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DEPARTMENT OF DEVELOPMENT STUDIES

THE ROLE OF IRRIGATED HORTICULTURE FARMING IN ASSURING FOOD SECURITY AND LIVELIHOOD MAKING AMONG SMALL-SCALE COMMERCIAL FARMERS IN MASIANOKENG SUB-CENTRES IN THE MASERU DISTRICT, LESOTHO.

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DECLARATION

I solemnly declare that the thesis submitted for my Master's Degree at the National University of Lesotho is the outcome of my independent research and that it was never used anywhere by anybody for any purpose. Individuals who made significant contributions to this research are duly acknowledged in the document. I acknowledge that I am fully legally responsible for this declaration.

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LIST OF ACRONYMS

ACO	Area Coordinating Officer
AEO	Area Extension Officer
CSA	Climate Smart Agriculture
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
GNP	Gross National Product
GHG	Greenhouse Gas Emissions
MEMWA	Ministry of Energy, Meteorology and Water Affairs
NAPA	National Adaptation Programme of Actions
NGOs	Non-Governmental Organisations
PHL	Post Harvest Losses
SDOH	Social Determinant of Health
SDGs	Sustainable Development Goals
SBA	Slash and Burn Agriculture
SLF	Sustainable Livelihood Framework
UNFCCC	United Nations Framework Convention on Climate Change

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ABSTRACT

The purpose of the study was to investigate the role of irrigated horticulture farming in assuring food security and livelihood making among small-scale commercial farmers. Mixed method entailing both qualitative and quantitative approaches was used for data collection in the study. According to the literature of the study, the recurring drought occurrences affect crop yield of the smallholder farmers. It affects the quantity and the quality of crops and in some cases, it leads to total failure of crops. This promotes poverty and food insecurity among smallholder farmers in the country. As an initiative to overcome the impacts of drought, the literature indicates that different measures such as climate smart agriculture practices, National Adaptation Programme and climate change policy and legal framework among others, were introduced by the government of Lesotho. The research findings revealed that irrigated horticulture farming promotes food security and livelihood among smallholder farmers. It caters for all people regardless of their age, gender and educational background. However, the results found that the most dominating group of farmers in this sector, is of less educated people. Irrigated farming enables farmers to diversify crops all year round despite the climate change challenges that they encounter in the farming endeavour. For instance, hail, frost, and pest and disease outbreaks. In order to help the smallholder farmers' production to prosper, the recommendations have been stipulated to the farmers and the government.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

There are various challenges that affect agriculture worldwide and particularly Africa. These problems include among others, severe droughts and heavy rainfalls which hindered agricultural production over the past decades. The climate change has affected food production and forced some farmers to shift from rain-fed farming to practising climate smart-agriculture. Among the climate smart agricultural practices, irrigation is used by some farmers to increase production. While there are some farmers who practise irrigation under the shade nets and tunnels (greenhouses), there are some who farm on open lands where the crops are not protected from effects of climate change such as hail, frost, floods and scorching sun.

1.1 Background to the study

Climate change is not a new phenomenon; it can be traced long time back in history. For instance, the large parts of Europe were affected by colder climate brought by The Little Ice Age from about the climate period of 1400-1900 (Waldinga, 2022). History shows that the lower temperatures shortened growing seasons and agricultural production declined as furthered by Waldinga. Peasants perceived a slowdown in the beginning of growing period, crops growing and the grape ripening period (Prentice, 2009).

Climate change affected some advanced countries such as the Mesopotamia that is located in the South western Asian (Sabir, 2025). The effects of climate change distorted agricultural productivity in the region. The rainstorms and high temperatures were experienced annually. The crops dried out when the water levels deteriorated due to high temperatures. According to Sabir (2025), the summer temperatures ranged from 130 degrees Celsius in the shade, and eight months without precipitation in the year. However, farmers persisted to grow crops and required the way to control the water for food growth success and stable water source the whole year (ibid).

In response to the changing climatic conditions, societies developed various coping strategies to improve agricultural food production. One notable strategy that is used to improve the drought season is the introduction of irrigation. Siebert et al. (2014) hypothesised that Ethiopia is the country in which irrigation was birthed after the start of agriculture whereas literature by Bunbury et al. (2023) emphasise that early irrigation systems can be traced back to Sumerians ancient civilisations. In pursuance of land irrigation, Siebert et al. (2014) reveal that the first settlers of the region cleared out the muddy land and assembled canals through the dry areas. Hence, Bunbury et al. (2023) show that irrigation systems gave Sumerian farmers adequate water to produce abundant food.

In Africa, before colonial rule, Oates et al. (2015) point out that comparatively, irrigation practices have been practiced in small scale using old technologies and controlled by customary institutions. For instance, these researchers stipulate that in countries like Morocco and Ethiopia, the practices have moved forward through the ages. As stipulated by Oates et al. (2015), an effort to improve agricultural production in Africa started during the 1920s under the control of colonial administrations, as well as large-scale irrigation developments in Sudan and Niger for cotton. Besides, Oates et al. (2015) indicate that in the twentieth century, it was thought that an increase of agricultural output was needed in order to meet the challenge of feeding the growing world population. In consequence, new irrigation technologies, at the same time with new seed varieties and fertilisers for yields improvement were effectively utilised in developing nations (Oates et al., 2015). Irrigation expanded remarkably, for instance, in Kenya, some irrigation systems were incorporated in the 1950s (ibid). Shah et al. (2020) reveal that though irrigation systems were created and controlled worldwide under colonial rule as agri-business, imposed monoculture, granted with all inputs and marketing outputs, farmers in Sub-Saharan Africa were owning micro-entrepreneur.

In the post-colonial era, Oates et al. (2015) maintain that many African nations were left with irrigation systems that were poorly maintained and it was not easy for them to maintain them. However, the irrigated agriculture that was successful, was the individually owned smallholder farmers because they were able to make their own decisions over their production, considering equipment maintenance, irrigation processes and enjoying the profits (Oates et al., 2015).

Worldwide, irrigation deteriorated food scarcity, however, Africa was failing to progress at the same rate to improve food security due to several challenges they experienced (Oates et al., 2015). They mention, among others, erratic water supply resulted in poor performance of irrigation systems, low use of agricultural inputs, lack of access to profitable agricultural produce markets and poor infrastructure. Apart from that, Oates et al. (2015) and Shah, et al. (2020) point out that African's markets were unable to compete with subsidised foreign markets due to world market prices fluctuations.

1.2 Problem statement

Lesotho's domestic production of fresh vegetables by commercial farmers is very low (World Bank, 2019). For this matter, the country largely depends on imports of vegetables from South Africa. Beginning past decades, Lesotho failed to produce enough vegetables and started to import them from South Africa due to productivity challenges in the sector, which includes, *inter alia*, outdated farm technologies and lack of an adequate irrigation system (World Bank, 2019). Withal, Rantšo and Seboka (2019) indicate that the country relies on imports because of climate shocks experiences and unfavourable farming strategies. Thus, the country depends on imported horticulture products and more than 28 000 tons of vegetables were imported from South Africa. The most imported vegetables are potatoes, cabbages, and tomatoes accounting for 83% (World Bank 2019). The decline in food production that contribute to high imports can be attributed to the effects of climate change, mainly drought. World Bank (2019) emphasises that droughts are of particular concern in Lesotho. Thus, severe droughts have affected crop farming, particularly vegetables.

1.3 Statement of purpose

The purpose of the study is to investigate the role of irrigated horticulture farming in assuring food security and livelihood making among small-scale commercial farmers.

1.4 Objectives of the study

- To assess the role of irrigated horticulture farming in assuring food security and livelihood making among small-scale commercial farmers.
- To investigate the impact of climate change on horticulture farmers practising farming on open landholdings.

- To examine the opportunities and threats faced by horticulture farmers practising irrigated farming on open landholdings.

1.5 Research questions

- What is the role that irrigated horticulture farming play in assuring food security and livelihood making among small-scale commercial farmers?
- What is the impact of climate change on horticulture farmers that practice farming on open landholdings?
- What are the opportunities and threats faced by horticulture farmers practising irrigated farming on open landholdings?

1.6 Hypotheses

- Irrigated horticulture farming plays a significant role in assuring food security and livelihood making among small-scale commercial farmers.
- Climate change impacts negatively on horticulture farming that is practised on open landholdings.
- Horticulture farmers practising farming on open landholdings have opportunities though they face threats.

1.7 Significance of the study

Despite the agricultural production challenges in the country, agriculture remains the backbone of the socio-economic growth. The significance of the study is to address the role of irrigated horticulture farming in food security and livelihood making among small-scale commercial farmers. The study will be for the betterment of the horticulture farmers to reap the significance of irrigated farming; and the already active farmers engaged in irrigated farming will be motivated to advance farming to produce vegetable crops for local and outside markets. The policy makers will be compelled to consider the individual farmers on how to be assisted based on the opportunities and threats they encounter to promote high improved vegetables production for local and export markets.

1.8 Assumptions of the study

The study assumes that irrigated horticulture farming has improved the food security and livelihood of the small-scale commercial farmers, community, street vendors and the country as production contribute to the Gross Domestic Product (GDP) of the country.

1.9 Delimitations of the study

Some of the small-scale farmers may be reluctant to share their farming information. Since the sample size may not be statistically representative to the national population, it may not be precise to generate quality conclusion and recommendation since the study will not be concentrating on the entire population of the small-scale commercial farmers practising irrigated horticulture farming on open landholdings. In addition, data collection will be a challenge as the participants are in different distant locations.

1.10 Theoretical framework

The Sustainable Livelihood Framework (SLF) is the theoretical framework that guide this study. SLF originated in the mid-1980s and was developed by Robert Chambers (Kollmair and Juli, 2002). Along the same vein, Bennett (2010) indicates that the framework was supported by various development agencies and organisations since its establishment. According to Bennett (2010), the SLF emanated as a reaction to recognised deficiency of top-down, bureaucratic, market-oriented approaches to development thinking of the 1950s-1970s. In consequence, Kollmair and Juli (2002) point out that Chambers' objective on SLF is to intensify the productivity of development cooperation.

The sustainable livelihoods framework provides a holistic approach to understanding how people, particularly smallholder farmers use different types of capital (resources) (Majale, 2002). SLF main focus is on development by decreasing poverty and supporting economic recovery for the social security of the poor (Morse et al., 2009; Ashagrie, 2021). Majale further emphasises that the framework enables the farmers to achieve food security and improved livelihoods, especially under changing environmental and economic conditions.

UNDP (2017) indicates that the theory of SLF advocates for different assets such as natural, physical, human, social and financial capital.

1.10.1 Natural capital

As highlighted by Majale (2002) and UNDP (2017), natural capital involves land, water (especially for irrigation), air, and genetic resources. The resources play a crucial role for improving food security and protecting the environment against climate change, thus supporting livelihoods (UNDP, 2017). However, Kollmair and Juli (2002) show that some natural processes such as fires, floods and earthquakes destroy natural capital.

1.10.2 Physical capital

As explained by Kollmair and Juli (2002) as well as UNDP (2017), physical capital are the essential elements and production inputs that are required to assist income. Physical capital comprises, among others, irrigation infrastructure, production tools, storage facilities, transport and communication (Majale, 2002). Kollmair and Juli (2002) expound that irrigation facilities are significant as they decrease gathering of water for watering the crops, thus, the personnel could participate on other activities. According to UNDP, achievement can be met if the farmers have experience and skills.

1.10.3 Human capital

Human capital incorporates farming knowledge, skills in horticulture techniques, information about climate change and capacity to perform work in the agriculture sector (Majale, 2002). Similarly, according to Kollmair and Juli (2002) as well as UNDP (2017), human capital enables farmers to achieve specific outcomes for their means using different strategies with the experience they have, skills acquired and being able to perform different activities under healthy conditions.

1.10.4 Social capital

Social capital touches upon the social resources which individuals (small-scale farmers) depend on in order to meet their livelihood goals (UNDP, 2017). For instance, Majale (2002) outlines networks, associations (farmer cooperatives), local officials (access to extension services) and training programs offered to farmers. Kollmair and Juli (2002) further emphasise that access and amount of social capital is weighed on birth, age, gender and might vary inside the household.

1.10.5 Financial capital

Financial capital is about availability of financial resources such as credit access and income from produce sales among others (Majale, 2002). According to some authors (Kollmair and Juli (2002); UNDP (2017), financial capital refers to financial resources that take into employment individuals (smallholder farmers) to attain the production intentions using available sources of financial income. For instance, Kollmair and Juli (2002) mention available stocks encompassing cash and regular inflows of money which includes labour income. Kollmair and Juli further reveal that financial capital is multifaceted because it can be transformed into other types of capital and can be used to deteriorate food insecurity by purchasing foodstuffs.

1.11 Definition of key terms

1.11.1 Irrigation

Irrigation is the supply of water for farming in arid and semi-arid regions in an artificial way to overcome drought periods. It promotes socio-economic of different countries as it promotes sustainable food production even during the severe drought periods (Stevens and Buys, 2012). Ranjan et al. (2022) define irrigation as an artificial application of water to the soil in order to provide essential moisture to the plant growth with different methods, such as surface irrigation, overhead irrigation and drip irrigation. In support of Ranjan et al.'s view, Eisenhauer et al. (2021) define irrigation as an artificial watering of crops to enable food production stability, prolongs the effective growing season and minimise the risk of wasting expensive agricultural inputs due to drought.

1.11.2 Horticulture

Jaskani and Khan (2021) define horticulture as knowledge and skill of farming various plants of high value comprising, among others, fruits and vegetables. It is part of the agriculture industry producing and offering vegetables, fruits and ornamental plants to various services (Isaak et al., 2021).

1.11.3 Food security

According to Havas and Salman (2011), food security is a situation that exists when all people constantly have safe and healthy abundant access to social and economic needs. Similarly, Gallegos (2023) implies that food security focal point is on social and economic factors impacting the availability and accessibility of quality and quantity of food to households.

1.11.4 Livelihood

Livelihoods can be defined as a set of activities and strategies pursued by household members, using their various assets (physical, natural, human, social, financial) in order to make a living (UNDP, 2012). Khan et al. (2020) define livelihood as the means, assets, and ability for life survival, including agriculture intensification, livelihood diversification and migration; thus, a livelihood is a combination of the resources used and the activities undertaken in order to live (Scoones, 2009).

1.11.5 Small-scale commercial farmers

Small-scale commercial farmers are defined as farmers with less than 5 hectares of land (TechnoServe, 2019). Regardless of the land they have, they play a vital role by developing sustainable food production systems for many communities and countries. Thus, they help in the provision of employment, food security, income generation and basic livelihood around the world (Dhillon and Moncur, 2023; Muzekenyi et al., 2022). However, Technoserve (2019) asserts that they lack access to improved inputs, mechanised farming equipment, technical skills, and markets.

1.12 Summary

This chapter has covered introduction to the study, the background to the study focusing on the impact of climate change on historical perspective and introduction of irrigation as a coping mechanism. The statement of the problem has been discussed to highlight the problems related to the study. The objectives to achieve in the study and the research questions have been addressed. To determine the beneficiaries and relevance of the study, as well as the significance of the study are outlined. Besides, assumptions, delimitations, theoretical framework and definition of key terms have been presented.

CHAPTER TWO

CLIMATE CHANGE AND CLIMATE SMART AGRICULTURAL PRACTICES AMONG SMALLHOLDER FARMERS IN DEVELOPING COUNTRIES: THE REVIEW OF LITERATURE

2.0 Introduction

Zenda (2024) defines climate change as a prevailing pattern in different climate systems such as increased temperatures, more frequent and severe floods, storms, rising sea levels and droughts. Climate change significantly impacts smallholder farming food production, food security, and the livelihoods of farmers (Mbilinyi, 2013). Mbilinyi further points out that the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) predicts that effects of climate change and climate variability will continue to challenge vulnerable people. Due to climate change, drought has become a major global natural disaster affecting human society today (Shi et al., 2022). As a result of droughts since the turn of the century, more than 11 million people have died and more than 2 billion have been affected worldwide as drought poses a constant threat to world food security (Ngcamu and Chari, 2020). It causes moisture deficiency, biotic loss, crop failure, loss of lives of both human and bovine (Huho and Mugalavai, 2010; Mbilinyi, 2013).

This chapter therefore, explores the brief overview of the causes of climate change. It also discusses the farming practices that make smallholder farmers vulnerable to climate change and the impact of climate change, particularly focusing on drought in smallholder farming. Again, the discussion is on the strategies used to overcome the effects of climate change in smallholder farming, the use of climate smart agricultural practices, and the role of irrigation in improving agricultural production during the changing climatic conditions. Then, the conclusion would follow.

2.1 Over-view of the causes of climate change

The world faces the most prominent challenge about how it can sustain and feed the population due to climate change that affects food security, access to clean water and sanitation, and increased number of both natural and man-made disasters (Matemilola, 2020; Onoja, 2011; Dirk, 2024). Climate change has emerged as one of the most pressing global challenges of the 21st century, and primarily driven by the increasing concentrations of greenhouse gases in the atmosphere (Chachar et al., 2023). Climate change has not just pop up, its causes have been a serious international debatable topic (Mgbemene et al., 2016). Onoja et al. (2011) emphasise that scientists have diverged the causes of climate change into natural events and human activities. The natural causes of climate change include solar variations and ocean currents.

2.1.1 Solar variations

As explained by Onoja (2011) and Mishra and Dubey (2015), the sun is the source of energy of life on the planet and controls the climate systems. Onoja (2011) emphasises that the sun's energy may appear to be constant from everyday point of view; nevertheless, some small changes over an extended period of time can influence climate patterns. Similarly, Mishra and Dubey (2015) posit that variations in the solar irradiance are found to be the cause of climate change affecting global temperatures.

2.1.2 Ocean currents

Ocean current plays a vital role in the climate system (Mishra and Dubey, 2015). Some of the importances are, on the one hand, its ability to provide over 70% of the globe to the surface temperature boundary condition for the atmosphere and provides over 85% of the water vapour in the atmosphere (Mishra and Dubey, 2015). On the other hand, the heat uptake by the oceans resulting in the oceans expansion can lead to struggle on climate change (Mishra and Dubey, 2015). Ocean currents are changing and affect fish stock and marine ecosystems (UNFCCC, 2006). In addition, Onoja (2011) stipulates that interactions between the ocean and atmosphere can also produce phenomenon called El- Nino which occurs every two to six years.

Apart from natural factors, human beings contribute to a number of climate change causes including increased carbon dioxide emissions and the increase in greenhouse gas levels that occurs due to burning of fuels such as coal, oil, petrol and wood (Onoja et al., 2011; Nwankwoala, 2015). Additionally, land use exacerbates pressure on greenhouse gases (Onoja et al., 2011; Royal Society, 2020; Nwankwoala, 2015). These include deforestation and industrialisation, owing to agricultural purposes (Royal Society, 2020; Nwankwoala, 2015).

2.1.3 Deforestation

Once the deforestation is practised in the region, carbon flux in the soil, vegetation and atmosphere are impacted, resulting in soil degradation, and carbon emission due to plant decomposition left on the forest floor (Gorte and Sheikh, 2010; Ali et al., 2014). The removal of forest cover does not only affect the region, but becomes the global threat leading to increased temperatures, catastrophic rainfall spells followed by prolonged dry periods (Ali et al., 2014; Wolf et al., 2021). The increase of greenhouse gases in the atmosphere raises global temperatures impacting sea-level rise and crop yields as observed by Smith et al. (2021). In South-Asia, in the Hindu Kush-Himalaya region and other areas, they are threatened by climate change due to the practices in the region. For instance, for fuel purposes, they rely mainly on forest. Mgbemene et al. (2016) postulate that clearing of forests generate interruption in the earth`s ability to balance atmospheric carbon dioxide (CO2) concentration. Thus, over alarming cutting of trees increased the risk of flooding, depletion of fresh water sources and droughts in the region and Pakistan experienced worst flood in 2010 and soil erosion which was worsened by deforestation (Ali et al., 2014).

2.1.4 Industrialisation

Industrialisation mainly employs advanced technologies, economic and social transformation as the key to wealth and better standards (Mgbemene et al., 2016). Human activities use machines and mechanisation processes contributing to the greenhouse gas emissions (GHG) (Wadanambi et al., 2020). For instance, in Sri Lanka, tea industry is one of the main GNP contributors in the country. Conversely, literature shows that the GHG emission happen from green leaf transportation, processing of tea and packaging, energy source in tea plantation, electricity from national supply, diesel, petrol for transportation and generators and from biomass (Wadanambi et al., 2020). Additionally, Royal Society (2020) indicates that some industrial processes discharge pollutants, that pollute water and the atmosphere. To exemplify, fertilizers and pesticides used in the crop yields contain harmful substances which some of them are not absorbed by the crops might be washed away to the nearby rivers and lakes by rain (Nwankwoala, 2015).

2.2 The farming practices that make smallholder farmers vulnerable to climate change

2.2.1 Dependence on rain-fed agriculture

Smallholder farmers in developing countries are more vulnerable to climate change due to agriculture’s dependence on rainfall (Harvey et al., 2018; Nyang'au et al., 2021; Ogundeji 2022; Rankoana, 2022). Agriculture’s dependence on rainfall is noted in some parts of Africa. For instance, Rankoana (2022) explains that the smallholder farmers in South Africa are affected by poor rainfall patterns. According to Ogundeji (2022), South Africa is considered as a water scarce country, so smallholder farmers who depend on rainwater would be food insecure due to agricultural production decline. It is further stated by Rankoana (2022) that the livelihoods of rural population depending on agriculture were negatively affected in Limpopo Province South Africa due to detectable rainfall which caused poor productivity. The smallholder farmers who suffer most are the ones whose agriculture is the main source of their livelihoods (Rankoana, 2022), including those who heavily rely on rainfall (Gwambene and Saria, 2024). Similarly, Nyang'au et al. (2021) emphasise that in Kenya, due to a high reliance on rainfall, agriculture by smallholder farmers, food security and the economy have been threatened by irregularity of rainfall. In addition, according to Harvey et al. (2018), rainfall patterns and cultivating marginal areas give rise to production instability. Along the same line, Rankoana (2022) asserts that local food security measures such as availability, accessibility, utilisation and stability are vulnerable due to detectable decrease of rainfall. Susceptibility to climate change, particularly rainfall fluctuations is exacerbated as a consequence of increased levels of poverty, poor infrastructural and technological development (Nyang'au et al., 2021).

2.2.2 Limited use of climate resistant crop varieties

The smallholder farmers often grow crops using traditional seeds that may not withstand climate change (Rankoana, 2022). It is indicated by Mbilinyi (2013) that smallholder farmers in Arusha use traditional inputs such as local seeds. They experience poor harvest in the view of the fact that they noticed the decreased crop yields, comparatively with the smallholder farmers using improved seeds. In some of the South African regions, smallholder farmers grow indigenous crops that are easily hit hard by drought, for example, maize and groundnut (Rankoana, 2022). According to Agustini (2021), old and low educated farmers are the ones who are reluctant to change from the traditional crop seeds they are used to grow. However, Ogundeji (2022) puts forward that smallholder farmers can purchase crop types that can resist extreme weather conditions if they are offered financial opportunities.

2.2.3 Landholdings

Smallholder farmers usually have the land size of less than two hectares (Harvey et al., 2018; Augustin, 2021). According to Billar et al. (2015), they grow crops to meet their daily needs instead of commercial purposes. According to Billah et al. (2015), about 96% of smallholder farmers in South East Asia are facing the problem of shortage of land. It is also pointed out by Gwambene and Saria (2024) that smallholder farmers' low food production in Tanzania is attributed to the limited crop land and land tenure issues. Reliance on rain-fed production on small land put them more susceptible to the negative effects of climatic changes (Rankoana, 2022). Similarly, Ogundeji (2022) asserts that smallholder farmers are particularly vulnerable to climate change because of poor access to land. To substantiate, in Madagascar, farmers cultivate less than 1ha for crop production which does not enable them to produce enough for consumption, resulting in inability to sell (Harvey et al., 2014). The study by Harvey et al. (2014) specify that low output was due to farming practices employed that include, among others, limited use of inputs, use of low technology practices and suboptimal land for crops.

2.2.4 Adaptation mechanisms

Smallholder farmers in economically developing countries are severely impacted by climate change due to the adaptative strategies they use to manage climate change (Rankoana, 2022). Poor adapted mechanisms trap smallholder farmers into a vicious cycle of low productivity, food insecurity and poverty due to climatic vulnerability (Mbuli et al., 2021). (Mbuli et al. (2021) observe that most farmers continue to depend on the traditional farming calendar and practices. For example, in Cameroon, due to lack of access to the weather forecast by smallholder farmers, they sow the crops after the rainy season of March. The implication here is that traditional calendar does not work for smallholder farmers. This is because the crops often dry up, destroyed by insects while some of the seeds do not germinate due to high temperature (Mbuli et al., 2021). Additionally, Rankoana's (2022) observation is that more than half of the world`s population depending on smallholder farms, face serious dangers because of their sensitivity and low resilience to the negative effects of climate fluctuations. Gwambene and Saria (2024) highlight that small-scale farmers' production fail owing to old and simple technology they use in the agriculture sector. These challenges obstruct the agricultural development sustainability (Gwambene and Saria, 2024). The notable argument is that smallholders are not able to easily adapt to climate stressors because they lack access to technical and financial support so that they can invest more on climate resilient agriculture (Harvey et al., 2014; Harvey et al., 2018; Ogundeji, 2022; Gwambene and Saria, 2024).

2.2.5 Limited access to climate change information

Smallholder farmers farming with lack of early warning systems are more vulnerable to negative impacts of climate change (Ogundeji, 2022). For instance, in South Africa, most provinces experienced decline in crop yields and reduced food availability due to unpredictability in rainfall and temperature (Ogundeji, 2022). Gwambene and Saria (2024) emphasise that forecasting the farming activities time ahead is challenging because of unpredictable weather conditions. Resulting from the doubt about when the rainy season would begin, farmers delay ploughing and planting (Rankoana, 2022). Rankoana (2022) adds that because of drought, food shortages increased severely as crops started to fail early in the season in Limpopo, South Africa. Augustini (2021) highlights that access to climate information plays a vital role in the changing seasons and unpredictable weather that create a high risk of loss in the agricultural system. In Indonesia, farmers seemed to be aware of climate fluctuations and decided to practise multi-cropping farming after the first raindrops. Nonetheless, the rainfall dropped to zero leading to high chance of plants to die due to unavailability of water in the region Augustini (2021). Berhanu et al. (2024) propose that weather information would help smallholder farmers to decide on the coping strategies based on the weather forecast information provided by the responsible weather information providers.

2.2.6 Slash and Burn Agriculture (SBA)

The planned grassfire (slash and burn) is considered to be devastating and leaving farmers with little or no harvest (Mbuli et al., 2021). According to Mbilinyi et al. (2013), this farming practice makes smallholder farmers vulnerable to climate change as burning of crop residues and forests leave soil bare and unprotected from the sun and wind. Bezerra et al. (2024) assert that SBA clears land for short term fertility, but further impact the environment by causing soil erosion and nutrient leaching, resulting in crop failure. Pollini (2014) purports that it is not easy to attain food security once slash and burn systems are in crises. Nevertheless, slight or no support to invest in more productive options may influence farmers to fall back on this method (Ogundeji 2022). On the one hand, smallholder farmers in some areas of Tanzania practiced SBA due to the fact that they could not afford to purchase industrial fertilizer, seeds, and pesticides because of high prices (Mbilinyi et al., 2013). On the other hand, Mbuli et al. (2021) maintain that most farmers in Santa are susceptible to climate hazards like grassfire due to SBA practice. They add that farmers practise this destructive method for productivity growth and to improve the grass growth for livestock feed.

2.2.7 Poor soil management practices

Wawire et al. (2021) argue that poor soil practices make smallholder farmers susceptible to climate change. The excessive and insufficient use of fertilizer leads to loss of soil fertility since the soil loses the nutrients contributing to agricultural production decrease (Wawire et al., 2021). Kamanga (2013) points out that soil fertility management is a complex activity which is affected by ownership of assets. Owing to low local manure in Meru and Tharaka Nithi, the smallholder farmers increase on-farm produced manure with local purchases

(Wawire et al., 2021). However, Wawire et al.'s study indicates that because of poor manure management practices, farmers regularly use manure of poor quality resulting to the loss of important soil nutrients. Similarly, Kamanga's (2013) findings show that as a consequence of lack of manure management before use, smallholder farmers in Malawi applied small and poor-quality manure. Thus, soil fertility may continue to decrease resulting in agricultural productivity decline. Kamanga warns that small amounts of manure may not be effective depending on the state of soil fertility depletion.

2.2.8 Post Harvest Losses (PHL)

Lack of proper harvest storage contributes to the susceptibility of smallholder farmers to climate change due to increase of post-harvest losses (Manandhar et al., 2018). Food production which may not be consumed leads to unnecessary greenhouse gas emissions that might increase climate change and other negative impacts on the environment (Chegere, 2017). As described by Kiaya (2014), losses are measurable reduction in foodstuffs that impact the quality and quantity of the crops. According to Kitinoja et al. (2011), quantity and quality losses are mainly because of poor temperature management, poor quality packages that are used by smallholder farmers and rough handling, among others. Manandhar et al. (2018) point out that pests or insects and rodents are the major factors affecting crops quality and crops losses in developing countries. The literature by Kitinoja et al. (2011) shows that the loss of fruits and vegetables by farmers before they reach the final consumer is between 30% and 40%. The literature from the study by Abass (2013) and Chegere (2017) postulate that postharvest losses in Africa are often estimated to be between 20% and 40%. In consequence, post-harvest loss of food crops during or after harvest, is a loss of valuable food, hence increasing food insecurity in times of climate induced shortages (Chegere, 2017).

2.3 Impacts of drought on food production and food security

Reliance of smallholder farmers on erratic rainfall and recurrent droughts results in the decrease in crop yields and even total crop failure in some cases due to the increased water needs of the crops (Knutson et al., 1998; Murendo et al., 2011; Tambo and Abdoulaye, 2012; Ngcamu and Chari, 2020; Zenda, 2024). Research done by Williams et al. (2019) shows that the horticultural farmers in Uganda reported that extended dry spell and hot temperature deteriorated production while increasing pest and disease outbreaks and indicated that high rainfall variations coupled with increased temperatures resulted in reduced tomato output in Mozambique and Ghana.

According to Mbilinyi (2013), farmers in one of the Tanzanian regions claimed a high decrease of the grown crops due drought experienced in 2004/2005, 2007/2008 and 2010/2011. For example, in 2010, the expected bags of maize crop were 60 bags, but the farmer only got eight bags and only 20 bags of rice, instead of 100 bags that were expected (Mbilinyi, 2013). On account of recurring droughts in the NENA region, the IPCC projections present for consideration a 10% to 20% decrease of crop yields in NENA by 2050. Lewis et al. (2018) substantiate that crops including barley, apples and olives production may decline or completely fail as a consequence of drought. Even in Sudan, the known summer crop like millet might be affected by increase in summer temperatures as crops may not mature if they are planted late; therefore, the farmers' food security would be affected (Lewis et al., 2018).

Furthermore, Twongyirwe et al. (2019) highlight that prolonged drought seasons cause food crises in sub-Saharan Africa because of their dependence on rainfall production. As explained by Ngcamu and Chari (2020), Niger mainly relies on unreliable rainfall patterns and recurrent droughts; as a consequence, the decrease in agricultural production slow down food security, and poverty reduction. In Nepal, a large number of crops were damaged because of 1995 drought period which clashed with sowing period of vegetables, potatoes, onion, garlic, chillies among others (Miyan, 2015). Thus, as perceived by Ngcamu and Chari (2020), erratic rainfall and droughts have negative effects on food security in rural communities that rely on subsistence economies. The study by Twinomugisha and Mushy (2021) demonstrates that in Malawi, a year after heavy floods, the state of national disaster was declared on 13 April 2016 following long drought period during the 2015/16 agriculture season. This means that the people were food insecure and needed humanitarian assistance relief from 2016-2017 consumption year.

The study by FAO (2006) shows that the 1994-1995 drought in north western Bangladesh led to crop deficit accounting for 3.5 million tons because the country relies on rice production, and that situation led to food security problems. It is also stated by Lewis et al. (2018) that the 1994/1995 drought in Morocco negatively impacted the Gross Domestic Product (GDP) which declined by 45%. Lewis et al. further disclose that the impact is linked to lack of access to technological and financial solutions by the small-scale farmers.

The study by Murendo et al. (2011) posit that drought results in more pests and diseases, in return, increase prolonged food insecurity. In support of this view, Lewis et al. (2018) pose that temperature increase could lead to heat stress in crops, resulting in low productivity and increasing the prevalence of pests and diseases. Increased incidences of pests and diseases caused by drought resulted in potato and cabbage crops failure in South Africa, leading to high yield problems (Chepkoech et al., 2018). South Africa had a destructive drought affecting agricultural production and costing more expenses on farmers (Ngcamu and Chari, 2020). Jordan et al. (2017) echo that 2015/2016 drought in South Africa had adverse impact on the agricultural sector and contributed to food shortages. Emanating from this, four dimensions of food security such as food availability, accessibility, utilisation, and stability are negatively affected by drought in the country (Jordan et al. 2017).

Ruwanza et al. (2022) declare that the drought affects agricultural productivity directly leading to food insecurity and poverty. For example, these authors explain that the 2018/2019 drought in Zimbabwe affected smallholder farmers resulting in low crop yields. Along the same line, the 2015 drought in Mali resulted in the starvation of more than 300 000 people because of food insecurity (Ruwanza et al., 2022). It is further revealed by Twongyirwe et al. (2019) that semi-arid of Uganda experienced drought increase with undesired results causing crop failure.

2.4 Impacts of drought on livelihoods of smallholder farmers

Drought affects the society, the economy and the environment differently (Ruwanza et al., 2022). One notable impact of drought on smallholder farmers in South Africa is that South Africa is a water scarce country (Jordan et al., 2017). The 2017-2018 drought in the Western Cape Province of South Africa contributed to water limitations which also had impacts on the wealth, well-being and, sanitisation (Ruwanza et al., 2022). It is further argued by Rankoana (2022) that South African farmers delayed ploughing and planting on account of doubtfulness about rainfall. It is noted that they experienced severe food decrease of the crops due to drought. The persistent drought resulted in lower standard of living of the farmers, contributing to some farmers quitting crop production and opting for non-agricultural activities for paid labour (Rankoana, 2022).

The impact of drought contributes to the reduction in some of the nutritious foodstuffs in the families. It decreases food quantity and quality which might lead to malnutrition, food insecurity, hunger, and poverty (Knutson et al., 1998; Tambo and Abdoulaye, 2012; Twongyirwe et al., 2019; Zenda, 2024). In some of the regions in South Africa, Hawkins et al. (2022) note that the extreme impact of droughts affected food availability, food diets and security. Since farmers were unable to produce any fresh vegetables during drought periods, they changed their diets and shifted from vegetable based to starchy based diets. The impact of drought on smallholder farming is also experienced elsewhere in Africa. For instance, in Kenya, increased temperatures caused yellowing of leaves on some vegetables such as spider plant and African nightshade and tough leaves of some vegetables (Chepkoech et al., 2018). It is also asserted that the drought of 1973 has caused about 300 000 deaths of animals, while farm yields dropped by about 60% that resulted in famine in northern Nigeria (Tambo and Abdoulaye, 2012). The crop failure and food insecurity in the NENA region resulting from recurring droughts and extreme events lead to difficult challenges in addressing malnutrition, famine and starvation (Lewis et al., 2018).

Ruwanza et al. (2022) clarify that drought is also associated with low income, high unemployment rate, poverty and migration, among rural farmers. In agreement with Ruwanza et al., Tambo and Abdoulaye (2016: 6) express that the severe drought in sub-Saharan resulted in income and employment decrease in the agricultural sector. The decrease in agricultural productivity negatively affects food supply resulting in increased unemployment and poverty as emphasised by Ruwanza et al. (2022). Similarly, Hawkins et al. (2022) report that drought affected smallholder farmers' land fertility, which in turn, affected some types of vegetables' growth, quality and quantity. All these resulted in farmers' inability to generate additional income for surplus. The researcher in Bangladesh reveals that smallholders' crops were badly affected due to 1994/1995 drought; consequently, farmers were in need of cash to purchase food which was very costly. Ultimately, they had to sell their farm assets at distress prices (FAO, 2006; Lewis et al., 2018). Additionally, South Africa experienced a bread price increase caused by the imports of wheat costing more than one million tons as a result of drought of 2014-2016 (Ruwanza et al., 2022). The food stuff prices were high due to declining yields during drought periods. Scarce food supply of farm produce resulted in high prices in the market causing households to experience income reductions and food insecurity (Aniaha et al., 2016).

2.5 Strategies used to overcome the effects of climate change in smallholder farming

There are different climate adaptation strategies used by smallholder farmers. Many of them are technology-based, while others are about changing ways of doing things.

2.5.1 Planting of drought tolerant crop varieties

Drought resistant crops help in decreasing the vulnerability of climate change, particularly drought (Makate et al., 2018). Drought-resistant crops help to improve food production, promoting food security and increasing income for growing population (Teklewold et al., 2018; Zenda, 2024). They are essential for improving soil fertility, conserving soil moisture and regulating soil temperature as well as tolerating pests and diseases as stipulated by several researchers (Makate et al., 2018; Ariom et al., 2022; Guja and Bedeke, 2024). Thus, they enable the smallholder farmers to meet the market demand (Makate et al., 2018). In some of the Tanzanian regions, Makate et al. (2018) report that farmers are trying to adapt to the changing climate by changing the type of seeds they use. For instance, these researchers purport that few farmers showed that they use new type of maize seeds that produce maize within a short time without requiring a lot of rain. Makate et al. (2018) maintain that drought tolerant maize (DTM) is high yielding and it is well-adapted to moisture stress. Additionally, Shaffril et al. (2024) reveal that in Ethiopia and Burundi, farmers use finger millet drought-tolerant crop that maintains its productivity.

This means that drought-tolerant crops increase farmer chances to harvest more output, minimise crop failure, and avoid potential losses due to climate change, particularly dry spells (Shaffril et al., 2024). Ariom et al. (2022) specify that crop varieties with shorter planting cycle promote food security rather than those with longer planting cycle. Moreover, Orimoloye (2022) expands that drought and heat tolerance crops are practical options that need appropriate implementation. Besides, Hawkins et al.'s (2022) study shows that the evidence base and development of drought tolerant fruit and vegetable are scarce.

2.5.2 Crop diversification

Teklewold et al. (2019) define crop diversification as the strategy for growing more than one crop across space (also referred to as intercropping) or time (referred to as crop rotation). For instance, some smallholder farmers in Kola region Ethiopia ploughed onions and other farmers grew maize, sorghum, teff, tomato, potato, beer-barley, cabbage, and pea (Shaffril et al., 2024). Integration of crops decreases the occurrence of weeds, pests and diseases; it improves soil fertility and retain water (Orimoloye, 2022; Teklewold et al., 2019). Furthermore, it involves growing different crops on the farm to meet the market demand and ensures a stable income. Guja and Bedeke (2024) and Castro et al. (2019) assert that diversification is one of the strategies in South East Nigeria, that is habitually used to the harsh climate change effects by the crop farmers. As a way of resilience to climate change, adoption of woodlots increases in Ruanda (Shaffril et al., (2024).

2.5.3 Planting of trees (afforestation) and agroforestry

Agroforestry integrates agricultural crop production together with trees, forestry plants and animal husbandry on the farm (Orimoloye, 2022; Augustin, 2021). The presence of forests increases farmers' ability to adapt to climate change as forests lessens the rate of small to moderate rain flows, improving soil fertility, soil moisture and preventing soil erosion (Augustini, 2021). For example, Mukhlis et al. (2022) state that agroforestry in Sub-Sahara Africa can be found in the multi-story home gardens on Mt. Kilimanjaro in Tanzania, cacao system in Côte d'Ivoire and rational woodlots in Kenya. Shaffril et al. (2024) indicate that in Burkina-Faso, farmers protect trees and their seedlings to promote regeneration of degraded soils and to create different agroforestry systems usage. Among the households, this presents a useful means of providing multiple benefits for smallholder farmers in the view of the fact that trees provide food, supplement income and environmental services (Teklewold et al., 2018; Orimoloye, 2022; Ariom et al., 2022). Further, the literature claims that farmers in Ethiopia and Nigeria plant trees to protect their crops from storms and about 12% of the smallholders use this approach to provide shade for their crops in response to high temperatures (Ogundeji, 2022).

2.5.4 Use of improved fertilisers

Smallholder farmers' application of fertiliser can have both climate change mitigation and adaptation effects (Teklewold et al., 2018). Mbilinyi et al. (2013) explain that smallholder farmers in Tanzania use fertilisers to reinstate the soil fertility that has been lost from excessive farming and soil erosion. Conversely, regardless of fertilisers' benefits, the crop productivity of smallholder farmers does not prosper as they use lower grade fertiliser since they cannot afford the scarcely available and expensive fertiliser (Mbilinyi et al., 2013; Mpala and Simatele, 2024). Contrarily, Mbilinyi et al. (2013) argue that though the chemicals applied in crops are said to have positive impact on crops, how to reduce the correlated negative impacts remains a challenge.

2.6 Climate Smart Agriculture (CSA)

The climate forecast designates that harsh weather extremes such as floods, droughts, and average temperatures negatively affect agriculture resulting in food insecurity (Nizamedinkhodjayeva, 2021; Myeni, 2023). Due to this, existing climate impacts forced small farmers to adopt innovative technologies and implement climate smart agricultural practices and or technologies (Myeni, 2023).

2.6.1 Climate smart agriculture practices among smallholder farmers in Africa

Due to the forthcoming threat caused by the effects of climate change, as a reaction, FAO established CSA in 2010 (Nizamedinkhodjayeva, 2021). CSA is a new agricultural development model which highlights the use of climate smart agricultural technologies in order to give attention to threefold challenges of climate change. These include greenhouse gas emissions, and at the same time ensuring national food security, reducing poverty and achieving development goals (FAO, 2015; FAO, 2018; Murray et al., 2016; Rodino et al., 2022; Myeni, 2023).

The objective of CSA is to achieve higher crop yields, stronger climate change adaptability, and lower agricultural carbon emissions as well as achieving economic growth and deteriorating environmental impacts of climate change (Nyasimi et al., 2014; Rodino et al., 2022). CSA includes among others, smart irrigation and crop management. It also improves the use of water, energy, the use of sensors, drones, artificial intelligence, and other technologies to monitor conditions together with other natural resources (Rodino et al., 2022). In addition, Nyasimi et al. (2014) indicate that climate-smart approaches can include many diverse components from farm-level techniques to international policy and finance mechanisms. From Jagadeesh et al.'s (2024) perspective, CSA is an approach that seeks ways to improve the farmers productivity and income by mitigating the impacts of climate change. The existing literature shows that there has been an attention on adopting CSA strategies in which among them, irrigation has attracted more farmers worldwide.

2.7 Irrigation

Irrigation is the artificial application of water through water infrastructure (Bojago and Abrham, 2023). Among others, water for irrigation can be sourced from groundwater or from surface water through rivers, lakes and reservoirs (Koesh and Langat, 2018; Bojago and Abrham, 2023). Additionally, irrigation comprises different irrigation systems such as surface irrigation which applies water over cultivated lands by gravity and includes furrow, basin, and border irrigation systems. Sprinkler irrigation applies water to crops in a controlled manner like rainfall while drip irrigation applies water directly to the crops (Bojago and Abrham, 2023). With drip irrigation systems, Koesh and Langat (2018) draw attention that water is delivered in small amounts via small nozzles installed in pipes or tapes, which can either be above the ground or underground. It saves up to 80% water use. However, Bojago and Abrham (2023) argue that not all irrigation systems are suitable for every crop type and notify that the suitability of irrigation systems depends on energy requirements, labour intensity and capital, among other factors. Irrigation technology for small-scale farmers includes treadle pumps and solar powered pumps as well as gravity and or river diversion methods. Gravity technology commonly entails diverting the flow of water through open channels without pumping. Motorised systems include pumps driven by engine. Treadle and rope and washer pumps are manual while wind and solar use renewable energy (Mango et al., 2018).

2.7.1 The role of irrigation in improving agricultural production during the changing climatic conditions

The role of irrigation in improving agricultural production is exceptional. Its role during climate change happens in different ways. Above all, it increases productivity of farmers by providing water for crop production (Ariom et al., 2022). As pointed out by Aniah et al. (2016), irrigation systems are beneficial for farmers who rely on rain-fed agriculture to engage in dry season farming. Implementation of various technologies such as drip irrigation, increases agricultural productivity with reduced impacts on the environment and its efficiency can significantly reduce water usage while maximising crop output (Batchelor and Schnetzer, 2018; Serote et al., 2023). It is also pointed out by Mbilinyi et al. (2013) that some farmers in Tanzania stopped producing maize after it has faced competition from vegetables production using drip irrigation that was introduced by the Non-Governmental Organisation (NGO). Drip irrigation is commended for improving agricultural production by directly delivering water and nutrients to the plant roots (Oiganji, 2025). Evidence from the literature shows that farmlands equipped with drip irrigation could record up to 100% increase in yields (Partey et al., 2018). According to Mhembwe et al. (2019), drip irrigation adaptation is considered the best farming practice by some smallholder farmers due to its ability to control the water needed by crops, and thus increase productivity.

Moreover, Frimpong et al. (2023) underscore that irrigation boosts agricultural growth in some parts of African developing countries. In some countries, governments adopted participatory development with farmers and the private sector. (). For example, these researchers point out that Ghana established 23 irrigation schemes from 2016 which are managed by the Irrigation Development Authority. They explain that the Bangari irrigation scheme is in Cote d`Ivoire producing cereals and vegetables including tomatoes, onions, green peppers and rice while in Egypt and Niger, the Nile irrigation schemes serve as a major source for agriculture. These countries used surface and groundwater irrigation methods for effective and efficient agricultural development (Frimpong et al., 2023). Kenya adopted drip irrigation system with renewable energy in order to empower smallholder farmers to increase yields by over 300% saving substantial costs (Oiganji, 2025). According to Nikolaou et al. (2020), drip irrigation systems have been used with success in arid and semi-arid regions for vegetable production, forage crops, and maintenance of trees, accounting for up to 90% application efficiency. Ethiopia is not an exception as it has faced recurring droughts which resulted in agricultural production decrease and food insecurity, leading to rural-urban migration as stated by Oiganji (2025). As a response to community-based adaptation strategies to address climate change, Oiganji explains that the country implemented technologies such as Wetting Front Detectors (WFD) and Chameleon sensors to guide irrigation practices on farming during the irrigation system.

In India, through initiatives like the Pradhan Mantri Krishni Sinchayee Yojana (PMKSY), the government promoted drip irrigation which resulted in higher yields in sugarcane and cotton crops and saved 40-50% water increase (Oiganji, 2025). Crop yields increases and the cost of fertilisers, pesticides and power for irrigation decreases when using drip irrigation (Patle et al. 2019); more water is saved because drip irrigation delivers water directly to plants through small plastic tubes as noted by Peña and Hughes (2007). The literature indicates that besides drip irrigation in the area that covered 3.37 Mha in India, the country also adopted sprinkler irrigation as a climate smart irrigation technology which covered area was 4.36 Mha ha (Patle et al., 2020). They further show that based on the climate, soil and management in a region, water requirement differs from 775 to 3,000mm.

Researchers like Mhembwe et al. (2019) as well as Bojago and Abrham (2023) posit that irrigation enhances intensification. This is in support with findings by Awazi (2022) in parts of the west and northwest regions of Cameroon revealing that farmers who adopted drip, sprinkler, furrow and manual irrigation during the dry season and prolong dry spells in the rainy season, were able to grow the market crops all year round. With irrigation, Mango et al. (2018) put forward that farmers can produce off-season as they can supplement their crops with water during dry spells mid-season. In the study about the contribution of small-scale rural irrigation schemes towards food security, it is shown that irrigation schemes in Zimbabwe are a mitigation measure against droughts and the mid-season dry spells where crops severely suffer from moisture stress (Mhembwe et al., 2019). Thus, irrigation allows farmers to intensify crop production, securing them against drought risk and transforming their farming activities throughout the year (Mango et al., 2018; Mhembwe et al., 2019; Bojago and Abrham, 2023).

The literature also reveals that irrigation permits diversification of crops (Mhembwe et al., 2019). Irrigated agriculture is acknowledged as a key practice to achieve agricultural growth by enabling crop diversification (Mupaso et al., 2023). Serote et al. (2021) highlight that in Limpopo, South Africa, farmers mainly produce different agricultural food crops such as maize and vegetables in order to deal with high climate variability and change. However, farmers choose to practise irrigation only on vegetables rather than on maize production. In the Nile Basin of Ethiopia, Castro et al. (2019) convey that different crop varieties were commonly the most used method, even so, among the major adaptation methods identified, irrigation was the least adaptation practised. In the South East Nigeria, irrigation and rainwater harvesting were the most commonly practised strategies to the severe consequences of climate change on the farmers crops.

Production increase results in more income increases from agriculture (Mango et al., 2018). The significance of irrigation cannot be overemphasised as Bojago and Abraham (2023) specify that irrigated agriculture is at least twice as productive as non-irrigated agriculture, thus, is crucial for income generation. In a different region of Ethiopia, the literature states that small-scale irrigation was found to improve stable production and incomes (Mango et al., 2018). Similarly, Mango et al. further demonstrate that in Chinyanja Triangle Southern Africa, irrigation contributed 5% on agricultural income due to intensification and diversification activities and through sales and surplus. Sinistra Ofanto irrigation scheme is mainly on crops grown such as vegetables, fruit orchards, vineyards, and olives and the country experiences inadequate rainfall, yet, profitable farming is strongly dependent on irrigation. Nearly 18.5% of Apulia's agricultural area is under irrigation; consequently, irrigated crops have contributed 69% of the total value of regional agricultural production (Levidow, 2014). In the Salinas Valley of California, irrigation of vegetables was estimated as 200% above actual crop evapotranspiration (Nikolaou et al., 2020). Different studies emphasise that increasing production and income lower food prices, enabling very poor households to meet basic needs which would result in household and economic welfare improvements (Mango et al., 2018; Mhembwe et al., 2018; Bojako and Abrham, 2023). Nonetheless, the farmers are influenced to still be involved in farming as highlighted by Mango et al. (2018).

2.8 Conclusion

This chapter has shown that climate change is caused by physical and human induced activities. Literature has brought to attention that some of the smallholder farming practices make them vulnerable to climate change; as a result, climate change negatively impacts food production or food security and livelihoods of smallholder farmers. However, the literature has revealed that there are different strategies that are used by smallholder farmers to overcome climate change impacts. The strategies used are about changing the traditional way of doing things and adopting those that are technologically based such as irrigation. In consequence, the literature disclosed the role played by irrigation as a climate smart agriculture practice.

CHAPTER THREE

THE IMPACT OF CLIMATE CHANGE ON FOOD PRODUCTION AND THE MEASURES USED TO OVERCOME THE EFFECTS OF CLIMATE CHANGE IN LESOTHO

3.0 Introduction

In Southern Africa, Lesotho is a small landlocked kingdom situated between latitudes 28° and 31°S, and longitudes 27° and 30°E (World Bank, 2021). The climate of Lesotho is categorised as temperate continental (LMS, 2017; Mukwada et al., 2020; Mofolo and Kheleli, 2021). Some research (Saha, 2011; World Bank, 2021) show that the nation is encircled by the Republic of South-Africa. Although there are currently just 2.2 million people living in the country, that number could rise to 3.9 million by 2095 (Mukwada et al., 2020). According to LMS (2017) and World Bank (2021), Lesotho's location and topography expose it to climatological trends from both the Atlantic and Indian Oceans, causing considerable temperature variability and leaving the nation extremely sensitive to climate change. The country is categorised into four environmental zones namely: the Lowlands (15%), Foothills (15%), mountains (59%) and Senqu River Valley (9%) (World Bank, 2021).

Agriculture is the mainstay of the nation's economy contributing 10% of Gross Domestic Product (GDP) and employing over 70% of the workforce (Mukwada et al., 2020). However, Mukwada et al. (ibid.) argue that since 1960s, the total cultivated area has declined from 450,000 hectares to between 136,500 and 300,500 hectares over the 2006–2008 period as a result of climate change. The literature indicates that drought is the foremost stressor among the smallholder farmers in the country (Dejene et al., 2011). This chapter covers the impact of climate change on food production and the measures used to overcome the effects of climate change in Lesotho.

3.1 The impact of drought in smallholder farming food production

The farmers' agriculture in Lesotho mainly relies on rain-fed production (Sekaleli and Sebusi, 2013; Kamara et al., 2019; Mukwada et al., 2020). Reliance on rain-fed agriculture makes it susceptible to drought, thus, resulting in agricultural production decreases and rural small-scale farmers becoming impoverished (Sekaleli and Sebusi, 2013; Kamara et al., 2019; Mukwada et al., 2020). According to Mofolo and Kheleli (2021), most farmers cultivate crops that are rain-fed, whereas just a small percentage cultivate vegetables in areas with irrigation. Dejene et al. (2011) state that dry spells in January and February decrease yields and at times attract pest outbreaks. The findings by Sekaleli and Sebusi (2013) accentuate that the effects of drought caused 40% of smallholder farmers output in Kolo and Tšakholo to deteriorate significantly and 20% of farmers harvested crops that are below their expectation. According to Bosch et al. (2021), crop failures induce food shortages and famine; therefore, the country becomes a net food importer (Kamara et al., 2019). As maintained by Mukwada et al. (2020), Lesotho is susceptible to ongoing food shortages brought on by drought because of its continental temperate climate.

Smallholder farmers' planting dates are impacted by early drought (Dejene et al., 2011). According to these authors, crops do not reach maturity as a result of late planting, which is frequently caused by early dry spell. This highly happens particularly in the mountains where the season is considerably shorter due to early frost incidences that damage crops before they reach maturity (Dejene et al., 2011). Due to hardest land, Rants'o and Seboka (2019) highlight that block farmers delayed to plough some fields. As indicated by Dejene et al. (2011), early in the agricultural season, dry spells cause fallowing fields and late planting.

In addition, Mukwada et al. (2020) argue that drought impacts the developmental stages of growing crops. According to Dejene et al. (2011), drought inhibits growth and seed development, and inadequate soil moisture during flowering and crucial growth phases results in poor fruit and seed set. Additionally, Sekaleli and Sebusi (2013) report that the effects of drought reduced the growing season and decreased the quality of the crops that were produced in Kolo and Tšakholo. Similarly, the WFP (2024) research highlights that drought impacts food production by influencing crop quality and quantity, as well as causing further crop destruction and spoiling. For instance, both Mohale`s Hoek and Mafeteng had 16% of poor crop quality due to drought (Sekaleli and Sebusi, 2013). As pointed out by Mofolo and Kheli (2021), prolonged dry spells cause minimal rainfall and lower water tables, leaving crops with shallow root systems without enough water.

The World Bank (2021) claims that longer dry spells and more frequent droughts worsen land degradation and soil erosion. Increased soil erosion and decreasing soil fertility decrease the growing season of crops, which lowers agricultural output (Sekaleli and Sebusi, 2013). In consequence, Bosch et al. (2021) emphasise that crop failure is made worse by the loss of soil fertility brought on by soil erosion and land degradation that are also aggravated by drought events. In accordance with WFP (2024), one of the principal environmental issues affecting agricultural production and food and nutrition security in Lesotho is land degradation. Thus, due to recurrent drought, there is a shortage of arable land for farming, which leads to an increase in food insecurity (Mukwada et al., 2020).

As reported by Mukwada et al. (2020), Lesotho has gone through six drought spells in the past decades: 1981–1983, 1990–1992, 2001–2003, 2007–2008, 2009–2013, and 2015–2016. These dry periods are linked to the majority of the food emergencies and state of emergency declared by the nation. In addition, Mukwada et al. (2020) further specify that food insecurity resulted from farmers' crop production being impacted by the droughts in 2002 and 2019, forcing the government to declare a state of famine and emergency. During the 2015–16 drought, 32% of the population needed humanitarian aid; the government had to spend 7% of GDP to intervene in drought relief efforts (Kamara et al., 2019). According to Mekbib et al. (2012), the country experienced unrecoverable crop damage as a result of the drought during the 2006–2007 cropping season.

Again, droughts have a significant negative effect on farmers' economies as reported by Kamara et al. (2019). This is due to the fact that the majority of Lesotho's rural population depend on agriculture for both job and income (Kamara et al., 2019; Bosch et al., 2021). Consequently, droughts occurrences hinder agricultural productivity, leaving households extremely vulnerable to the effects of climate change (Bosch et al., 2021). According to Sekaleli and Sebusi (2013), the adverse effects of climate change on agricultural output reduced income and pushed communities in the Mafeteng district into extreme poverty with few possibilities for a living. Recurrent weather disasters contribute to the decline in revenues because the nation's agricultural productivity is already low (WFP, 2024). Due to this situation, Lesotho's current food security declination cause buying power to decline due to a severe drought and a general increase in food prices (Bosch et al., 2021). WFP (2024) indicates that food price pressure on staple crops has a significant impact on vulnerable households, especially those led by women as they choose to sell their possessions, engage in non-agricultural jobs, or skip meals in order to meet their nutritional needs.

Additionally, drought has a detrimental impact on diet and health (Kamara et al., 2019). In agreement with Kamara et al., Mukwada et al. (2020) acknowledge that food insecurity brought on by protracted droughts causes undernourishment. Furthermore, drought may cause fewer dietary changes, which could result in micronutrient shortages as a result of lower agricultural output (Bosch et al., 2021). However, Bosch et al. (2021) contend that recurrent droughts lead to a lack of high-quality water, which in turn increases the risk of famine and malnutrition-related disease outbreaks. Approximately 25% of Lesotho's total population is undernourished (Mukwada et al., 2020), 33.2% of children are stunted, and 14.8% are severely stunted as a result of undernourishment brought on by inadequate water supply (Bosch et al., 2021).

Kamara et al. (2019) mention that drought also negatively affects health and nutrition. The report by Mukwada et al. (2020) emphasises that food insecurity consequent to prolonged droughts leads to undernourishment. Additionally, Bosch et al. (2021) state that drought might lead to a decrease in changing the dietary, resulting to micronutrient deficiencies due to a decrease in agricultural output. Furthermore, these authors pose that frequent occurrences of drought result in scarce availability of quality water, which causes disease outbreaks due to famine and malnutrition.

Among the factors that contribute to food shortages, drought is the primary source of food shortages (Mukwada et al., 2020). According to Kamara et al. (2019), frequent droughts ruin farmers' livelihoods and push them further into poverty, hunger, and restricted access to food, particularly smallholder farming communities in rural areas. A severe drought and a general rise in food prices are the main causes of Lesotho's declining food security condition (Bosch et al., 2021). Bosch et al. further argue that due to low purchasing power, there is less food available from domestic production. Women farmers are particularly regarded to be poorly equipped to handle shocks because their asset base and productive capacity are significantly lower than those of male farmers (Bosch et al., 2021). For instance, due to labour-intensive nature of the Machobane farming system, women participate at a rate of 49% while men dominate at 51% (Mekbib et al., 2012).

3.2 The measures used to overcome the effects of climate change in smallholder farming

In order to improve resilience and food security, the country encourages farmers to use CSA practices (LMS, 2017). According to Mekbib et al. (2012), the nation prioritises adaptive measures because of its high susceptibility to the negative consequences of climate change. Smallholder farmers have responded by implementing a variety of measures to combat the consequences of climate change on food production. For instance, they adapted the use of fertilisers, use of drought-tolerant crop varieties, keyhole gardening, agroforestry, crop diversification, and small-scale irrigation. The government also developed the National Adaptation Programme (NAPA), institutions involved in climate-related initiatives, and a Climate Change Policy and Legal Framework in Lesotho to curb the effects of climate change were developed.

3.2.1 Use of fertilisers

For crops' growth, farmers use chemical fertilisers, organic fertilisers, or both. Applying fertilisers in response to climate change aids smallholder farmers in increasing soil fertility and moisture (Sekaleli and Sebusi, 2013; Morahanye, 2017). In addition to improving climate change resilience, fertiliser use boosts agricultural production (Dejene et al., 2011). For instance, according to Sekaleli and Sebusi (2013), crop production by smallholder farmers in Mafeteng produced the highest yields. Dejene et al. (2011) claim that approximately 65% of farmers in the lowlands use manure or inorganic fertilizers, with 10-15% using purchased inorganic and occasionally combining both inorganic and organic manure.

3.2.2 Planting of drought resistant crops

Planting of drought resistant crops can withstand harsh weather conditions, particularly drought (Kane et al., 2022). The drought tolerant crops practice enables smallholder farmers to conserve water, ensuring better crop survival in drought-prone areas (Kane et al., 2022). Based on the study by Morahanye (2017), most of the farmers situated in the lowlands use drought tolerant crops. Sekaleli and Sebusi (2013) affirm that smallholder farmers in Mafeteng are happy with the used improved drought tolerant seeds as they grow faster and provide high yield output. In the Machobane farming system, some farmers, particularly the ones situated in the mountains, indicated that they would switch to crops that would be suitable for changing climate conditions and grow within a short time, that imply drought resistant crops (Mekbib et al., 2012).

3.2.3 Keyhole gardening

Keyhole gardening is the prominent measure that has been adopted in the country for climate change resilience. It was introduced by Care Lesotho, World Vision Lesotho and Lesotho Red Cross Society (Sekaleli and Sebusi, 2013). Keyhole gardens are mainly employed by smallholder farmers in different districts of the country. The study by Sekaleli and Sebusi (2013) shows that keyhole gardening grows at an alarming rate in Mafeteng district, with 80% of small-scale farmers having adopted the strategy against climate change impacts. They are showcased to be effective for growing vegetable crops all year round (World Bank, 2018). Keyhole gardens are applauded by their ability to keep moisture and provide the soil with nutrients. They are made up of layers of soil, ash, manure and other organic material hence increasing the productivity even during dry period (Mofolo and Kheleli, 2021). That being the case, keyhole gardening adapts from climate change, improves food security, nutrition, and further increases incomes and savings as vegetables are marketable (Sekaleli and Sebusi, 2013; World Bank, 2018; Reva, 2019; Mofolo and Kheleli, 2021). In particular, Reva (2019) indicates that the nutritious vegetables produced include spinach, carrots and beetroot.

3.2.4 Agroforestry

The farmers use agroforestry as a way of removing carbon from the atmosphere and depositing it in a reservoir (Sekaleli and Sebusi, 2013). World Bank (2018) shows that Lesotho is heavily deforested with forests covering just 1.5% of the country`s land area. However, agroforestry enables farmers to have more chances for additional food production as it is also used as a living contour hedge for controlling erosion, to conserve and increase biodiversity (Sekaleli and Sebusi, 2013). Forest cover can be integrated with different fruit trees (World Bank, 2018). Agroforestry was adopted in Mafeteng district; however, the researcher reports that farmers' worry concerning agroforestry farming is that trees take a long time to grow (Sekaleli and Sebusi, 2013). Sekaleli and Sebusi assert that agroforestry provides diversified income and food sources, such as fruit trees. For decades, agroforestry has existed in Lesotho, guided by the Government and NGOs such as CARE Lesotho and the Rural Self-help Development Lesotho (RSDA). Dejene et al. (2011) confirm that there has been the formation of woodlots, protective hedges and live fences around homestead and home gardens for both food and non-food. However, the programme failed due to lack of ongoing external assistance as well as lack of operating market development.

3.2.5 Crop diversification

Crop diversification helps farmers to adjust to climate change, reducing its negative impacts on economic and food security (Marake et al., 2023). Sekaleli and Sebusi (2013) profess that in Mafeteng district, crop diversification has been executed using different drought and pest resistant crop types in order to stop a total loss of crop production due to climate change impact. In accordance with Morahanye's (2017) study, the diversified crops grown in the lowlands include maize, beans, sorghum, and leafy vegetables; thence improving food security and increasing climate resilience (Oladele and Nthama, 2024). Moreover, smallholder farmers in the foothills use crop diversification growing crops including green leafy vegetables (Mekbib et al., 2012). Additionally, crop diversification puts smallholder farmers on the save side against farming risk, as well as climate related risk (Dejene et al., 2011). In fact, Dejene et al. (2011) highlight that smallholder farmers diversifying crops are unlikely to endure total crop failure.

3.2.6 Small-scale irrigation

Owing to experiences of a continental temperate climate, Lesotho becomes a drought prone country, resulting in scarcity of foodstuffs (Mukwada et al., 2020). Recurring droughts that the country experiences, influence smallholder farmers to use irrigation systems to improve crop production while concurrently protecting and enhancing the land resources on which production depends. Among others, the most used irrigation systems include drip irrigation, sprinkler irrigation and small-scale surface irrigation (World Bank, 2018). Adapting irrigation systems reduce crop failure risks, and emissions, hence it increases yields and improves food security (World Bank, 2018; Marake et al., 2023). Nkuebele's (2024) study demonstrates that, well managed irrigation enhances crop yield and quality while conserving water resources. On top of that, irrigation systems as part of CSA practice, enhance crop production resulting in increased levels of food security and sustainable livelihoods of smallholder farmers (Tsese, 2023).

Surface and sprinkler irrigation systems for vegetables and fruits have been put in at small scale, especially in the dry spell prone lowlands of the country, resulting in rise to water use efficiency (World Bank, 2018). World Bank (2007) showcases that sprinkler irrigation uses only the water the vegetables need by minimising the drainage problems when it is well managed. Ntai's (2011) findings show that sprinkler irrigation is commonly used in Maseru and Quthing districts.

Drip irrigation and gravity-fed sprinkler irrigation reduce the vulnerability of field and horticultural crops to water stress during the early plant development stages (Marake et al., 2023). Ntai (2011) reveals that irrigation schemes using low-cost gravity fed irrigation have been developed in Masianokeng, Likotsi, St Michael, Semphetenyane and Qeme whereas there are limited records for individual farmers in the Ministry of Agriculture and Food Security. Drip irrigation and gravity-fed irrigation deliver water directly to the roots of the plants reducing water loss through evaporation and runoff, thus, encourage water to be used efficiently aligning with CSA goals of environmental sustainability (Marake et al., 2023). On the one hand, FAO (2005) reports that gravity-fed systems allow smallholder farmers to grow high value crops like vegetables and fruits promoting agricultural commercialisation. As stated by World Bank (2018), drip irrigation improves food security through consistent yields as it strengthens crops resilience to climate shocks like drought, in turn, it ensures maximum vegetation cover. World Bank shows that drip irrigation is adopted in the highlands and foothills of the country. Findings from a study done by Tsese (2023) from Thaba-Tseka Urban Council reveal that some smallholder farmers use drip irrigation which ensured food security.

Diversified farms that combine crop, vegetable and fruit production are practised in the country (World Bank, 2018). Irrigation increases the chances of smallholder farmers to intensify and diversify their crop production, for example, vegetables and fruits such as paprika, asparagus and apples (World Bank, 2007). Although horticultural crops are seasonal, irrigation has enabled farmers to grow different crops the whole year. For example, the findings by FAO (2005) highlight large quantities of vegetables produced the whole year in the lowlands under irrigation inclusive of cabbage, carrots and spinach. This diversification increases income diversification from self-employment creation by farmers, involves women and youth participation, improves nutrition, reduces poverty, and strengthens market resilience (Daemane and Chinwendu, 2014). Some farmers in Thaba-Tseka show that they are able to diversify their crops, enabling them to feed their families and sell the surplus vegetables because of irrigation adaptation.

3.2.7 National Adaptation Programme (NAPA)

In response to address climate change challenges, in 2006, the Government of Lesotho introduced National Adaptation Programme of Actions (NAPA) under the United Nations Framework Convention on Climate Change (UNFCCC) (Thabane et al., 2014; Mukwada et al., 2020). The main objective of NAPA is to pinpoint the community’s livelihoods that are susceptible to climate change in order to determine adaptation strategies for the vulnerable regions to cope with climate change (Gwimbi et al., 2013; Mukwada et al., 2020). The NAPA is an inclusive program that includes diverse stakeholders from government ministries and local communities and its activities are correlated by the Lesotho Meteorological Services (LMS) (Mukwada et al., 2020). As stated by Gwimbi et al. (2013), the NAPA involves a preference list of adaptation projects, such as improvement of agricultural productivity (including irrigation systems), early warning systems for droughts and water resource development, and research and development. Conversely, Dejene et al. (2011) claim that small-scale irrigation and water harvesting and management are not regarded as priority for adaptation option in the Lesotho NAPA. Besides, in accordance with Mukwada et al. (2020), the NAPA is one of the fundamental elements for a national poverty reduction plan in the country.

3.2.8 Institutions working on climate related programs in Lesotho

There are various institutions that work with the government of Lesotho to address climate change impacts. Lesotho Ministry of Energy, Meteorology and Water Affairs (MEMWA) is one of the meteorology department responsible for the country's climate change strategies. It corroborates the full implementation of the strategies and measures for suppressing the adverse impacts of climate change and variability for all sectors while it also promotes sustainable economic growth and development (World Bank, 2021). In addition, World Bank (2021) states that the Lesotho Meteorological Service (LMS) is responsible for the regular collection, processing, formatting, and management of data relating to weather, climate and climate change for the Government. It is responsible for reporting on climate change to the UNFCCC (Marake et al., 2023). Other than that, different stakeholders in the public and private sector organisations, including Non-Governmental Organisations (NGOs) such as Red Cross and World Vision, civil society, the donor community such as FAO and WFP, and local communities are part of the country's organisations that participate in curbing harmful climate change impacts (Marake et al., 2023).

3.2.9 Climate Change Policy and Legal Framework in Lesotho

Climate change impacts influenced the country to adapt climate change policy. Lesotho is the member of UNFCCC and the Kyoto protocol (Thabane et al., 2014; Mukwada et al., 2020). The purpose of UNFCCC is to ensure that food production is not threatened and to enable sustainable economic development. This would be achieved by maintaining greenhouse gas concentrations in the atmosphere by preventing threatening anthropogenic interference with the climate change (LMS, 2017). There is a Lesotho National Climate Change Policy under the Ministry of Energy and Meteorology. As asserted by Marake et al. (2023), the policy establishment is geared not only to promote climate-resilient environment, explore low-carbon development opportunities for sustainable use of resources and strengthen a framework that promotes efficient climate change governance, strong international cooperation, capacity building, research and systematic observations, but also to accelerate clean technology development, transfer and use, education, training and public awareness as well as financing in a way that benefits the most vulnerable through the implementation arrangements.

3.3 Conclusion

The crop production in the country is mainly affected by adverse impacts of climate change. Among them, drought is the major threat in the country, leading Lesotho to be a drought prone country. The literature points out that negative impacts of drought result in food shortages in the country, causing the country to be a net importer of vegetable crops. The literature reveals that smallholder farmers are the most vulnerable group in the country. However, different studies show that there are different measures that smallholder farmers use to curb the negative impacts of climate which improve productivity. Similarly, the government took initiatives that would help the smallholder farmers to overcome the effects of climate change by introducing CSA practices in the country and becoming a member of UNFCCC.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.0 Introduction

This section outlines the research paradigm, research methodology, research design, population and sampling, research instruments and data collection procedure. The validity, reliability and ethical considerations are also explained in this section.

4.1 Research paradigm

Research paradigm is the researcher's perspective that influences what should be studied, how it should be studied, and how the results of the study should be interpreted (Ugwu et al., 2021). For this study, the researcher used pragmatic paradigm. From Yen's (n.d.) and Ugwu et al.'s (2021) view, pragmatic paradigm is appropriate for the research as it braces the application of mixed method approach and helps the researcher to acknowledge the human actions and accentuate feasibility in the study.

In order to achieve the objectives of the study, the pragmatic paradigm aids the researcher to regard 'what' questions (Yen, n.d.). Similarly, Ugwu et al. (2021) indicate that the pragmatic addresses 'what' questions; as a result, it enables the researcher to completely address the questions quantitatively and qualitatively in nature. Thus, the pragmatic paradigm helped the present study to get answers from 'what' research questions in order to achieve the objectives of the study. The paradigm enabled the researcher to address the problem of the study.

4.2 Research approach

The study used a mixed method approach to assess the role of irrigated horticulture farming in assuring food security and livelihood making among small-scale commercial farmers. Mixed method research is an approach which involves both qualitative and quantitative methods. Radhakrishnan (2014) states that mixed method designs correlate each other, enrich validity of the research results as the weaknesses of one approach is complemented by one another for obtaining stable findings.

A mixed method approach aided the current researcher to find clear and precise results of the study as both qualitative and quantitative questionnaires were used in the same study. According to Onwuegbuzie and Combs (2011), mixed method is a procedure for collecting, analysing, and mixing both quantitative and qualitative research methods in a single study to understand a research problem. The mixed method approach enabled the farmers to express their thoughts and experiences. Thus, both close-ended quantitative data and open-ended qualitative data helped the researcher in the interpretation of the research problem (Sharmer et al., 2023).

4.3 Research design

A research design is a plan to conduct research which involves the intersection of philosophy, strategies of inquiry and specific methods (Cresswell, 2009). Different designs that fall under mixed method approach are convergent parallel, embedded design, explanatory and exploratory sequential designs. In this study, the convergent parallel design was employed. In order to best understand the research problem, the intent of the convergent design is to acquire diverse data on one topic, with findings supporting each other (Sharmer et al., 2023). In consequence, the researcher was able to integrate both qualitative and quantitative data to interpret the unified dataset to address the research problem. Creswell (2009) implies that the combined data of qualitative and quantitative data can form a single substantial result.

4.4 Population

Population is a set of all the units which possess variable characteristics under study and for which research findings can be generalised (Casteel and Bridier, 2021). For this study, the data has been collected from small-scale commercial farmers in the Maseru district, particularly from Masianokeng sub-centres.

4.5 Sample

Sample is the units selected from the population and representing all kinds of characteristics of different types of units of population (Shukla, 2020). Thus, for this study, the sample of fifty smallholder farmers practising irrigated horticulture farming, particularly vegetables crop producers on open landholdings were selected from different villages such as Likotsi, Ha-Jimisi, Ha-Makhalanyane, Ha-Mofoka, Thaba-Bosiu and Ha-Makhoathi villages.

4.6 Sampling method

In order to get accurate results in this study, the researcher used both probability and non-probability sampling methods. As described by Showkat and Parveen (2017), in probability sampling, each sample has fair opportunity of being chosen hence in this study, the researcher used stratified random sampling. Regarding non-probability sampling methods, the study used purposive sampling method due to its judgemental nature and accessibility of participants.

In stratified sampling, the sample is split into distinct groups that are comparatively similar and a random sample from each sub-group or stratum is chosen (Onwuegbuzie and Collins, 2007). The researcher was able to select the commercial farmers practising irrigated horticulture farming on open landholdings in different sub-centres in Masianokeng. The stratified sampling helps the researcher to control sample sizes for different sub-populations, ensures a more representative sample as well as different sample strategies within each sub-population (Iliyasu and Etikan, 2021).

Furthermore, purposive sampling is explained as an approach whereby specific individuals are intentionally chosen to provide significant information which cannot be found from alternative options (Taherdoost, 2016); thus, purposive sampling selects farmers for a sample according to their applicability to the goals of the study (Makwana et al., 2023). Therefore, in order to achieve the objectives of the study, only small-scale commercial farmers practising irrigated horticulture farming on open landholdings were selected. Thus, the desired results have been gathered as the researcher has communicated directly with the target group of farmers which had suitable proficiency and solid understanding of the topic (Bhardwaj, 2019). In consequence, the farmers' expertise and experiences were of great significance in this study.

4.7 Research instruments

There are various procedures for collecting data. The research instruments used in this study are face-to-face interviews using both closed and open-ended questionnaires. In response to research questions, both qualitative (open-ended) and quantitative (close-ended) data can be gathered (Creswell, 2018). The study employed the multiple-choice questionnaires that easily probed the farmers in order to provide them with guidance. The multiple-choice questionnaires provided possible answers that addressed the study problem and further included the options that allowed the participants to write their own answers (any other) if they feel that they do not support any given option. Furthermore, open-ended questionnaires were included in order to allow the respondents to express their opinions to further achieve the objectives of the study; as a result, the respondents did express their opinions. In that way, more information was collected and the researcher was able to make inferences.

4.8 Data presentation procedure

Data analysis is the process of transforming the gathered data into a meaningful information. It is defined as changing of collected raw data into significant facts and ideas to be understood either qualitatively or quantitatively (Taherdoost, 2020). For this study, the data was analysed based on primary data and supported by secondary data. The secondary data was sourced from journal articles, reports, and books. The quantitative primary data was analysed using descriptive and inferential statistical analysis. The collected data was presented using bar charts, pie charts, and through frequency distribution tables. Then, the qualitative data was thematically employed to describe the findings. Using these analytical tools, the researcher was able to make inferences on the role of irrigated horticulture farming on food security and livelihood making among small-scale farmers.

4.9 Validity

Validity means suitability of tools, processes, and data. It determines whether the research questions are suitable for addressing the objectives. It ensures the suitability on the choice of methodology used for answering the research questions, and whether the design is suitable for the methodology. Furthermore, validity ensures that the sampling and data analysis are suitable, and whether the findings and conclusions are logical based on the given context (Leung, 2015). In order to get valid results, researcher collected data based on the objectives of the study from fifty respondents of smallholder farmers, particularly the ones on open landholdings.

The use of interviews promoted the validity of the study. The structured interviews employed for data collection assisted the researcher to have an open discussion with the interviewees. The interviewer had an opportunity to clarify the questions that were not clear to the interviewees as the researcher was able to probe the respondents where necessary; consequently, the farmers offered well-grounded answers. Thus, the responses helped the study to reach its validity as it was easy for the researcher to analyse and interpret the collected data.

4.10 Reliability

Reliability is the consistency within the used analytical techniques (Noble and Smith, 2015). According to Golafshani (2003), reliability is the degree to which the findings are stable over time and accurately representing the entire population being studied. Additionally, if the findings can be repeated under a similar approach, the research instrument is regarded to be reliable (Golafshani, 2003). In order to ensure the reliability and consistency of the study, the researcher conducted farmers who engaged in open landholdings irrigated horticulture. This means that the same results would be produced even if the same study has to be replicated using the same procedures.

Clear understanding of the study aided the researcher to explain the purpose of the study to be respondents. Understanding the purpose of the study, together with clear and precise questionnaires influenced the respondents to provide transparent information.

4.11 Ethical considerations

Ethics is an exploration into what is good and bad, and what researchers have to do (Mirza, et al., 2023). The focal point of the researchers' trustworthiness to the rights and interests of their participants, audience, the academic community, and the society is their main accountability (Mirza, et al., 2023).

Above all, the researcher paid a visit to the Ministry of Agriculture and Food Security. The purpose of the visit was for self-introduction and explanation of the purpose of the study to the Area Coordinating Officer (ACO) of the study site. The visit helped the researcher as the ACO provided lists of individual farmers together with each farmer's phone numbers. Apart from that, the ACO introduced the researcher to the Extension Officers (EO) who are responsible to the villages in which the study was to be carried out. The EOs introduced the researcher to the farmers who were telephonically called (by the researcher) to make appointments.

Besides, the researcher was able to explain the purpose and significance of the study to the participants. The researcher notified the farmers that they should not expect any payback after the completion of the study and that the gathered individual's information would be secured. Consent and confidentiality are the two main ethical considerations for any research as highlighted by Shukla (2020); as a result, confidentiality and integrity were given top consideration during this study.

4.12 Conclusion

In this chapter, the research methodology has been outlined. The study has made use of mixed research methodology employing both quantitative and qualitative approaches. The population of the study was from Masianokeng sub-centres where the sample size of fifty smallholder farmers on open landholdings was selected. In order to control sample size and obtain relevant information for the research objectives, the study used stratified and purposive sampling methods. To gather more and clear information, both closed and open-ended questionnaires were utilised in this study. Primary data was supported with secondary data for analysis. Furthermore, validity, reliability and ethical considerations of the study were discussed.

CHAPTER FIVE

IRRIGATED HORTICULTURE FARMING AND LIVELIHOOD MAKING AMONG SMALL-SCALE COMMERCIAL FARMERS IN MASIANOKENG SUB-CENTRES

5.0 Introduction

The purpose of this chapter is to present and analyse data collected from small-scale commercial farmers in Masianokeng sub-centres in the Maseru district. The sub-centres in which data was collected are Ha-Makhalanyane, Thaba-Bosiu, Ha-Makhoathi, Ha-Jimisi, Ha-Mofoka and Qeme in Masianokeng in the Maseru district. The sample of collected data presented and analysed in this chapter is 50 small-scale commercial farmers selected from the above listed sub-centres. The analysed issues are about demographic information of small-scale commercial farmers, land issues, water accessibility for crops, storage and packaging, marketing strategies, income and savings from irrigated horticulture, use of labour and use of transport.

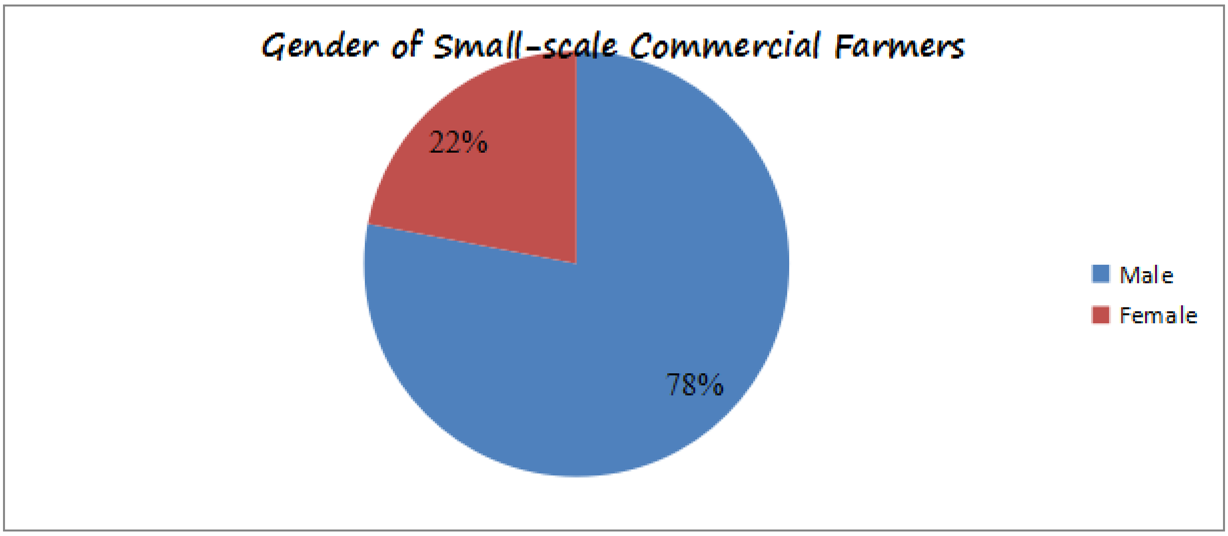
5.1 Demographic characteristics of small-scale commercial farmers

The characteristics of farmers play a pivotal role for identifying potentials of the farmers in order to present and analyse the study. It is, therefore, crucial in this section to provide a detailed overview of the demographic information of the small-scale commercial farmers in Masianokeng sub-centres. The demographic factors that are discussed include age, gender, marital status, size of the household members and educational background of the small-scale commercial farmers.

5.1.1 Gender of small-scale commercial farmers

Back in the 1980s, most Basotho men worked in the gold mines in South Africa and their migration resulted in reduction in agricultural output (Moletsane et al., 2017). In support, the study by Rantšo and Seboka (2019) also shows that farming was practised by women, elderly and children. It is, therefore, significant in this study to determine the gender that is actively engaged in small-scale commercial farming. Figure 5.1 below shows the gender distribution of small-scale commercial farmers who are actively involved in irrigated horticulture farming.

Figure 5. 1: Gender of small-scale commercial farmers, July 2025



Source: Field work data

Figure 5.1 above indicates that 78% of small-scale commercial farmers engaged in farming are males. The research findings show a different view from what used to be a practice. It is stated by Rantšo and Seboka (2019) that many Basotho men used to work in the South African mines in the past years, leaving farming in the hands of women and children. However, with retrenchment of many Basotho from South African mines starting from the 1990s, men resort to farming as a means of livelihood. Men took over farming while women performed the household duties. A small number of women (22%) involved in farming can be linked with the current trend in labour migration between Lesotho and South Africa. Women are migrating in large numbers to work as domestic workers. The conclusion that can be made from the study is that, men are now involved in farming compared to the last time when farming was in the hands of women (Rantšo and Seboka, 2019).

5.1.2 Age of small-scale commercial farmers

The economy of different countries is likely to improve if there is a large percentage of youth than elders in that country (Akintunde, 2020). The emphasis is that youths are creative, innovative and energetic; however, African governments and policymakers fail to create opportunities for the youth (Odoh, 2014). Thus, the youth are unable to improve their living standards and contribute to the economic growth of their countries. This section provides the age categories of the small-scale commercial farmers to determine the dominating age in irrigated horticulture farming.

Table 5. 1: Age group of the small-scale commercial farmers, July 2025

Age group	Frequency	Percentage
18-25	1	2
26-35	8	16
36-45	19	38
46-55	17	34
56-65	3	6
66 +	2	4
Total	**50**	**100**

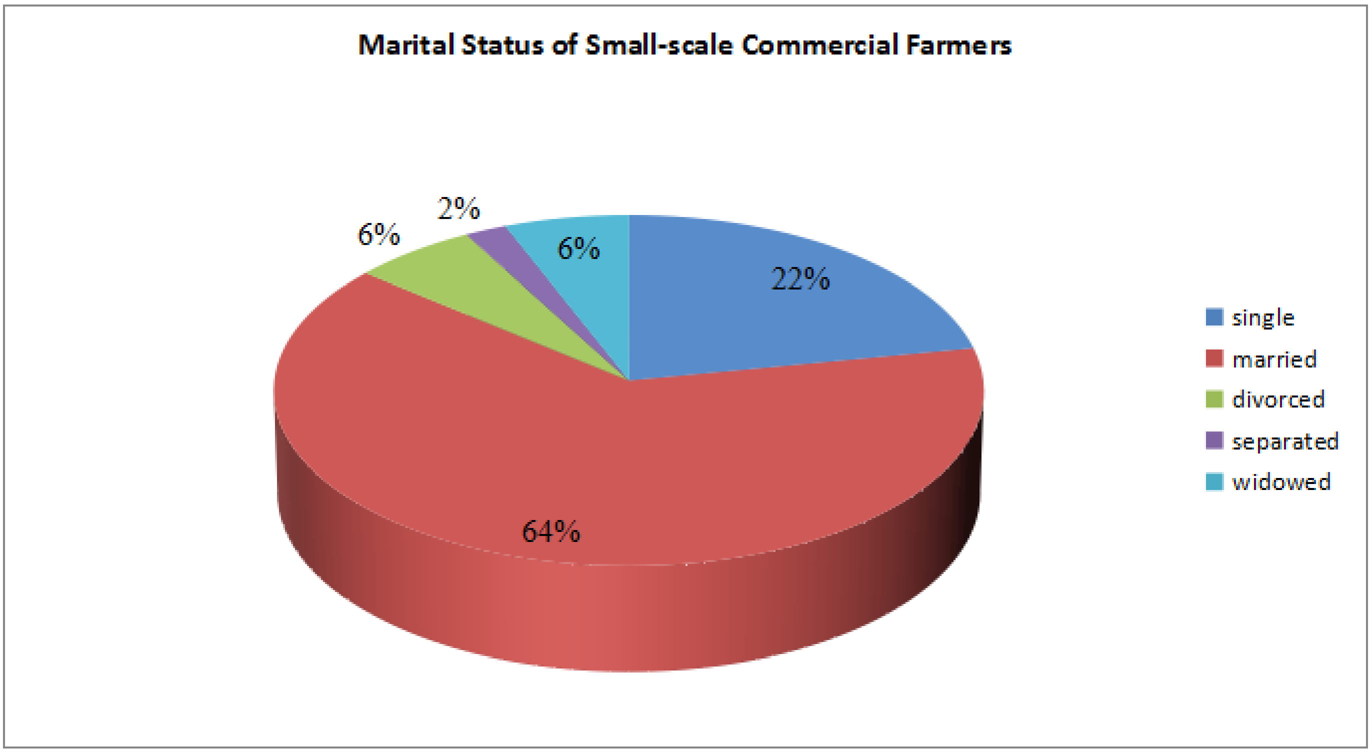
Source: Field work data

Table 5.1 above shows that 72% of small-scale commercial farmers in horticulture farming are found in the age category 36 – 55. This age group consists of adults who support their families. Many of them have responsibilities of taking care of their families, and thus involved in horticulture farming to make a living. It can also be noted from the above Table 5.1 that a small percentage (18%) of small-scale farmers age between 18 – 35. This age group is made up of youth who most of them are unemployed. In this case, it can be deduced that, young people are not found in large numbers in agriculture. There are many factors that restrict youth to participate in farming. These include among others, lack of capital and access to land. Though land plays a crucial role in producing crops, it is not easy for the youth to own it. They have to wait numerous years for inheritance (Lesaane and Akintunde, 2020). It can be concluded that, young people are not actively involved in small-scale commercial farming. This might have a negative impact on the country state of food security because youth is the most energetic age group, and when it is not included in farming, the country might suffer the consequences of high food insecurity.

5.1.3 Marital status

The marital status can contribute to the success or failure of farming. Understanding the marital status of the farmers in small-scale commercial farming can be helpful for contextualising and interpreting the findings of this study. This section provides whether farmers are single, married, divorced, separated or widowed. Figure 5.2 below illustrates the status of small-scale commercial farmers in Masianokeng sub-centres:

Figure 5. 2: Marital status of small-scale farmers, July 2025



Source: Field work data

Figure 5.2 above indicates that 64% of the small-scale commercial farmers is married. These results show that the married people are found in large numbers in farming. The couples can work together to increase production yield in farming by making joined decisions, contributing their income together, and sharing labour. It can, therefore, be concluded that married couples have potential of producing more crops and improving their livelihoods than single headed families. However, it cannot be ignored that, some conflicts in marriages can hinder farming.

5.1.4 Household size of small-scale commercial farmers

The number of households helps to determine a total of household members that might contribute to the success or failure of small-scale commercial farming. The literature reveals that in Nigeria, household heads couples are better food secure than single households (Ubokudom, et al., 2017). This could be attributed to the resourceful contribution between the couples to create increased earnings. Conversely, the households with large unproductive family members are likely to be food insecure as they provide food burden on progressive labour (Ubokudom, et al., 2017). Table 5.2 below presents the number of household members in Masianokeng sub-centres.

Table 5. 2: Number of household members, July 2025

Number of Household members	Frequency	Percentages
1-3	22	44
4-6	22	44
7-9	6	12
10-12	0	0
TOTAL	**50**	**100**

Source: Field work data

It can be noted from Table 5.2 above that 88% of small-scale commercial farmers have household sizes ranging between 1 – 6 members. According to Basotho tradition, these are not large households. The small household sizes in Lesotho and elsewhere in African countries can be attributed to the health challenges that were experienced mainly during the COVID-19 pandemic. In addition, the cost of living that is caused by the declining economy is also a major contributing factor.

The contribution of small household sizes to food production is also impacted negatively. This is because small-scale commercial farming is known by its dependence on family labour (Muzekenyi et al., 2022). The families with a smaller number of family households, have less family labour which may force them to incur more expenses on hired labour for farming activities, whereas families with more household members could use only household labour. The study by Rantšo and Seboka (2019) reveals that most of the Africans small-scale farmers rely on unpaid labour for agriculture.

5.1.5 Educational background of small-scale commercial farmers

Educational background unlocks the insights of the individuals. Agricultural sector is an important sector requiring the skilled, trained and knowledgeable farmers in different agricultural activities (Kőmíves et al., 2019). Through education, farmers can improve and sustain economy over extended period of time and extend agricultural production to another level (Ninh, 2020). When farmers are equipped with essential knowledge for agricultural production, they are likely to make constructive decisions for the best adaptation of new technology and inputs (Ninh, 2020). Table 5.3 below gives a detailed overview of the educational background of the small-scale commercial farmers in Masianokeng sub-centres:

Table 5. 3: Educational level of the small-scale commercial farmers, July 2025

Education Level	Frequency	Percentage
Non-Formal	1	2
Primary	8	16
Secondary	5	10
High School	19	38
Tertiary	17	34
TOTAL	**50**	**100**

Source: Field work data

It can be noticed from Table 5.3 above that there is no specific qualification for one to be involved in farming. The results in Table 5.3 reflect that 38% of farmers have high school education. These results suggest that, farming is a source of employment for the less educated people. Therefore, farming is important for livelihood making for people who failed to secure employment in the formal sector because of low educational level. However, low level of education hinders farmers to explore the modern farming techniques from different online sources such as the internet.

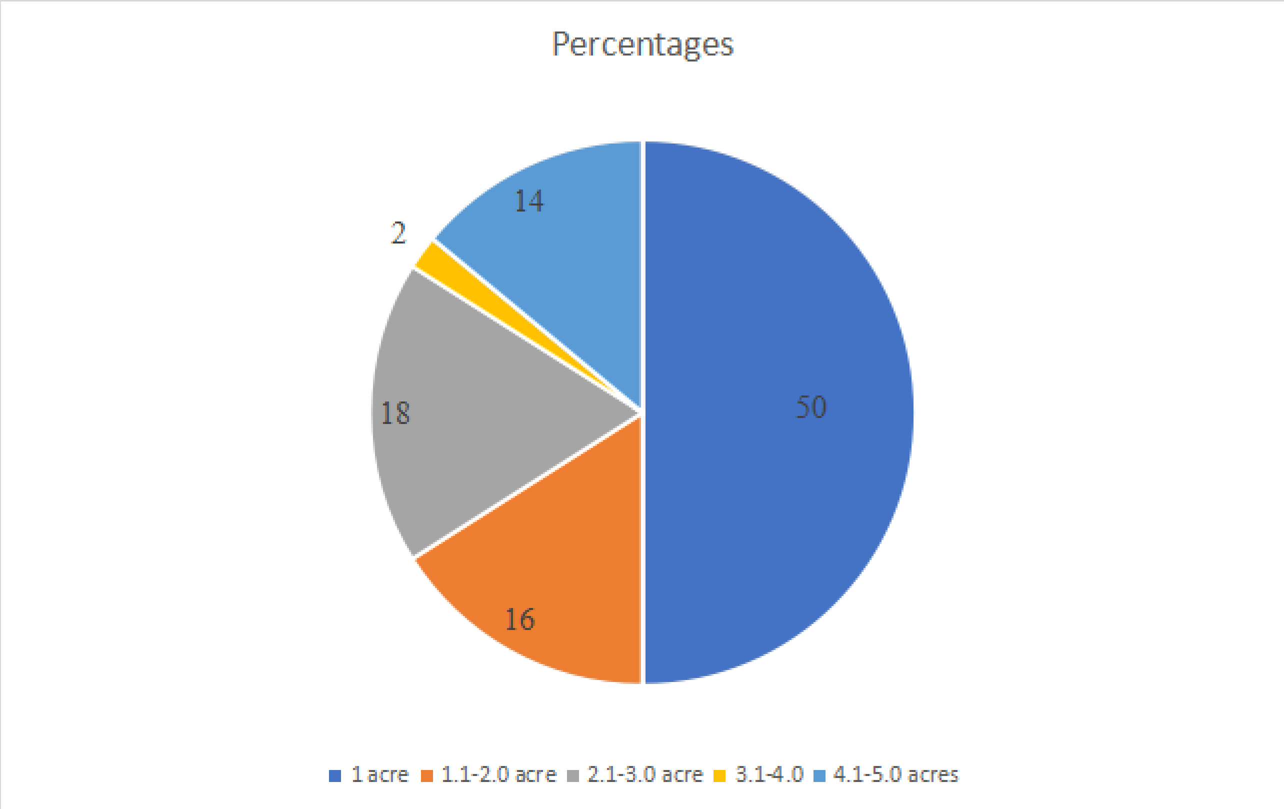
There are also farmers with tertiary education participating in small-scale commercial agriculture. In this case, 34% of small-scale farmers have tertiary education. People with tertiary education now venture into farming because of increasing unemployment rate among the educated ones. Many university graduates are faced with lack of jobs, and many of them have resorted to the informal sector and farming to make ends meet. It can, therefore, be deduced that, while farming was regarded to employ the uneducated people (Rantšo and Seboka, 2019), there is increasingly a higher number of educated people who participate in farming due to lack of jobs in the formal sector.

5.2 Land issues

5.2.1 Land sizes of the small-scale commercial farmers

Land is one of the factors of production, and it is mostly used for agricultural purposes. The land size is also important for agricultural production. This is because the small-landholding produce less compared to the large ones. However, investment in the small-landholding can contribute to increased yields. Research shows that smallholder farmers usually own small landholding with an average size of less than two hectares (Harvey et al., 2018; Augustin, 2021). The results showing the land size of small-scale commercial farmers are presented in Figure 5.3 below.

Figure 5. 3: Sizes of the farm land for small-scale commercial farmers, July 2025



Source: Field work data

Figure 5.3 above shows that 50% of smallholder commercial farmers utilise the land size of 1acre for farming. Farming in Lesotho is practised in small landholding, and this affects production negatively. The decline in arable land is caused mainly by the agent of climate change and over-stocking of livestock. Lesotho has experienced massive soil erosion over the past years. Too much rainfall, floods and wind have decreased the arable land negatively. This has contributed to limited agricultural land in many parts of the country.

The traditional land tenure systems also contribute to limited access to land in Lesotho. There are many fallow lands in different parts of the country, but they cannot be put in use because of the traditional ownership. These implies that although many farmers show potential and interest in producing vegetable crops, access to land remains a major challenge that restricts them from producing more crops. One farmer explained:

> **As the demand increases in the market, I couldn't supply all my customers with my products due to limited land I own. Therefore, I had to hire 1 acre that I rent for M2,500 annually in addition to 2 acres I have.**

Another farmer added: "**I borrowed land from my neighbour who was not using it to start crop production after being retrenched from the factories**." This highlights that there is a scarcity of land for people who want to invest in the farming sector.

This is in line with studies in other developing countries that shortage of food security is contributed by limited arable land and land tenure issues (Gwambene and Saria**,** 2024). Similarly, in Lesotho, the study by Rantšo and Seboka (2019) reveal that the freehold tenure issues can be related to the deterioration in agricultural production.

From this analysis, it can be deduced that, scarcity of land affects many farmers negatively. They fail to show potentials in producing large quantities of vegetables that can improve the livelihoods of farmers and assure national food security. Also, small land makes smallholder farmers to be more vulnerable to climate change (Ogundeji, 2022). This is because for a potential farmer, small land cannot accommodate crop diversification. In consequence, reduction in agricultural output slows down food security and poverty (Ngcamu and Chari, 2020).

5.2.2 Type of crops and seasons grown by small-scale commercial farmers

In Lesotho, production of crops varies depending on the four agro-ecological zones. It is essential to state that agricultural production is seasonal owing to varying temperatures across the seasons. Just like other Sub-Saharan countries, Lesotho is prone to climate change conditions that contribute to low agricultural production (Rantšo and Seboka, 2019). Choosing the type of seeds and crops to grow based on the seasons of the year and climate conditions that might arise along the development of the crops, particularly dry spells, is prioritised by farmers to maximise yield harvest. In this regard, it is important to list the type of crops that are grown by smallholder farmers in Masianokeng and the suitable and challenging seasons to grow such crops.

The study reveals that small-scale commercial farmers in Masianokeng sub-centres grow cabbage, spinach, rape, tomato, peppers, onion, garlic, beetroot, carrots, lettuce and mustard spinach (referred to s*epaile* in Sesotho). According to the findings, some vegetable crops such as peppers, tomatoes, chillies and lettuce are seasonal while the rest of the crops are not as they can be grown the whole year round. According to FAO (2005), irrigation allows farmers to grow various vegetable crops such as cabbage, spinach and beetroot all year round. The results show that 52% of small-scale commercial farmers find summer to be the suitable season for growing different types of crops. In this case, one farmer said:

> **I normally grow different types of crops in my farm depending on the suitable season for each crop. I grow peppers and tomato specifically in summer due to warmer temperatures and lots of rain. Other crops like rape and cabbage, I grow them in every season as they can sustain different weather conditions and they are mostly marketable.**

This highlights that irrigation accommodates farmers to diversify the vegetable crops throughout the year.

Another farmer said:

> **I grow cabbage, spinach, carrots and onion the whole year. They can be resilient to different weather climate conditions; however, summer remains the challenging season owing to pests and diseases outbreaks and hail.**

The above qualitative results indicate that though some small-scale commercial farmers have ability to produce vegetable crops all year round, there are some obstacles pertaining to their production in each season. For instance, 48% of small-scale commercial farmers showed that winter is the most challenging season. The season is associated with slow growth of crops due to cold weather conditions. The crops grown in winter delay to reach the maturity stage and increases farmers expenditure in that they have to purchase some boosting fertilisers to maintain crops lifespan. This is in line with Waldinga (2015) that lower temperatures result in agricultural production decline. One farmer explained that:

> **In winter, I sell my products after a longer time than in any other seasons. This increases my expenditures, as I have to pay the employees without incomes from regular sales.**

Another farmer lamented that:

> **Winter is very expensive for vegetable farming as I have to help my crops to resist winter conditions. I have to buy boosting fertilisers. If I don't boost them, their quality is negatively impacted, for example, my cabbage and rape change from green to purple and yellow colour.**

It can be concluded that, irrigation allows small-scale commercial farmers to produce different vegetable crops all year round. Nonetheless, farmers have to consider the crops that can survive in different seasons of the year. Also, it can be inferred that the smallholder farmers do not use tunnel farming and shade nets; hence they are prone to various climate conditions. This vulnerability to climate conditions results in decreased agricultural production and food security. Rantšo and Seboka (2019) assert that Lesotho encounters low agricultural production owing to poor agricultural practices.

5.3 Water accessibility for crops

5.3.1 Water sources for growing crops

Small-scale commercial farmers in Masianokeng rely on different sources of water for irrigating the crops. The most common types of water sources include among others, rain water, river water, dam water, tap water and borehole water. The findings show that 100% of the smallholder farmers depend on rain-fed agriculture. The farmers who rely mainly on rain-fed agriculture are more vulnerable to climate change, particularly drought (Harvey et al., 2018; Nyang'au et al., 2021; Ogundeji, 2022; Rankoana, 2022). The extend at which their water sources are affected during dry spells differ on the water source a potential farmer uses.

However, some farmers stated that they still have water during dry spells while others run out of water completely during the dry season.

It can be inferred that rainwater plays a significant role for efficient crops growth in the small-scale commercial farming sector in the study area. It can also be concluded that small-scale commercial farmers in Masianokeng mainly rely on rain-fed agriculture.

Different studies elsewhere stipulate that smallholder farmers in developing countries are at risk to climate change because of agriculture's dependence on rainfall (Harvey et al., 2018; Nyang'au et al., 2021; Ogundeji, 2022; Rankoana, 2022). The results of the study are in line with those of Sekaleli and Sebusi (2013), Kamara et al. (2019) and Mukwada et al. (2020) who argue that agriculture in Lesotho rely on rainfall.

5.3.2 Impacts of drought

According to Zenda (2024), drought leads to decreased yield crops output and total failure of crops in different regions. The research findings indicate that owing to drought, many farmers (86%) in Masianokeng sub-centres experience the reduction of crop yield output while some farmers (16%) experience total failure of crops. The decrease or total failure in crop yields could be attributed to the farmers' reliance on rain-fed agriculture. Dependence on rainfall makes the farmers more vulnerable to climate change, particularly drought. The decrease in crop output leads to food shortages and promote poverty. In support of the findings, the literature highlights that droughts affect food availability, food diets and food security (Hawkins et al., 2022).

Nevertheless, small-scale commercial farmers in Masianokeng sub-centres have derived different strategies to adapt to drought. These help them to be resilient to drought and keep on producing crops even under the prevailing circumstances of drought. One farmer explained:

> **I normally use hybrid seeds, then mulch my vegetable gardens all year round to retain moisture and conserve amount of water I use for watering my crops.**

Another farmer added:

I use a lot of animal manure and little chemical fertilisers to improve soil fertility. Together they help to retain soil moisture and promote fast growth. I also have borehole tap that keeps my tank reservoirs full all the time and help my drip irrigation to keep on supplying moisture to my crops.

While the other farmer explained:

I have planted fruit trees in my garden which help to protect my crops from the scotching sun, especially in spring when it is too dry. I have to wait a bit longer for late rains before I could plant my crops.

The recurring drought denotes that there is a pressing need for farmers to use irrigation systems while still considering Climate Smart Agricultural practices. In this regard, farmers in Masianokeng sub-centres use different methods of irrigation for their crops. Among others, the adopted irrigation systems are sprinkler irrigation, drip irrigation, furrow irrigation and manual irrigation. One farmer indicated:

I purchased sprinkler irrigation in 2015 because I wanted to increase the farm land that I am using. From the time I started using sprinkler, I noticed mass production that allowed me to cater for all my customers.

Another farmer stated:

Since I started using drip irrigation system that I bought in 2021, I began to notice increasing crop output. That was the time when I began to produce quality crops all year round with efficient water use and decreased labour force expenses.

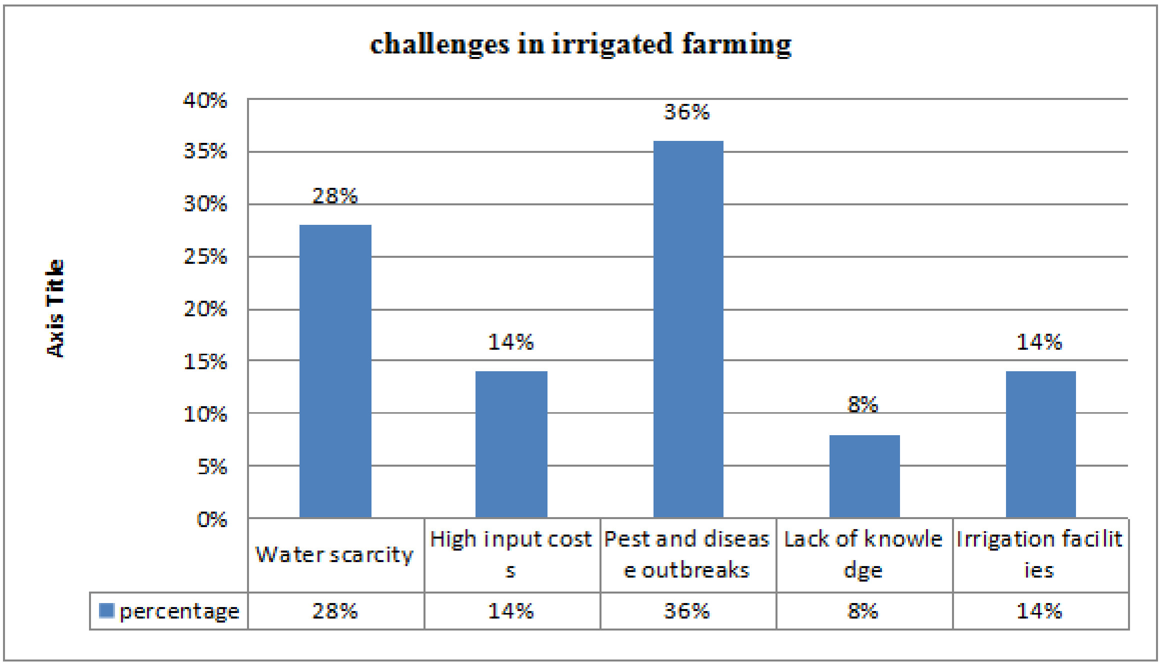
It can be inferred that the smallholder farmers have knowledge and skills on how to overcome the impacts of climate change. This could be linked with the strategies and irrigation systems that they employ in farming. Besides, the farming practices farmers utilise could be because of the agricultural extension services and visits they often get from the Ministry of Agriculture Officers.

Further, it can be noted that irrigation improves crop production. Smallholder farmers are able to intensify and diversify the crops as irrigation provides the crops with adequate water supply. Thus, the farmers are able to produce quality crops.

5.3.3 Challenges of irrigation on crop production

Although irrigation plays a significant role in improving the agricultural production among the smallholder farmers, there are some obstacles that hinder the sustainability of crops yield output and profitability. These include, among others, scarcity of water, high costs of agricultural inputs, pest and disease outbreaks, lack of knowledge by smallholder farmers and lack of access to proper irrigation systems. Figure 5.4 below presents the data about the challenges encountered by small-scale commercial farmers in Masianokeng sub-centres.

Figure 5. 4: Challenges faced in irrigated horticulture farming, July 2025



Source: Field work data

As presented in Figure 5.4 above, 36% of smallholder farmers mentioned pest and disease outbreaks as the main challenge facing irrigated horticulture farming. Pest and disease result in decreased productivity and poor-quality crops for the market. The results are in accordance with Fanadzo et al.'s (2010) study asserting that in some developing countries, decreased in agricultural production is caused by pest and disease outbreaks.

The results further indicate that both high input costs and irrigation facilities are obstacles in irrigated horticulture farming. While during the study, 71% of farmers stated that the Lesotho Government subsidises the agricultural inputs, they (agricultural inputs) are not easily accessible due to high demand and low supply. Scarcity of agricultural inputs contributed to the high costs. When some farmers cannot access the agricultural inputs, they resort to affordable traditional seeds that are less productive. In this regard, Mbilinyi (2013) emphasises that farmers using traditional seeds encounter poor crops harvest as explained by one farmer that:

> **Government subsidy on seeds, fertilisers, and the pesticides makes the agricultural outputs to be cheaper. However, the major challenging issue is that, they are insufficient and we sometimes have to sleep at the Ministry of Agriculture in order to get them. Yet sometimes we completely fail to get them.**

Another farmer added that:

> **The main challenge is that, sometimes the varieties of the seeds that are subsidised by the government isn't what my customers like most and I resort to buy expensive ones from outside the country in order to meet the demand of the market. After all, the agricultural inputs are only sold twice a year while I grow the vegetable crops the whole year.**

5.4 Use of labour

Labour plays a vital role in increasing production and profitability in a farming sector. When there are many people working in the farm, there are different farming activities that are shared and performed within a short period of time. This helps to free the farm owner to focus on other farm activities such as marketing and delivery. Both household and hired labour are essential to activate agricultural processes.

The data collected in the study area reveals that 60% of the farmers use both household and hired labour in the farming sector. As explained by one farmer:

> **I have hired 2 permanent workers that help me to manage my farm with different daily agricultural activities. However, during transplanting period and harvesting, I have to hire about two casuals to help us to perform those activities fast.**

Another farmer added:

"I have employed only one permanent worker to help me and my family to work in the farm."

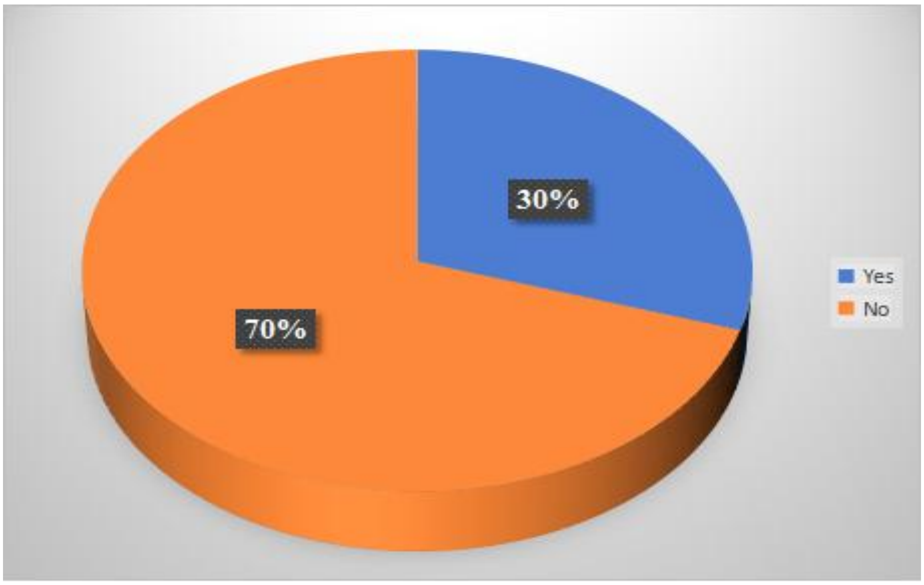
It can be observed that small-scale irrigated horticulture farming creates job opportunities. This promotes food security and livelihoods of the individuals as they are able to meet basic daily needs from the salary earned.

5.5 Storage and packaging

Storage availability for small-scale commercial farmers plays an essential role for safely keeping the produce after harvest before they reach to the customers. Thus, post-harvest storage extends shelf-life of crops. According to Faqeerzada et al. (2018), post-harvest storage helps smallholder farmers produce to keep the crops quality some days before delivery, thus reducing the unnecessary food losses. If the quality of the crops is well managed, market prices would be secured.

Packaging enhances the shelf life and hygiene of the agricultural products (Aaron et al., 2008). When small-scale commercial farmers package their agricultural products, they add value to the products and in turn, gain better profits than when the products are sold unprocessed. Besides that, packaged products are easy to pack in a vehicle without harming their quality when they are delivered to the market. To avoid post-harvest losses, farmers need to have efficient and proper storage for packaging vegetable products. The data in Figure 5.5 below illustrates whether small-scale commercial farmers in Masianokeng sub-centres package their products before delivering them to the market or not.

Figure 5. 5: Packaging of vegetable products, July 2025



Source: Field work data

The findings in Figure 5.5 above reveal that 70% of small-scale commercial farmers do not package their products before supplying them to the market. There are different factors pertaining to this. One, farmers do not have post-harvest storages that they can use for packaging their products as pointed out by one farmer:

> **I have no storage for post-harvest; and I don't package my produce, as I don't even have any other shelter that I can use to package my products.**

Two, farmers find packaging materials to be expensive and contribute to unnecessary costs as explained by one farmer:

> **I don't use the packaging materials because they are expensive and using them will cause me unnecessary expenditures.**

Another farmer added that:

> **My customers come with their sacks and plastics to my farm and buy fresh vegetables straight from my farm. Therefore, there is no need for storage and packaging materials.**

Three, most farmers' products do not meet the formal markets' standards; therefore, they sell their products to street vendors, local households and non-formal supermarkets. One farmer clarified:

> **I have regular customers whom I supply with my products and I find no reason to package my products because I deliver the products from the field, straight to them.**

In contrast, 30% of small-scale commercial farmers package their products as indicated in Figure 5.5 above. They purchase the packaging materials in local shops. One farmer explained:

> **Before taking my products, for example, tomatoes, green pepper and onion to the market, I usually clean and pack them in small transparent plastics that I buy from the local supermarkets.**

Another farmer added:

> **I buy the boxes for tomatoes and peppers in some supermarkets in town. I am even able to buy the cabbage bags in the shopping markets that are found in town.**

The results suggest that most farmers do not have storages for post-harvest; as a result, to avoid post-harvest losses, they are driven to sell their products unpackaged to non-formal markets. Louw and Jordan (2016) emphasise that farmers do not sell to high value markets due to expensive packaging and labelling of the vegetable produce. This illustrates that their potential to invest in more profits in their farming endeavour is hindered by their level of production and lack of knowledge to expand the businesses. It can also be concluded that small-scale commercial farmers in Masianokeng sub-centres do not use branded packaging materials.

5.6 Marketing strategies

Marketing agricultural products is an essential tool for the sustainability and successfulness of all agricultural activities. Marketing agricultural produce can help farmers to enhance food security, improve livelihoods and reduce poverty (Oyekale, 2014). It is, therefore, important for farmers to market their products as to transform farming into business adventure.

All small-scale commercial farmers (100%) in the study area market their products using different marketing strategies. These are exhibitions, social media (Facebook, WhatsApp), billboards and radios. The results show that 84% of small-scale commercial farmers in Masianokeng sub-centres use social media more than any other marketing strategy. There are various reasons for social media being the predominating marketing strategy. First and foremost, social media targets the intended audience group and allows for personalised messages. Secondly, it is cheaper and effective (Cui, 2014), resulting in massive return of incomes into the businesses. The majority of the farmers in Masianokeng sub-centres find the street vendors and households consumers as their reliable market for their products as one farmer noted:

> **I sell my products to the street vendors and the local household consumers, but there are times when I have to sell the produce to them on credit due to high competition in the market, particularly during the rainy seasons.**

However, there are farmers who have sustainable market at the small fruits and vegetables shops, as one farmer stated:

> **I sell all my produce to local small fruits and vegetables and I normally run out of the stock because 1.5 acres land that I have, doesn't cater for the market demand.**

On the other hand, only one farmer is able to sell the products to another district. A farmer explained:

"I have loyal customers from Thaba-Tseka district, who sometimes buy all the cabbage I have and are satisfied with my product."

It can be concluded that the marketing strategies that farmers employ in farming, are crucial depending on the targeted market. Even though all smallholder farmers in the study area market their produce, some farmers struggle to sell all the crops; this is attributed to their marketing techniques. In most cases, ineffective marketing strategies limit farmers to sell their yield output to well-paying markets (Digvijay et al., 2018).

5.7 Use of transport

5.7.1 Delivery of the products to the market

Transport service plays a significant role in agricultural production activities. It promotes access to the market, efficient production and increases profitability to farmers. Delivering agricultural outputs to customers helps small-scale commercial farmers to avoid post-harvest damages and allows farmers to regulate market prices as the products reach the market still fresh.

The majority of the farmers in the study area use vehicles as a reliable mode of transport to deliver their products to the market. One farmer explained:

> **I hire a vehicle to deliver my products to the customers. It helps me to carry more of my products that meet the market demand.**

Another farmer added:
"I use my own vehicle to deliver my products to the market. It helps me to reach the market with fresh vegetables."

These results illustrate the need for farmers to deliver the products to the market using either hired or owned vehicles. It can be concluded that the market is far from the small-scale commercial farmers. Hence farmers are bound to use vehicles to deliver their products to the market.

5.8 Income and savings from irrigated horticulture

The income from the irrigated horticulture can improve the livelihoods of the small-scale farmers in different ways under good management. For instance, increased and stable income promote food security and alleviate poverty among the farmers. It helps farmers to meet other essential services like investing in education and health services issues. When small-scale commercial farmers are financially stable with the income from their farm, they can invest more on agricultural inputs and create employment for the youth.

The evidence from the study area reflects that 70% of small-scale commercial farmers in Masianokeng sub-centres rely mainly on irrigated horticulture as their means of living. The farmers' monthly sales are not regular, but rely mostly on the availability of products during the time of harvest. However, 54% of farmers collects on average less than M5000.00 per month, while 52% of them is able to save between M500-M1,500 per month. One farmer explained:

> **Farming has really improved my live tremendously. We farmers can collect any amount of money depending on the demand and supply at any time of harvest. But I normally collect M4,000 monthly. Part of it I pay the school fees and other household's needs like grocery shopping.**

Another farmer said:

> **Since I started growing vegetable crops, my life transformed to a better standard of living for, we never lack food in the family. I also manage to pay for the health services and the school fees for my children.**

On the other hand, all 50 farmers save money seasonally for agricultural inputs. These results highlight that most farmers depend on farming to earn their living. This suggests that, while farming is regarded as business which is expected to create jobs for many people, with the reliance of the farmers on the income generated from it, the transformation process may be noticed after a long time.

5.9 Conclusion

This chapter has presented and analysed the data by first discussing the demographic information of the farmers practising irrigated horticulture farming in Masianokeng sub-centres. The demographic information discussed include: age, gender, educational level, marital status and number of household members. It is determined that males are the predominating gender in the agricultural sector. The findings also revealed that agriculture sector employs many people regardless of age, gender and educational background.

The results indicate that even though drought is a major threat to farmers in the country, farmers are able to cope with drought conditions. This is because of the climate smart agricultural practices they employ in farming, which among others, include the use of fertilisers, growing drought resistant crops and using applicable irrigation systems. The study revealed that irrigation enables farmers to diversify crops throughout the year, hence this helps to improve productivity, livelihoods and ensure food security.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This chapter offers the discussion concerning the findings of the study. It provides the summary, conclusion, and the recommendations based on the findings of the study. The summary is done on the basis of the specific objectives and the evidence of the study. The chapter provides some recommendations based on the practices that farmers can put in place to transform farming into business adventure and the interventions that the government should initiate to improve the small-scale commercial farmers.

6.1 Summary

In many developing countries, farming is regarded as a key component that creates jobs for many people, improves food security and the livelihoods of the people. Nevertheless, climate change has increasingly become a major challenge that farmers face recently and has forced farmers to employ irrigated horticulture farming in contrast of the rain-fed. Due to high unemployment rate in Lesotho, many people have resorted to irrigated horticulture farming as an alternative for employment. The government of Lesotho through the subsidy of the seeds, fertilisers and pesticides has played a significant role in extending a helping hand to support the farmers with cheap agricultural outputs.

The study investigated the role of irrigated horticulture farming in assuring food security and livelihood making among small-scale commercial farmers in Masianokeng sub-centres in the Maseru district, Lesotho. The principal reason was to assess the role of irrigated horticulture farming in assuring food security and livelihood making among small-scale commercial farmers. It also aimed to investigate the impact of climate change on horticulture farmers practising farming on open landholdings and to examine the opportunities and threats faced by horticulture farmers practising irrigated farming on open landholdings.

The data was collected from 50 small-scale commercial farmers making use of a mixed method approach.

The study deduces that irrigated horticulture farming plays a significant role in assuring food security and livelihood making among small-scale commercial farmers in Masianokeng sub-centres. This is due to the fact that, irrigation allows farmers to grow vegetables the whole year round as irrigation provides crops with efficient amount of water supply when needed. Additionally, the study revealed that irrigation enables farmers to diversify vegetable crops throughout the year. Thus, irrigation improves food availability and dietary diversity of high-quality crops.

Moreover, the study revealed that, irrigation contributes to improved farmers' living standards as they are able to earn income from the sales all year-round. This implies that although the youths and other people may undermine irrigated horticulture farming; under good management, it offers many job opportunities regardless of the age group and improves the livelihoods of the farmers. The findings from the study further revealed that only 18% of the youths are participating in irrigated horticulture. This could be linked to lack of capital and access to land. They also revealed that farming is important for livelihood making for people who failed to secure employment in the formal sector because of low educational level.

The other main objective was to investigate the impact of climate change on horticulture farmers practising farming on open landholdings. Several climate changes have become a worrying factor to small-scale commercial farmers in Lesotho. The findings revealed that smallholder farmers who are practising farming on open spaces are more vulnerable to climate change conditions such as hails, frost and drought. These impacts result in crop yield reduction or total failure of crops. Most farmers (86%) indicated that drought resulted in reduction of crop yields output; as a consequence, it escalates to food shortages and poverty in the country. The findings further demonstrated that there are often outbreaks of pest and disease on account of recurring drought which results in increased agricultural expenses, as farmers are bound to buy the insecticides to treat the pests and diseases. Further, based on the findings, frost slows down the growth rate of the crops and affects their quality.

The last objective was to examine the opportunities and threats faced by horticulture farmers practising irrigated farming on open landholdings. Small-scale commercial farmers experience different opportunities in irrigated farming. The study established that farmers are able to practise crop diversification. In this study, 90% of the small-scale commercial farmers, among others, diversify crops such as cabbage, rape, spinach, peppers, onion, carrots, garlic, beetroot and tomatoes. The results further indicated that some crops such as cabbage, rape, spinach, beetroot and carrots can be grown all year round. Consequently, they earn more income due to increased productivity and profitability, presenting more employment opportunities. Other than that, most farmers own land; therefore, this helps them to invest more on improving the soil fertility of their own land and be able to invest more by installing the irrigation systems for effective and sustainable all year-round production.

The study uncovered that 100% of farmers market their products. This opens some chances to sell their products from the farm straight to the local and street vendors' market. Thus, they reduce much of post-harvest losses of the produce, as 88% of farmers do not have storages and 70% lack packaging materials.

The findings disclosed that there are threats that affect farmers productivity and profitability. Pests and disease outbreaks affect the crops quality of farmers in the study area, leading them to extra expenses of pesticides. Water scarcity was found in the study area hindering the small-scale commercial farming produce because of recurring droughts and high input cost was discovered as a contributing factor to the low produce. These result in poor productivity, hence, exacerbate food shortages.

6.2 Conclusion

Based on the study findings, it can be concluded that irrigated horticulture farming plays a vital role in assuring food security and livelihoods of small-scale commercial farmers in Masianokeng sub-centres. Even though irrigation improves productivity and livelihoods, there are challenges that they encounter which need to be addressed.

6.3 Recommendations

There are various threats and obstacles that small-scale commercial farmers encounter in the practice of irrigation as a coping mechanism to drought. These challenges call for attention from both the farmers and the government to address them for the success and sustainability of the irrigated horticulture farming. For this reason, there are recommendations that both farmers and the government should take into a serious consideration in order to put them into practice for the betterment of improved food security and livelihood.

6.3.1 Recommendations to the farmers

Incorporating various marketing strategies open chances for higher sales and profit making, in return, the business may thrive and become resilient. For these reasons, farmers should vary the marketing strategies that focus on different group of people, for example, word of mouth and hawking. They should use the marketing strategies that cover a wide audience all at once. Also, farmers should market their produce to both the formal markets and informal markets. This may help them meet the demand of all the markets in the country and compete with the imported vegetables from South Africa.

Saving the incomes in small-scale farming is significant for the growth and sustainability of the business. For these reasons, farmers should save more money to cater for the threats and security of the farm, such as pests and diseases outbreak, breaking down of the machineries and total failure of the crops. It is also recommended that, farmers should save more money to invest for long term growth of their farms such as investing on irrigation systems, greenhouses, upgrading the farming tools to machinery, building the storages for post harvests and packaging. If farmers can treat their farms as businesses, they may save enough money to buy quality agricultural inputs that can in turn increase yield output regardless of the climate change conditions.

6.3.2 Recommendations to the government

Farming is an inclusive business catering for all people regardless of their age group and gender. However, the study indicated that very few youths (18%) and women (22%) are participating in farming. This calls for the government interventions to empower women and youths to participate in irrigated horticulture. Both women and youth should be supported to form cooperatives and have full access to land ownership. The youths should be given an equal opportunity as women to participate in the parliament so that they can raise their opinion on the policy making regarding farming.

Availability of farming inputs influences farmers to increase production. For this reason, the government should ensure that the subsidised hybrids seeds, fertilisers and pesticides are always available in abundance and brought to the centres nearer to the farmers as to cut the transportation costs. This would promote sustainable production and improve the livelihoods of many people, which would attract many people to invest in farming.

Water harvesting is significant for the farmers who are experiencing recurring drought. Growing of vegetable crops requires adequate water and proper irrigation systems for the efficient use of the water and production of quality crops. In this case, the government should assist farmers in constructing dams nearer to the areas where farmers grow their vegetable crops and help them to install the irrigation pipes that bring water closer to their farm lands.

Lack of farming skills and knowledge restrain more investments in the farming sector. In this regard, since most farmers are not professionals, the government should hold regular trainings to equip farmers with the farming strategies that can lead them to mass production and impressive incomes. Also, the government should strive for frequent provision of information and trainings about appropriate technology for effective farming.

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APPENDIX

ANNEX 1

QUESTIONNAIRE

FARMERS QUESTIONNAIRE

Section A:

Demographic information

Name (Optional)/contacts…………………………………………………………….

Village…………………………………………………………………………………….

1. Age

18- 25	( )
26-35	( )
36-45	( )
46-55	( )
56-65	( )
66 and above	( )

2. Gender

Male	( )
Female	( )

3. Education Level

No formal Education	( )
Primary	( )
Secondary	( )
High School	( )
Tertiary	( )

4. Marital Status

Single	( )
Married	( )
Divorced	( )
Separated	( )
Widow	( )

5. Number of Household members

1-3	( )
3-6	( )
6-9	( )
9-12	( )

SECTION B:

Land issues

6. What is the size of your farm land?

1.0 acres ( )

1.1-2.0 acres ( )

2.1-3.0 acres ( )

3.1-4.0 acres ( )

4.1-5.0 acres ( )

5.1 acres ( )

7. What type of land do you farm?

Own land ( )

Rented ( )

Borrowed ( )

Other (please specify) ……………………………………………………………

8. If rented, how much do you pay per year or month?

Duration	Amount
Year	
Month	

The type of crops

9. What type of vegetables do you grow on the farm?

Spinach ( )

Cabbage ( )

Tomato ( )

Onion ( )

Beetroot ( )

Carrots ( )

Rape ( )

Chillies ( )

Peppers (green, yellow, red) ( )

Garlic ( )

Lettuce ( )

Others (specify) ………………………………………………………………….

10. What type of crops do you plant in:

Season	Type of crops
Summer	
Autumn	
Winter	
Spring	

11. What season do you find more suitable for farming?

………………………………………………………………………………………………………

12. Which season do you find most challenging for vegetable farming?

……………………………………………………………………………………………………

Water accessibility for crops

13.What type of water sources do your plants rely on?

Rain water ( )

River water ( )

Dam water ( )

Tap water ( )

All of the above ( )

14. If your plants rely on one or all of the above, how are the water sources affected during the dry season?

They become dry ( )

The water is still available ( )

Shortage of water ( )

15. If the availability of water is negatively affected during the dry season, how do you cope with the situation?

………………………………………………………………………………………..

Impact of drought

16. How does drought affect your vegetable production?

Reduction of crop yield output ( )

Severe crop yield output ( )

Total failure of crops ( )

Increased crop yield output ( )

More pests and diseases ( )

Planting dates ( )

Food shortages ( )

No impact ( )

Other (please specify) ……………………………………………………………………

17. How do you cope with the drought that affects your plants?

……………………………………………………………………………………………………
……………………………………………………………………………………………………

18. What strategies do you use to cope with drought in different areas?

Sector/area	Type/dates
Crops	
Fertilizers	
Crop diversification	
Water harvesting	
Changing planting dates	
Irrigation	
Planting trees	

19. If you use irrigation as a method of coping to drought, when did you start using it?

……………………………………………………………………………………..

Irrigation facilities

20. What type of irrigation methods do you use?

(a) Drip irrigation ( )

(b) Sprinkler irrigation ( )

Surface irrigation ( )

Furrow irrigation ( )

Manual irrigation ( )

Other (specify)…………………………………………………………………..

21. How did you acquire the irrigation facilities?

Bought for myself ( )

Donation/assistant ( )

Government subsidy programme ( )

Others (please specify)…………………………………………………………………………

22. If it is a government subsidy, what are the terms of payment?

……………………………………………………………………………………………………
…………………………………………………………………………………………………….

23. Has irrigation improved your crop production?

Yes ( )

No ( )

24. If Yes to the above question, then how do you observe the increase?

Increase in food sufficiency ( )

Harvesting quality crops ( )

Water efficiency in crops ( )

All year-round production ( )

Others (specify)…………………………………………………………………………………

25. What are the main challenges you face in irrigated horticulture farming?

Water scarcity ( )

High input costs ( )

Pest and disease outbreaks ( )

Lack of knowledge ( )

Others (specify)…………………………………………………………………………………

Post-harvest storage

26. Do you have storage for post-harvest?

Yes ( )

No ( )

27. If yes to the answer above, how does it benefit you?

……………………………………………………………………………………………………
…………………………………………………………………………………………………….

28. If no to the answer above, how does it affect your produce?

………………………………………………………………………………………………
………………………………………………………………………………………………

Income from irrigated horticulture

29. Is farming your main source of income?

Yes ( )

No ( )

(c) Others (specify)…………………………………………………………………………..

30. How much do you make from selling vegetable per month?

Less than M5,000 ( )

M5,000-M10,000 ( )

M10,000 and above ( )

31. How much saving do you make from the income per month?

M500-M1500 ( )

M1600-M2500 ( )

M2600-M3500 ( )

Above M3600 ( )

32. How do you spend the savings?

………………………………………………………………………………………………..

33. Do you use some income for some household purposes?

Yes ( )

No ( )

34. If yes to the above question, how do you use them?

Purchase food ( )

Health services ( )

Education of children ( )

Other (Specify)…………………………………………………………………………

35. How have the incomes derived from selling vegetables improved your living standard?

Improve it tremendously ( )

Improved it moderately ( )

Has not improved ( )

36. Do you save some money for farming?

Yes ( )

No ( )

37. If yes to the above question, how much do you save for farming per season?

M1500-M4500

M4800-M7500

Above M10800

Use of Labour

38. What type of labour do you use on your farm?

Household labour ( )

Hired labour ( )

13.1 If you use hired labour, how many people have you employed?

…………………………………………………………………………………………

39. How many of the employees are:

Permanent workers………………………………………………………….

Casual workers……………………………………………………………

Packaging and Marketing

40. Do you package your harvest before supplying to the market?

Yes ( )

No ( )

41. If yes, where do you get the packaging material?

…………………………………………………………………………………………
…………………………………………………………………………………………

42. If no, why do you not use packaging?

…………………………………………………………………………………………
…………………………………………………………………………………………

43. Do you market your products?

Yes ( )

No ( )

43. If yes, how do you market them?

Exhibition ( )

Social media (Facebook, WhatsApp, Instagram, Twitter) ( )

Billboards ( )

Radios ( )

Others (please specify) ……………………………………………………….

44. Where do you market your products?

Local household consumers ( )

Street vendors ( )

Small Fruits & Vegetables shops ( )

Fresh produce markets ( )

Local Supermarket shops ( )

Other districts markets ( )

International markets ( )

Other (specify)……………………………………………………………

45. Is the market reliable?

Yes ( )

No ( )

46. If No to the above question, what are your alternatives?

………………………………………………………………………………………
………………………………………………………………………………………

48. Are you able to produce more vegetables that meet the market demands?

Yes ( )

No ( )

49. If yes to the above answer, are you able to sell them all to the consumers?

Yes ( )

No ( )

If no, what are the constraints?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

50. If you are not able to produce enough for the market, what are the obstacles?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

Use of transport

51. Do you deliver products to consumers/market?

Yes ( )

No ( )

52. If yes, what mode of transport do you use?

Use vehicle ( )

Use wheelbarrow ( )

Use animal draught power ( )

Other (specify)…………………………………………………………………

53. Is the mode of transport you use efficient?

Yes ( )

No ( )

54. If No to the above question, how does it affect your products?

………………………………………………………………………….

55. If you do not have transport, how do you deliver goods to customers/market?

………………………………………………………………………………….

56. How does lack of transport affect your business?

Does not affect it ( )

Moderately ( )

Negatively ( )

Extension services

57. Do you get agricultural extension services to improve your production?

Yes ( )

No ( )

58. If yes to the above question, how often do extension officers visit your farm?

Once a week ( )

Once a month ( )

Once in a quarter ( )

Once in a session ( )

Once in a year ( )

Never ( )

59. If agricultural extension services visit your farm, what type of services do they render?

Advice about suitable dates for planting certain crops ( )

Advice about application of fertilizers ( )

Advice about drought resistant seeds ( )

Advice how to grow crops interchangeably ( )

Share expected climate change information ( )

Other (please specify)……………………………………………………………

60. From which organisation do extension officer come?

Government extension officers ( )

NGO extension officers ( )

Individuals ( )

Other (please specify) …………………………………………………………..

61. Have you received any CSA practice training or support?

Yes ( )

No ( )

62. If yes, who offered the training?

Ministry of agriculture extension officers ( )

Non-Governmental Organisations (NGOs) ( )

Both ( )

Other (specify)…………………………………………………………………….

63. Does the government play any role to improve your crop output?

Yes ( )

No ( )

64. If yes to above question, which role does it play?

………………………………………………………………………………………

65. What kind of support do you need from the government to improve your horticulture farming?

Irrigation infrastructure ( )

Access to credit ( )

Technical training ( )

Improved agricultural inputs ( )

Market access ( )

Other (specify)……………………………………………………………………….

Thank you very much for your cooperation.