural sustainability will be discussed in detail in chapter two.

Many dry lands in the world's low-income countries situated primarily in Central Asia, West Asia, the Middle East, North Africa, parts of sub-Saharan Africa and in Latin America have developed and successfully implemented different sustainable farming strategies to suit the regions conditions (ICARDA, 2010). However, according to ICARDA, African countries are lagging behind in adopting these farming strategies but it has been established that such countries could make much progress toward poverty reduction and food and nutrition security by targeting policies and investment strategies towards sustainable crop production practices as it has been the case in a number of countries that have adopted these practices.

In Kenya for example where agriculture is a major contributor to the economy and to the livelihoods for a majority of the country's population adoption of sustainable farming practices has been low with the adoption activity being spearheaded by non government institutions (FAO, 2009). The country's potential to increase agricultural productivity is largely unexploited partly due to high agricultural production costs and unsustainable farming practices especially in the arid and semi arid regions of the country (Agricultural Sector Coordination Unit [ASCU], 2011).

For example in the horticulture subsector of the country, an important sector in contributing to food security and poverty reduction in the country, farming practices are capital intensive and mainly rain fed making them unsustainable for the poor communities in the arid and semi-arid regions of the country (Ministry of agriculture, 2010a). Misewani, is one of the semi-arid regions in the eastern part of Kenya (see Figure 1.1) that suffers from frequent droughts and famines due to unsustainable farming practices for the climatic conditions that the region experiences making the local community a frequent candidate for food and nonfood aid distributions (Kenya Food

Security Steering Group, 2011). Figure 1.1 is a map of Kenya showing former Kitui district where Misewani is found.

Figure 1.1: A map of Kenya showing former Kitui district where Misewani is found



This study, motivated by the fact that horticulture farming in Kenya is a major source of food security, incomes, and better livelihoods for communities that participate in horticulture farming (Ministry of agriculture, 2010a); and the fact that there have been sustainable farming strategies that have been developed for dry lands (International Center for Agricultural Research in the Dry Areas [ICARDA], 2013), was designed with the objective to establish strategies for sustainable horticulture farming in Misewani so as to help people in the region address frequent droughts and famines that they experience. The study used the strategic study tool of environmental scanning to carry out the research process which involved gathering information on the nature and scope of sustainable farming practices, horticultural farming practices in Kenya and the current farming practices in Misewani.

To define the study problem clearly a literature review was done. This involved studying the global environment of sustainable farming to understand the scope and nature of sustainable farming globally. Then a review of the horticultural practices in Kenya as whole was done to understand the wider horticultural environment within which horticulture farming in Misewani operates. Finally a review of current horticultural practices in Misewani was done to establish the factors which would need to be changed to make horticulture farming in the region more

sustainable. A population for the study was then defined, data collected and analyzed for results upon which conclusions were drawn and recommendations given.

1.2 Statement of the Problem

Misewani sub-location is characterized by semi-arid climatic conditions with very erratic and unreliable rainfall and scarce water sources which limit agricultural activity in the region (Kuria, Gachari, Macharia and Mungai, 2012). A large segment of the population in Misewani is unable to meet basic needs due to high poverty levels occasioned by limited alternative economic activities, dependence on subsistence farming, unreliable weather patterns, low agricultural productivity, high economic dependency and unemployment among other factors (Kenya Food Security Steering Group, 2011).

The region's main economic activity is mixed farming which is limited by unreliable and erratic rainfalls that characterize the region leaving the community unable to produce enough food to feed their families throughout the year (Kenya Food Security Steering Group, 2009). As a result, according to the Kenya Food Security Steering Group (2009) report, the community is faced with perennial food shortages making it a frequent candidate for food and nonfood aid distributions. This calls for ways to help the region come up with sustainable farming practices to address food security and poverty and hence the motivation for this study.

A review of studies on sustainable farming practices like the ones done by FAO in 2011, ICARDA in 2010, 2011, 2012 and 2013 show that there have been sustainable farming strategies that have been developed for dry lands like Misewani where communities have been able to increase crop productivity and hence address food security challenges. Therefore with the knowledge of such findings this study was designed to establish strategies for sustainable horticulture farming in Misewani. Therefore the statement of the research problem was to establish strategies for sustainable horticulture farming in Misewani region.

1.3 Purpose of the Study

The purpose of this study was to establish strategies for sustainable horticultural farming for Misewani region to help the local community address frequent food shortages and increase agricultural economic sustainability in the region.

1.4 Research Questions

The following research questions were generated to guide the study.

1.4.1 What is the nature and scope of sustainable farming?

1.4.2 What is the nature and scope of horticulture farming in Kenya?

1.4.3 What factors need to be addressed to make horticulture farming in Misewani more sustainable?

1.4.4 What key recommendations arise from this study?

1.5 Importance of the Study

1.5.1 Food security

Sustainable crop production approaches have the potential to improve food security through increased productivity and diversified crop strategies (Babu and Blom, 2014). Sustainable farming practices increase yields through use of better quality crop varieties and efficient use of available resources (FAO, 2011). Therefore if farmers in Misewani could adopt sustainable farming practices they could increase their crop productivity which would help in addressing food security challenges in the region.

1.5.2 Increased agricultural economic sustainability

Sustainable farming practices increase incomes from farming activity as a result of high crop productivity leading to surplus produce for sell and reduced cost of producing crops which in turn improves farmers' livelihoods through increased incomes for expenditure (International Center for Agricultural Research in the Dry Areas [ICARDA], 2013). Also planting diversified crop would increase farmers' variety to sell in the market for extra incomes (FAO, 2011). Farmers can use these extra incomes to pay for their education and health hence living better lives (FAO, IFAD and WFP, 2013).

1.5.3 Healthy Environments for a better tomorrow

Sustainable farming practices save on the usage of natural resources through efficient applications of inputs and the use of ecosystem farming approaches which do not cause

degradation of the environment (FAO, 2011). Farming practices like conservation agriculture and integrated pest management (IPM) are resource saving because they eliminate tillage and use of herbicides and they mitigate on climate change effects too (Kassam, Friedrich, Shaxson and Pretty, 2009). These practices also enable land that has been degraded to be brought back into productive use through the buildup of nitrogen, organic matter and micro- organisms in the soil which improve soil structure and water and nutrient holding capacity of the soil (FAO, 2009).

1.5.4 Local economy growth

Horticultural production generates forward production linkages when horticultural outputs are supplied as inputs to non-agricultural production and backward production linkages through its demand for intermediate inputs such as fertilizers and seeds leading to local economic growth which would create employment opportunities for the local community and hence improve on livelihoods (FAO, 2011). Employment opportunities would also provide incomes for purchasing different foods with different nutritional values further improving on improving on food security (FAO, IFAD and WFP, 2013).

1.6 Scope of the Study

The scope of this study includes sustainability of farming practices in arid and semi arid regions especially for the small scale farmers with limited resources like it is the case for Misewani. Therefore the findings of the study can be of use in regions with the same farming characteristics as those of Misewani.

1.7 Definition of Terms

1.7.1 Semi Arid climatic conditions

Semi Arid climatic conditions are climatic conditions characterized by relatively low annual rainfall of 25 to 50 centimeters (10 to 20 inches) and with a vegetative cover characterized mainly by shrubs, scrubs, and grass (ICARDA, 2009).

1.7.2 Agriculture

Agriculture also called farming encompasses the entirety of the system that grows, processes, and provides food, fiber, ornamentals, biofuel and other products used to sustain and enhance human

life (National Research Council of the National Academies, USA, 2010). This study uses the words agriculture and farming interchangeably.

1.7.3 Sustainable Agriculture

Sustainable agriculture can be defined in many ways, but ultimately it seeks to sustain farmers, resources and communities by promoting farming practices and methods that are profitable, environmentally sound and good for communities (SARE, 2012). The U.S Congress defines sustainable agriculture as “an integrated system of plant and animal production practices having a site-specific application that will, over the long term: satisfy human food and fiber needs; enhance environmental quality and the natural resource base upon which the agricultural economy depends; make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls; sustain the economic viability of farm operations; and enhance the quality of life for farmers and society as a whole" (National Research Council of the National Academies, USA, 2010). It is therefore a form of agriculture aimed at meeting the food and fuel needs of the present generation without endangering the resource base for the future generations (SARE, 2012).

1.7.4 Conservation Agriculture

Conservation Agriculture is a farming practice that involves the use of minimum or zero tillage and maintaining a protective organic cover on the soil surface, using crops, cover crops or crop residues to reduce soil erosion and water runoff, increase soil water retention, and reduce soil degradation and the cultivation of a wider range of plant species in associations, sequences and rotations to enhance crop nutrition and improve system resilience (National Research Council of the National Academies, USA, 2010).

1.7.5 Horticultural farming

Horticulture is the science, art, technology and business involved in plant cultivation for human use and it is very diverse in activities as it incorporates plants for food (like fruits, vegetables and mushrooms), non-food crops (like flowers, trees and shrubs, turf-grass, and medicinal herbs) and related services in plant conservation, landscaping, gardening, horticulture therapy and much more (Institute of Horticulture, 2011). The scope of this study was within that part of horticulture concerned with plants for food.

1.7.6 Food Security

The World Summit for Food Security defined food security to exist when “all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (FAO, 2012).

1.7.7 Poverty

The World Bank describes poverty as hunger, lack of shelter, being sick and not being able to see a doctor, not having access to school and not knowing how to read, not having a job, fear for the future and living one day at a time (FAO, IFAD and WFP, 2013).

1.7.8 Economic Sustainability of agriculture

Economic sustainability of agriculture at the farm level is its ability to ensure individual farm business viability, to maintain farm household economic security and to maintain or increase the quality of life for farm families and workers (National Research Council of the National Academies, USA, 2010).

1.8 Chapter Summary

This chapter was for introducing the reader to the study. It began with background introduction by stating the role played by the Kenyan horticultural sector in food security of the communities practicing, the main issue that motivated this study. The chapter then briefly discussed the global trends on sustainable farming and its application in the semi arid regions of the world. It then stated the problem of the study which was to establish strategies for sustainable horticultural farming in Misewani. The general objective of the study was to come up with up strategies for sustainable horticulture farming in Misewani so as to contribute in addressing food security and economic sustainability of agriculture in the region. Three research questions were generated to guide the research process and these were: the nature and scope of sustainable farming, nature and scope of horticulture farming practices in Kenya and farming practices in Misewani. The chapter also explained the benefits expected from the study, the scope of the study and the key words used in the study.

Chapter two gives a review of literature on the nature and scope of sustainable farming practices in globally, horticultural farming practices in Kenya and the current farming practices in Misewani while chapter three describes the methods and procedures used to carry out the study. Chapter four presents the results and findings of the study. Chapter five discusses the results and

findings in chapter four, draws conclusions from the discussion and makes recommendations in relation to those conclusions and for further studies.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature on the nature and scope of sustainable farming practices, the nature and scope of horticulture farming practices in Kenya and horticultural farming practices in Misewani. The chapter is structured according to the research questions; that is, the nature and scope of sustainable farming practices globally, the nature and scope of horticulture farming in Kenya and finally horticultural farming practices in Misewani. The chapter then closes with a summary of the main items covered throughout and a brief introduction of the remaining chapters.

2.2 Nature and Scope Sustainable Farming

Agriculture today is facing overwhelming challenges even though there have been tremendous achievements in science and agricultural production (FAO, 2011). First are the challenges associated with the Green Revolution of the 1960s in developing countries which used the industrial model to increase productivity (International assessment of agricultural knowledge, science and technology for development [IAASTD], 2009). The Green Revolution model used high-yielding crop varieties, irrigation, agrochemicals and modern management techniques to intensify crop production but this intensification was accompanied by unintended consequences such as land degradation, salinization of irrigated areas, over-extraction of groundwater, buildup of pest resistance, erosion of biodiversity, increased costs of production, and the disintegration of economic and social conditions in rural communities (Gerald and Olofinbiyi, 2011).

A second challenge facing agriculture is the increasing number of under nourished people in the world (FAO, 2011), majority of them being found in rural areas of developing countries (UNEP, 2012). A third challenge is the increasing demand for food and feed crops as driven by growing world population, changing urbanization trends, income growth in developing countries which is changing consumption styles, the use of agricultural commodities in the production of biofuels and increased demand for cereals to feed livestock (Food and Agriculture Organization of the United Nations [FAO], 2013). A fourth challenge is the need to adapt to climate change, which through alterations in temperature, precipitation and pest incidence will affect which crops can be grown and their potential yields (ICARDA, 2012). Fifth is the price and availability of energy

needed to power farm operations and produce key inputs like which is making agricultural production costs to go up (Gerald and Olofinbiyi, 2011). A sixth challenge is the rate at which pressure is mounting on resources and the broader environment from the expansion and intensification of agriculture (FAO, 2012). To address these challenges sustainable farming has emerged as a priority for world leaders (FAO, 2011).

2.2.1 What is involved in sustainable farming?

Sustainable farming describes farming systems that are capable of maintaining their productivity and usefulness to society indefinitely because they are resource-conserving, socially supportive, commercially competitive, and environmentally sound (SARE, 2012). Sustainable agriculture has four key goals, that is to: food security for all, enhanced environmental quality and the resource base that agriculture depends on, sustainable economic viability of agriculture and enhanced quality of life for farmers, farm workers, and society as a whole (US National Research council, 2010). It uses various ecosystem-based strategies to achieve these goals (FAO, 2011).

2.2.2 Goals of sustainable Farming

2.2.2.1 Food security

Food security is one of the key global challenges today (FAO, 2011). Thirteen years ago, world leaders came together to adopt the United Nations Millennium Declaration known as the Millennium Development Goals (MDGs) which committed nations to a global partnership to reduce extreme poverty and hunger (FAO, IFAD and WFP, 2013). Policies must be put in place to enhance agricultural productivity and increasing food availability, especially targeting the small scale farmers (FAO, 2011). However such production increases must be achieved in an environmentally sustainable way (FAO, 2012).

2.2.2.2 Enhancing environmental quality and the resource base

Transforming natural resources into food and non-food agricultural products in many cases has had negative consequences for the environment (FAO, 2012). Farming practices used should help minimize harm to the natural environment and to preserve the quality of basic natural resources by maintaining a healthy soil, clean water, and clean air (SARE, 2004). Sustainable farming practices based on ecosystem approaches have been found useful because they reduce the overuse of inputs such as mineral fertilizers while increasing productivity (Babu and Blom, 2014).

2.2.2.3 Sustainable Economic Viability of agriculture

Agriculture should be able to contribute to the economic security of the key actors in the farm and food system (U.S National Research Council, 2010). Farming practices must ensure that the individual farm business is viable, maintain farm's household economic security, and maintain or increase the quality of life for the farm families and workers (CIAS, 2012). Sustainable farming practices can increase the incomes of poor and spur rural development by creating markets and employment opportunities making possible equitable economic growth (FAO, IFAD and WFP 2013).

2.2.2.4 Social and Economic Equity

Marginalized smallholder farmers have long been locked in a cycle of low productivity, lack of assets and services and weak market power (ICRDA, 2011). In addition, they face a number of newer challenges including climate change, land degradation and groundwater depletion which are increasingly posing a threat to their livelihoods (FAO, 2011). Therefore agricultural systems should be retooled to address these challenge so as to reduce income inequalities and ensure fair access to production inputs and knowledge to all (IAASTD, 2009).

2.2.3 Key strategies in successful Sustainable farming

The success of sustainable farming depends on various strategies which have been developed over time in relation to the farming systems that farmers employ, soil management practices, crops and crop varieties planted, water management practices, plant protection practices, and policies and institutional arrangements governing agricultural activities (FAO, 2011). These are reviewed in the following sections.

2.2.3.1 Farming systems

Sustainable agriculture involves the use of farming systems that can offer a range of productivity, socio-economic and environmental benefits to producers and to society at large (FAO, 2011). Current farming systems are constrained in their capacity to respond to poverty and generate a range of livelihood options in rural areas for they are economically unviable (IAASTD, 2009) and continuing dependence on such systems has diminished the viability of subsistence production and caused environmental degradation (ICARDA, 2011). Farming systems for sustainable agriculture are based on conservation agriculture practices, the use of good seed of high-yielding adapted varieties, integrated pest management, plant nutrition based on healthy soils, efficient water management, and the integration of crops, pastures, trees and livestock

(FAO, 2011). They use ecosystem approaches characterized by minimal disturbance of the natural environment, plant nutrition from organic and non-organic sources, and the use of both natural and managed biodiversity to produce crops (ICARDA, 2012). Such systems are knowledge intensive and therefore policies should be put in place to build capacity through extension approaches such as farmer field schools, and facilitate local production of specialized farm tools (ICARDA, 2013).

2.2.3.2 Crops and variety Management

Crop diversity involves the cultivation of a wider range of plant species in associations, sequences and rotations that may include trees, shrubs and pasture (ICARDA, 2010). Sustainable farming requires crops and varieties that are better adapted to ecologically based production practices (FAO, 2011). Such crops must contain desirable genes that will provide farmers with higher yields, resistance to biotic and abiotic stress, greater adaptation to local conditions, and traits that offer high market value like increased shelf life and better processing characteristics (U.S National Research Council, 2010).

2.2.3.3 Pest management

The first line of defense against crop pests and diseases is a healthy agro-ecosystem which requires prevention before pests get a foothold in the garden (FAO, 2011). Sustainable farming practices have been found to offer prevention measures through maintaining a healthy soil, crops and varieties that are well-suited to the soil and climate, insect and disease-resistant crops, regular crop monitoring and spot control measures to keep pests in check and avoiding using pesticides that can kill beneficial predators and parasites found in gardens, orchards, and fields (ICARDA, 2013).

2.2.3.4 Soil Management

Two crucial characteristics of a healthy soil are a rich diversity of biota and a high content of non-living soil organic (FAO, 2011). A healthy soil must draw on natural sources of plant nutrition and a judicious use of mineral fertilizers (ICARDA, 2011). A well managed soil provides suitable fertility, structure, water holding capacity, better drainage capacity and sufficient depth for healthy crops and it makes crops that are less susceptible to pests and diseases (Magdoff and Van Es, 2009). Some sustainable farming practices which help in building a healthy soil include maintaining a permanent soil cover, using mulches rich in carbon, use of

minimum or zero tillage farming and planting leguminous crops and trees that are able to fix atmospheric nitrogen (FAO, 2011).

2.2.3.5 Water management

Growing pressure from competing demands for water, along with environmental imperatives globally call for efficient management of water resources and the need for farmers to learn farming practices that will produce more crops from fewer drops of water (U.S National Research Council, 2010). Under rain-fed systems water management can be improved by using deep-rooting crops in rotation, adapting crops to develop a deeper rooting habit, increasing soil water storage capacity through conservation agriculture, improving water infiltration and minimizing evaporation through organic mulching, and capturing of runoff from adjacent lands (FAO, 2011). Also farmers can adopt low-input supplementary irrigation systems in order to bridge short dry spells during critical growth stages by managing on-farm runoff (ICARDA, 2011).

2.2.3.6 Policy and institutional arrangements

To encourage smallholder farmers to adopt sustainable crop production practices and to include those other non agricultural sectors which are affected by the implementation of sustainable development goals, fundamental changes are needed in agricultural development policies and institutions (Kassam, Friedrich, Shaxson, & Pretty, 2009). Policies in various domains of agriculture will have to be redesigned to enable the small scale farmer and the rural population, and to provide them with incentives to adopt sustainable farming practices (IFAD, 2010). Such areas of agriculture that would require policy change include input and output pricing, access to quality seeds, payments for environmental services, and investment in public infrastructure and services (FAO, 2011).

Further to ensure effective policy implementation, institutional capacity is required (IFAD, 2010). Such institutions include those that provide land tenure programmes to encourage sustainable farming practices, quality plant genetic resources, effective agricultural research programmes, technical advice to farmers, financial services, insurance services, market access, and productive social safety nets (FAO, 2011). For example a well functioning agricultural extension service is one of the critical inputs required for increased agricultural productivity and hence governments should ensure that these services are adequately funded, well coordinated and

regulated to enable farmers to have timely access to technical information on farming practices at reduced transaction costs as research on farming technology unfolds (IFAD, 2011).

2.3 Horticultural farming practices in Kenya

This section reviewed literature on farming practices in the Kenyan horticultural industry so as to get a general view of the larger horticultural environment in which Misewani, a sub location in eastern Kenya is operates. It is structured into a brief overview of the industry, the farming systems in use, crop variety management strategies, pest management practices, soil management practices, water management practices, and the policy and institutional arrangements in the sector.

2.3.1 Overview of the industry

The Kenyan horticulture industry is an important sector in contributing to food security, livelihoods and reduction of poverty for communities practicing horticulture farming (Ministry of agriculture, 2010a). Horticultural farming in Kenya began during the early settlements of immigrant races under British colonial rule when missionaries and early settlers brought with them some fruit trees and vegetable seeds for growing in their kitchen gardens (Horticultural Crops Development Authority [HCDA], 2008a). According to HCDA there was no commercial activity then as all the products were consumed at family level and the indigenous Kenyans hardly participated in the growing of these horticultural crops as they were inaccessible and also not part of their diets.

After independence the government began to develop marketing systems for the subsector and today horticulture farming is an important subsector in Kenya's economy (Ministry of agriculture, 2010a). Farmers use advanced methods of crop production such as use of high yielding seeds, regular spraying to control pests and diseases and heavy application of fertilizers to ensure high yields (Ministry of Agriculture, 2010b). However, this advanced horticulture faming is found only in the highland regions of the country which occupy less than 20 % of the arable land whereas in the arid and semi arid regions occupying over 80% of the country horticultural production is not developed due to lack of rainfall (Agricultural Sector Coordination Unit [ASCU], 2011).

2.3.2 Farming systems

Horticultural production in Kenya is carried out under both rain-fed and irrigation systems (Government of Kenya, 2010b). Farmers practice integrated crop and livestock farming systems with the high and medium rainfall potential zones producing most of the crops while the low potential arid and semi-arid areas produce mostly livestock for beef and small ruminants (Government of Kenya, 2010a). Production systems are largely smallholders where the smallholder farmer is limited in the ability of applying advanced farming technology due to poor resource endowment and lack of adequate extension services (Government of Kenya, 2010b). Farming activity is capital and labor intensive (Ministry of agriculture, 2010a).

Irrigation-based farming is limited due to water scarcity and it accounts for only 1.7 percent of the total land area under agriculture (Ministry of Environment, Water and Natural Resources, 2013).

2.3.2 Crop Diversity Management

Kenya has a climate that favors growth of varied horticultural crops like vegetables, flowers, fruits, nuts medicinal and aromatic plants (Ministry of agriculture, 2010a). However this study is limited to farming practices on vegetables and fruits. The country has a hot and wet climate that favors the growth of tropical crops and a cool and wet climate prevailing in the Kenya Highlands especially in areas like Limuru that favours the growth of temperate crops (Agricultural Sector Coordination Unit [ASCU], 2012). Fruits include grapes, oranges, lemons and tangerines, bananas, loquat, dates, pawpaws, pineapple, avocados, apples, pears, peaches, plums and apricots while vegetables include carrots, turnips, parsnips, beetroot, peas, beans, lentils, soya beans, groundnuts cabbages, cauliflower, broccoli, Brussels sprouts, green grams, spinach, spruce, kales (sukuma wiki), strawberries, brassicas, onions, tomatoes, chillies and mushrooms among others (Horticulture Crops Development Authority (HCDA), 2008b).

The sector largely depends on imported planting material that offer high yielding seeds but mostly it is unaffordable for the small farmer (Ministry of agriculture, 2010a). However, there are many smallholder commercial fruit tree nurseries spread all over the country but the majority do not meet standards that would ensure supply of quality planting materials (Agricultural Sector Coordination Unit [ASCU], 2012).

2.3.3 Pest management

In Kenya a number of crop pests and diseases have continued to reduce the potential crop yields both pre and post harvest due to lack of or poor handling of pest and disease (Ministry of Agriculture, 2010b). Farmers use pesticides to control pests and diseases but the cost of pesticides is very high and unaffordable to most farmers leading to low application or adulteration to make the pesticide cheaper and this makes pesticides usage ineffective (Ministry of agriculture, 2010a). Also there is poor observance of safety in the use of agrochemicals which creates a risk factor for human and animal health (HCDA 2008a). Invasive pests like locusts, army worms and quelea birds are controlled by the Government (Ministry of Agriculture, 2010b).

2.3.4 Soil management practices

In the high potential horticulture producing zones soils are of volcanic origin and fertile favoring growing of a variety of crops and fertility is sustained by the liberal application of fertilizers (Ministry of Agriculture, 2010b). The zones are however characterized by high population density, many smallholder enterprises and intensive land use which have caused serious depletion of soil nutrients (Ministry of Environment, Water and Natural Resources [MEWNR], 2013).

In the medium and low production zones there is serious degradation of natural resources resulting from unsustainable farming practices and soils are infertile (KARI, 2011).

2.3.5 Water Management

Horticultural production in Kenya is mainly rain fed even though only 17% of the country's land is suitable for rain-fed agriculture because over 80 % of the land mass lies in the arid and semi-arid lands (ASALs) which experience unreliable and erratic rainfall (Ministry of Agriculture, 2010b). In the high altitude areas productivity as well as predictability of a good crop is high while in the medium altitude and moderate rainfall areas there is a relatively high risk of crop failure due to increased frequency of dry spells (Kenya Agricultural Research Institute [KARI], 2011). This makes it necessary for mechanisms to be developed on irrigation practices to supplement rain fed farming especially in the arid and semi arid regions of the country (The Kenya Arid and Semi-Arid Lands Programme [KASAL], 2014).

Sustainable development and management of irrigation in Kenya has been constrained by lack of a national policy and adequate financial resources (ASCU, 2011). Use of modern technology is

still limited by low investment in irrigation infrastructure despite availability of such technology in the market (Ministry of Agriculture, 2010a). Also water harvesting for irrigation is low (Ministry of Environment, Water and Natural Resources, 2013). The country's watersheds have been degraded by human activity leading to disappearance of some perennial rivers (Ministry of Agriculture, 2010b). Also increasing pollution of water bodies by industrial and domestic waste water is threatening the quality of water available for agriculture (Water resources management authority [WRMA], 2012).

2.3.6 Policy and Institutions

The Ministry of Agriculture is the lead agent in agricultural transformation in the country and it provides overall policy, regulation and operational direction through a national policy document known as the Agricultural Sector Development Strategy [ASDS] (Ministry of Agriculture, 2010b). The ASDS provides direction for all sector ministries and other key bodies in dealing with farmers, producers, processors and marketers of agricultural produce (ASCU, 2011). Different institutions are involved in the operations of the horticulture industry, both government and private (Ministry of Agriculture, 2010b).

Government Institutions include the sector ministries (Agriculture, Water and Irrigation, Public Health and Sanitation, Environment and Mineral Resources, Local Government, Cooperatives development and Marketing, Trade and Regional Development Authorities), Horticultural Crops Development Authority (HCDA), Kenya Plant Health Inspectorate service (KEPHIS), Kenya Agricultural Research Institute (KARI), Pest Control Products Board (PCPB), Kenya Bureau of standards (KEBS), Kenya Industrial Research and Development Institute (KIRDI), Export Promotion Council (EPC), National Environment Management Authority (NEMA) and all Universities and Colleges of Agriculture. The private sector organizations include among others, The Fresh Produce Exporters Association of Kenya (FPEAK), The Kenya Flower Council (KFC), The Kenya National Federation of Agricultural Producers (KNFAP), The Agrochemical Association of Kenya (AAK), and The Seed Traders Association (STAK) [Ministry of Agriculture, 2010a]. Other extension service providers include NGOs, community-based and faith-based organizations which have helped to fill the gap created by the reduced presence of public sector extension service (KARI, 2011).

Most of the small and medium scale horticultural farmers rely on the public service providers while large scale farmers depend on private extension services (HCDA, 2009). However, there are inadequate extension service providers to cater for the needs of all horticultural farmers (Ministry of Agriculture, 2010a).

2.4 Horticultural farming practices in Misewani.

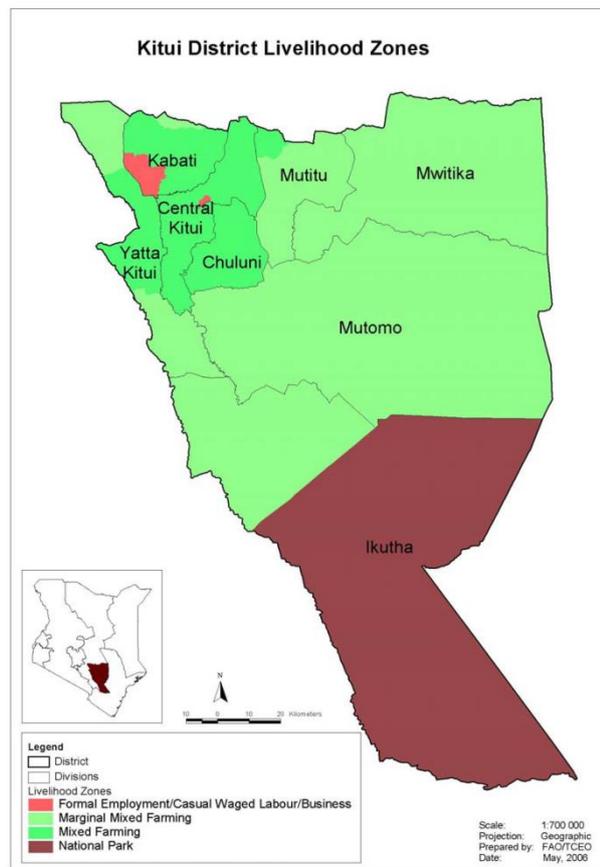
This section reviewed literature on current horticultural farming practices in Misewani sub location with an objective to identify areas that need to be addressed to enable farmers in that region adopt sustainable horticulture farming. It looked at the climatic, economic and characteristics of the region; the farming systems; crops grown; soil management practices; pest management practices; water management practices and the government support services to the farmers.

2.4.1 Climate, economic and physical environment characteristics

Misewani is in Kitui Central sub-county, Kitui County in the eastern part of Kenya and is situated on the highest areas of County where mixed farming is practiced as it can be seen in figure 2 which shows the livelihood zones on the map of former Kitui district before it was merged into the current Kitui County (National Drought Management Authority [NDMA], 2013). The region is characterized by semi-arid climatic conditions with very erratic and unreliable rainfall (between 500- 760mm per year), an increasing lack of rainfall due to climate change and frequent droughts (Kenya Food Security Steering Group, 2011).

The main economic activity is subsistence farming characterized by low agricultural productivity and limited alternative economic activities leading to poor livelihoods of the local community (Kenya Food Security Steering Group, 2009). Human activity such as clearing of land for agriculture and settlements has caused loss of biodiversity and severe land degradation in the region which further affects agricultural activity (Ministry of Environment and Natural Resources, 2009). Also water scarcity is a limiting factor for sustainable agricultural production in the region leading to perennial food shortages and widespread poverty (Kuria, Gachari, Macharia, & Mungai, 2012). Figure 2 is a Map of former Kitui District showing the livelihood zones.

Figure 2: Map of former Kitui District showing the livelihood zones



Source: FAO food security district profile, 2006

2.4.2 Farming practices in Misewani

2.4.2.1 Farming systems

Farmers in Misewani practice subsistence mixed farming where they grow crops and keep a few animals as a means to adapt to the difficult climate and physical environment and to spread risk against drought (Kenya Food Security Steering Group, 2011). Farming activity is mainly small scale and crop production depends on natural rainfall (Kuria, Gachari, Macharia, & Mungai, 2012). Horticultural activity is limited and is done along the river banks and other shallow wells where bucket irrigation is carried out before the water sources dry up during the dry season (Kenya Food Security Steering Group, 2009).

2.4.2.2 Crop Variety Management practices

Farmers in Misewani grow a variety of crops such as maize, beans, sorghum, pigeon peas, millet, mangoes, bananas, citrus fruits, sweet potatoes, kales and spinach but production is very limited

due to unreliable rainfall and lack of water for irrigation (Kenya Food Security Steering Group, 2012). Farmers also use poor quality varieties due to high cost of quality seeds and lack credit facilities to purchase quality seeds (Kenya Food Security Steering Group, 2009).

2.4.2.3 Pest management practices

A number of crop pests and diseases characterize this region posing a major challenge to most farmers (National Drought Management Authority [NDMA], 2014). Farmers use pesticides to control the pests but due to high cost of the pesticides most of the farmers are unable to afford therefore continuing to lose their potential of crop yields through pests and diseases (Ministry of Agriculture, 2010b).

2.4.2.4 Soil management practices

The soil types in this region range from sedimentary rocks to red sandy soils and clay black cotton soils which are generally low in fertility (Kenya Food Security Steering Group, 2009). Continuous land tilling and burning of vegetation during land preparations over time has caused a lot of land degradation and soil depletion (Ministry of Environment and Natural Resources, 2009). This has led to loss of biodiversity and low crop productivity in the region (KFSSG, 2011). To improve on soil fertility farmers use fertilizers but due to high cost of fertilizers, most of them are unable to afford the fertilizers and therefore they do not add anything to improve their soils (KFSSG, 2011).

2.4.2.5 Water management

The region receives limited unreliable rainfall and therefore there scarce water resources a factor that limits farming activity in the region (Kuria, Gachari, Macharia, & Mungai, 2012). Available water resources include seasonal rivers which form during rainy seasons and dry soon after the rains; underground water sources like boreholes, wells, springs and sand-storage dams; and piped water schemes from Masinga Dam (Ministry of Environment and Natural Resources, 2009).

However most of these available water facilities are poorly maintained and as a result they dry up during the dry seasons leaving the community with no water provisions (Kenya Food Security Steering Group, 2009) There is no modern irrigation system and farmers use bucket irrigation for any supplemental irrigation farming (Ertsen and Hut, 2009). Also water harvesting practices by farmers in this region are limited (Kuria, Gachari, Macharia, & Mungai, 2012).

2.4.2.6 Policy and Institutional Arrangements

Over the years institutional support and infrastructure have been inadequate in this region leaving farmers unable to employ the most contemporary methods and technologies in the region (Kenya Food Security Steering Group, 2009). But an overall national agricultural sector policy document, the ASDS, has been designed to provide direction for all agricultural activity throughout Kenya (Ministry of Agriculture, 2010b). The ASDS is implemented through district agricultural development committees (DADCs) made up of the sector ministries and stakeholders and it seeks to spur agricultural growth through the use of most contemporary methods and technologies (ASCU, 2012c). However, currently agricultural extension services are not sufficient in the region (Kenya Food Security Steering Group, 2012).

2.5 Chapter summary

This chapter reviewed literature on what is involved in sustainable farming, the nature and scope of horticulture farming in Kenya and horticulture farming practices in Misewani. Under sustainable farming the study looked at the challenges facing the current state of agriculture that uses industrial approach to farming and hence the need for adoption of sustainable agricultural practices. Sustainable agriculture was then defined, its goals explained, and the main principles underlying it described.

Under horticulture farming in Kenya the study began with a brief historical background, then the importance of the horticulture sector to the Kenyan economy and finally looked at the production practices in the industry. Under horticultural practices in Misewani, the study reviewed the current horticultural farming practices in the region to see which practices would require modification to enable farmers adopt sustainable horticulture farming practices.

The next chapter explains the research methodology used in this study.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This chapter explains the method used to carry out the study. It explains the research design used, the population of the study, the sampling design, data collection methods used, the research procedures followed and the data analysis methods used. It then closes with a summary of the main points included in chapter.

3.2 Research Design

A descriptive research design was used in this study. Descriptive research design is a type of research method that is used when one wants to get information on the current status of a person, an object or a situation and it is used to describe what is in existence in respect to conditions or variables that are found in a given situation without affecting normal behavior (Shuttleworth, 2008). According to Shuttleworth descriptive studies may involve surveys, interviews, observational studies and studies involving data collection using existing records to collect the necessary information. Descriptive research designs help provide answers to the questions of who, what, when, where, and how associated with a particular research problem but they cannot conclusively ascertain answers to why (Herek 2012).

The objective of this study was to establish strategies for sustainable horticulture farming in Misewani sub-location, a region with scarce water resources. To achieve this objective one needed to know what sustainable farming involves, the farming practices in the wider Kenyan horticulture industry and the current horticultural practices in Misewani. Therefore a descriptive research design was found to be appropriate for the study so as to collect data on the current situation on sustainable farming around the world, on the Kenyan horticulture industry and on Misewani sub-location. The design involved use of both secondary and primary data.

Questions one and two used secondary data, that is, desk research. Desk research involves processing data that has already been collected by another party and the researchers consults previous studies and findings such as reports, press articles and previous market research projects in order to come to a conclusion (Market Research World [MRW], Accessed 2014). Question one aimed to gather information the nature and strategies employed on sustainable farming

generally while question two aimed to gather information on the nature and scope of horticultural practices in Kenya and therefore the study sought to use relevant publications and reports for these areas. Question three which was on horticultural farming practices in Misewani used primary data collected through an interview process.

3.3 Population and Sampling Design

3.3.1 Population

A research population is a well-defined collection of individuals or objects known to have similar characteristics that is the main focus of a scientific query and all individuals or objects within a certain population usually have a common, binding characteristic or trait (Explorable.com, 2009). There are two types of population in research, target population and accessible population (Shuttleworth, 2008). Target population, also known as the theoretical population, refers to the entire group of individuals or objects to which researchers are interested in generalizing the conclusions and usually has varying characteristics (Explorable.com, 2009). The target population for this study was horticultural farmers in Kitui central sub-county where Misewani sub-location is found. According to HCDA (2010), Kitui central sub-county has a total population of 1,840 horticultural farmers mainly growing mango trees as most of the other horticultural crops do not do well in the region due to water scarcity (Kuria, Gachari, Macharia, & Mungai, 2012).

The accessible population also known as the study population is the population in research to which the researchers can apply their conclusions and it is a subset of the target population and the population that researchers draw their samples from (Explorable.com, 2009). The accessible population for this study was horticultural farmers in Misewani sub-location growing vegetables and fruits. A preliminary study in the area found only ten farmers doing horticulture farming in the region on very small scales basis due water scarcity to sustain crops after rainy seasons. These ten farmers were taken to form the study population.

3.3.2 Sampling Design

3.3.2.1 Sampling Frame

Sampling is the process of selecting units from the study population of interest to form a sample so that by studying the sample we may fairly generalize our results back to the research target population (Trochim 2006). A sampling frame is the list of all elements in the study population and it defines the population from which the sample is drawn (Herek 2012). It is a listing of the accessible population from which one can draw a sample (Trochim 2006). The accessible population and hence the sampling frame for this study was the ten farmers identified through the preliminary study to be growing vegetables and fruits in Misewani sub-location. These were allocated symbols F1, F2...up to F10 for ease in referencing during the study.

3.3.2.2 Sampling Technique

A Sampling technique is the procedure of selecting the sampling units from the sampling frame and it should provide the required estimates with associated margins of uncertainty arising from examining only a part and not the whole (Trochim, 2006). For this study the sampling frame consisted of ten farmers who were located at fairly close ranges because they shared the water sources used to water the crops. It was then decided to involve all ten of them in the study since the number was small. Therefore all the ten units in the sampling frame were included in the research design process as the number that would be interviewed and hence no sampling technique was used.

3.3.2.3 Sample size

The total number of ten farmers forming the sampling frame was included in the design stage for interview and therefore the sample size was the same as the accessible population, that is, ten farmers.

3.4 Data Collection Methods

This study involved data collection at two different levels. There was data collection that used secondary data sources where data was collected from existing documents for research questions one and two. There was also data collection from primary data sources which involved a field study. The field study used personal interviews with the farmers to collect data.

3.5 Research Procedures

The research procedures for this study involved collecting both primary and secondary data. Secondary data was collected for question one on the nature and scope of sustainable farming and question two on the nature and scope of horticulture farming in Kenya. The process involved reading different publications and reports and collected data then sorted and analyzed for results and recommendations.

Primary data was collected for question three on current horticultural practices in Misewani. Data collection involved interviewing horticultural farmers in Misewani and response recorded in the questionnaires. Collected data was then analyzed using SPSS computer software for results and recommendations.

3.6 Data Analysis Methods

For questions one and two which involved analysis of secondary data collected from different publications and reports data was sorted and conclusions drawn from the findings. SPSS computer software was used for data analysis in for research question three which involved field work and primary data collection from farmers in Misewani. After data was collected, it was sorted out and checked for correctness, then coded and keyed into computer for analysis. The SPSS computer software was used to generate frequency tables which were used in drawing conclusions from the study.

3.7 Chapter Summary

This chapter detailed the methodology used in this study. It began with a brief outline of what was to be done. It then explained the research design or strategy followed in the study, it being a descriptive study approach. The chapter also explained the study population and the sampling process, the data collection methods used, research procedures followed and data analysis methods used followed were all explained.

Chapter four will present the results and findings of the study.

CHAPTER FOUR

4.0 RESULTS AND FINDINGS

4.1 Introduction

This chapter presents the results and findings of the study. It starts with general information on the study subjects and it then presents the findings on the research questions. Findings presentation start with research question one on the nature and scope of sustainable farming, then question two on the nature and scope of horticulture farming in Kenya and finally on question three on horticultural practices in Misewani. The chapter ends with a summary of the main findings of the study.

4.2 General Information

This study used both primary and secondary data. Findings on questions one and two are based on secondary data collected from different publications. For question one which was meant to provide information on the nature and scope of sustainable farming, findings are based on publications from different organizations and individuals who have been researching on sustainable farming practices around the world including FAO, ICARDA, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), UNEP and Sustainable Agriculture Research and Education (SARE) programs among many others. Findings on question two are based on publications from government, private and non government institutions in the Kenyan horticulture industry.

Findings on question three are based on primary data collected through a field study on horticultural practices in Misewani which involved interviewing farmers practicing horticulture farming in the region. Ten farmers, the only farmers identified to be carrying some form of horticulture farming in the area of study identified through a pilot study were included in the design process.

4.2.1 Response Rate

The response rate for the field study under research question three was 60% was considered sufficient for the study since all farmers in the region experience similar farming conditions and were not likely to differ in a significant way in their responses to the study questions.

Figures 4.1 and 4.2 show the gender and the age distributions of the respondents respectively.

Figure 4.1: Gender of the respondents

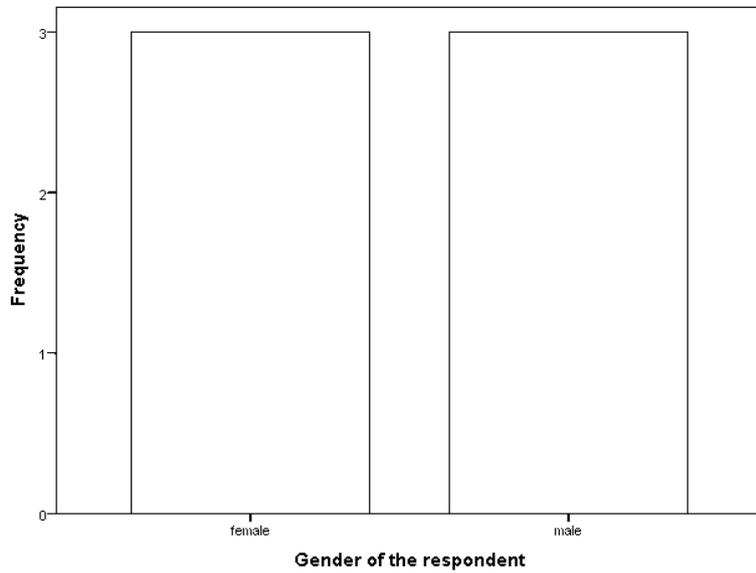
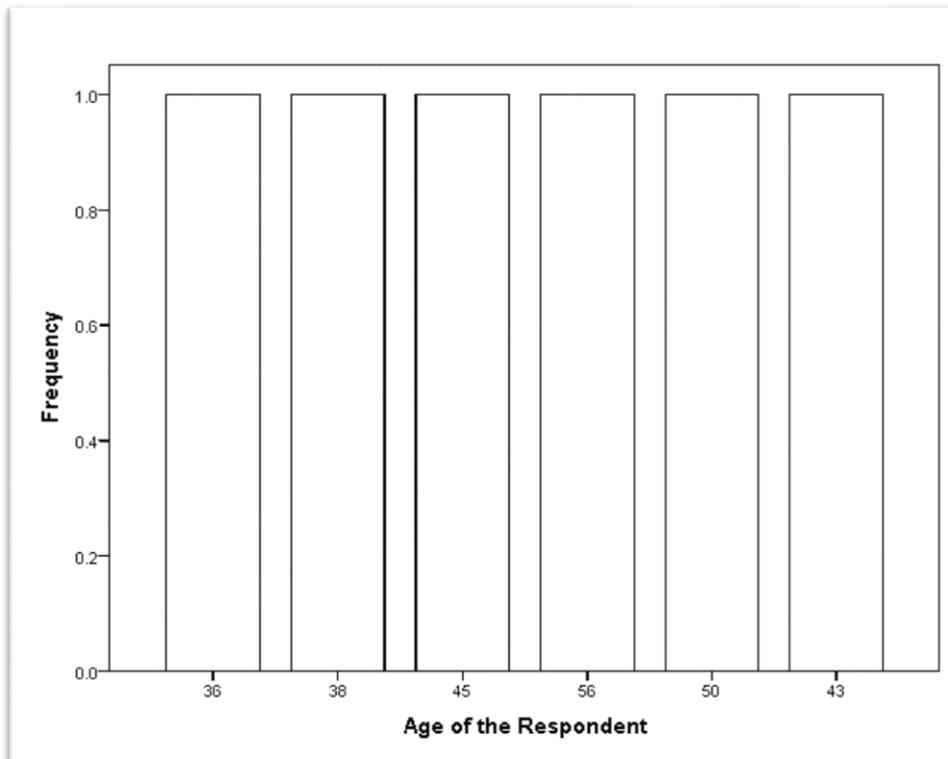


Figure 4.2 Ages of Respondents



4.3 Nature and Scope of Sustainable farming

This section used secondary data from different publications on sustainable farming. It presents findings on the definition of sustainable farming, its goals and the strategies used to implement it.

4.3.1 What is sustainable farming

This study consulted various publications on the meaning of sustainable farming and the following are some of the definitions among the many found. The National Research Council of the National Academies (2010) uses the term ‘sustainable farming’ to refer to farming approaches (farming practices and systems, technological advances and management strategies) aimed at achieving four main goals of sustainable food security for the world population, economic viability of agriculture, environmental enhancement and quality life for farmers, farm workers, and society as a whole. FAO (2011) report on sustainable intensification of food production defines it as farming that enables farmers to produce more from the same area of land while reducing negative environmental impacts and increasing contributions to natural capital and the flow of environmental services.

The U.S Congress defines sustainable agriculture as “an integrated system of plant and animal production practices having a site-specific application that will, over the long term: satisfy human food and fiber needs; enhance environmental quality and the natural resource base upon which the agricultural economy depends; make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls; sustain the economic viability of farm operations; and enhance the quality of life for farmers and society as a whole” (National Research Council of the National Academies, USA, 2010).

The need for adoption of sustainable farming practices has been brought about by various challenges facing current farming practices which include land degradation, buildup of pest resistance, erosion of biodiversity, increased costs of production, and the disintegration of economic and social conditions in rural communities which resulted from the green revolution of the 1960s (FAO, 2011); increasing number of under nourished people in the world (FAO, 2010); increasing demand for food driven by growing world population (FAO, 2013); the need to adapt to climate change (ICARDA, 2012); and the price and availability of energy needed to power farm operations (National Research Council of the National Academies, USA, 2010) among others.

From these definitions sustainable farming practices are able to increase crop productivity for food security using fewer resources.

4.3.2 Goals of sustainable farming

This study found that sustainable farming has four main goals of food security, enhancing environmental sustainability, agricultural economic viability and enhancing quality of life for farmers, farm workers, and society as a whole (The Sustainable Agriculture Research and Education [SARE], 2009).

4.3.2.1 Food Security

Food security is a key global challenge which thirteen years ago made world leaders to come together to adopt the United Nations Millennium Declaration known as the Millennium Development Goals (MDGs) of which MDG 1 committed nations to a global partnership to halve the proportion of hungry people in the total population by the year 2015 so as to improve the lives of billions of people (FAO, 2011). Studies on food security have found that policies aimed at enhancing agricultural productivity and increasing food availability, especially when smallholders are targeted, can achieve hunger reduction even where poverty is widespread (United Nations Environment Programme [UNEP], 2012). However such food production increases must be achieved in an environmentally sustainable way given the pressures building on global ecosystems (FAO, 2012).

This implies that policies aimed at enhancing agricultural productivity should be formulated to reduce hunger and poverty and they should target smallholder farmers.

4.3.2.2 Enhancing environmental quality and the resource base.

Transforming natural resources into food and non-food agricultural products in many cases has negative consequences for the environment (FAO, 2012). But research has shown that sustainable agricultural practices help minimize this harm to the natural environment through the use of principles of nature to develop systems for raising crops and livestock that are self-sustaining (Babu and Blom, 2014). Sustainable farming practices ensure increased productivity with minimum negative impacts on the environment and the resource base and they also help in recovering already degraded lands (FAO, 2011). Therefore if farmers adopt sustainable farming practices they would save further degradation of the environment and can also restore already degraded lands.

4.3.2.3 Sustainable economic viability of agriculture

For agriculture to be able to contribute to sustainable development, it should be economically viable so that it contributes to the economic security of the key actors in the farm and food system (FAO, IFAD and WFP, 2013). Farming practices must ensure that the individual farm business is viable, maintain farm's household economic security, and maintain or increase the quality of life for the farm families and workers (National Research Council of the National Academies, USA, 2010). Therefore besides financial profitability, efficiency, and returns to various assets, agriculture should provide broader outcomes such as having sufficient income to meet household needs and ensure an adequate quality of life for those working in the farms (FAO, 2011).

Measures that increase the incomes of poor families can have an even more positive effective and spur rural development by creating vibrant markets and employment opportunities making possible for equitable economic growth (FAO, IFAD and WFP, 2013). Appendix A summarizes strategies that can be used to achieve economic viability as reducing cost of production through use of conservation agriculture practices and biological means of controlling pest. Sustained economic viability of farming practices would lead to increased incomes available to farmers and therefore better living conditions for them.

4.3.2.4 Enhanced quality life for farmers, workers, and general society

Research has shown that marginalized smallholder farmers have long been locked in a cycle of low productivity, lack of assets and services and weak market power (ICARDA, 2011; FAO, 2011; Gerald and Olofinbiyi, 2012). In addition, they face a number of newer challenges including climate change, land degradation and groundwater depletion which are increasingly posing a threat to food security and the livelihoods of rural people majority of who depend on agriculture for their livelihoods (Babu and Blom, 2014). To address these challenges world leaders have called for agricultural systems to be retooled so as to reduce income inequalities and ensure fair access to production inputs and knowledge to all (IAASTD, 2009).

Such retooling must include options for enhancing rural livelihoods through increasing access by small scale farmers to land and economic resources and to remunerative local urban and export markets; and increasing local value added and value captured by small scale farmers (Babu and Blom, 2014). It has been established that sustainable farming practices empower farmers to innovatively manage soils, water, biological resources, pests, disease vectors, crop diversity, and conserve natural resources in a culturally appropriate manner (FAO, 2011).

Appendix A shows some of the farming strategies that contribute towards this goal to include diversified crop varieties which contribute to more income, respectful treatment of employees working on the farm to whom are offered personal loans, good communications, healthy and safe work environment among others. Such practices would improve on the wellbeing of the farmer, those working for him and that of the general society by creating happy and well fed society free of poverty.

4.3.3 Strategies for Sustainable farming

This study found that several strategies are employed to achieve sustainable farming. These are embedded in the areas of farming systems, soil management practices, crops and crop varieties, water management practices, plant protection practices, and policies and institutional arrangements (FAO, 2011).

4.3.3.1 Farming systems strategies

Sustainable farming systems are based on conservation Agriculture (CA) principles of zero or minimum tillage in order to maintain soil organic matter, soil structure and overall soil health; maintaining a protective organic cover on the soil surface to protect the soil surface, conserve water and nutrients, promote soil biological activity and contribute to integrated weed and pest management; and cultivating a wider range of plant species in order to enhance crop nutrition and improve system resilience (FAO, 2011). However for these principles to produce best results in productivity they must be supported by management practices of using well adapted high-yielding crop varieties, healthy soils, integrated pest management practices and efficient water management (ICARDA, 2012).

Farming systems based on these principles and management practices offer a range of productivity, socio-economic and environmental benefits to producers and to society at large which include high and stable production and profitability; adaptation and reduced vulnerability to climate change; enhanced ecosystem functioning and services; and reductions in agriculture's greenhouse gas emissions (Babu and Blom, 2014).

4.3.3.2 Soil management strategies

Farmers must maintain healthy soils because they help control plant diseases, form beneficial symbiotic associations with plant roots, recycle essential plant nutrients, improve soil structure and nutrient holding capacity, pollution to the environment and ultimately improve crop

production (Intergovernmental Panel on Climate Change [IPCC], 2007). A combination of ecosystem processes and wise use of mineral fertilizers forms the basis of a sustainable soil health management system that has the capacity to produce higher yields while using fewer external inputs (FAO, 2011).

For a good crop produce farmers should ensure availability of soils nutrients by applying balanced amount of nutrients from organic sources and from mineral fertilizers, if required (Babu and Blom, 2014). Nitrogen can also be added to soil by integrating nitrogen fixing legumes and trees into cropping systems (Gerald and Olofinbiyi, 2011). Where these ecosystem processes fail to supply sufficient nutrients for high yields, then a judicious and efficient application of mineral fertilizers should be used (FAO, 2011). Soil management practices which draw on natural sources of plant nutrition will reduce the cost of farming as farmers will use less mineral fertilizers and will also lead to healthier environments because there will be less pollution of ground water by mineral salts.

4.3.3.3 Crops and crop variety management strategies

This study found out that sustainable farming involves the use of a genetically diverse portfolio of improved crop varieties that are suited to a range of agro-ecosystems and farming practices, and resilient to climate change (FAO, 2011). Crop diversity involves the cultivation of a wider range of plant species in associations, sequences and rotations that may include trees, shrubs and pasture (ICARDA, 2010). Crop diversity management can contribute towards better livelihoods as it can help farmers reduce their risk by responding to changes in market demand and adapting to external shocks caused by climate change.

4.3.3.4 Water management strategies

Sustainable farming requires smarter precision technologies for water application and farming practices that use ecosystem approaches to conserve water (ICARDA, 2010). Farmers must improve the efficiency of water application and minimize water loss (Gerald and Olofinbiyi, 2012). Appendix A has listed some of these practices to include use of plant cover crops, organic matter, conservation tillage, mulches, grass waterways, buffer strips, riparian vegetation, drip irrigation, irrigation scheduling based on soil moisture.

Adoption of better water management practices especially in the arid and semi arid regions would improve on agricultural productivity and hence improve farmer's livelihoods.

4.3.3.5 Plant protection strategies

This study found that sustainable farming practices must apply integrated pest management (IPM) practices to control pests and diseases. IPM is founded on the idea that the first and most fundamental line of defense against pests and diseases in agriculture is a healthy agro-ecosystem, in which the biological processes that underpin production are protected, encouraged and enhanced (FAO, 2011). The aim of pest management is not to totally eradicate an insect pest but to manage the insect pest populations to the point where natural predation operates in a balanced way and crop losses to pests are kept to an acceptable minimum (New South Wales Department of Primary Industries, 2006).

Pests and accompanying species such as predators, parasites, pollinators, competitors and decomposers are components of crop associated agro-biodiversity that perform a wide range of ecosystem functions and a total eradication would reduce the food supply of the pest's natural enemies, undermining a key element in system resilience (McDougall, 2011). From appendix A lists some of the strategies for use in IPM to include use of diverse range of pest-resistant crop varieties, crop rotations, inter-cropping, optimized planting time and weed management.

Farmers would benefit from a better understanding of the functioning and dynamics of ecosystems and the role of pests as an integral part of agro-biodiversity because enhancing those processes can increase yields and sustainability while reducing input costs (FAO, 2011).

4.3.3.6 Policies and institutional arrangement strategies

Findings on agricultural policies and institutions are that policies and institutions in the current farming systems do not to encourage smallholder farmers to adopt sustainable crop production practices (FAO, 2011). Therefore to encourage the small scale farmers adopt sustainable farming and to include those other non agricultural sectors which are affected by the implementation of sustainable development goals, policies in various domains of agriculture will have to be redesigned to come up with strategies which will help the small scale farmer and the rural population, and to provide them with incentives to adopt sustainable farming practices (IFAD, 2010). Such areas of agriculture that would require policy change include input and output pricing, access to quality seeds, payments for environmental services, and investment in public infrastructure and services (FAO, 2011).

4.4 Nature and scope of horticultural farming practices in Kenya

This section used secondary data obtained from publications on the performance of the Kenyan horticultural industry. It is structured into general performance of the industry, the farming systems, crop varieties management, pest management practices, soil management practices, water management practices, and policy and institutional arrangement strategies.

4.4.1 Performance of the industry in terms of goals of sustainability

In terms of performance of the industry in contributing to the goals of sustainability this study found out that the Kenyan horticulture industry plays an important role in contributing to food security, economic sustainability through employment creation and income to farmers, and social wellbeing for those communities in the high altitude parts of the country where horticulture production is favored by conducive climate (Horticultural Crops Development Authority [HCDA], 2008a). Due to this importance of agriculture in contributing towards the goals of sustainability and towards which horticulture contributes 33%, it has been identified under the country's Vision 2030 as one of the key economic sectors expected to drive the country's economic growth.

However this study further found that in the arid and semi arid regions which occupy over 80% of the country horticultural production has not developed due to lack of reliable rainfall (Ministry of Agriculture, 2010b). Populations in these arid and semi arid regions are poor and have suffered social exclusion and economic marginalization resulting from investment patterns favoring areas deemed to be of highest potential returns (Poverty Eradication Commission [PEC], 2009). This implies that for horticulture to be able to contribute towards the achievement of the goals of Kenya vision 2030 in the arid and semi arid regions, farmers have to start using farming practices that support the climatic conditions of the regions.

On environmental enhancement, the study found out that there have been unsustainable land use practices accompanied by increasing population, changing patterns of human settlement and expansion of urban environments causing serious degradation of the environment and natural resources (Ministry of Agriculture 2010b). This has led to loss of biodiversity resources and the country is considered among countries with low forest cover (Ministry of Environment and Natural Resources, 2009). Pollution and waste from increased agricultural activity is also one of

the environmental health problems affecting both rural and urban populations (Ministry of Agriculture, 2010b).

More, the country's water towers (the forests of the Aberdares, Mt Kenya, Mt Elgon, Cheranganyi Hills and Mau) have suffered forest clearance making many lakes and rivers to reach critical low levels and some other rivers disappearing from the map altogether (Ministry of Environment and Mineral Resources , 2010). This shows that farmers have to be educated on farming practices that will beside increasing productivity also reduce the harm caused to the environment by farming activities.

4.4.2 Farming system strategies

This study found out that the farming systems in Kenya are predominantly conventional where land preparation involves tilling before planting the crops (Agricultural Sector Coordination Unit [ASCU], 2012). According to a FAO report on food security and agricultural mitigation in developing countries (FAO, 2009) the area under conservation Agriculture in Kenya is approximately 18000 (ha) with about 5000 small scale farmers involved where the take up experiences are driven by donor and non-governmental organizations.

Also horticulture farming operations are intensive and high input dependent systems (Horticultura Crops Development Authority (HCDA), 2008b). Scale operation is mainly small-scale farming and adoption of modern farming practices by the small scale farmers is relatively low because the smallholder farmers are less endowed with the necessary physical facilities and skills (Ministry of agriculture, 2010a). These findings imply that for horticulture to become a low cost farming activity for the small scale farmer, farmers have to learn how to use the ecosystem approaches in farming which lower the cost of crop production through conservation agricultural practices (FAO, 2011).

4.4.3 Crop varieties strategies

This study found out that Kenya's ideal tropical and temperate climatic condition makes it favorable for production of wide range of vegetables, fruits and nuts (Ministry of agriculture, 2010a). Vegetables grown include cabbages, kales tomatoes, onions, carrots, French beans, spinach, peas, potatoes, spices and indigenous vegetables while fruits include bananas, mangoes, avocado citrus, passion fruits, pineapples, pawpaw, melons, temperate fruits, minor Fruits and

nuts include macadamia nuts, cashew nuts and ground nuts(Horticultura Crops Development Authority (HCDA), 2008b). This shows that farmers are able to diversify their production activities and better their lively hoods.

Further the study found that the sector largely depends on imported planting material which is mostly unaffordable to the small scale farmer and that locally produced certified material is inadequate due to low investments in that area(Ministry of agriculture, 2010a). There are many smallholder commercial fruit tree nurseries spread all over the country but the majority do not meet standards that would ensure supply of quality planting materials (Agricultural Sector Coordination Unit [ASCU], 2012). There is also counterfeiting, adulteration and lack of quality advisory services to farmers on the best seeds to use (Ministry of agriculture, 2010a). This shows that there is need for the horticulture sector and the supporting ministries to better the seed development policies.

4.4.4 Pest Management strategies

This study found out most of the farmers use pesticides to control pests and diseases but the cost of the pesticides is high leading to low application and adulteration (Kenya Agricultural Research Institute [KARI], 2011). Many farmers do not have adequate information on pest and disease control leading heavy losses caused by plant diseases and reduced productivity or poor quality produce with less market value (Horticultura Crops Development Authority (HCDA), 2008b). There is also low preparedness, response capacity and coping mechanisms in the event of diseases and pests disasters on the part of the government (Government of Kenya, 2012a).

This shows that farmers in the industry need to learn and adopt the Integrated Pest Management (IPM) practices as practiced in sustainable farming systems. Such practices are cheaper and environment friendly (FAO, 2011).

4.4.5 Water management strategies

On water management this study found out that Kenya's agriculture is mainly rain fed, even though over 80 per cent of Kenya's land lies in the arid and semi-arid lands (ASALs) where sustainable rain fed crop production is limited by unreliable erratic rainfalls (Ministry of Environment and Mineral Resources , 2010). Seasonal variations in production are very common and production is usually below optimum since farmers have to wait until it is rainy season to

plant any crops (Ministry of agriculture, 2010a). This means lost opportunity for better livelihoods.

It was further found that Kenya has an estimated irrigation potential of 1.3 million ha with about only 114,600 ha of irrigation area having been developed (Ministry of Environment, Water and Natural Resources[MEWNR], 2013). According to MEWNR of the remaining irrigation potential, 540,000 ha can be developed with the available water resources, while the rest will require water harvesting and storage. The country's water harvesting and storage is very low standing at only 183.6 million m³ for all uses which is equivalent to only 3 months of use. If the country does not receive rains for only 3 months, it would experience famine, drought and low irrigation levels (Water resources management authority [WRMA], 2012).

Also the quantity and quality of water available for use is continually declining partly due to agricultural activities on riparian land and water catchment areas (Ministry of Agriculture, 2010b). This calls for adoption of efficient water management practices so as to increase agricultural productivity with the available water resources, increase water harvesting techniques to enable more irrigation farming and adopt conservation agriculture practices which prevent evaporation of water moisture (FAO, 2011). There is also need to educate farmers on the benefits of reclaiming riparian lands and catchment areas for sustainable future farming (Gerald & Olofinbiyi, 2011).

4.4.6 Soil Management strategies

This study has found that there have been unsustainable land use practices which have led to continued soil degradation and a decline in productivity (Agricultural Sector Coordination Unit [ASCU], 2012). According to ASCU rising population density has contributed to reduction of fallow periods leading to continuous cultivation of land which has caused serious depletion of soil nutrients, declining yields and environmental degradation. This calls for soil management practices that will increase productivity without depleting the natural resources.

4.4.7 Policy and Institutions strategies

Agricultural policy in Kenya is coordinated by the Agricultural Sector Coordination Unit (ASCU) which was established to address the fragmentation of responsibilities among different agricultural and rural development related ministries (Ministry of Agriculture, 2010b). According to this ministry report, that is, (Ministry of Agriculture, 2010b), the ASCU has developed an

overall national policy document for the sector ministries and all stakeholders in Kenya known as the Agricultural Sector Development Strategy (ASDS).

Under the ASDS the sector ministries and other key bodies are expected to ensure that farmers, producers, processors and marketers of agricultural produce employ the most contemporary methods and technologies through the district agricultural development committees (Agricultural Sector Coordination Unit [ASCU], 2011). However this has not been the case especially for the arid and semi regions where productive farming activity has been neglected with no extension service for the farmers (Poverty Eradication Commission [PEC], 2009). This implies that policies in the ASDS for the arid and semi arid regions have not been implemented as intended to exploit the potential of the industry in addressing food security, unemployment and poverty alleviation in the regions.

4.5 Horticultural farming practices in Misewani

This section reports on the findings on contributions of horticulture farming in Misewani based on the goals of sustainable farming as identified under section 4.3.2 of this chapter and an evaluation of farming strategies used by the farmers against the findings of section 4.3.3 of the chapter.

4.5.1 Contributions towards goals of sustainable farming

The study used one factor to measure the performance of each goal of sustainable farming. For food security it used food availability; for environmental enhancement it used soil erosion prevention; for economic viability it used profit which is the difference between amount earned from farming activity and the amount spent for the same; for social equity the study used the ability to acquire new assets or services using profits from farming activity to improve living conditions.

4.5.1.1 Contribution to food security

Table 4.5.1.1 Does horticulture farming contribute to food security

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid yes	1	16.7	16.7	16.7
Valid no	5	83.3	83.3	100.0
Total	6	100.0	100.0	

Only 16.7% of the respondents have had horticultural farming contributing to food security.

4.5.1.2 Contribution to enhancement of the environment (Preventing soil erosion)

Table 4.5.1.2 Do you control soil erosion

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid yes	6	100.0	100.0	100.0

Every interviewed farmer had some measure of soil erosion control in place. This shows that the farmers are aware of the importance of maintaining a healthy soil.

4.5.1.3 Contribution to Economic Sustainability of farming

This goal was measured by excess income over expenditure on the farming activity.

Table 4.5.1.3 Do you earn more than you spend in farming

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Yes	1	16.7	16.7	16.7
Valid No	5	83.3	83.3	100.0
Total	6	100.0	100.0	

Only 16.7% of the respondents earn more than they spend in their farming activities implying that horticulture farming in the region is not economically sustainable.

4.5.1.4 Contribution to quality life for farmers

This was measured using availability of surpluses from horticulture farming for farmers to acquire new assets or services for better living conditions.

Table 4.5.1.4 Surplus to acquire new assets

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	1	16.7	16.7	16.7
Valid no	5	83.3	83.3	100.0
Total	6	100.0	100.0	

Only 16.7% of the respondents have had surpluses from horticulture farming to enable them acquire new assets and or services to improve their living conditions.

4.5.2 Farming practice strategies

The farming practice strategies were evaluated against three principles of conservation agriculture, a major strategy used to ensure sustainability of farming systems as established under the findings in section 4.3.3.1. These principles are zero tillage of land, crop rotation and use of cover crops to protect top soil and retain moisture.

4.5.2.1 Land tillage practices

Table 4.5.2.1 Tilling Land

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid yes	6	100.0	100.0	100.0

100% of the respondents till their land during preparations to plant crops

4.5.2.2 Crop Rotation practices

Table 4.5.2.2 Practice crop rotation

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid yes	1	16.7	16.7	16.7
Valid no	5	83.3	83.3	100.0
Valid Total	6	100.0	100.0	

Only 16.7% of the respondents practice crop rotation

4.5.2.3 Have planted cover crops

Table 4.5.2.4 Have cover crops

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid no	6	100.0	100.0	100.0

None of the respondents has planted cover crops to protect their soils.

As per these results all three principles of conservation farming are not in practice in this region.

4.5.3 Crop varieties management strategies

Two factors were measured in this section, diversity of crops grown and quality of seeds planted.

4.5.3.1 Crop Diversity

Table 4.5.3.1 Do you plant different varieties in one season

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid yes	6	100.0	100.0	100.0

100 % of the respondents plant different crops hence they practice crop diversity.

4.5.3.2 Quality of seeds used

Measure used here was whether farmers use hybrids seeds from specialized producers or from other local sources not of good quality.

Table 4.5.3.2 Do you plant hybrid or local varieties

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid local	4	66.7	66.7	66.7
both local and hybrid	2	33.3	33.3	100.0
Total	6	100.0	100.0	

66.7 % use sources of seeds that are not of good quality while the remaining 33.3 % use both hybrid and other local sources.

4.5.4 Pest Management strategies

Two factors were used; the presence of Integrated Pest Management (IPM), a strategy used under sustainable farming practices as per findings in section 4.3.3.5 and the usage of pesticides.

4.5.4.1 Use of Integrated Pest Management (IPM)

Table 4.5.4.1 Do you know of Integrated Pest Management

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid No	6	100.0	100.0	100.0

100% of the respondents do not know about IPM

4.5.4.2 Use of Pesticides

Table 4.5.4.2 Do you use pesticides to control pest?

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid yes	6	100.0	100.0	100.0

100 % of the respondents use pesticides to control pests in their farms. This implies that the pest management strategies in use in the region do not agree with the guidelines of pest management strategies under sustainable farming practices.

4.5.5 Soil Management strategies

Two factors were used; use of fertilizers and use of manure.

Table 4.5.5.1 Do you use fertilizer to add soil nutrient

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid yes	6	100.0	100.0	100.0

100 % of the respondents use fertilizers to increase soil nutrients.

Table 4.5.5.2 Use manure to add soil nutrients

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid yes	6	100.0	100.0	100.0

Also all respondents use manure in their farming practices.

4.5.6 Water management strategies

Under this section three variables were used; use of supplemental irrigation, source of water for irrigation and the watering technology used.

Table 4.5.6.1 Irrigation used

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Yes	6	100.0	100.0	100.0

Table 4.5.6.2 Source of water for irrigation

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Seasonal river/well	5	83.3	83.3	83.3
Hand dug Borehole	1	16.7	16.7	100.0
Total	6	100.0	100.0	

Table 4.5.6.3 Irrigation Technology used

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Bucket irrigation	6	100.0	100.0	100.0

All respondents use supplemental irrigation where 83.3 % use seasonal rivers for irrigation water with the rest using hand dug boreholes. All use bucket irrigation. Use of seasonal sources of water implies limited availability of irrigation water.

4.5.7 Agricultural Extension services

Table 4.5.7 Use of extension services

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid No	6	100.0	100.0	100.0

All respondents have never used extension services to inform their farming activities. This implies that their activity does not benefit from any new technologies and information which is supposed to be passed to farmers by agricultural extension officers.

4.6 Summary of the chapter

This chapter presented findings on the three research questions, that is, nature and scope of sustainable farming, nature of horticulture farming in the Kenya, and horticultural farming practices in Misewani. The study found out that sustainable farming involves the use ecosystem approaches to produce enough food to meet people's needs in a way that conserves natural resources and enables progress towards social equity and poverty reduction goals. It has four main goals of food security, enhancing environmental sustainability, agricultural economic viability and enhancing quality of life for farmers, farm workers, and society as a whole through

application of a combination of strategies that suit chosen according to local production conditions and constraints.

In Kenya horticulture farming is important in contributing to food security, farmers' income and to better livelihoods for the communities that participate in horticulture farming. However horticulture farming in Kenya is mainly rain fed, intensive and high input dependent and therefore not sustainable in the arid and semi arid regions which occupy over 80% of the country due to lack of rainfall. It has contributed to high levels of natural resource degradation in the high production zones due to unsustainable farming practices in use.

Horticulture farming in Misewani, a region that experiences semi arid climatic conditions, has not been productive to contribute towards the goals of sustainable farming and most of the farming strategies are not in line with strategies for sustainable farming practices as established under section 4.3. of this chapter.

Chapter five discusses these findings and makes conclusions and recommendations based on the findings.

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSIONS AND RECOMMENDATION

5.1 Introduction

This chapter discusses the results and findings of the study, draws conclusions and gives recommendations for practice based on the research findings and for further studies. The chapter begins by giving a summary of the purpose of the study, research questions, the research methodology used, and of the major findings. Then the chapter follows with a discussion of the results, conclusions from the discussions and it ends with recommendations from the study.

5.2 Summary

The main objective of this study was to establish strategies for sustainable horticulture farming in Misewani, Kitui County, a region characterized with semi arid climatic conditions. To guide the study process three research questions were formulated. Question one was on the nature and scope of sustainable farming generally to provide the basics of sustainable farming; question two on the nature and scope of horticultural farming in Kenya, the larger environment within which Misewani farming practices operate; and question three on horticultural farming practices in Misewani so as to identify the issues that would need to be addressed in order to draw strategies for sustainable horticulture farming in the region.

For questions one and two the study used desk top research where secondary data from different publications on sustainable farming and the horticulture industry in Kenya was used. Secondary data was used for these two questions because the study needed to gain a thorough understanding of sustainable farming and the strategies used in the practice and on the nature of horticultural practice in Kenya, the wider environment within which Misewani operates. Question three used primary data collected through interviews with horticultural farmers in Misewani and was analyzed using SPSS computer software.

The study found out that sustainable farming involves the use of ecosystem approaches to produce crops in a way that conserves natural resources to achieve four main goals of food security, enhancing environmental sustainability, agricultural economic viability and enhancing quality of life for farmers, farm workers, and society as a whole. Different strategies embedded in

the farming systems, crop varieties, soil management practices, pest management practices, water management and policies and institutional arrangements are employed towards the achievement of the goals.

In Kenya horticulture farming is an important sector in contributing to food security, income sustainability and livelihoods of communities that participate in the horticulture farming. However, Kenyan horticulture is mainly rain fed, intensive and high input dependent making it unsustainable for the communities living in the arid and semi arid regions of the country and its practice has contributed to a lot of environmental degradation due to use of unsustainable farming practices.

In Misewani, horticulture farming is not widely practiced and for the farmers found to be doing horticulture farming, it does not contribute much towards food security, economic sustainability and social well being of the farmers. Farmers do not practice principles of conservation agriculture which are key strategies for successful sustainable farming as was established under section 4.3 of this study.

5.3 Discussion

This section discusses the findings and the results of the study and is organized according to the research questions. Part one is on scope and nature of sustainable farming, part two on nature and scope of horticulture farming in Kenya, and part three on horticultural farming practices in Misewani.

5.3.1 Nature and scope of Sustainable Farming

The findings of the study are that sustainable farming involves the use of farming practices based on ecosystem approaches to achieve four main goals of sustainable food security for the world population, economic viability of agriculture, environmental enhancement and quality life for farmers, farm workers, and society as a whole through the use of a combination of strategies that are chosen according to conditions and constraints of a given region (Royal Society, 2009; FAO, 2011; National Research Council of the National Academies, 2010).

Ecosystem approaches are those that use inputs such as land, water, seed and fertilizer to complement the natural processes that support plant growth (Royal Society, 2009). Such approaches have been found to simultaneously raise yields, increase efficiency in the use of inputs and reduce the negative environmental effects of food production (FAO, 2011).

Food security is a key global challenge which made world leaders thirteen years ago come together to address it under the United Nations Millennium Development Goals (MDGs) of which MDG1 addresses food security (FAO, IFAD and WFP, 2013). Ecosystem approaches increase crop yields (Gerald and Olofinbiyi, 2011). High yields would increase food productivity for farmers thus increasing their food security and also providing a chance to earn income from selling extra farm produce that is not consumed as food.

Farming should be economically sustainable so that it can contribute to the economic security of key actors in the farm and in the food system as a whole (SARE, 2004). Economic sustainability can be achieved through increased efficiencies in the use of farm inputs to lower the cost of production for farmers and thus providing savings which can be used to improve on other aspects of livelihood (FAO, 2011). Such savings available for expenditure on other aspects of life beside food would create new industries in the community and new employment opportunities and hence better living standards for the society.

Sustainable farming practices raise productivity with minimum negative impacts on the environment and the resource base and they also help in recovering already degraded lands (FAO, 2011). Therefore if farmers adopt sustainable farming practices they would save further degradation of the environment and can also restore already degraded lands. This would ensure future generations will have resources for farming.

Also as per the findings sustainable farming uses strategies based on principles of conservation agriculture in the choice of farming systems, crop management practices, soil management practices, pest management practices and water management practices (FAO, 2011). Conservation agriculture principles are: minimum or zero tillage, protection of soil surface, and crop rotations and associations where cereals are alternated or combined with soil enriching legumes (ICARDA, 2010).

Zero or minimum tillage have minimal disturbance of the natural environment, plant nutrition from organic and non-organic sources, and the biodiversity found in soils and thereby reducing the need for mineral fertilizers and agrochemicals leading to healthy agro ecosystems (ICARDA, 2011). They also help to reduce crops' water needs by 30 percent and the energy costs of production by up to 60 percent (FAO, 2011). Reduced use of mineral fertilizers, agrochemicals and water requirements by plants make farming more sustainable as farmers will spend less on farming inputs.

Crop rotations and or associations of plant species that contain desirable genes for higher yields, resistance to stress, greater adaptation, and increased shelf life and processing characteristics would increase productivity, reduce the need for use of pesticides and increase the market value of crops (FAO, 2011). Increased crop productivity and market value would improve on food security, economic sustainability of farming, and the quality of life for farmers while reduced use of pesticides lead to healthier environments. Cover crops used to protect the soil service offer water management strategies which produce more crops from fewer drops through reduced water loss (ICARDA, 2012).

Since these principles of conservation agriculture increase the sustainability of farming, farmers need to be educated on them and their adoption facilitated. Therefore governments must put in place investment policies and institutions to enable farmers learn about them and to provide the farmers with incentives for adopting such strategies (Royal society, 2009). Such information can be made available through public offices for the poor farmer to be able to access it because leaving the provision of such to the private providers may leave out the poor farmer from participating in sustainable farming practices (FAO, 2011). Therefore the presence of public agricultural extension service is a key requirement for successful adoption of sustainable farming practices.

5.3.2 Nature and scope of horticulture farming in Kenya.

The findings under this section were that horticulture farming plays an important role in contributing to food security, economic and the social wellbeing of farmers participating in horticulture farming (Horticultural Crops Development Authority [HCDA], 2008a). However, horticulture farming in the country is mainly rainfed and therefore not sustainable in the dry arid and semi regions of the country which receive unreliable rainfalls and that there has been serious degradation of the environment and natural resources by unsustainable land use practices accompanied by increasing population, changing patterns of human settlement and expansion of urban environments (Ministry of Agriculture, 2010b).

Horticulture farming in Kenya plays an important role in contributing to food security, employment creation and income generation for farmers living in the high altitude parts of the country where horticulture production is favored by conducive climate (Horticultural Crops Development Authority [HCDA], 2008a). Actually horticulture is one of the key economic

sectors expected to drive the country's economic growth (Agricultural Sector Coordination Unit [ASCU], 2012). However horticulture farming in the arid and semi arid regions which occupy over 80% of the country horticultural production has not been developed due to lack of reliable rainfall (Ministry of Agriculture, 2010b). But the situation can be reversed through application of sustainable farming strategies which have been proved through research over time to be viable for sustainable crop production in the dry regions (ICARDA, 2013; IAASTD, 2009; Kassam et al. 2009; and SARE, 2009).

These practices which are based on ecosystem approaches have been found to increase crop productivity and to rebuild already degraded lands, which are a major challenge in the arid and semi arid regions (SARE, 2009). Therefore if these sustainable farming approaches could be adopted in the dry lands of Kenya they would increase crop productivity in the regions and hence in turn improve on food security and poverty reduction.

On degradation of natural resources which has led to loss of biodiversity and key natural resources like forest cover farmers should be encouraged to adopt farming systems which would reduce or stop the destruction of natural resources. For agriculture to be able to meet the new millennium goals of sustainable development, farming systems must use farming practices which save on natural resources (FAO, 2011). Conservation agriculture principles help to conserve natural resources and they also offer savings to farmers on production costs.

Most of the horticultural farming operations in Kenya are intensive and high input dependent systems making them untenable for the small scale farmers (Horticultura Crops Development Authority (HCDA), 2008b). Also adoption of modern farming practices by the small scale farmers is relatively low because the smallholder farmers are less endowed with the necessary physical facilities and skills (Ministry of agriculture, 2010a). This limits the economic viability of the farming activity. Adoption of sustainable farming practices which apply principles of nature to grow crops would increase agricultures economic viability (FAO, 2011).

Conservation agriculture principles also offer farmers pest management strategies that do not require the use of pesticides to control pests and diseases. They provide farmers IPM practices which are cheaper and safer for human beings and the environment (Hagglade, 2011). IPM involves maintaining a healthy agro-ecosystem by maintaining a healthy soil; planting crops and varieties that are well-suited to the soil and climate, and that are insect and disease-resistance; regular crop monitoring and spot control measures to keep pests in check; and avoiding using

pesticides (McDougall, 2011). Conservation agriculture principles also reduce water requirements for plants by preventing evaporation of water moisture thus enabling farming where rain fed farming is not feasible (ICARDA, 2011).

For farmers to be able to adopt these conservation agriculture principles widely in Kenya agricultural extension service is required to educate the farmers. However such service is lacking in many parts of the country (Agricultural Sector Coordination Unit [ASCU], 2012). This calls for a better strategy on providing agricultural extension services to all farmers especially to the arid and semi arid regions. This is because a well functioning agricultural extension service is one of the critical inputs required for increased agricultural productivity to transform subsistence farming into modern and commercial farming (United Nations Environment Programme [UNEP], 2012).

5.3.3 Horticulture farming practices in Misewani.

The findings under this section were that horticulture farming is not widely practiced in Misewani and for the few farmers found to be doing horticulture farming it does not contribute much towards food security, economic sustainability and social well being of the farmers. Also farmers do not practice principles of conservation agriculture which are key in successful sustainable farming.

Only 16.7% of the respondents have had horticultural farming contributing to food security. According to FAO (2011), for the world to address development challenges it must address food security issues. To address the challenge of food security world leaders came together to adopt the United Nations Millennium Declaration known as the Millennium Development Goals (MDGs) which committed nations to a global partnership to reduce extreme poverty and hunger and sustainable intensification of food production was given a priority (FAO, IFAD and WFP, 2013). Adoption of sustainable farming practices have been found to increase crop productivity thus increasing food security and reducing poverty (FAO, 2011; Royal society, 2009; ICARDA, 2011). Therefore farmers in Misewani should be encouraged to adopt farming approaches as practiced under sustainable farming. Such approaches reduce resource degradation as they conserve on natural resource use to prevent further environmental degradation and even recover the already damaged land (ICARDA, 2010). They lower costs of production and hence increase agriculture's economic sustainability (FAO, 2011).

Most of the farming strategies were found to be unsustainable because they do not apply the conservation agriculture principles (section 4.5.2). Conservation agriculture principles use zero or

minimum tillage, crop rotations and cover crops to maintain healthy soils, control pests and retain water moisture for maximum crop yield (FAO, 2011). Zero tillage reduces the cost of land preparation and hence of crop production while crop rotations based seeds with good quality genes that will provide farmers with higher yields, resistance to biotic and abiotic stress, greater adaptation to local conditions, and traits that offer high market value like increased shelf life and better processing characteristics (ICARDA, 2011).

Application of these reduce the over reliance on pesticides which disrupt the natural crop ecosystem balance causing outbreaks of secondary pests and they offer water management practices which increase crop productivity of dry lands (FAO, 2011). A well functioning agricultural extension service can help farmers adopt these principles to help transform current farming into a more sustainable farming which can attain food security, improve incomes and reduce poverty.

5.4 Conclusions

5.4.1 Nature and scope of sustainable farming

Since sustainable farming strategies which are based on ecosystem approaches have been found to be capable of increasing crop productivity while conserving natural resources and contributing to poverty reduction then such farming practices should be widely adopted across the globe. They should especially be encouraged among the poor farming communities who are not able to afford the current high cost farming practices as the approaches reduce the cost of farm inputs through the use conservation agriculture principles. These farming approaches are also environment friendly as they minimize the use of chemicals and mineral fertilizers in the farming activity and can be used to reclaim degraded lands.

5.4.2 Nature and scope of Horticulture farming in Kenya

Since the horticulture farming in Kenya is an important sector in contributing to food security, economic sustainability of the farmer, providing a source of quality livelihood to participating communities, it should be expanded to include all communities in the country including those in the semi arid regions. Sustainable farming approaches have been used to help communities in the arid and semi arid regions to adopt sustainable horticulture farming practices (ICARDA, 2013; ICARDA, 2012; ICARDA, 2011) and the same can be borrowed for Kenyan dry lands. They can also be adopted in place of the current farming practices in the sector which are mainly rain fed, capital intensive and destructive to the natural environment.

5.4.3 Horticulture Farming in Misewani

Horticulture farming in Misewani can be turned into a sustainable economic activity which is able to contribute to food security in the region and reduce poverty among the farmers through increased farm productivity if sustainable farming practices which have worked to address same issues of food security and poverty reduction in many dry land regions of the world are adopted in this region. Therefore farmers in the region be educated on these sustainable farming strategies and be supported to adopt them.

5.5 Recommendations

5.5.1 Recommendations for improvement

5.5.1.1 Nature and scope of Sustainable farming

Since sustainable farming practices can simultaneously raise yields, increase efficiency in the use of inputs and reduce the negative environmental effects of food production (FAO, 2011; SARE, 2009; Babu and Blom, 2014), and that the adoption rate of the same especially in developing countries has been low (FAO, 2009); the adoption rate should be up scaled to include all around the globe and especially the poor farmer who cannot afford high cost farming methods.

5.5.1.2 Nature and scope of Horticulture farming in Kenya

Horticulture farmers in Kenya should be encouraged and trained to adopt sustainable farming practices so that they can reduce their cost of production to improve on their economic sustainability and reduce natural resource degradation which is occasioned by current unsustainable farming practices. Also communities living in the arid and semi regions of the country where crop farming has not been in practice due to lack of reliable rainfall should be trained on conservation agriculture principles with which farmers are able to grow crops with limited water availability.

5.5.1.3 Horticultural farming practices in Misewani

Farmers in Misewani should be educated and supported to adopt sustainable farming approaches. With such knowledge farmers can then be encouraged engage in horticulture farming to address the perennial food shortages and poverty which the community experiences. Such farming

approaches would also help in reclaiming degraded lands which have been occasioned by unsustainable farming practices in the region over time.

5.5.2 Recommendations for further studies

This study recommends further studies to find out which of the conservation agriculture principles would produce maximum yields for Misewani region as the sustainable approaches are supposed to be chosen according to local conditions and constraints.

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APPENDICES

APPENDIX A: A summary of sustainable farming goals, strategies and farming practices

Sustainability goals	Strategy	Farming practices
1. Satisfy human food, fiber, feed, and fuel needs	Crop management	Fertility, pest, and water management
	Plant breeding	Plant breeding and genetic modification to improve yield and stress tolerance. Crops bred for increased resistance to biotic and abiotic stresses, enhanced nutrient use efficiency, and yield stability
2. Maintain and enhance environmental quality and resource base		
a) Maintain or improve soil quality	Soil fertility Management	Fertilizer and organic amendment application, use of soil and tissue tests, nutrient budget calculations
	Organic matter Management	Conservation tillage, organic amendments, composts, green manure Plant cover crops, use of organic amendments, soil

<p>b) Maintain or improve water quality</p>	<p>Crop management, vegetation management, nutrient management, and erosion and runoff Control</p>	<p>and tissue tests, conservation tillage, mulches, grass waterways, buffer strips, riparian vegetation, treatment wetlands</p>
<p>c) Conserve freshwater supply</p>	<p>Irrigation management</p>	<p>Drip irrigation, irrigation scheduling based on soil moisture Integrated pest management practices, biological and ecological approaches, soil organic matter management, crop breeding</p>
<p>d) Reduce pesticide use</p>	<p>Management of pests</p>	<p>In-field insectaries, hedgerows, riparian vegetation, habitat corridors, natural habitat fragments</p>
<p>e) Conserve and enhance biodiversity</p>	<p>Habitat management</p>	<p>Conservation farming (zero/minimum tillage, crop rotations, cover crops)</p>
<p>3. Sustain the economic viability of agriculture</p>	<p>Reduce production costs, increase value of farm products, and diversify income streams.</p>	<p>Crop Nutrient Management (balance purchased and on-farm nutrient), Precision agriculture, Integrated pest management, Enterprise diversification</p> <p>Resilient and diversified crop varieties</p>

<p>4. Enhance the quality of life for farmers, farm workers, and society as a whole</p>	<p>Higher yields; Resilience to climate, pest, disease, or market condition changes</p> <p>Improve workers' labor conditions</p> <p>Local community development</p> <p>Quality community life (clean air, water, social amenities)</p>	<p>Respectful treatment, Year-round work, Personal loans, good communications,</p> <p>healthy and safe work environment, diversity of tasks, Compensation</p> <p>Crop rotations and integration of crop and livestock production for diversified enterprises.</p> <p>Diversified landscapes with noncrop vegetation</p>
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Sources:(National Research Council of the National Academies, USA, 2010);(FAO, 2011)

APPENDIX B: QUESTIONNAIRE

PART A: NATURE AND SCOPE OF SUSTAINABLE FARMING

1. What is involved in sustainable farming
2. What are the key strategies for successful sustainable farming

PART B: NATURE AND SCOPE OF HORTICULTURE FARMING IN KENYA

1. Overview of the horticulture industry in Kenya
2. Key strategies employed in:-
 - i) Farming systems
 - ii) Crop diversity management
 - iii) Pest management
 - iv) Soil management
 - v) Water management
 - vi) Policy and institutional arrangements

PART C: HORTICULTURAL FARMING PRACTICES IN MISEWANI

a) DEMOGRAPHIC INFORMATION

1. Gender
 - Farmer 1
 - Farmer 2
 - Farmer 3
 - Farmer 4
 - Farmer 5
 - Farmer 6
2. Age
 - Farmer 1
 - Farmer 2

- Farmer 3
- Farmer 4
- Farmer 5
- Farmer 6

3. Level of education

- Farmer 1
- Farmer 2
- Farmer 3
- Farmer 4
- Farmer 5
- Farmer 6

b) Interview question guidelines

1. Goals of Sustainable Farming

i) Does farming provide food security

1. Yes 2. No

ii) Do you have soil erosion prevention measures in place

1. Yes 2. No

iii) Do you earn more than you spend in farming

1. Yes 2. No

iv) Does farming generate income for use in paying for services like education or health needs

1. Yes 2. No

2. Farming systems

i) Do you till land during preparation

1. Yes 2. No

ii) Do you practice crop rotation

1. Yes 2. No

iii) Do you use cover crops to protect land from exposure

- 1 Yes 2. No

3. Crop management practices
 - i) Do you plant different crop varieties in you farm
 1. Yes 2. No
 - ii) Seed quality
 - a) Treated seeds
 1. Yes 2. No
 - b) Untreated seeds
 1. Yes 2. No
4. Pest management practices
 - i) Do you use pesticides to control pests on crops
 1. Yes 2. No
 - ii) Do you practice IPM
 1. Yes 2. No
5. Soil management practices
 - i) Do you use fertilizers to add soil nutrients
 1. Yes 2. No
 - ii) Do you use manure to add soil nutrients
 1. Yes 2. No
6. Water management practices
 - i) Do you use rainfed farming
 1. Yes 2. No
 - ii) Do you use supplemental irrigation
 1. Yes 2. No
 - iii) If yes, what irrigation technology do you use
 1. Bucket irrigation 2. Drip irrigation
 - iv) Which source of water do you use for supplemental irrigation
 1. Seasonal river 2. Piped water 3. Borehole
7. Do you use agricultural extension services
 1. Yes 2. No