

Sustainability of Vegetable Production Systems by Small-Scale Farmers of
Limpopo Province in South Africa

by

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Abstract

The study was conducted in 23 villages of Limpopo Province through an article-based format. The study in area A, was conducted in six villages, four in Makhado Municipality of Vhembe District, and two villages in Greater Letaba Municipality in Mopani District. The objective of the study was to characterise vegetable production systems of small-scale farmers in the study area. Data was collected using a questionnaire and some information was gathered through direct observation. Fifty-two farmers were sampled using a multi-stage random sampling technique and were interviewed. The sample size was calculated using Lovin's formula. Data was analysed using a SPSS. The results of the study showed that 59.62% of the farmers were males, 57.69% were above 61 years of age. The education status of women was lower than that of men and more women had no formal qualification. The 92.31% owned land and 80% of the plots ranged between 0.5 and two hectares. The 84.62% had vegetable farming experience ranging between 5 and 16 years. Water management system was characterised by some farmers (50%) who adapted to water shortage by planting drought tolerant vegetables, some 19.23% used drip irrigation system and others (13.46%) used conservation tillage. The majority (71.15%) of these farmers used furrow irrigation and gravitational canal, and their main source of water was the river. They drew water using gravitation and pipes as well as gravitation and canals. Water availability ranged from daily to monthly. Human resource management was characterised by 48.08% of the vegetable farmers who employed a mixture of youth, male and female workers and 60% of the farmers hired workers on seasonal basis. Soil sampling did not exist because 65.54% did not take soil samples and 67.31% did not know when last they took soil samples, 65.38% used both organic and inorganic fertilisers. About 81% applied between 10-200kg fertiliser per hectare using band placing method. Other vegetable production practices identified include chemical pest control (100%); soil resource management was done through conventional tillage (86.64%); contours to control erosion (71.18%). Weed control was mainly manual (73.08%). Income generated from sale of vegetables was mainly used for labour, production inputs and mechanisation. Farmers in the study area kept records for finance, input, planting dates and yields. Most farmers used 0-10% of vegetables they produce for home consumption. The results of the study showed that vegetable production can be sustainable if water, soil, pests and disease are managed appropriately.

The study in area B, was conducted in six villages situated in the four municipalities within the two districts of the Limpopo Province in South Africa. The study investigated vegetable production systems and consumption patterns as determinants of food security amongst small-scale vegetable farmers. A multi-stage random sampling technique was used to select

52 respondents for this study. The sample size was calculated using Slovin's formula. Data was collected through a questionnaire and other information through direct observation. Data was analysed using the statistical package for social sciences. The study revealed that 65.38% of the participants were males 42.31% had an average age of 51-61 years and had 5-10 years farming experience. The study shows that male respondents 63.46% had secondary education and are more than females, and 71.16% had dependants ranging from five to above nine per household. The majority 92.31% own land for vegetable cultivation and more respondents who own land are males while 65.38% cultivating vegetables on land size ranging from 1-2 hectares. Most farmers (71.15%) cultivated a variety of vegetables; 90.38% grew vegetables in order to generate income; 38.46% grow vegetables because the market for vegetables is available. The study also revealed that 44.23% used drying method to preserve vegetable seeds; 90.38% used single cropping system for vegetables, and they practiced intensive vegetable production system. Vegetable preparation for food is characterised by 71% who use boiling as a cooking method while 55.77% used tomato and onion to enhance vegetable flavour and used salt to enhance vegetable taste. The study noted that 48.07% experienced pest infestation and high inputs costs as the main constraints in vegetable production. Vegetable consumption is characterised by 40.38% who consumed vegetables once per week; the 51.92% preferred to eat leafy vegetables than other vegetables. Most of the respondents (55.77%) were encouraged to eat vegetables that were appropriately cooked. The study also noted that adult women (38.46%) consume vegetable in the family, and they consumed 50-100g of vegetable per day. The study shows that 57.69% preserved vegetables by drying, because it is the cheapest method. The results of the study show that a variety of vegetables produced, and preservation are the main determinants of food security in the study area.

The study in area C, was conducted in four villages, three from Thulamela municipality and one in Maruleng municipality. The objective of the study was to analyse climate change mitigation strategies adopted by small-scale farmers towards a sustainable vegetable production and resilient from food shortages in Limpopo Province. A multi-stage random sampling technique was used to select 52 respondents for this study. The size of the sample was calculated using Lovin's formula. Data was collected through a structured questionnaire and direct observations. Data was analysed using the statistical package for social sciences. Results of the study revealed that more (53.85%) women participate in vegetable production. The study also shows that 59.62% had an average of 51-61 and above 61 years of age. The 61.54% had secondary education. The 90.38% had no qualification in agriculture. The majority (67.31%) cultivate their crops on 1-2ha. The 81.76% have moderate ability to high ability to adapt to climate change. The majority of the respondents (88.46%) rate decrease

in quality of irrigation water, decrease in soil fertility and increased soil erosion as factors that lead to land degradation due to climate change. The 86.54% view drought, high temperatures and more pests as rare events as a result of climate change. The 61.54% experienced a slight decrease in summer rainfall patterns. The adaptation to change in summer rainfall is mitigated by planting drought resistance vegetable crops and irrigating frequently to adapt to that change. The 61.54% experienced increased pest infestation due to climate change and they noticed an increase in the use of pesticides to adapt. An increase in winter temperature was noticed by 80.77% of farmers and 67.32% adapt by growing cool season vegetables. Changes in summer temperatures was noticed by 90.30% who experienced an increase in summer temperatures due to climate change. The respondents are aware that local authorities are concerned about climate change and other activities such as soil mining, veld fires and tree cutting that may be contributing to climate change. Strategies in response to climate changes include knowing about the importance of weather and climate change forecasts. The 57.69% say forecasting helps them to plan planting dates, others say it helps them to make a choice of vegetable varieties and to project rainfall distribution. The majority (84.62%) use Radio and TV as their main source of information about weather and climate. Farmers in the study area apply Climate-smart agriculture technologies including crop rotation by 71.15%, others use mixed cropping, mulching, no till, crop residue, contours to counter the impact of climate change. They also use climate smart agriculture for increased productivity, 51.92% use hybrid seeds, pesticides and fertilisers. The CSA soil fertility technologies are the use of manure (52%), others use crop residue and mulching. Types of fertilisers used, 63.46% use both organic and inorganic fertilisers. Water saving technologies feature 50% who use water harvesting technology as a way of saving water, few use mulching for soils to retain moisture longer. The results of the study show that 59.62% of the respondents use ridges/terraces to control soil erosion, and others use contour planting, other use grass strips. Risks posed by climate change are identified amongst others as reduced crop yield reduced, amount of rain, floods and rise in temperatures. The 63.46% minimise risks by using crop diversification and use hybrid seeds. The study shows that farmers in the study area are aware of the climate change and the related factors. They are also applying CSA technologies as mitigation strategies to ensure sustainable food supply. However, there is a need to support small-scale farmers with improved technologies for them to be able to mitigate and cope with climate change challenges.

The study in area D, was conducted in five villages, the three villages in Vhembe District, and two villages in Mopani District. The objective of the study was to assess the potential of African Indigenous Vegetables (AIVs) towards the formation of a commercial, nutritional and sustainable production system. A total of 53 small-scale vegetable farmers were randomly

sampled using a multi-stage cluster sampling procedure. Sample size was calculated using Slovin's formula. Data was collected by means of a questionnaire and analysed using descriptive statistics. The study revealed that more women (64.15%) participated in the production of AIVs. The 54.72% of the respondents supplied AIVs all-year round. Some respondents (49.06%) grow AIVs for home consumption, while 64.15% are encouraged to grow AIVs because they are well adapted to the area, easy to grow and have short growing period. About 60% of the respondents indicated that AIVs are highly consumed by adults and pregnant women in the families. The study revealed that 90.57% of the respondents could harvest and sell 1-2 tons of AIVs per season. About 57% of the respondents benefited from all types of markets, local, farm stalls and high value markets. The study showed that 86.79% of the farmers in the study area received support from the Department of Agriculture and Rural Development, in the form of advice, and production inputs. The results of the study confirm that there is a potential for the formation of a nutritional and a commercial production system from AIVs in the study area because the market of AIVs is growing.

The study in area E, was conducted in the eight villages, three of Vhembe District, and five villages of Mopani District. The objective of the study was to identify and analyse the opportunities and constraints of a wide adaptation to organic vegetable production systems by small-scale farmers. A total of 52 small-scale vegetable farmers were randomly sampled using a multi-stage cluster sampling procedures. Sample size was calculated using Slovin's formula. Data was collected through a questionnaire and analysed using the SPSS. The female respondents (55.77%) participated in vegetable production. The study shows that 21.15% of women attended secondary-level education. The study shows that farmers in the study area have experience ranging from 11-21 years. The study also revealed that 61.54% of the respondents have access to land they own, lease and communal use. The study also showed that the respondents have dependents ranging from 1-above 9 in number. The study shows that farmers use fertilisers, crop rotation and practicing intercropping in order to promote soil fertility. The study shows that the respondents apply livestock manure, poultry manure and other types to boost their vegetables. It was also revealed that farmers are aware that pesticides are not healthy, and they use protective clothing, and wash their hands with soap after use. Weed is controlled manually. The respondents agreed that organic market has a potential of growth, while others say there is shortage of local organic markets. The study revealed that 80.77% of the respondents considered organic farming (OF) as more profitable, and 78.85% say that it saves on production costs. The study showed that 75.00% of the respondents believed that organic products fetch higher prices. About 53.85% had moderate knowledge of organic farming, while 65.38% were ready to receive technical skills on organic farming (OF). The study captured that 75% viewed conversion to organics as

expensive while 44.23% were willing to convert to organic farming in the near future. The results of this study show that there are opportunities in farming on organic vegetables if the constraints and difficulties identified in the study area are dealt with.

It is concluded that vegetable production in the study area is sustainable but can improve further by exploiting the opportunities presented by this sector, however, needs support where the needs and necessities are identified, so that it continues contributing in feeding the nation and generating income for the livelihoods of the small-scale farmers.

Key words: *Sustainable, vegetable production system, small-scale farmers.*

Preface

Vegetable production systems by small-scale farmers of Limpopo Province are described and evaluated to understand their level of sustainability. This study follows my Master's degree study on sustainability of Sweet potato production at Tshiombo village in Vhembe District. My initial application for PhD degree was not successful because it was late. I then applied for the second time which this time was successful. I presented my research proposal to the study panel meeting held in Pretoria and it was accepted. After registration at the University, I was advised to apply for Ethical Clearance before I could administer the information gathering instrument. I did what was required and eventually got the ethical clearance. In the Limpopo Department of Agriculture and Rural Development I was advised to ask for permission to conduct the study from the Departmental Research Committee, my request was approved and was referred to the districts to negotiate for assistance with the Districts Heads who then referred me to the Municipalities Heads and again referred to the Service centres so that Extension Officers could link me with the farmers in the vegetable production projects situated in various villages. The Extension Officers organised farmers at neutral venues. I appointed two master's Students of the University of Limpopo to assist in administering the questionnaires to facilitate and to save time I had to issue them with my vehicle to do the work. Financially, it was exhausting because I had to pay for the running costs and paying them for the work. The work could have been completed earlier had it not been the Covid 19 restrictions where gatherings of many people at one point were limited to accommodate fewer people and following the protocols laid down for Covid-19. I was humbled because I thought that the research will be smooth sailing, the reality of facing friendly and hostile reception/environment is something to remember. I am happy that this work was accomplished having created friends and gained valuable experience.

Mathobo D.N

Declaration

I David Nndineni Mathobo ID NO 5904275888087, declare that this thesis hereby submitted for the degree of Doctor of Philosophy at the University of the Free State, is my own, original and independent work, and has not been previously submitted in any form by myself or anyone else for any degree to any other university.

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MATHOBO D.N

.....

DATE

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- Mr. Walter Kekana, Computer Applied Technology Specialist, for his guidance regarding advanced computer related activities.
- Above all, God Almighty has been forever faithful in granting me His mercy and love. I am thankful.

Dedication

This work is dedicated to:

- My late mother, Vho- Muofhe Maria Mathobo who did not taste the fruits of my academic achievements.
- My spiritual mother, Pastor Violet Mathobo of Christian Worship Centre, Makonde for inspiration, motivation and spiritual support.
- My wife, Mukondeleli Joyce Mathobo who remained supportive through thick and thin.

Abbreviations

ACAPS –Assessment Capacities Project

ACB- African Centre for Biodiversity

AER- Economic Research Service

AIVs African Indigenous Vegetables

ALVs-African Leafy Vegetables

ARARI-Amhara Regional Agricultural Research Institute

ARC-Agricultural Research Council

ARPH-Asian Research Publishing Network

ASC-Agricultural Service Centre

AVRDC-Asian Vegetable Research and Development Centre. Now World Vegetable Centre

BMP-Best Management Practices

CA-Conservation Agriculture

CABI- Centre for Agriculture and Bioscience International

CASP-Comprehensive Agricultural Support Programme.

CCAA- Conference on Commercial Agriculture in Sub-Saharan Africa

CDC- Centre for Diseases Control and Prevention

CDN- Canal Distribution Network

CLES- Centre for Local Economic Strategies

CRS-Community Research Connections

CRT- Contour Ridge Tillage

CSA- Climate Smart Agriculture

CSIR Council for Scientific and Industrial Research\

CVDs-Cardiovascular Diseases

DAE- Deloitte Access Economics

DAF- Department of Agriculture and Fisheries

DAFF-Department of Agriculture, Forestry and Fisheries

DARD-Department of Agriculture and Rural Development

DFID-Department for International Development

DOI-Digital Object Identifier
ECs Exchangeable Bases
Eds-Editors
EFAD- European Federation of the Association of Dietitians
EPA-Environmental Protection Agency
ESRF- Economic and Soil Research Foundation
FANRPAN- Food, Agriculture and Natural Resources Policy Analysis Network
FAO-Food and Agricultural Organisation of the United Nations
FFTC- Food and Fertilizer Technology Centre
FISP- Farmer Input Support Programme
FSP Farmer Support Programme
fy- financial year
g- gramme
GDP Gross Domestic Product
GPS Global Positioning System
GTZ- Gesellschaft für Technische Zusammenarbeit
GVLs- Green Leafy Vegetables
ha- hectare
IAAE- International Association of Agricultural Economists
IAEA- International Atomic Energy Agency
Ibid-ibidem (In the same place)
ICBET- International Conference of Biomedical Engineering and Technology
ICIPE- International Centre of Insect Physiology and Ecology
ICMW- Integrated Crop Water Management
IDP-Integrated Development Plan
IFAMA-International Food and Agribusiness Association
IFASA-Institute of Food and Agricultural Sciences
IFPRI- International Food Policy Research Institute
IGAs- Income Generating Activities
IKS-Indigenous Knowledge Systems

ILO-International Labour Organisation
IMF-International Monetary Fund
INM- Integrated Nutrient Management
IPCBE- International Conference on Food and Agricultural Sciences
IPM-Integrated Pest Management
ISB-Information Seeking Behaviour
ISF-Integrated Soil Fertility
ISFM- Integrated Soil Fertility Management
ISOFAR-International Society of Organic Agriculture Research
IWMI International Water Management Institute
kg- kilogram
LDARD- Limpopo Department of Agriculture and Rural development
N-Nitrogen
NARO-National Agricultural Research Organisation
NEMA-National Environment Management Act
NENA-Near East and North Africa
NGO-Non-Governmental Organisation
NM-Nutrient Management
OECD- Organisation for Economic Cooperation and Development
OF-Organic Farming
OPE-Overall Project Efficiency
Org-Organisation
P- Phosphorus
PES- Provincial Equitable Share
pH- Potential Hydrogen
PMS- Performance Management System
PND- Pipe Distribution Network
PRB- Population Reference Bureau
PREM-Poverty Reduction and Economic Management Network
PTO –Permission to occupy

RESIS-Revitalisation of smallholder Irrigation Schemes
RTE-Ready to eat
SACAU-South Africa Confederation of Agricultural Unions
SANNEE- South Asia Network for Development and Environmental Economics
SDF-Spatial Development Framework
SEF-Syferkuil Experimental Farm
SLWM-Sustainable Land and Water Management
SOC-Soil Organic Carbon
SPSS Statistical Package for Social Sciences
SSA-Sub-Saharan Africa
STATSSA-Statistics South Africa
SVPS-Sustainable Vegetable Production Systems
TAC-Total Anthocyanin Content
TCC- Total Carotenoid Content
TPC- Total Polyphenol Content
TV-Television
TVLs Traditional Leafy Vegetables
UN-United Nations
USA-United States of America
USAID-United States Agency for International Development
USDA-United States Department of Agriculture
VAT-Value Added Tax
WAP-Week after planting
WFO-World Farmers Organisation
WHO-World Health Organisation
WSI- Water Soluble Index
YARD- Youth in Agriculture and Rural Development

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Chapter 1

1. General Introduction

1.1 Background to the study

Vegetable production is widely reported to have a significant role in provision of several nutrients (Slavin & Lloyd., 2012); employment and reduction of poverty (Schreinemachers, *et al.*, 2018).

Vegetables are reported to be a rich source of many essential micronutrients and health related phytochemicals, and that vegetable production is dependent on availability of suitable soils, climate, water, inputs and market (Juroszek *et al*, 2008).

Juroszek *et al.*, 2008 assert that many vegetable production systems are not sustainable over a long term, some systems lead to degradation of environment due to intense application of pesticides and fertilisers which also lead to food contamination and ground water pollution and contributing to soils erosion (Juroszek, *ibid*).

Sustainable vegetable production system is defined as a system that meets the needs of present as well as future generation in which the approaches used are not harmful to the health of farmers and consumers (Juroszek, *ibid*).

A review of vegetable production systems by small-scale farmers suggests that there is a room for improvement. However, this view may not be correct because there is lack of information on vegetable production systems by the small-scale farmers in the Limpopo Province.

There are vegetable produced under irrigation systems and those that in the grow wild and those produced under rain-fed conditions in the province, but the extent and understanding of production in these systems is not quantifiable and cannot be proven sustainable until investigated.

There used to be interventions through extension officers, inputs supply by government and commodity specialisation in order to create a niche market. There are some schemes in the villages that are redundant due to problems related to infrastructure, water availability and climate related challenges. Yet the sustainability of these systems is not clear.

The production of vegetables within the South African context of small-scale rural farmers may not have been adequately investigated, because of scanty available information. This situation has prompted the need to investigate the sustainability of vegetable production systems within the rural communities.

This chapter presents, problem statement, rationale of the study, significance of the study, aims and objectives, research questions, theoretical framework, conceptual framework and thesis layout.

1.2 Problem statement

In terms of reducing poverty, ensuring food security, and fostering economic expansion, agriculture is crucial to society. Agriculture is the primary source of income for about 86% of rural people worldwide, and it employs 1.3 billion smallholder and landless workers (Matsane & Oyekale, 2014). However, more than 800 million people worldwide do not consume enough food to meet their daily energy demands, and about half of the populace have no access to adequate food supply (Keatinge *et al.*, 2015).

Agriculture in African nations places a greater emphasis on producing staple crops (i.e., grains) than on addressing malnutrition, sometimes known as "the hidden hunger," which is a major contributor to health issues, higher mortality, and low economic productivity (Grubben *et al.*, 2014). Other nations view vegetables as supplementary foods of the highest order and strongly advocate them above goods of animal sources to prevent micronutrient deficiencies (Ibekwe & Adesope, 2010).

Additionally, it is predicted that if vegetable production and consumption are substantially expanded and sustained, up to 2.7 million lives might potentially be saved each year (WHO, 2002; 2003). However, Juroszek *et al.* (2008) pointed out that there has only been a relatively limited amount of comprehensive study on sustainable vegetable production systems (SVPS). Five out of 148 presentations at the International Society of Organic Agriculture Research's (ISO FAR) first scientific conference, "Researching Sustainable Systems," held in Adelaide, Australia in 2005, focused on vegetable production. According to Grubben *et al.* (2014), who underline that the vegetable industry in Africa is trailing behind that of tropical Asia due to inadequate research, the ISO FAR is consistent with their views.

The problem which is a major concern of this study is:

- How sustainable vegetable production systems are, by small-scale farmers in the Limpopo Province?

In practice, most of the problems are found to be too encompassing to be solved without breaking them into sub-problems. In dealing with the problem posed in the question above, it will be necessary to sub-divide the main problem statement into the following sub-problems:

- What characterises the production systems, resource utilisation, yields and income generation by small-scale vegetable farmers in Limpopo Province?
- What are the determinants to vegetable intake and food security by small-scale farmers of Limpopo?
- Which climate smart agriculture technologies and mitigation strategies are adopted by small-scale farmers of Limpopo towards a sustainable vegetable production and resilient from food shortages?
- What potential do African indigenous vegetables have towards the formation of a commercial, and nutritional production system in Limpopo Province?
- What are the opportunities and constraints of a wide adaptation to organic vegetable production systems by small-scale farmers towards a commercial enterprise in the study area?

1.3 Rationale for the study

In South Africa, vegetables are produced in most parts of the country, both under commercial and subsistence level. Most of the vegetable research programmes at the Agricultural Research Council (ARC) as a scientific institution since its inception in 1950 are focused more on the development of new vegetable cultivars and provision of diagnostic and analytical services to manage pests and diseases for commercial producers. Information about sustainable small-scale vegetable production is not available. It is in this area that the study will contribute to the knowledge of sustainable of vegetable production systems. Small scale farmers cannot be left out since they are the foot soldiers whose activities could contribute 50% to the growth of the South African vegetable industry. The Strategic Plan of the

Department of Agriculture, Forestry and Fisheries 2013/14 to 2017/18 serves as a driving force to ensure that rural people gain access to food within an economy that promotes sustainable livelihood (DAFF, 2013).

1.4 Significance of the study

The study's significance is supported by both dietary and cultural considerations. Vegetables have historically played a significant role as sustenance in many nations during times of famine and when people were fighting for survival. The first inhabitants of southern Africa were hunter-gatherers who subsisted by foraging for wild vegetables and herbs (Van Rensburg *et al.*, 2007).

Traditional leafy vegetables (TLVs) such as *morogo* or *muroho* have long been a cornerstone of rural family food security plans (Voster, 2007).

Because they include a wide range of vitamins and minerals, vegetables are typically seen as being more valuable than food that comes from animals. Once more, vegetables are considered the most important source of household income and are seen as having commercial worth (Ebert, 2014).

The study will reveal how vegetables are being produced by small-scale farmers in Limpopo Province. The study also looked at how the production could be improved for sustainability. The study will also provide knowledge to the Limpopo small scale farmers in terms of vegetable production. It is also hoped that the study will sensitize the Limpopo Department of Agriculture and Rural Development (LDARD) on areas that need intervention in terms of farmer support strategies. Above all, the study may be of importance to Limpopo Province in understanding the behaviour of small-scale farmers in the production of vegetables, as well as the suggested sustainable production systems arising from the data collected. Limpopo may not be exceptional, and other provinces in South Africa may learn from the results of this study. The study will contribute to the body of knowledge about vegetable production.

1.5 Aims and objectives of the study

1.5.1 Primary objective

To assess the sustainability of vegetable production systems currently adopted by small-scale farmers in Limpopo Province.

1.5.2 Secondary objectives

- To characterise and assess the efficiency of vegetable production systems, resource utilisation, yields and income generation by small-scale farmers in Limpopo Province.
- To identify vegetable production systems and consumption patterns as determinants of food security in the study area.
- To identify and analyse climate change and mitigation strategies adopted by small-scale farmers towards a sustainable vegetable production and resilient from food shortages in the study area.
- To investigate the potential of African indigenous vegetables towards the formation of a commercial, nutritional and sustainable production system in the study area.
- To analyse the opportunities and constraints of a wide adaptation to organic vegetable production systems by small-scale farmers towards a vibrant commercial enterprise in Limpopo.

1.5.3 Research questions

In order to realise the objectives, the study will seek to answer the following research questions:

- What are the characteristics of vegetable production systems in the study area?
- Are vegetable production systems and consumption patterns determinants of food security in the study area?
- Which climate mitigation strategies are adopted by small-scale farmers of Limpopo towards a sustainable vegetable production and resilient from food shortages?
- Do African indigenous vegetables have potential towards the formation of a commercial, and nutritional production system in Limpopo Province?
- What are the opportunities and constraints for a wide adaptation to organic vegetable production systems by small-scale farmers towards a commercial enterprise in the study area?

1.6 Statement of Hypotheses

- Vegetable production systems in the study area are not sustainable.
- There are no constraints that impact on the sustainability of vegetable production in the study area.

1.7 Theoretical framework

This study aims to evaluate the sustainability of vegetable production systems in Limpopo Province. The sustainability of vegetables in Limpopo will be evaluated based on how different proponents view sustainability.

Ben-Eli (2015) defines sustainability as a dynamic equilibrium in the process of interaction between a population and the carrying capacity of its environment such that the population develops to express its full potential without causing irreversible negative effects on the carrying capacity of the environment upon which it depends. Sustainable development, according to WCE (1987), is defined as a development that satisfies current demands without jeopardizing the capacity of future generations to meet their own needs.

The practice of producing food, fibre, or other plant or animal products while protecting the environment, human health, local communities, and animal welfare is known as sustainable agriculture, according to Radebe (2014). Dumanski (1997) contends that this kind of agriculture should give future generations the same range of alternatives as the current communities do for themselves.

According to the National Environmental Management Act (Law No. 107 of 1998), sustainable development is the integration of social, economic and Development that incorporates environmental considerations. According to Juroszek et al. (2008) sustainable agriculture is considered a useful work for both the present and future generations.

Jibril (2019) believes that for sustainable production natural resources must be used in a way that does not destroy or degrade them, otherwise their usefulness for future generations will be compromised. According to Klarin (2018), full sustainable development is achieved through a balance between the following triple bottom lines (TBLs):

Economic, social, and environmental aspects of agriculture. Kuhlman and Farrington (2010) reiterate this point by pointing out that economic development, social development, and environmental protection are interdependent and mutually reinforcing elements of sustainable development.

According to OLRC(2012) the term sustainable agriculture means an integrated system of plant and animal production practices having a site-specific application that will, over the long-term (a) satisfy human food and fibre needs; (b) enhance environmental quality and the natural resource base upon which the agriculture economy depends; (c) make the most efficient use of non-renewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls; (d) sustain the economic viability of farm operations; and (e) enhance the quality of life for farmers and society as a whole.

McCauley *et al.* (2004) view sustainable agriculture as the integration of agricultural management technologies to produce quality food and fibre while maintaining or increasing soil productivity, farm profitability, and environmental quality.

FAO (2011) identified four pillars of sustainability, namely:

- Environmental integrity (which encompasses water resource management, soil, ecosystems and climate mitigation strategies)
- Economic resilience (by securing livelihoods, sustainable production and risk aversion strategies))
- Social well-being (encompassing labour rights, education, equity, health, safety and social commitment), and
- Good governance (through rule of law and accountability).

FAO (2004) refers to the sustainable vegetable farming system when it is ecologically sound; economically viable; socially just; culturally appropriate; long-term production; humane and based on a holistic scientific approach. Harwood (1990) defines a sustainable vegetable farming system as a farming system that evolves indefinitely toward greater human utility, greater efficiency of resource use, and a balance with the environment that is favourable to humans and to most other plants and animals.

O'Connell (1992) defines sustainable farming practices as those that include:

- Crop rotations that mitigate weeds, diseases, insects, and other pest problems; provide alternative sources of soil nitrogen; reduce soil erosion; and reduce the risk of water contamination by agricultural chemicals.
- Pest control strategies that are not harmful to natural systems, farmers, their neighbours, or consumers. This includes integrated pest management techniques that reduce the need for pesticides by practices such as scouting, use of resistant cultivars, timing of planting, and biological pest controls.
- Increased mechanical or biological weed control; more soil and water conservation practices; and strategic use of animal and green manures.
- Use of natural or synthetic inputs in a way that poses no significant hazard to man, animals, or the environment.

Nimfa *et al.* (2021) identified different theories that underline sustainability, namely:

- Institutional theory: sustainable practices are not primarily a voluntary act in that the performance of different enterprises are featured with several challenges including government rules and marketplace pressures. Meaning that sustainable practices are possible when supported with favourable government policies.
- Resource-based view theory: which indicates that resources possessed, deployed and used effectively would give more results than those used ineffectively.
- Diffusion of innovation theory: which indicates that the primary drivers for sustainability and efficiency of small enterprises are the introduction of new technology and non-technology innovations.
- Stakeholder theory: which indicates that an enterprise will never operate on its own, but must accommodate suppliers, consumers, customers and employees, as stakeholders. Thus, a sustainable production system need to practice a culture of incorporating the environment, social and economic systems into its functional practices.
- Contingency theory: which indicates that structures need to be modified to fit the environment, size, and strategy.

1.8 Conceptual Framework

The current study was guided by the framework in Figure 1.1, which was consistent with the conceptualisation of vegetable production and the sustainability of production practices by small-scale farmers in Limpopo. The variables in the study were divided into three categories: background, independent variables, and dependent variables.

The conceptual framework's assumptions, as shown in Figure 1.1, were that there is a relationship between the background factors, independent variables, and the dependent variable. The background factors in the conceptual framework included, among other things, age, gender, and level of education, household size, attitudes, and years of agricultural experience, size of land, land ownership, access to extension services, and access to markets. The production practices and managerial characteristics were the independent variables, while the dependent variable was the sustainability of vegetable production systems.

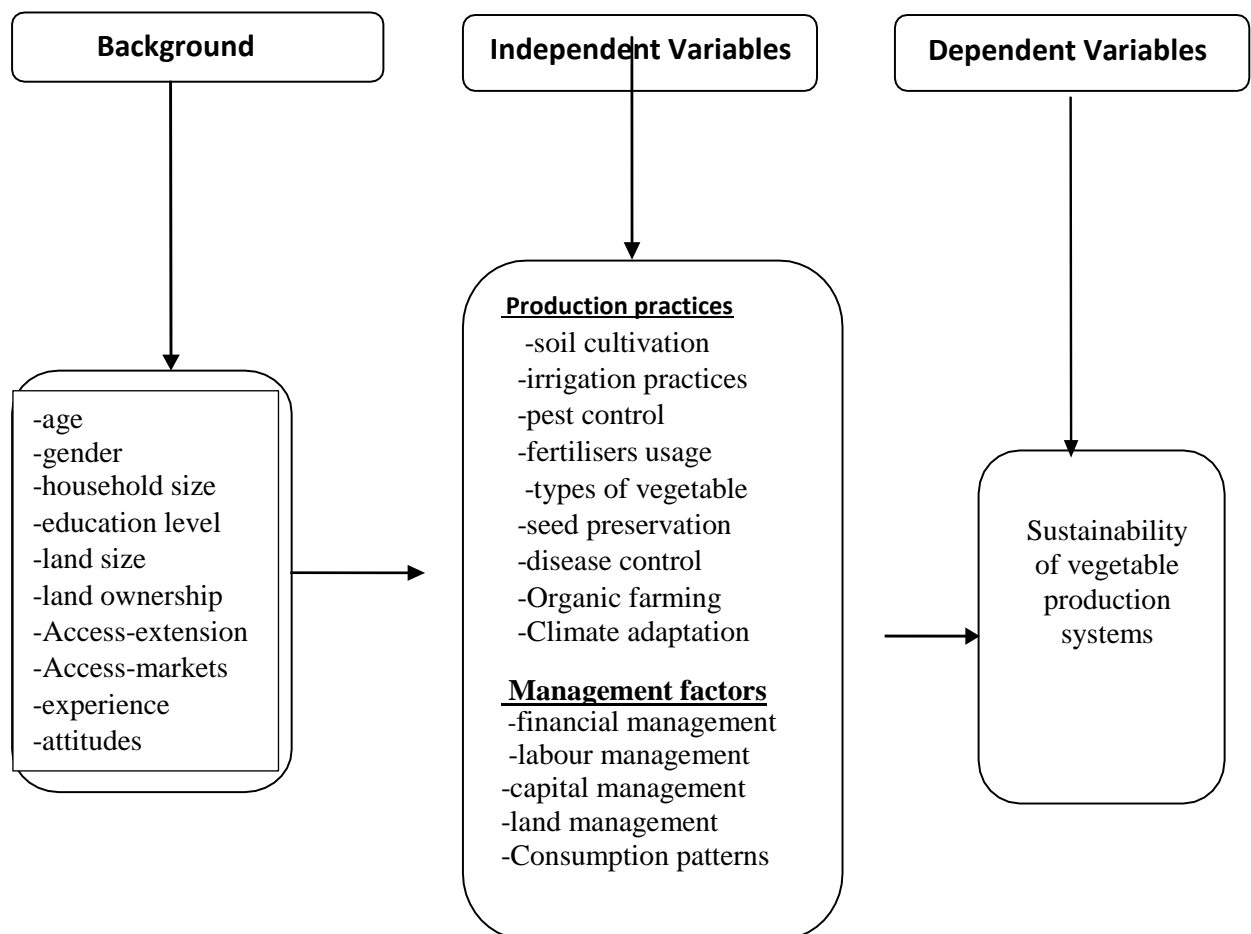


Figure 1.1 Conceptual Framework

1.9 Thesis layout

The study aims to investigate the sustainability of vegetable production systems by small-scale farmers of Limpopo Province. The study will follow a sequence of steps from chapter one to chapter nine. Chapter one gives a general introduction and background that informs the basis of this study. It presents: (a) background of the study; (b) problem statement; (c) rationale; (d) Purpose of the study; (e) aims and objectives; (f) Theoretical framework; (g) Conceptual framework; (h) hypothesis and (i) thesis layout.

Chapter two presents a review with focus on: (a) introduction; (b) the importance of agriculture; (c) sustainable agriculture; (d) categorisation of farmers; (e) synopsis of vegetable production; (f) constraints in vegetable production; (g) sustainable vegetable production systems; (h) climate change and climate smart agriculture, and (i) vegetable consumption patterns.

Chapter three presents methodology with focus on: (a) research approach and design; (b) theoretical underpinning mixed methods; (c) description of the study area; (d) researcher's philosophy; (e) the study type; (f) research strategy; and (g) ethical considerations.

Chapters 4 to 8 are article- based, and still must be submitted for publishing.

Chapter four is presenting the characteristics and the assessment of the efficiency of vegetable production systems, resource utilisation, yields and income generation by small-scale farmers in Limpopo Province.

Chapter five identifies vegetable production systems and consumption patterns as the determinants of food security among small-scale farmers of Limpopo Province.

Chapter six identifies, and analyses climate change and mitigation strategies adopted by small-scale farmers towards a sustainable vegetable production and resilient from food shortages in the Limpopo Province.

Chapter seven investigates the potential of African indigenous vegetables towards the formation of a commercial, nutritional and sustainable production system in the study area.

Chapter eight presents an analysis of the opportunities and constraints of a wide adaptation to organic vegetable production systems by small-scale farmers. Chapter nine presents general conclusions and recommendations.

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Chapter 2

Review of literature

2.1 Introduction

The purpose of this chapter is to provide a view on the existing literature with regards to the origin and history of vegetable production, importance of vegetable production, vegetable production at global, continental, and country level. The chapter further reviews literature on the importance of agriculture, sustainable agriculture, categories of vegetable farmers, and the importance of vegetables.

Literature study further covers the review on the constraints in vegetable production, sustainable vegetable production systems, organic vegetable production, climate change and climate smart agriculture, vegetable consumption patterns at global, continental, and country level.

2.2 The importance of agriculture

Every citizen of every nation depends on agriculture either directly or indirectly for food (Kuhnen, 1978). Agriculture is crucial for reducing hunger and poverty in African nations. The main reason for this is that most Africans reside in rural areas, where hunger and poverty are more widespread. Rural residents work in agriculture to generate food for their own consumption as a means of coping with these challenging circumstances (Diao *et al.*, 2010).

According to research by Cervantes-Godoy and Dewbre (2010), 50% of the Organization for Economic Co-operation and Development (OECD) member countries reduce poverty by increasing agricultural incomes, while over one-third (33%) and 10% of the countries do so by increasing remittance and non-farm incomes, respectively.

In sub-Saharan Africa, agriculture accounts for 30% to 50% of national incomes, according to Toenniessen *et al.* (2008). According to research findings by Obera (2009), agriculture now represents 45% of the country's income, 90% of all foreign exchange profits, and 85% of employment in Ethiopia. Due to the dependence of 45% (4.6 million) of the poor on agriculture, Zambia also has a significant agricultural sector. The same is true for Malawi, where agriculture accounts for 39% of GDP, and

for Mozambique, where agriculture employs 80% of the population (Mucavele, undated). Omoti (2012) discloses in the synthesis report that 60–70% of the population of Zimbabwe is employed in agriculture, earning an income, and providing 60% of the raw materials needed by the industrial sector. In a similar vein, Nyanga (2013) asserts that the agriculture sector in Zimbabwe generates up to 47% of exports and ranks second in terms of foreign currency production. Al-Hassan and Jatoe (2003) noted that 60% of Ghana's economically active population is employed in agriculture, which is used as a method for reducing poverty in the country. Additionally, Al-Hassan and Jatoe (*ibid*) further noted that in 1980 and 1990, respectively, it contributed an average of 54% and 36% of GDP. In Swaziland, the agriculture sector, sugar cane contributes 7% of the nation's foreign exchange revenues and 18% of the GDP (Dlamini, 2012). Elbashir and Imam (2010) also noted that with an estimated 45% contribution to the GDP, agriculture is the largest industry in the Sudanese economy and employs 67% of those working in the manufacturing sector. According to Mathivha (2012), 4.8 million South Africans work in agriculture, 4 million of whom are involved in subsistence farming.

2.3 Sustainable agriculture

Sustainable agriculture means many things to many people. According to Phatak (1992), it can be defined from the perspective of environmentalists as the preservation or renewal of agricultural natural resources, or from the perspective of producers of organic food products as production without the use of chemical fertilizers, pesticides, and plant growth regulators. Phatak (*ibid*) went on to link organic farming and sustainable agriculture. According to Brundtland (1987), sustainability is concerned with the future of our society, or to make sure that agriculture satisfies current needs without endangering the capacity of future generations to satiate their own needs, or to transform agriculture so that it respects environmental limits while satiating social needs.

Radebe (2014) defines sustainable agriculture as the process of producing food, fibre, or other plant or animal products while preserving the environment, human health, local communities, and animal welfare. According to Dumanski (1997), this type of agriculture ought to provide future generations with just as many options as the current communities have for themselves. According to the National

Environmental Management Act, Act No. 107 of 1998, sustainable development is one that incorporates social, economic, and environmental considerations into its planning, implementation, and decision-making to benefit both current and future generations. Sustainable agriculture, according to Juroszek *et al.* (2008), is viewed as the production that serves both the current generation and the ones to come.

2.4 Categorisation of vegetable farmers

2.4.1 Small-scale vegetable farmers

Small-scale vegetable farmers are described in many ways by different people. According to Kirsten and Van Zyl (1998), these farmers operate at a size that prevents them from obtaining the services they require to substantially raise their output. Furthermore, according to Kirsten and Van Zyl (*ibid*), small-scale farmers should be given the necessary resources to join a brand-new, thriving agricultural sector. Furthermore, these farmers should not be compared to non-productive, non-commercial, subsistence farmers who are inefficient, unproductive, and backward. Economies of scale should be used to define them (Kirsten & Van Zyl, 1998). Often, the terms "smallholder" and "small-scale" are used synonymously. Small-scale or "smallholder" farmers are simply those who have fewer resources available to them than other farmers, in general. Owners of small-scale parcels of land where cash crops are grown are also considered to be smallholders (DAFF, 2012).

Most small-scale farmers in African nations cultivate their fields using the traditional hand-hoeing tillage method, after the rains, with native and recycled hybrid seeds, and with little access to inorganic fertilisers (Chiona, 2011). According to Umeh *et al.* (2013), small-scale agricultural activities are predominately carried out by men, and the majority of farmers only have primary education. They are also typically poor, have an average family size of seven, and have farms that are 1.8 ha in size. According to Sadiq *et al.* (2013), small-scale farmers with big families are more likely to use family labour, and women are less likely to participate in farming activities, which would prevent them from being able to own a farm while their husbands are still alive.

According to Huang *et al.* (2012)'s study of Asian nations, 200 million small-scale farmers in China maintain farms with an average size of 0.7 ha. According to Huang

et al. (ibid), these farmers also make up 4% of exports and 11% of the nation's GDP. Similarly, Patkar *et al.* (2012) report that India's 93 million small-scale farmers provide 11% of the nation's exports and 18% of the GDP, respectively, with an average farm size of 1.5 hectares. Despite the fact that Asian small-scale holdings are the smallest in the world, FAO (2010) claims that farmers there can maximise land usage, increase household food security, and increase their income by switching to intensive farming (i.e. four crops a year).

2.4.2 Subsistence vegetable farmers

It is important to note that subsistence vegetable farmers are defined in a number of ways by different disciplines. Kostov and Lingard (2004) use subsistence to gauge the level of living, consumption, and output in agricultural economics. Subsistence farmers are defined as individuals who primarily grow food for their own families' consumption (Bruntrup and Heidhues, 2002). Kostov and Lingard (*ibid*) define self-sufficiency for subsistence families as producing simply enough food for their own needs.

According to Mathivha (2012), subsistence farming is the sector in South Africa where black farmers with limited resources are most likely to be found. These farmers typically cultivate a variety of crops and rear animals that the family needs to feed and clothe itself throughout the year, and their average farm size is 6 hectares or less. According to Baah (2017), subsistence farmers rely primarily on farming as a source of income, have family members who perform most of the farm's labour, and use the farm's produce mostly for sustenance and limited commercial reasons when there is a harvest excess. According to Baah (*ibid*), subsistence farming is the most popular means of survival for rural poor communities worldwide.

According to observations collected by Kostov and Lingard (2004), 51% of Romanian farm households do not sell any products, compared to 77% of households in Bulgaria which are subsistence farmers. In a similar vein, Kostov, and Lingard (*ibid*) discovered that over half of all farms in Poland have virtually little contact with the market, whereas 40% of the total agricultural output in Russia in 1995 could be attributable to the self-sufficient sector. According to Ndungu *et al.* (2013), more than 75% of farmers in Africa practice subsistence farming, which lowers agricultural

productivity on the continent by 2-3 times compared to the global average due to a lack of asset base, knowledge, and skills.

2.4.3 Commercial vegetable farmers

Varied authors have different opinions about commercial vegetable farmers. Regardless of the volume of production, commercial vegetable farmers, according to Poulton *et al.* (2008), are those that grow vegetables primarily for the market. According to Quan (2009), commercial farmers are a viable substitute for subsistence farmers. Obera (2009), who reaffirmed that commercial farmers' goal is to bring about a shift from production that is only for domestic use to market-oriented production, supports this opinion.

According to FAO (2014), there are differences between commercialised farmers and their colleagues who farm for subsistence. According to FAO (*ibid*), whereas subsistence farmers make most of their inputs (such as seeds and labour) and grow a wider variety of crops for household consumption, commercial farmers concentrate on buying inputs and specialise in specific crops. According to Okezie *et al.* (2012), commercialisation encompasses more than just marketing.

Commercialisation, according to Okezie *et al.* (*ibid*), may entail replacing non-traded inputs with purchased inputs, abandoning integrated farming systems in favour of specialised crops, raising the opportunity cost of family labour, raising the market demand for food, and basing all decisions on the maximisation of profit. There are a variety of variables that support farmers' increased market participation. According to research by Poulton *et al.* (2008), in sub-Saharan Africa, foods grown for the market typically provide larger returns than those grown for personal consumption. According to Abdullah *et al.* (2017), the commercialisation of agriculture can be boosted by offering producers subsidies, cold storage facilities, and training in new technologies, improved contact with extension agents, and the provision of genetically modified seeds.

2.4.4 Organic vegetable farmers

Phatak (1992) defined organic vegetable farmers as those who are more committed to sustainability than other farming enterprise. The use of chemical fertilisers, insecticides, and plant growth regulators will be substantially avoided by these

farmers, according to Phatak (*ibid*). This claim is backed up by Scott (2013), who reaffirmed that the foundation of organic farming practices is the limited use of off-farm or external inputs for the management of plant diseases, pests, and soil fertility. To put it another way, Scott (*ibid*) believes that the methods used by organic farmers are designed to improve, preserve, and restore ecological equilibrium. They use techniques that, to put it simply, promote and improve biological cycles, soil biological activity, and biodiversity.

INR (2008) found that by managing both the inorganic and organic soil elements, organic farmers would manage the soil in a way that would maximise soil health. In a similar vein, INR (*ibid*) defines organic farmers as those that manage crop combinations and rotations in a way that enhances plants' ability to compete and fosters the existence of natural crop insect predators. In the case of organic livestock farmers, animals would be raised with appropriate nutrition and management techniques that disrupt host and pathogen connections in order to increase their natural resistance to pests and diseases. According to observations by Lawson (2010), the organic farming sector, along with organically grown fruits and vegetables, is one of the agricultural sectors that is growing the fastest. This is partial because conventional agriculture, with its excessive use of synthetic fertilisers and pesticides, has more negative effects on the environment and human health.

According to USDA (2008), California has the most certified organic fruit and vegetable growers in the United States (1539 and 546 respectively), while Wisconsin had 177 such growers for field crops. According to Ndungu *et al.* (2013), more than 200 000 farmers in Kenya have received training in organic agricultural methods. While South Africa is said to rank number 21 with only 250 certified organic farmers, research by Kelly and Metelerkamp (2015) indicated that Uganda has the highest number of organic producers in Africa, with approximately 190 000 organic farmers.

2.5 A synopsis of vegetable production

2.5.1 Origin and history of vegetable production

Varied authors have different perspectives on the development of vegetable cultivation. Early explorers, beginning with Christopher Columbus, transported many kinds of vegetables from the Americas to Europe, claims Kushner (2015). In addition, according to Kushner (*ibid*), during his first journey in 1492, Christopher Columbus

discovered some of the vegetables on the Island of Guadeloupe, in Hispaniola, and Cuba and brought them to Europe and China. According to Kushner (*ibid*), some of the vegetables were reportedly carried to the West Indies by Indians from their homeland countries of Paraguay and Brazil in South America. Currently, the majority of vegetables are grown in India, China, South America, Europe, the Middle East, and Africa (Kushner, 2015).

Leafy vegetables have been consumed in South Africa for as long as there have been modern humans, according to Van Rensburg *et al.* (2007)'s research. Van Rensburg *et al.* (*ibid*) claim that the Bantu-spoken tribes who first arrived in South Africa 2000 years ago also harvested green vegetables from the wild, much as the Khoisanoid people who have resided in Southern Africa for the preceding 120 000 years have done. Van Rensburg *et al.* (2007) added that the construction of new vegetable gardens was a result of Jan van Riebeeck's arrival in the Cape in 1652. According to Pooley (2009), the planting and harvesting of vegetables are still widely practiced by Africans in South Africa.

2.5.2 The importance of vegetables

People have diverse perspectives on the value of vegetables. Vegetables are abundant providers of several nutrients, including vitamins, trace minerals, dietary fibre, and phytochemicals, particularly antioxidants, according to Slavin and Lloyd (2012). According to Abdulai (2006), vegetables not only offer nutrients to diets but also flavour to food and act as roughage to aid in digestion and avoid constipation, as opposed to other foods. According to Ibekwe and Adesope (2010), vegetables are first-class complementary foods that are far more generally advised for human health than items of animal origins. According to FAO/WHO (2004) recommendations, consuming at least 400g of vegetables a day could avoid chronic diseases like obesity, diabetes, cancer, and heart disease.

Vegetables are important for preserving the body's alkaline reserve, according to Hanif *et al.* (2006). According to Oguntibeju *et al.* (2013), regular vegetable eating can reduce the risk of developing most cancers by 20%, including oesophageal, stomach, pancreatic, bladder, and cervical cancers. According to Nielsen *et al.* (2014), consuming lots of vegetables may protect against cardiovascular illnesses (CVDs). According to Yang and Keding (2009), there are 2.7 million deaths worldwide

each year that are primarily related to inadequate vegetable consumption. On the other hand, WHO (2002; 2003) further reported that low vegetable intake is estimated to be causing about 31% of ischaemic heart diseases and 11% of stroke worldwide. Woldesenbet (2013) is of the view that the labour to land ratio of vegetable cultivation is high such that it plays an important role in poverty alleviation through employment generation.

2.5.3 Global vegetable production

The production of vegetables has grown to be a significant global industry. According to observations made by Palada *et al.* (2006), the World Vegetable Centre (AVRDC) in 1971 played a role in the constant rise in global vegetable production. Additionally, it was revealed that global vegetable production has increased at a pace of 5.15% per year since 1995. Acosta *et al.* (2016) discovered that a year-round vegetable production program has been developed in the Philippines and Cambodia to address a hidden hunger brought on by vitamin deficiency. According to Acosta *et al.* (*ibid*), the program entails the building of a network of skilled farmers who will carry out the program across the nation as well as the training of more government extension employees in technical skills to provide year-round advisory services. A year-round vegetable production program in the Philippines is made possible, according to Gerona *et al.* (2016), by the widespread usage of inexpensive protective structures that are utilised to guard against harsh environmental conditions including heavy rains and high temperatures. According to Davies and Bowman (2016), the USAID "Feed the Future" program also provides resources for vegetable cultivation with a view to reducing global hunger and ensuring nutrient security in nations like Nepal, Bangladesh Honduras, and Guatemala

According to Sahu (2004), China is both the world's largest producer and consumer of vegetables. China produces 102.51 million metric tons of vegetables annually, or around 27.16% of the world's total, according to Sahu (*ibid*). The consumption of vegetables in China is estimated to be 500g per person per day, which is higher than the standard recommendation of 400g per person per day. India is the second-largest producer and consumer of vegetables, according to Sahu (2004). The nation produces 38.67 million metric tons of vegetables or roughly 10.24% of global production. Vegetable consumption in India is estimated at 134 grams per day per

person, which is significantly less than the average amount advised. According to observations provided by Dias and Ryder (2011), Turkey ranks second after the United States in terms of global vegetable production. According to Dias and Ryder (*ibid*), Turkey accounts for about 4% of global vegetable exports. According to Long and Bohme (2012), when living standards rise and the use of pesticides rises, vegetable output and consumption rise in Vietnam.

2.5.4 Vegetable production in Africa

Vegetable production and consumption are quite low in African nations. Very few nations, according to Ganry (2009), have attained the daily recommended intake of 400 g of vegetables per person. The few nations noted by Ganry (*ibid*) are those with humid forests, including Burundi, Cameroon, Gabon, Guinea, and Rwanda. Additionally, several vegetable production methods have been implemented by African nations, some of which are long-term viable and others that are not. In the Northern Guinea region of Nigeria, during the dry seasons, wetlands (*fadama*) are the sole other sources of vegetable supply, according to a study done by Ibrahim and Omotesho (2009).

Ibrahim and Omotesho (*ibid*) claim that this approach is to blame for the extinction of plant species that act as flood-control buffers. Similarly, to this, Asongwe *et al.* (2014) reported that wetlands in Cameroon are periodically reclaimed for vegetable farming. The Kenyan vegetable sub-sector is regarded as being harmful to the environment since it is linked to excessive chemical consumption, according to Macharia *et al.* (2009). According to Macharia *et al.* (*ibid*), 263 t of pesticides are reportedly used annually to combat diseases and pests that affect vegetables. It should also be highlighted that 47% of the pesticides used are extremely toxic to beneficial insects, while 64% of them pollute groundwater. In the same breath, Macharia *et al.* (2013) contend that improper management of pesticides by small-scale farmers through overdosing and unsafe disposal of leftovers is the key contributing cause to chemical dangers.

According to Ayana *et al.* (2014), vegetables are grown in backyard gardens, smallholder farms, and commercial farms in Ethiopia's humid tropics. The livelihood of farmers in 25 Sub-Saharan African nations, including Ghana, is exclusively dependent on urban vegetable production, according to Darkey *et al.* (2014). By

2030, it is predicted that this production method will have an impact on 41 nations. Traditional vegetables have market potential in Africa, according to studies by Chagomoka *et al.* (2014). Sales of these vegetables are shown to contribute 30% and 35%, respectively, to the income of small-scale farmers in Mozambique and Malawi.

2.5.5 Vegetable production in South Africa

Traditional leafy vegetables (TLVs) are a significant summertime food source in South Africa. According to research by Vorster *et al.*(2007a), amaranths, pumpkins, Jude mallow, spider plants, nightshades, and cowpeas are the most widely consumed crops among all age groups. Different rural households employ a variety of drying techniques to guarantee that these vegetables are available even during the winter (Vorster *et al.*, 2007a). Since the 1960s, when research and extension in South Africa pushed households to grow exotic vegetables like those they saw in the shops, traditional leafy vegetables have been classified as weeds, claim Vorster *et al.* (2007b).

Observations are that the method of growing exotic vegetables has a detrimental impact on the consumption of traditional green vegetables in South African populations. The traditional leafy vegetables have almost entirely been displaced by exotic vegetables like cabbage and spinach (Vorster *et al.*, 2007c). Mandiriza-Mukwirimba *et al.* (2016), who reaffirmed that cabbage is the most popular brassica vegetable farmed on a large scale in South African conditions, lend support to this hypothesis. Traditional leafy vegetables (TLVs) are a significant summertime food source in South Africa. According to personal observations, amaranths, pumpkin leaves, spider plants, nightshades, mustard and cowpeas are the most widely consumed crops among all age groups. Different rural households employ a variety of drying techniques to guarantee that these vegetables are available even during the winter (Vorster *et al.*, 2007a). Since the 1960s, when research and extension in South Africa pushed households to grow exotic vegetables like those they saw in the shops, some of the traditional leafy vegetables have been classified as weeds, claim Vorster *et al.* (2007b).

2.6 Constraints in vegetable production

From one nation to the next, various pests and diseases can impact vegetables. Vegetable production in Kenya is typically constrained by insect pests and diseases, according to Macharia *et al.* (2013) and Macharia (2015). Abang *et al.* (2014) reaffirmed that pests, and caterpillars are the most significant production barriers for several vegetable crops, which lends support to this idea. According to Sithanantham *et al.* (2005), caterpillar pests could account for 70–90% of Eastern African crops' losses. It is further stated that the main factors that encourage the growth of pests in tropical environments are rain, heavy dew, warm temperatures, and dry climates (Abang *et al.*, 2014).

The overuse of pesticides and fungicides is the other significant issue affecting the vegetable industry. According to Macharia *et al.* (2009), these chemicals are costly for subsistence farmers with limited resources who would not be able to afford the crop. The majority of the agrochemicals needed to manage crop pests, according to Okolle *et al.* (2014), are extremely harmful to people and the environment. Vegetable crops, according to ESRF (2010), require extensive usage of fertilisers, herbicides, pesticides, irrigation, and high-quality seeds. Small-scale farmers in African nations are found to be constrained by these inputs. Mpandeli and Maponya (2014), who contend that the high cost of fertilisers, seeds, and pesticides is a significant obstacle for small-scale vegetable growers, support this viewpoint.

According to Samantaray *et al.* (2009), the primary obstacles facing tribal vegetable growers in India are a lack of timely technical guidance, inconsistent visits, and a low level of trust in extension workers. The lack of extension services in Tanzania hinders the level of vegetable production by small-scale farmers, according to ESRF (2010), reaffirming this point. According to Matsane and Oyekale (2014), the Northwest Province of South Africa's small-scale vegetable farmers face significant difficulty due to inadequate communication and an inefficient information flow between government agencies and the farming community. In addition, according to Daramola *et al.* (2016), 92% of Nigeria's Ondo State's vegetable growers lack access to information about finance, prices, and markets. In addition to the lack of price information, Stoeva (2012) found that some of the issues with vegetable production in Bulgaria include poor organisation of vegetable growing, producers' reluctance to join organisations

for vegetable farming, a lack of commercial agreements between producers and dealers for the sales of finished product, a lack of labour, and the use of unskilled labour.

Climate variability and change are the other challenges that vegetable farmers around the world must contend with. More variable rainfall patterns, unpredictable high temperatures, decreased water availability, excessive moisture, and increasing soil salinity, according to De la-Pena and Hughes (2007), are severe environmental constraints affecting vegetable output. According to ESRF (2010), smallholder vegetable farmers in Tanzania are suffering from crop diseases, drought conditions which are more common, and a lack of water as a result of climate change. According to findings by Johansson *et al.* (2016), large-scale irrigation projects in Chad, Nigeria, Niger, and Cameroon as well as climatic changes have caused Lake Chad to shrink by 95% since 1963.

Pittock (2011) asserts that climate change is likely to result in an increase in the frequency of water-related natural disasters that have an impact on agriculture, such as floods and droughts. Additionally, Indian tribal vegetable growers have a significant barrier due to a lack of storage facilities (Samantaray *et al.*, 2009). According to Rebelo *et al.* (2014), a significant barrier to vegetable production in Egypt is the lack of accurate data on irrigation coverage and water use as well as records of river flow. Matsane and Oyekale (2014) discovered that 53% of small-scale vegetable growers in South Africa's Northwest Province lacked access to storage facilities. This conclusion is corroborated by Negi and Anand (2015), who reaffirmed that a lack of cold chain infrastructure and cooling shed capacity limits vegetable production and supply in India. Poor storage and preservation tactics to extend the shelf life of vegetables are a significant concern for 90% of vegetable producers in Ondo State of Nigeria, according to research by Daramola *et al.* (2016). Negi and Anand (2015) discovered that inadequate knowledge on how to handle post-harvest output had an impact on vegetable production in Thailand.

2.7 Sustainable vegetable production systems

A system can be defined in several ways by various academics. According to Rana and Rana's (2011) definition from a biological perspective, a system is a collection of interdependent parts that work together to achieve a common goal and can respond

collectively to external stimuli. As per Juroszek *et al.* (2008), sustainable vegetable production systems (SVPS) are agricultural methods that increase productivity without endangering the well-being of farmers, consumers, or the environment. Fernando *et al.* (2008) contend that the only way to ensure the productivity of vegetables for future generations is to lessen reliance on chemically produced fertilisers and pesticides. On the other hand, as said by Rana and Rana (2011), a sustainable agriculture system is one that can continue to be productive and helpful to society indefinitely.

Younes (2012) argues that a farming system is sustainable when it incorporates key ideas such as resource conservation, social support, commercial competition, and environmental soundness. Farmers from different nations have used a variety of sustainable vegetable-producing techniques. Among other things, the researcher has mentioned crop nutrition, pest and disease management, crop water management, and soil management techniques. To achieve sustainability, various nations have adopted various vegetable production methods. Vegetable diseases and pests are managed with several plant-derived chemicals. Nematicidal substances derived from plants like wormwood and radish are used to manage nematodes and insects in Southern Italy, according to D'Addabo *et al.* (2014). It is generally accepted that substances derived from plants are safe for the environment, people, and animals.

According to Yamada's (2008) research, Japan could fight clubroot disease by rotating crops like cabbage and sweet corn over a period of three to four years. Similarly, to this, Mandiriza-Mukwirimba *et al.* (2016) discovered that crop rotation with tomatoes, onions, and beetroots is used by 74% of small-scale farmers in the South African provinces of Limpopo and Gauteng to control pests and diseases on cabbages. Crop rotations can disrupt the cycles of insects and diseases and lessen weed growth, according to universal consensus. Intercropping systems, in which the primary crop is inter-sown with a smother crop, are some of the sustainable weed control methods in horticultural crops, according to Ouma and Jeruto (2010). Observations made by Ravella *et al.* (2013) are that weed suppression can be improved by increasing the abundance of cover crop biomass and residue.

Contrarily, CABI (2017) discovered that the mass-raising of a naturally occurring bacterium called *Bacillus thuringiensis* (Bt) was one of the sustainable approaches

for managing caterpillar pests in vegetables in Uganda. The use of sex pheromone baits to catch, stop mating, or kill pests was another technique. The sterile insect technique (SIT), according to IAEA (2004), is one of the most eco-friendly ways to manage pests that affect vegetables (Medflies). This method of nuclear research entails mass-raising insects and gamma-sterilising them thereafter.

Other nations employ a variety of irrigation techniques to manage or eradicate vegetable pests and diseases. Drip irrigation would be utilised in Kenya, as per Sithanantham *et al.* (2002), to stop the spread of pests that live in the soil, such as nematodes and wilts. Similarly, one may use sprinklers to clean vegetables of pests like aphids, thrips, and spider mites. Gopi *et al.* (2016) discovered that leaf extracts of several plants, such as *Datura* (*Datura stramonium*) and *Angeri* (*Lyonia ovalifolia*), are traditionally used in the Sikkim region of the Himalaya to manage pests and diseases. These herbs are also used to control ants and cutworms in vegetables.

Integrated Pest Management (IPM) is thought to be the best protection against pests and diseases in Cameroon (Maho-Yalen *et al.*, 2013). According to CABI (2017), IPM will necessitate the harmonious blending of all tactics and methodologies to reduce hazards to human health, beneficial insects, and the environment while keeping pest populations below the threshold level of significant economic loss. Gopi *et al.* (2016) reported that the application of traditional landraces is one of the sustainable pests and disease control approaches in the Sikkim region of the Himalayas. These local vegetable varieties are believed to be adaptive and resistant to pests and diseases. As per CABI (2017), research organisations like NARO oversee creating vegetable varieties that are resistant to pests and diseases in Uganda.

Most authors agree that proper crop water management is essential for achieving sustainable vegetable production systems, in addition to managing pests and diseases. According to IAEA (2004) findings, one of the best methods for conserving water and boosting agricultural output in the West African Sahel countries (Burkina Faso, Mali, Niger, and Senegal) is the use of micro-irrigation systems. Gebrehiwot and Gebrewahid (2004) reaffirmed that drip irrigation has developed into a leading method on a global scale by tripling water productivity and yield per unit of water in periods of severe water scarcity, which lends support to this viewpoint. By placing inexpensive perforated plastic hoses next to vegetable crop beds, Glatzel *et al.* (2014) discovered that this irrigation system could be economical in rural settings.

Inocencio *et al.* (2003) discovered that drip irrigation or hand-watering made possible by water harvesting will improve productivity in African nations like Kenya and Sudan by a factor of three to four. To combat the water crisis, various nations have used various water harvesting techniques. In Kenya, simple stone bunds are frequently built across slopes to increase water retention, and in Burkina Faso, dams, ponds, and ditches are used to channel run-off into the field. Meanwhile, Israel, Ethiopia, and Sudan use dams, ponds, and ditches to direct run-off into the field.

According to research by Jagermeyr *et al.* (2016), integrated crop water management (ICWM) could boost global productivity by 41% while also saving water by 62%. This model integrates water gathering, soil moisture conservation, and drip irrigation. Contrarily, Inocencio *et al.* (2003) discovered that conservation tillage might be used to manage agricultural water in another manner (minimum tillage; no-till, or zero-tillage). Due to the build-up of soil organic matter, this strategy is commonly employed in Australia and the USA to boost water retention, decrease surface runoff, and prevent soil evaporation, according to Crop Life International (2004).

According to Abou Hadid (2013), the employment of greenhouse and plastic techniques in the Near East and North Africa (NENA) region will improve the efficiency of water usage by reducing wind and radiation, which in turn lowers evapotranspiration in open fields. The sustainability of vegetable production is a key concern for soil scientists, who believe that good soil and nutrient management strategies are essential. A healthy, fertile, and productive soil can be created, according to the majority of the authors, by using crop rotation techniques. When vegetables are planted in a rotation with wheat, barley, and oats, 2 to 2.5 tons of dry matter per hectare of soil may be added, according to Mitchel *et al.* (2000). According to research findings by Nair (2017), a more varied and prolonged crop rotation in Iowa will enhance soil physical qualities, lessen soil erosion and nitrogen (N) leaching, and produce crops with competitive yields. Similarly, to this, most writers relate an increase in plant species' biodiversity to intercropping systems.

According to Brooker *et al.* (2014)'s findings, intercropping or diversified systems will produce more plant residues than monoculture systems by a factor of 1.7. This shows that the earlier scenario has a larger rate of soil organic matter accumulation than the latter. Along with emphasising a broad crop rotation, Snapp *et al.* (1998) discovered

that utilising fast-growing legumes with high-quality residues and deep root systems in a fallow could significantly increase soil fertility, nitrogen cycling, and crop yields in southern Africa compared to grass fallow.

Similarly, to this, Torres (2017) believes that planting legumes as pre-crops in a rotation in the Boreal-Nemoral region of Europe will create healthier and more productive soil. Diverse kinds of organic matter play a role in sustainable soil and nutrient management, as highlighted in literature by various writers. Crop residues, in accordance with Phatak (1992), would enhance the number of soil pores, and water percolation, and thus reduce soil erosion. In a different study, Snapp *et al.* (1998) discovered that high-quality residues, such as green manure and legume tree trimming, swiftly break down and release roughly 70–95 percent of their nitrogen (N) within a season in tropical environments.

According to studies by Omotayo and Chukwuka (2009), the use of green manure in western Kenya would increase potato output compared to the use of artificial fertilisers. White *et al.* (2012), lending support to this hypothesis reaffirmed that the usage of organic amendments would frequently increase the productivity of soil as well as the nutritional value of crops cultivated in that soil. Research results by Franzluebbbers *et al.* (1998) are showing that the presence of mulch cover will enhance microbial activities, modifies soil temperature, improves soil water conservation, reduces soil crusting and sealing, and reduces soil erosion in sub-Saharan Africa. According to research by Forster *et al.* (2013), most Switzerland's organically managed soils contain 33% more microbial biomass than those maintained using conventional methods. According to research by Kebede and Bokelmann (2017), the application of organic fertilisers on African indigenous vegetables (AIV) in Kenya would enhance soil fertility, boost local biodiversity, and ultimately increase output.

Other authors have a broader perspective on sustainable soil and nutrient management than just organic fertilisers. One of the most long-lasting soil management techniques in the tropics, according to Hossner and Juo (1999), is the implementation of integrated nutrient management (INM). This method uses both organic and inorganic sources of nutrients in a way that is sensible, economical, and environmentally friendly. Similarly, Toenniessen *et al.* (2008) contend that a mix of

organic and inorganic techniques, such as green manure, cover crops, and composting crop wastes, will increase soil fertility. In addition, FAO (2017) indicated that the application of integrated soil fertility management (ISFM) would lead to increased soil organic carbon (SOC) and improved soil quality. This involves agricultural practices such as the retention of crop residue mulch, organic farming, composting and continuous vegetative cover.

The use of cover crops in a rotation between several vegetable growing seasons would be an efficient strategy to recycle crop nutrients and lower the need for inorganic fertilisers in North Carolina, according to research findings by Ravella *et al.* (2013). Lal (2015), however, argued further that a site-specific strategy like conservation agriculture (CA) would improve and sustain soil quality. According to some authors, the health of the soil will be impacted by various tillage techniques. According to White *et al.* (2012), fields that use conservation tillage (zero tillage) have better microbiological and physiochemical qualities. Conservation agriculture decreases water run-off and enhances water infiltration, according to synthesis results of Sommer *et al.* (2013).

2.8 Climate change and climate-smart agriculture

Different people have different theories about how climate change is caused. Mahato (2014) defined climate change as any major long-term alteration in projected regional weather patterns over a significant amount of time. Ayyogari *et al.* (2014), who reaffirmed that climate change can be any change in climate over time caused by natural variability or because of human activity, endorse this addition. Due to the numerous ways in which it impacts agriculture and food security, climate change has become a global issue. According to Mahato (2014), increased temperatures, altered precipitation patterns, and increased atmospheric carbon dioxide (CO₂) all have an impact on agriculture. Deressa *et al.* (2011) provided support for this entry by arguing that increasing temperatures, less rain, and increased rainfall variability because of climate change are to blame for decreased agricultural yields, which endangers food security in low-income and agriculture-based economies. In a similar vein, Ahmed, and Saha (2021) asserted that climate change increases pests' susceptibility to various crops, while altered rainfall patterns decrease water availability and have an impact on both irrigated and rain-fed farming operations.

In a different interpretation, Yadav *et al.* (2022) link the effects of climate change to extended dry spells, global warming, erratic monsoon patterns, floods, violent storms, a rise in sea level, and an increase in air pollution as a result of the release of greenhouse gases (CO₂, CH₄, H₂S, and N₂O), which act as a blanket in the atmosphere and prevent heat from escaping the earth's surface. Crop failure, a lack of yield, decreased crop quality, and an increase in pest and disease issues are some of the usual repercussions of climate change, according to Ayyogari *et al.* (2014), which also make it unprofitable to grow vegetables. This claim is backed by Skendzic *et al.* (2021) who underlined that a change in climate might affect pests by expanding their geographic range, increasing overwinter survival, increasing the number of generations, increasing the risk of invasion by migratory pests, increasing the incidence of insect-transmitted plant diseases, and decreasing the efficiency of biological control by natural enemies.

Farmers can use a variety of climate-smart agriculture (CSA) technology to lessen the impact of climate change on crop production. Agricultural techniques that sustainably boost productivity and system resilience while lowering greenhouse gas emissions are referred to as CSA, according to Sullivan *et al.* (2012). Climate-smart agriculture technology may generate cultivars that are tolerant to heat, and salinity, and resistant to floods, according to Devi *et al.* (2017). Changes in sowing dates, the use of effective irrigation systems like drip irrigation, the management of fertiliser through fertigation, and the use of plant regulators, protected cultivation, and improved pest management are some of the effective adaptation strategies to lessen the effects of climate change, according to Devi *et al.* (*ibid*). According to a different version by Tadesse *et al.* (2021), examples of climate-smart agriculture (CSA) activities include the use of structures for managing soil and water, establishing hedgerows, installing water collection systems, using agricultural wastes, and rotating crops. According to research done by Ogunleye (2015), farmers in Osun State, Nigeria, are aware of how climate change affects crop output, but they also struggle to control the impact.

2.9 Organic vegetable production

Different authors provide numerous explanations for the development of organic vegetables. Producing organic vegetables is the way that ensures environmental safety and limits the use of synthetic inputs, claims Ilakiya *et al.* (2020). According to Fernandez *et al.* (2022), the strategy emphasises the use of biological and ecological management practices above the use of off-farm inputs while also considering the need for regionally adapted systems according to regional conditions. Similarly, to this, Singh *et al.* (2017) defined organic vegetable production as relying on soil organic matter management to improve the chemical, biological, and physical qualities of the soil. Olle and Williams (2012), on either hand, define organic vegetable growing as a technique that employs a range of approaches for disease and insect control, including the use of hot water, hot air, electronic treatments, and the treatment of seeds with plant extracts. Olle & Williams (*ibid*) also stated that ploughing, mulching, burning, and hot water treatments are preferable weed-control methods.

Ilakiya *et al.* (2020) claim that the major goal of organic vegetable production is to maximise the health and productivity of the interdependent communities of plant, soil, people, and animals. There are many reasons to practice organic vegetable farming. This demonstrates how growing organic vegetables is in tune with the environment. According to research by Olle and William (2012), vegetables cultivated organically are more nutrient-dense than those grown conventionally. According to Ndungu *et al.* (2013), smallholder farmers in Kenya's Kajiado and Kiambu counties saw an increase in farm gross margins of 0.58 USD because of using organic vegetable production methods. Boateng *et al.* (2018) confirmed that organic vegetable farmers in Ghana's Northern Region produced more than conventional farmers, which lends validity to this finding. According to study findings by Sarhan *et al.* (2011), both organic and bio-fertilisers produced summer squash with the best performance in terms of vegetative and reproductive characteristics in Iraq.

2.10 Vegetable consumption patterns

2.10.1 Global vegetable consumption patterns

At the worldwide level, many areas are still working to meet the FAO/WHO recommended intake of at least 400g (five servings of 80g) of vegetables per day for adults, despite regional differences in vegetable consumption habits (Pem & Jeewon, 2015). The consumption of vegetables is said to be impacted by a variety of characteristics, including age, gender, ethnicity, religion, and level of education, according to various writers. Oguntibeju *et al.* (2013) found that ladies with higher levels of education prefer to eat more vegetables and inspire their children to do the same in contrast to mothers with lower levels of education.

Studies by Nurul-Izzah *et al.* (2012) discovered that in Malaysia, adult females would typically consume more vegetables than adult males because vegetable consumption rates vary between sexes. Similarly, to this, Perera and Madhujith (2012) found that female university students in Sri Lanka were more likely than male students to consume vegetables for both lunch and dinner. According to reports from Canada, women consume greens more frequently than males (Perez, 2002). All this research support Al- Otaibi's (2014) observation that 40–80% of Saudi Arabian female university students consume five servings of vegetables each day.

Additionally, age and denomination will have an impact on how much vegetables and fruit are consumed. According to observations made by Tan *et al.* (2013), the Seventh-day Adventist church and the Church of Jesus Christ of the latter-day saints would advise their members to eat more vegetables and less cholesterol. According to a study by Peltzer and Pengpid (2012), 76% of South-eastern Asian schoolchildren between the ages of 13 and 15 do not eat the recommended number of servings of vegetables per day. Ervin *et al.* (2015) 's argument that a sizable fraction of students aged 6 to 12 in Australian rural schools are more likely to detest vegetables than fruits support this viewpoint. According to Nurul-Izzah *et al.* (2012), those who live in Malaysia's rural areas consume more vegetables than those who live elsewhere. People who live in cities, on the other hand, eat more fruits than vegetables. In a similar vein, Lancet Global Health (2016) holds that affordability contributes to a decline in vegetable intake. Simply put, when the nation's economic standing declines, so does the affordability of fresh vegetables. The percentage of household

income needed to buy the recommended amounts of vegetables will therefore be higher in low-income nations than in high-income countries.

People from different regions prepare vegetables in various ways. According to Taylor *et al.* (2015), the Pacific area consumes all green vegetable plant sections. People can consume fried or pickled leaf blades and petioles. According to Keatinge *et al.* (2015), pumpkin fruit, seeds, leaves, and flowers are practically used in a variety of recipes. According to Singh *et al.* (2012), sweet potatoes are prepared into wafers or chips in India, while vegetables are made into liquids, pulps, frozen foods, and dehydrated goods. Bevan *et al.* (2016) discovered in their research on Europe that adding a dip or disguising vegetables with sauces or dressings encourages consumption. To promote intake, other vegetables, such as cauliflower, would be presented through mashing or pounding.

2.10.2 African vegetable consumption patterns

African green vegetable consumption in Sub-Saharan Africa has decreased over time as a result of the spread of foreign species like cabbage, carrots, tomatoes, and onions (Smith & Eyzaguirre, 2007). In comparison to Asian and Latin American nations, Onim and Mwaniki (2008) found that vegetable intake in Africa is often quite low. However, Kenya has emerged as an exception, with urban residents consuming up to 403g of vegetables daily (Onim & Mwaniki, *ibid*). Vegetables continue to be a component of African diets, along with other mainstays like maize and sorghum flours, according to Asongwe *et al.* (2014). Opiyo *et al.* (2015) highlighted that traditional leafy vegetables (TLVs) play a significant part in Kenyan household food security because of their availability, capacity to grow fast, and ability to be harvested in a short amount of time. This hypothesis is matched with their findings.

Season, money, age, and culture are all elements that affect vegetable intake around the world; however, how they present themselves may vary depending on where you are in Africa. According to Kimiywe *et al.* (2007), consumption of local green vegetables is highest in Nairobi's Peri-urban districts during the wet seasons and when prices are lowest. Ruel *et al.* (2005) discovered that households with higher incomes in Sub-Saharan Africa generally consume more vegetables, and a wider variety than lower-income households. Ogundari and Arifalo (2013) reaffirmed that in

Nigeria, wealthier households respond to the demand for vegetables more quickly than poorer households, which lends support to this notion.

In terms of age, Ogundari and Arifalo (2013) discovered that households with younger members in Nigeria are more likely than those with older members to demand and consume more vegetables. Owuor and Olaimer-Anyara's (2007) research found that young African women are typically the ones to pick leafy vegetables, whereas older women are consulted while preparing traditional recipes. According to Kimiywe *et al.* (2007)'s observations, native leafy greens are used medicinally in Kenya and Tanzania. According to Abukutsa-Onyang'o (2007), African leafy greens with a bitter taste, such as black nightshades and spider plants, can treat conditions relating to the stomach. According to Grubben *et al.* (2014), to make grain-based meals more appetising in Sudan and Guinea, vegetables are prepared as salad or stew and eaten as a relish, along with soups, sauces, oil, or groundnuts. Emana *et al.* (2015) highlighted those vegetables are utilised as a source of raw ingredients for processed foods such as tomato paste, tomato juice, ground seasoning, and oleoresin in the humid tropics of Ethiopia.

2.10.3 South African vegetable consumption patterns

Vegetable eating is a product of both African culture and western civilization in South Africa. African green vegetables are historically consumed by South Africans, according to Voster *et al.* (2007a). These vegetables are either cultivated or harvested from the wild or from weeds (Venter et al, 2007). Depending on the cultural group, different people may consume different types of African leafy vegetables. According to research by Voster *et al.* (2007b), the Xhosa would blend the leaves into stiff maize porridge and eat it as a single meal, whereas the Zulu, Shangaan, Swazi, Pedi, and Ndebele would consume traditional leafy vegetables as a relish accompanying stiff porridge. According to Maanda and Bhat's (2010) observations, the Venda communities would consume African leafy vegetables as pot herbs, relish, or side dishes.

Age, gender, and income all have an impact on the intake of African green vegetables in South Africa. Van Rensburg *et al.* (2007) found that impoverished households use African green vegetables more frequently than their more affluent counterparts. According to research by Voster *et al.* (2007c), men from the Eastern Cape favour

bitter-tasting vegetables. According to research by Taruvinga and Nengovhela (2015), the Eastern Cape's consumption of African green vegetables would rise when household head ages rose. Youth would also consider African leafy vegetables to be foodstuff for the impoverished. Furthermore, according to Van Rensburg *et al.* (2007), the advent of extension workers and western civilisation has promoted exotic vegetables in South Africa to the detriment of African leafy vegetables. Voster (2007), who stated that South African academics and extension agents would designate African plants as weeds and persuade households to exclusively raise those veggies that are available in the supermarkets, supports this theory. According to Van Rensburg *et al.* (2007), extension agents would advise small-scale farmers against using selective weeding methods.

2.10.4 Conclusions

The literature review assisted in the understanding of the global and local situations on vegetable production and its challenges regarding constrains, climate change, the extent of production, and consumption. Literature review also provided guidance to the current study in terms of information gathering instruments, type of study to be conducted, with the intention of providing local information about a sustainable vegetable production in Limpopo Province.

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Chapter 3

Methodology

3.1 Research approach and design

Different researchers are of the understanding that research can either be approached from quantitative or qualitative perspective. Quantitative research are characterised by the collection of information which can be analysed numerically, and results are typically presented using statistics, tables and graphs (ACAPS, 2012). On the other hand, qualitative researches are concerned with the quality of information, and are attempting to gain an understanding of the underlying reasons and motives of human behaviour and establish how people interpret their experiences and the world around them, and generate case studies and summaries rather than lists of numerical data (MacDonald & Headlam, 2015). Qualitative research is also used to analyse various factors which make people like or dislike a particular thing, and the results of the study are a function of the researcher's insights and impressions (Kothari, 2004).

This study followed a mixture of qualitative and quantitative approaches with primary goal of complementing both methods. The qualitative approach was used to respond to textual data, with the aim of in-depth description and understanding of actions of small-scale vegetable farmers and other events as they occur in rural areas. The study was based more on information expressed in words, accounts, opinions and feelings. The researcher deeply understood and described the production of vegetables by small-scale farmers of Limpopo Province in their natural setting. On the other hand, quantitative approach was used to respond to research questions requiring numerical data and subjected them to rigorous quantitative analysis.

A research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure (Kothari, 2004). It is also a conceptual structure within which the research would be conducted (Pandey & Pandey, 2015). According to Thomas (2013), a research design is understood as a blueprint for the research. This is an idea on how the research will be conducted before it is done in practice (Babbie & Mouton, 2001). It is also understood as a plan for the research from the first step to the last step. Designing a study helped the researcher to plan and implement the

study in a way that help the researcher to obtain the intended results, and thus increased the chance of obtaining information that could be associated with the real situation (Bless & Higson-Smith, 1995; Walliman, 2006).

The study followed a descriptive design, in which the researcher observed, described, and documented various aspects of the phenomenon. The descriptive design also describes what actually exists, determines the frequency with which it occurs, and categorises the information (Sousa *et al.*, 2007; Singh, 2014). Descriptive research helps to understand the characteristics of a group in a situation of interest, aids in thinking systematically about aspects in each situation, offers ideas for further research and helps make simple decisions (Nor *et al.*, 2011). Descriptive research studies also concerned with specific predictions, with narration of facts and characteristics of a particular individual, group or situation (Kothari, 2004).

3.2 Theoretical Underpinning Mixed-methods Research

As indicated in section 3.1 above, this study adopted a mixed-methods research approach. A mixed-methods approach is described in many ways by different people. Doyle *et al.* (2012) defined mixed methods as research in which the investigator collects, analyses data, and integrates the findings, and draws inferences using both qualitative and quantitative approaches in a single study. According to Greene *et al.* (1989), mixed methods are designs that include at least one quantitative method (designed to collect numbers) and one qualitative method (designed to collect words) where neither type of method is inherently linked to any inquiry paradigm.

Kemper, Springfield and Teddlie (2003) defined mixed methods design as a method that includes both qualitative and quantitative data collection and analysis in parallel form (concurrent mixed method design in which two types of data are collected and analysed in sequential form). Bazely (2003) defines this method as the use of mixed data (numerical and text) and alternative tools (statistics and analysis) but apply the same method. It is a type of research in which a researcher uses the qualitative research paradigm for one phase of a study and a quantitative research paradigm for another phase of the study.

According to Kallemeyn *et al.* (2019), mixed-methods research is founded on the premise of “*Complexity theory*”. Ladyman *et al.* (2016) described a complex system

as one in which there are multiple interactions between many different components. According to Kallemeyn *et al. (ibid)* complexity theory frames a phenomenon as a complex system, which requires researchers to use alternative methods of thinking about reality, and methods that put more emphasis on holism, interconnectedness, nonlinearity, and uncertainty. This view is supported by Turner and Baker (2019) who reiterated that complexity sciences expand on the reductionist framework by not only understanding the parts that contribute to the whole but by understanding how each part interacts with all the other parts and emerges into a new entity. On that score, mixed-method is viewed as an appropriate method to tackle complex problems by thinking about the phenomena and methods differently.

The importance for using mixed method research is varied. According to Sahin (2019) mixed methods research balances the limitations inherent in qualitative and quantitative methods. Sahin (*ibid*) further argues that the method is emerging as a good way to find answers to research problems which a single research method is not sufficient. Dawadi *et al. (2021)* is in support by asserting that two methods might be superior to a single method as it is likely to provide rich insights into the research phenomenon that cannot be fully understood by using only qualitative or quantitative methods.

Ngulube and Ngulube (2022) argued that mixed methods research allows researchers to achieve a number of aspects, namely: expansion, complementarity, development, triangulation and initiation. This argument is supported by Dawadi *et al. (2021)* who respectively referred the achievements of each aspect to the widening of inquiry with sufficient depth and breadth, to the utilisation of values from both kinds of research to the development of an in-depth understanding of a research phenomenon, to the validation of results obtained with individual method, and to obtaining more rigorous conclusions such that the strengths of one method offset the weakness of the other.

3.3 Description of the study area

The area under study is the Limpopo Province, which is situated in the northern part of South Africa. It is adjacent to the Northwest Province, Gauteng and Mpumalanga and shares borders with Botswana, Zimbabwe, and Mozambique. The province covers an area of 12, 3 million ha, accounting for 10.2% of the total surface area of

the Republic of South Africa (Oni *et al.* (2003). The province is mostly rural in character, with 89% of the population (5.4m) living in non-urban areas. This is proportionally, the largest rural population in the country (Mmbengeni & Mokoka, 2002). The province has three climatic regions namely: the low veld region (arid and semi-arid); middle and high veld region (semi-arid) and the escarpment region (sub-humid) with rainfall more than 700mm per annum. These varied climates allow Limpopo to produce a wide variety of agricultural produce, ranging from tropical fruits to cereals and vegetables (Oni *et al.*, 2003).

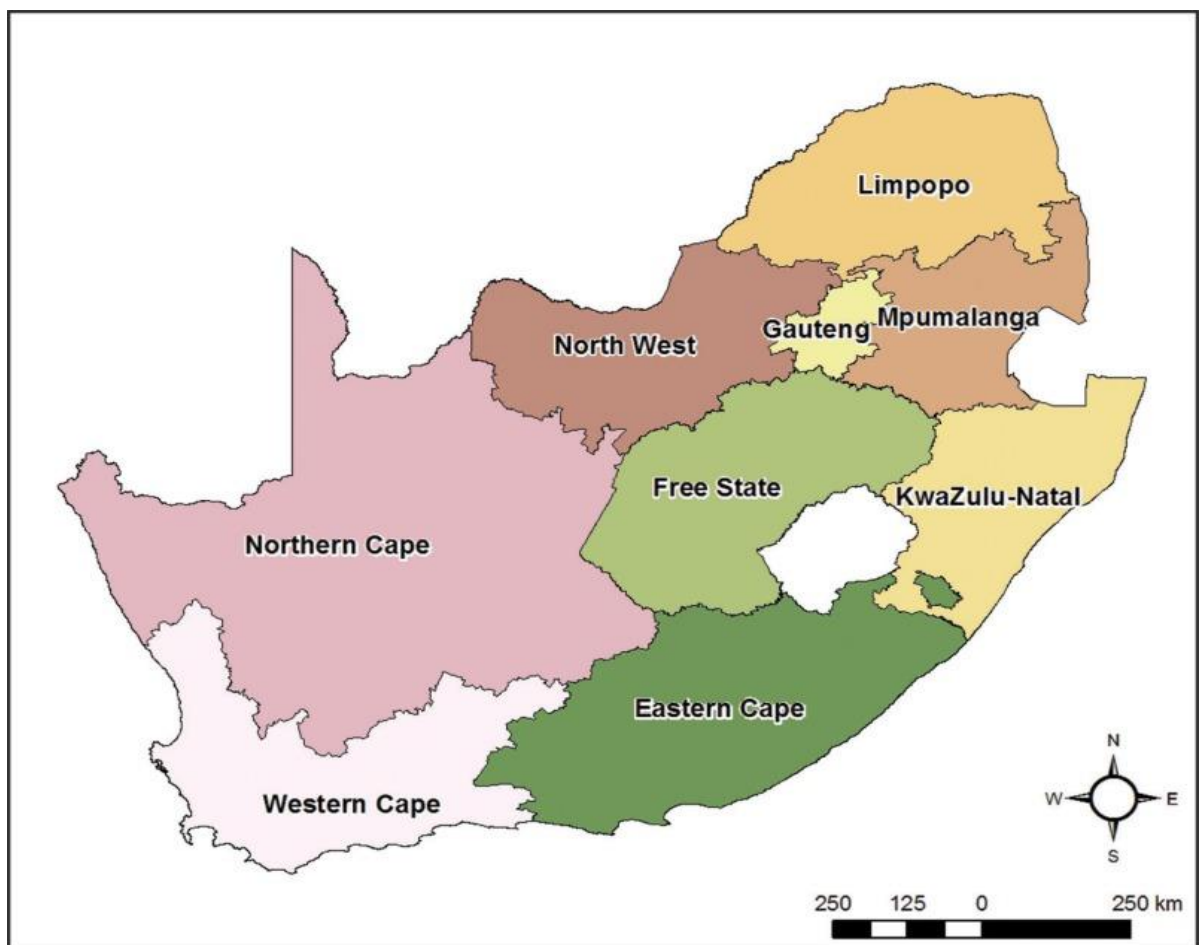


Figure 3 1 Location of Limpopo Province

Source: <https://www.ncbi.nlm.nih.gov/books/NBK481848/figure/chapter2.f1/>. Accessed on 19/10/2019



Figure 3 2 Limpopo Province District and local municipalities

Source: <https://municipalities.co.za/provinces/view/5/limpopo>. Accessed on 19/10/2019

3.4 Researcher’s philosophy

Different researchers subscribe to anyone of the philosophies such as positivism, pragmatism, postmodernism, critical realism and interpretivism. For this study, the researcher subscribed to interpretivism. This philosophy assumes that the meaning is embedded in the participant’s experiences and that the meaning is mediated through the researcher’s own perceptions. In this philosophy, a researcher is immersed in a culture by observing its people, their interactions, interviewing key informants, constructing case studies, and analysing existing documents (Juli, 2010).

3.5 The study type

The type of this study is a survey. This is the study that looked at the individuals, groups, institutions, methods, and materials in order to describe, compare, contrast, classify, analyse and interpret the events that constitute their various fields of inquiry (Cohen *et al.*, 2007). The study also collected observed data about people, their

preferences, traits, thoughts, attitudes, behaviours, and beliefs from a large, remote area using questionnaires or interviews (Bhattacharjee, 2012).

3.6 The research strategy

3.6.1 Population and sampling

A population is a total number of all possible individuals which can be included in a study if there are enough resources (Thomas, 2013). According to Walliman (2006) a population can consist of objects, people or even events. In Limpopo Province, the population comprises of 103874 smallholder agricultural households involved in vegetable production (STATSSA, 2016).

The study followed a multistage cluster sampling procedure. Since Limpopo consists of five main municipal districts, initial sampling was done on districts and followed by sampling of farmers from the selected districts and irrigation schemes. The two districts selected were Vhembe and Mopani, and the 23 irrigation schemes selected were Rambuda, Tshiombo, Tshitavha, Mamuhoyi, Luvhada, Ha-Mphaila, Gumbu, Rabali, Tshikonelo, Dovheni, Makumeke, Belleview, Solani, Julesburg, Guwela, Hlaneki, Sekororo, Haenertzberg, Gravelote, Seloane, Mokwakwaila, Sekgosese 1, and Phadzima. Cluster sampling reduces costs of travelling and compilation of sampling frames (Walliman, 2006; Krathwohl, 2009; Babbie, 2010).

The Slovin's formula $n=N/(1+N(e)^2)$ was used to calculate the sample of the study area where n =sample size; N =population size; e = acceptable margin of error (Slovin, E., 1960). In this case the given population size (N) is 103874 and the error of margin (e) is 0,06.

$$\begin{aligned} \text{The Calculation went: } & \frac{103874}{1+103874 \times 0.06^2} \\ & = \frac{103874}{374,9} \\ & n = 277 \end{aligned}$$

However, 261 farmers were interviewed, while 16 farmers could not be available.

In this study, 52 small-scale vegetable farmers were sampled for each of the first four objectives, and 53 farmers were sampled for the fifth objective, giving a total of 261 farmers who were sampled for the whole study area.

3.6.2 Data gathering techniques and instruments

A multiple of data collection techniques, namely: questionnaires, observations, and documentary sources were used to increase the credibility and validity of the results.

3.6.2.1 Questionnaires

A questionnaire was administered to collect data. Research questionnaire is a tool for collecting and recording information about a particular issue of interest. It is mainly made up of a list of questions but should also include clear instructions and space for answers or administrative details (Gay *et al.*, 2011). For this study, face to face questionnaire was administered to make it easier to identify the appropriate persons and to avoid unambiguous responses.

3.6.2.2 Observations

Participant observation was used by the researcher as a data collecting technique in this study. De Vos *et al.* (2002) view participant observation as a valuable procedure for data collection in qualitative studies as it has an exploratory character. Babbie (2004) and De Vos *et al.* (2002) support the notion that participatory observation implicates a continuum from complete observer to complete participant with a variety of degrees of involvement in-between.

The challenge was to make regular notes on observations and experiences in the research field and to convert it into field notes as soon as possible in order to reduce errors. Observation was followed up with informal one-on-one interviews. Simple observation is the recording of events or behaviours as observed by an outsider (Bless & Higson-Smith, 1995). One of the biggest advantages of simple observation is that it can be done anywhere (Babbie & Mouton, 2001) and that information collected is original since the method is unobtrusive and subjects cannot fake behaviours (Veal, 2011). For this study, farmers were observed in their cropping areas.

3.6.2.3 Documentary sources

Documents were examined to investigate patterns and trends of the past as is commonly done by historians. The examination of documents also provided confirmatory evidence of the information obtained from interviews and observations (Mogalakwe, 2009). For this study, research articles, journals, maps, records, and books were used as secondary sources of information.

3.6.3 Data analysis

Collected data from the questionnaires was loaded into Excel spreadsheet by the researcher and analysed with SPSS (2015). Data was analysed and used in chapters, four to eight. Descriptive statistics were used to determine frequencies and simple figures. The frequencies were developed into tables and figures as results.

Analysis of data in chapter 4 on Characterisation of vegetable production systems, include, demographic information; water resource management systems; fertiliser management systems; soil resource management systems and financial management.

Analysis of data in chapter 5 on Vegetable production systems and consumption patterns as determinants of food security, include, demographic information; vegetable production and food security; vegetable preparation systems and food security; vegetable consumption patterns and food security; vegetable preservation and food security.

Chapter 6 on climate change mitigation strategies, include, demographic information; climate change perceptions and adaptability; strategies in response to climate change.

Chapter 7 on potential of African indigenous vegetables towards formation of a commercial, nutritional, and sustainable production systems, include, demographic information; farmers 'perceptions on indigenous vegetables; farmer's participation in African Indigenous market activities; production of African Indigenous vegetables; Harvesting and marketing of AIVs; support accessibility and consumption of AIVs.

Chapter 8 on opportunities and constraints of a wide adaptation to organic vegetable production system, include, demographic information; fertiliser and pest management

systems; farmers' attitude towards organic farming; farmers' beliefs about organic farming; information seeking and communication about organic farming, and intentions and interventions.

Other information collected through observation was also analysed and factored into the results.

3.7 Ethical considerations

The study considered the following ethical standards:

- The study was conducted only after the letter granting permission to access the farming areas was received from the Limpopo Department of Agriculture.
- The study was also conducted after the ethical clearance certificate has been issued by the Ethical Clearance Committee of the University of the Free State.
- Consent of the farmers, farmer unions, and village leaderships was sought by asking them to sign a concern form willingly.
- The study acknowledged all the sources that were used, from literature materials to participants.
- The study observed the rights of the respondents to confidentiality, anonymity, and access to the report.
- The study observed Covid-19 protocols to avoid the spread of Corona virus.

3.8 Validity and Reliability of the Study

3.8.1 Reliability

According to Surucu and Maslakci (2020) reliability is an indicator of the stability of the measured values obtained in repeated measurements under the same circumstances using the same measuring instrument. Golafshani (2003) is of the opinion that a test is seen as being reliable when it can be used by several different researchers under stable conditions with consistent results and without the results

not varying. In other words, reliability reflects consistency and replicability over time. Heale and Twycross (2015) see reliability as the degree to which a test is free from measurement errors, since the more the measurement errors occur, the less reliable the test. The reliability of the instrument used in the collection of data (questionnaire) was piloted to determine the reliability. The errors and irrelevant questions were noticed and removed.

3.8.2 Validity

Validity is defined as the extent to which the instrument measures the behaviour or quality that it intends to measure or how well the measuring instrument performs its function (Surucu & Maslakci, 2020). According to Heale and Twycross (2015) validity is defined as the extent to which a concept is accurately measured in a quantitative study. There are two categories of validity:

3.8.2.1 Content validity

According to Heale and Twycross (2015) content validity determines whether all the areas or domains of the concept are appropriately covered within the assessment. Surucu and Maslakci (2020) are of the opinion that content validity evaluates whether the expressions contained in the measuring instruments represent the phenomenon intended to be measured. Validity determines whether the researcher truly measures that which it was intended to measure or how truthful the research results are (Golafshani, 2003).

3.8.2.2 Construct validity

Construct has to do with the efficacy of a test to gauge participants knowledge about a relevant topic concerned, and also the extent to which it is culture-free; easier or harder for certain participants (Golafshani ,2003).

The *content validity* and *construct validity* of the questionnaires have been assessed. An expert in the field of agriculture was used to judge the extent to which the content of the questionnaires appeared logically and covered the scope of the research. Where questions were irrelevant, they were corrected.

Validity and reliability of the study was enhanced by the inclusion of two Municipal districts, a total of 23 villages for the whole study, an average of 5-6 villages for each objective, and small-scale farmers across the Municipal districts.

The willingness of the researcher to address queries, the assistance given to illiterate participants by means of a structured interviews enhanced validity.

The use of two Masters' students in the field of agriculture, in the enumeration of questionnaires, the presence of the researcher during the completion of questionnaires provided consistency and further enhanced the validity of the study.

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Chapter 4

Characterisation of vegetable production systems by small-scale farmers in rural areas of Limpopo Province, South Africa

Abstract

A study was conducted in six villages, four in Makhado Municipality of Vhembe District, and two villages in Greater Letaba Municipality in Mopani District. The objective of the study was to characterise vegetable production systems of small-scale farmers in the study area. Data was collected using a questionnaire and some information was gathered through direct observation. Fifty-two farmers were sampled using a multi-stage random sampling technique and were interviewed. Sample size was calculated using Slovin's formula. Data was analysed using a SPSS. The results of the study showed that 59.62% of the farmers were males, 57.69% were above 61 years of age. The education status of women was lower than that of men and more women had no formal qualification. The 92.31% owned land and 80% of the plots ranged between 0.5 and two hectares. The 84.62% had vegetable farming experience ranging between 5 and above 16 years. Water management system was characterised by some farmers (50%) who adapted to water shortage by planting drought tolerant vegetables, some 19.23% used drip irrigation system and others (13.46%) used conservation tillage. The majority (71.15%) of these farmers used furrow irrigation and gravitational canal, and their main source of water was the river. They drew water using gravitation and pipes as well as gravitation and canals. Water availability ranged from daily to monthly. Human resource management was characterised by 48.08% of the vegetable farmers who employed a mixture of youth, male and female workers and 60% of the farmers hired workers on seasonal basis. Soil sampling did not exist because 65.54% did not take soil samples and 67.31% did not know when last they took soil samples, 65.38% used both organic and inorganic fertilisers. About 81% applied between 10-200kg fertiliser per hectare using band placing method. Other vegetable production practices identified include chemical pest control (100%); soil resource management was done through conventional tillage (86.64%); contours to control erosion (71.18%). Weed control was mainly manual (73.08%). Income generated from sale of vegetables was mainly used for labour, production inputs and mechanisation. Farmers in the study area kept records for finance, input, planting dates and yields. Most farmers used 0-10% of vegetables they produce for home consumption. The results of the study showed that vegetable production can be sustainable if water, soil, pests and disease are managed appropriately.

KEYWORDS: *Characterisation; vegetables, production systems, small-scale farmers.*

4.1 Introduction

In South Africa, growing vegetables is more than just planting seeds and hoping for the best results. Vegetable production makes use of a variety of production techniques. Juroszek *et al.* (2008) state that some vegetable production methods are not long-term sustainable, some are rapidly deteriorating the environment as a result of excessive application of synthetic pesticides and fertilisers, and others will pollute water and food. The research by Martin *et al.* (2014), on Best Management Practices (BMPs) have demonstrated that profitable vegetable produce can be maintained while minimising negative effects on the environment. Dias (2012) suggested that vegetable production systems should aim to promote both quantity and quality food because vegetables are considered essential for the supply of vitamins, minerals, dietary fibre, phytochemicals, and other nutrients. Van Dijl *et al.* (2015) in another version believe that understanding vegetable growers' drought adaptation systems is also important given the threat to water availability posed by climate change and water demand.

The objective of this chapter is to present the characteristics of vegetable production systems of small-scale farmers in rural areas of Limpopo Province of South Africa, with the view to understand among others, the management systems regarding water utilisation; human resource; fertilisers; soil conservation; tillage; pest and disease control.

4.2 Materials and methods

4.2.1 The study area

The study was carried out in the four villages of Makhado Municipality of Vhembe District, namely, Tshitavha, Phadzima, Rabali and Mphephu and two villages of Greater Letaba Municipality, Mopani District, namely, Bellevue and Sekgosese 1. This study area is referred to as area A.

The Makhado Municipality is in the northern part of Limpopo Province (coordinates latitude 23° 00' 00" S and longitude 29° 45' 00" E), approximately 100km from the Zimbabwean border along the N1 Route. The municipality is predominately rural due to the vastness of rural populace. The Municipal area is 7605, 06 km², which

translates into 760506 ha in size, and approximately 416728 people are currently residing within the municipality (IDP, 2022/23- 2026/7).

The Greater Letaba Municipality is in the north-eastern quadrant of the Limpopo Province (coordinates latitude 23° 53' 56" S and longitude 30° 23' 8.999"E). Greater Letaba Municipality is bordered by Greater Tzaneen to the south, Greater Giyani to the east, and Molemole to the west and Makhado to the North (IDP, 2010/11). The land area of the municipality extends to approximately 1891 km², with the population of 218030 (IDP, 2020/21). According to (IDP, 2010/11), Greater Letaba Municipality is characterised by varied topography, population densities (low in the south and relatively dense in the north-east), prolific vegetation in the south (timber) and sparse in the north (bush veld).

4.2.2 The sample

A total of 52 small-scale vegetable farmers were randomly sampled using a multi-stage cluster sampling procedures in which the stage one sampling was done at District level, stage two at the municipality level and third stage at the Agricultural Service centres level. Chapter three shows how a sample was calculated from the population, using a Slovin's formula. In this case, two Municipal Districts (Vhembe and Mopani) were purposively selected, and one Municipality from each of the two districts was also sampled (i.e., Makhado and Greater Letaba), from the two Municipalities, database of six villages selected (Phadzima, Tshitavha, Mphephu, Rabali, Bellevue and Sekgosese 1) were sampled. The 52 small-scale vegetable farmers for this objective, constituted about 20% of the total number of farmers (261) who were interviewed. The 20% small-scale vegetable farmers were uniformly spread over the five objectives of this thesis.

4.2.3 Data collection and analysis

A questionnaire was used to collect data. The respondents were asked to supply information on demography, human resource management, water usage, soil management systems, fertilisers, financial management systems; weed and pest control. The raw data was analysed and interpreted into meaningful information using statistical package for social sciences (SPSS, 2015).

4.3 Results and discussions

This chapter presents the results on the characteristics of vegetable production systems by small-scale farmers in rural areas of Limpopo Province, South Africa. The results among others include demographic information; water management systems; human resource management; methods of cultivation; soil conservation; fertiliser usage; weed control systems; pest and disease control methods.

4.3.1 Demographical information

4.3.1.1 Participation by gender

The results of the study presented in Table 4.1 show that (59.62%) of participants were males and females were (40.38%). The study also shows that females participating in vegetable production activities are few, though it did not reveal the reasons for that. It could presumably be related to social expectations that women perform significant quantities of unpaid job and domestic work, and contribute to unpaid labour on their husband's plots not controlling the output of that work.

Table 4.1 Participation by gender

Gender	No of respondents	%
Male	31	59.62
Female	21	40.38
Total	52	100.

According to Muzari (2016), gender inequality is also higher in the most impoverished countries. Simply put, according to Muzari (*ibid*), gender inequality strongly correlates with higher hunger rates. As per the research done by Akram-Lodhi and Komba (2018), Tanzania's gender gap may be closed in ten years, lifting roughly 80 000 people out of poverty each year. According to the findings of the study done by Quisumbing and Maluccio (2000), women's ownership over assets in countries like Bangladesh, Indonesia, Ethiopia, and South Africa has a favourable and considerable impact on how much money is spent on things like education and children's clothes. Akamin *et al.* (2017) argued that greater female involvement in vegetable farming in Cameroon's humid tropics results in significant increases in vegetable output, which lends credibility to this assertion. The reason for this is because women farmers are more technically adept than men farmers (Oladeebo & Fajuyigbe, 2007). Danzie and

Dasmani (2010) found that farms managed by female farmers were found to be more efficient and closer to the potential output defined by metafrontier production function approach compared to farms owned by male farmers, despite Mukasa and Salami (2015) finding that female-managed agricultural lands are on average less productive than their male counterparts in Nigeria, Tanzania, and Uganda. This conclusion is corroborated by FAO (2018), which found that Zambian yields could improve by 20–30% if women had equal access to productive resources as males.

4.3.1.2 Age of the respondents

The results of the study presented in Table 4.2 show that (57.69%) of the respondents in this study are over 61 years of age, followed by the younger generation of between 26-44yrs (36.54%) and then (15.39%) who are the middle aged (45-60 years), are practising vegetable production in the study area. The study also shows that the low number of younger generations is participating in agricultural activities. This could be that there are other better opportunities attracting the youth.

Table 4.2 Age of the respondents

Age (yrs)	No of respondents	%
<18	1	1.92
26-30	1	1.92
31-35	6	11.54
36-40	3	5.77
41-44	3	5.77
45-60	8	15.39
>61	30	57.69
Total	52	100

Mathivha (2012) claims that South African youth view agriculture as outdated, of low status, providing little prospects for financial gain, and being exclusively designated for the elderly and the underprivileged in rural areas. Since the elderly would be unable to pass on their knowledge to the next generation, this could have a severe effect on the nation's food output. According to Akamin *et al.* (2017), as a farmer ages in Cameroon, technical efficiency with relation to vegetable output tends to decline. The reason for this is that elderly farmers are typically considered to be less knowledgeable and less open to new concepts and technologies. As stated by Naamwintome and Bagson (2013), youth participation in agricultural activities in

Ghana is limited due to lack of youth control over financial returns. Haruna and *et al.* (2019) contend that providing youth in North Central Nigeria with the appropriate opportunities could have a beneficial effect on the country's economy. Swarts and Aliber (2013) believe that one factor contributing to the youth unemployment crisis in South Africa is young people's reluctance to participate in agricultural activities. They also believe that the already low levels of agricultural activities in rural areas are likely to drop even further, jeopardising any hope for rural development in the future. Guo *et al.* (2015), on the other hand found that aging has a statistically significant negative impact on employment shares in Chinese agriculture.

4.3.1.3 Age by gender

The results presented in Table 4.3 show that 57.69% are elderly farmers over 60 years old and there are more elderly males than women. The middle-aged farmers (26.93%) are between 36 and 60 years old. The middle age male farmers are also more than the female middle-aged farmers. The observation is that elderly farmers turn to have health and physical challenges that may hamper them to continue with farming in the area if there is no arrangement for the youth to take over and continue. Women also seem to be at a disadvantage because their numbers are less than those of males, this may have an implication when decisions are made. The outcome may favour the males at the expense of the minority women.

Table 4.3 Age by gender

Age/yrs	Male	Female	Total	%
< 18	1	0	1	1.92
26-30	1	0	1	1.92
31-35	5	1	6	11.54
36-40	2	1	3	5.77
41-44	2	1	3	5.77
45-60	4	4	8	15.39
>61	16	14	30	57.69
Total	31	21	52	100

4.3.1.4 Education status of respondents

The results of the study presented in Table 4.4 show that 9.62% of the respondents do not have any formal education, 23.08% have primary school education, 44.23%

went up to secondary school education, and the other respondents 13.46% have diplomas while 5.77% have degrees. The literacy level in this study area is reasonable because 67.31% of the respondents attained secondary and tertiary level of education. This literacy level can be of benefit to the respondents as they can be in a position to adopt and use new technologies that are introduced from time to time. These respondents regard farming as their only way to secure food, generating income, poverty reduction and job creation.

Table 4.4 Education status of respondents

Status	No of respondents	%
No formal education	5	9.62
Primary school	12	23.08
Secondary school	23	44.23
Diploma	7	13.46
Degree	3	5.77
Other	2	3.85
Total	52	100

Butt *et al.* (2011) found that Pakistan's rate of development would be greater the higher the percentage of educated people. As stated by Akamin *et al.* (2017), vegetable production is more efficient in Cameroon for farmers with at least a secondary education than for farmers with only a primary education or no education at all. Xaba and Masuka (2013), reiterating that the profitability of vegetable production in Swaziland would increase by E0, 304 with each additional year of education, back up this argument. This is because people with more education tend to be better at analysing and understanding information than people with less education or no education at all. Ibrahim *et al.* (2013) claim that the farmer's capacity and propensity to adopt novel farming concepts and methods are consequently enhanced by their high level of education. In a similar vein, Xaba and Masuka (*ibid*) are of the opinion that farmers' natural talents and inherent entrepreneurial qualities can be unlocked through education.

4.3.1.5 Education status of women

The study revealed as reflected in Figure 4.1 that there are more women who have no formal education and in terms of education levels women have low levels of

education compared to men. This situation may lend itself to challenges of decision making that could be biased to male than to women.

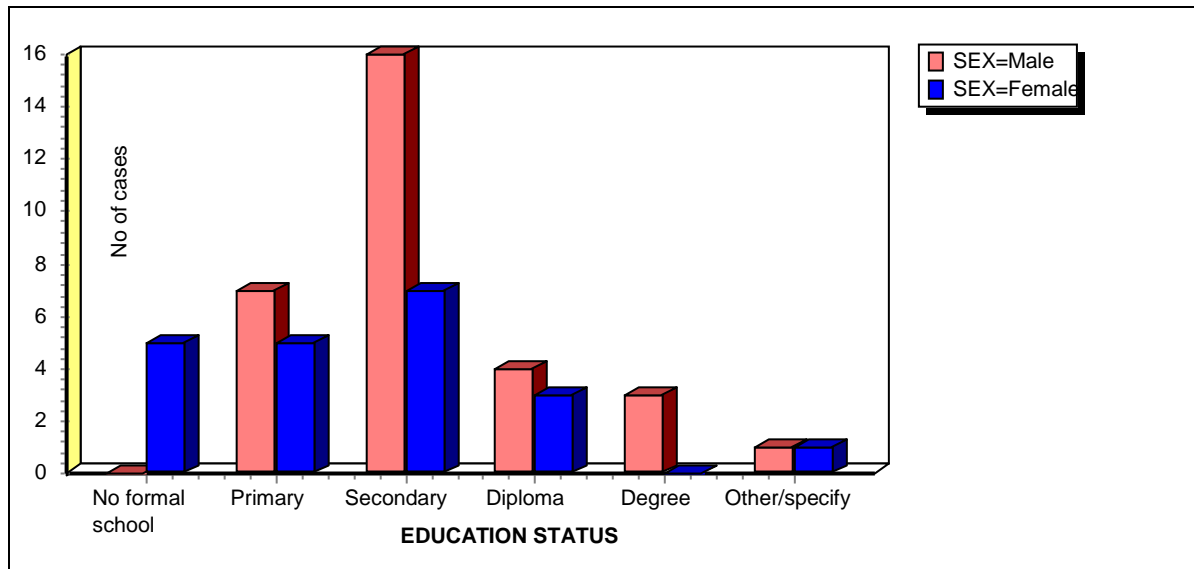


Figure 4.1 Education status of women

According to Ashford (2012), the lower status of women in general and the lower priority given to the education of girl children prevent women in many traditional societies from realising their full potential. Roudi-Fahimi and Moghadam (2003) detailed that as female training goes down in the Center East and North Africa, richness, populace development, baby and kid mortality rise and family wellbeing declines, and youngsters or girls of uninformed moms are less inclined to be signed up for school and achieve more significant level of training. Konate (2010) claims that education for women and girls has a significant impact on the socioeconomic development of a society in Mali because these groups are the pillars and foundations of their families. As stated by Agenor and Canuto (2013), educated mothers in Brazil typically possess more bargaining power within the household regarding the allocation of financial resources within the family.

4.3.1.6 Education status of youth

The study results presented in Table 4.5 show that 15.38% of the respondents are the youth of between 18 and 35 years old and they are all literate with levels of education ranging from secondary school to tertiary levels. The issue is that their number is low and a cause for concern. It could be that the educated youth section of the population has focus on things other than agriculture as means of income

generation, job creation, food security, and poverty reduction. This trend presents an uncertain future for agriculture because the youth of the study area does not seem interested in agriculture.

Table 4.5 Education status of youth

Age (yrs)	Status						Total	%
	No formal qualification	Primary school	Secondary school	Diploma	Degree	Other		
<18	0	0	0	1	0	0	1	1.92
26-30	0	0	1	0	0	0	1	1.92
31-35	0	0	2	2	1	1	6	11.54
36-40	0	0	2	1	0	0	3	5.77
41-44	0	0	2	1	0	0	3	5.77
45-60	1	0	6	1	0	0	8	15.39
>61	4	12	10	1	2	1	30	57.69
Total	5	12	23	7	3	2	52	100

According to Nyoni (2012), youth in Zimbabwe generally believe that white-collar jobs are more appealing, and that agriculture is only for retirees or the uneducated. In the synthesis report for the sub-Saharan countries, SACAU (2013) said that young people in Madagascar think farming is for the weak and poor, young people in Malawi think farming is for old, illiterate people with nothing to do, and that young people in Zambia and South Africa think farming is the last option they have after trying everything else and failing.

There is a need to shift that mentality of the educated youth to regard agriculture as one which can create jobs for the jobless, income for those who cannot generate other forms of income and also food security issues.

4.3.1.7 Land ownership

The results of the study presented in Table 4.6 show that 92.31% of the respondents own land, and 57.69% are males as compared to 34.62% females, hence their dominance on agricultural activities. This means that government need to empower more women on land ownership to reduce dependency by women on their husband for food security, income, and poverty reduction. Such farmers may have difficulty in

obtaining loans for agricultural purposes because they cannot use the land as collateral as they do not have title deed for it.

Table 4.6 Land ownership

Ownership	Gender				Total
	Male	%	Female	%	
Yes	30	57.69	18	34.62	92.31%
No	1	1.92	3	5.77	7.69%
Total	31	59.61	21	40.39	100%

Panter and Arekapudi (undated) claim that many land tenure systems are gendered by design, favouring male community or family members with primary rights. According to Quisumbing and Maluccio (2000), women worldwide have less access to land than men do, and Sexsmith *et al.* (2017) assert that it frequently has a smaller size, lower quality, and less stable tenure. This assertion is supported by Muzari (2016) who found that women in sub-Saharan African countries are five times less likely than men to own land. Additionally, Mukasa and Salami (2016) reiterated that land restrictions, unequal land tenure systems, and property rights are among the global factors that discriminate against women; restrict access to advisory system resources; exclusions from financial markets and credit. Study findings by Quisumbing and Smith (2007), reveal that women's control of assets has a positive and significant impact on how money is spent on things like children's clothing and education for future generations. In contrast, Muzari (*ibid*) stated that inequalities in women's access to resources and opportunities contribute to agricultural sector underperformance in many sub-Saharan African nations. Apparently, Xaba and Masuka (2013) assert that owning land influences agricultural production, as farmers who do not own land may be reluctant to develop and maintain it.

4.3.1.8 Land size for vegetable production

Majority of the respondents as presented in Figure 4.2 show that 65.38% have land sizes of between 1-2ha, followed by 17.31% who have > 5ha. Those who have 0.5-1ha are 15.38%.

Pie chart for LANDSIZE

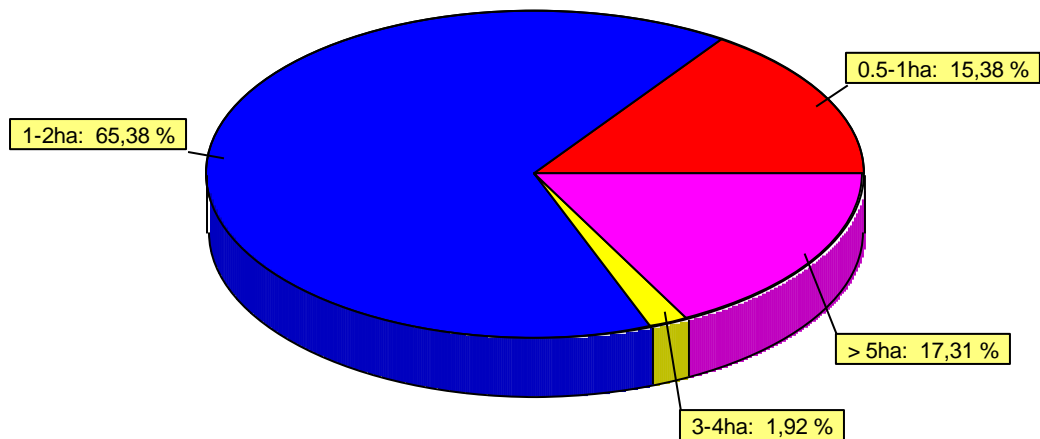


Figure 4.2 Land size for vegetable production

Akamin *et al.* (2017) stated that as Cameroon's farm sizes grow, farmers become less technically effective in vegetable production. This is because managing larger farms is more challenging than managing smaller farms. In a similar vein, Akamin *et al.* (*ibid*) argue that most low-income farmers struggle with a lack of technical know-how and insufficient capital. The vastness of the land cannot possibly accommodate these resources. Studies conducted by Herera *et al.* (2021) found that small land size was the cause of food insecurity in the rural communities of Northeast Madagascar. In simple terms, Herera *et al.* (*ibid*) is of the opinion that food insecurity decreases with increasing land size, and that farmers with large farms have lower probability of food insecurity.

4.3.1.9 Experience in vegetable farming

The results of the study show that the respondents have various farming experiences in years as presented in Table 4.7. Majority of the respondents (50.00%) have more than 16 years of experience in vegetable farming, while 11.54% of the respondents had less than 5 years of vegetable farming experience. Those with 5-10 years; and 11-15 years of experience are 17.31% each.

Table 4.7 Experience in vegetable farming

Experience	No of respondents	%
<5 Years	6	11.54
5-10 Years	9	17.31
11-15 Years	9	17.31
>16 Years	26	50.00
Other	2	3.85
Total	52	100

Chawda (1978) stated that experience is more valuable than education. Chawda (*ibid*) further indicated that when experience and knowledge are combined, it gives momentum for agriculture progress and to achieve the desired objectives. Guo *et al.* (2015) provide support for this assertion and argued that young farmers who intend to give up farming had a lower agricultural output in China than elderly farmers who did not intend to abandon farming. This is because younger farmers are more likely to work in non-agricultural industries and older farmers have more production experience. Gyampoh *et al.* (2009) add that farming issues in Ghana's rural areas have been largely solved by utilising traditional knowledge and practices that have been learned through experience and oral transmission. Seleti and Tlhompho (2014) discovered that when developing agricultural technology for South Africa's rural areas, it is beneficial to combine scientific knowledge with community or Indigenous knowledge systems (IKS) from women.

4.3.1.10 Number of dependents

The results of the study as presented in Table 4.8 show that 48.08% of the respondents have 5-6 dependents, while 23.08% have 3-4 dependents, followed by 17.31% who have 7-8 dependents, while 5.77% of the respondents had 1-2 dependents. Larger families can be at an advantage because members of the families can provide labour for production of vegetables, but, at the same time it becomes a burden if the family is not well resourced because more food is required as well as the need to cater for schools, health, and other needs.

Table 4.8 Number of dependents

Number	No of respondents	%
1-2	3	5.77
3-4	12	23.08
5-6	25	48.08
7-8	9	17.31
>9	3	5.77
Total	52	100

Olayemi (2012) claims that the more dependents a household has in Osun State, Nigeria, the more likely it is that they provide manual labour for family farms. Olayemi (*ibid*) went on to say that larger families tend to be more likely to live in poverty and have a negative impact on food security. Herera *et al.* (2021) provide support for this assertion by reiterating that the prevalence of food insecurity in rural Madagascar increases with household size. To put it another way, when families are large, both the nutritional status of each member of the household and the quantity of food consumed will be affected. According to Xaba and Masuka (2013), since the farmer must meet the needs of the household before selling, a larger household would discourage the sale of vegetables. Haq *et al.* (2010) contend that a large family size indicates a decline in the immediate environment and land for excessive resource access. It is generally accepted that a large human population is accompanied by a depletion of natural resources and a decrease in the capacity of ecosystems to support life.

In this study it can be commented that, the implication of less female farmers to male farmers is that decision making may tend to favour males than females.

Farming in the study area is performed by the older sector of the community and limited young farmers' participation is anticipated to have an adverse effect on succession rates and jeopardise the sustainability of vegetable production in the study area.

Experience and high education levels are positive factors in the study area which in turn boosts vegetable production and sustainability.

Size of land for vegetable production which ranges from less than 1 to 2 hectares will probably enhance the sustainability of vegetable production, since farmers will manage smaller areas of land with ease.

4.3.2 Water resource management

This section presents the results on how the respondents use water for irrigation purposes, and how it impacts on the sustainability of vegetable production. It describes among others the types of irrigation system used, source of water, method of drawing water from the river and the adaptation to water shortages.

4.3.2.1 Water shortage adaptation systems

The results of the study as presented in Table 4.9 reveal that 50.00% of the respondents use drought tolerant vegetables which can withstand the harshest type of weather condition in the study area, only 19.23% of the respondents use drip irrigation system which allows them to irrigate a targeted area and leave other portions which they do not want to irrigate. About 13.46% only use conservation tillage system which reduces soil degradation, and they till only where they want to use. Other respondents (17.31%) use various methods as means to conserve the land, they indicated that seeds naturally germinate on their own without interventions by humans, but humans manipulate the soil to maximise profits.

Table 4.9 Water shortage adaptation systems

System	No of respondents	%
Drought tolerant vegetable	26	50.00
Drip irrigation	10	19.23
Conservation tillage	7	13.46
Other	9	17.31
Total	52	100

According to Ali (2009), crops with a short life cycle, early vigour, a deep root system, thick cuticle, and a high harvest index are chosen for their drought tolerance. The study by Musa *et al.* (2014) showed that drip irrigation in a plastic tunnel in Pakistan increased water use efficiency by 250% for cucumber and 274% for tomato when compared to furrow irrigation. Tagar *et al.* (2012) provide support for this finding by reaffirming that the drip irrigation system in Umarkot could conserve 56.4 percent of water and produce 22% more yield than the furrow irrigation method.

4.3.2.2 Types of irrigation systems

The study revealed that the majority of respondents (71.15%) use furrow irrigation on their vegetable plots as it is better compared to those using drip irrigation (25.00%) in terms of the initial cost of the infrastructure, only 3.85% use overhead irrigation system as presented in Table 4.10.

Table 4.10 Types of irrigation systems

System	No of respondents	%	Cum.%
Drip	13	25.00	25.00
Furrow	37	71.15	96.15
Overhead	2	3.85	100.00
Total	52	100.00	

The study by Yonts *et al.* (2007) shows that furrow irrigation works well for a wide range of soils and many crops, particularly row crops and those that are susceptible to damage if water covers their stems or crowns. According to Rogers (1995), a well-managed furrow irrigation system can increase crop yields while reducing water application, initial equipment investment, and irrigation pumping costs per unit acre of water pumped, chemical leaching, and other costs. Nevertheless, Muhammad *et al.* (2010) indicate that furrow irrigation uses 27-31% more water than drip, sprinkler, mobile nozzle, and subsurface irrigation, making it less water efficient.

4.3.2.3 Main water sources

The results of the study presented in Table 4.11 show that 65.38% of the respondents have the river as the main source of water; the 15.38% get water from the borehole, and the same number 15.38% get water from the dam; only 1.92% get water from the spring and well individually. It looks like water is not an issue, and what people normally blame is for low production potential of farms, management, and skills. Water from the river will contain several nutrient elements depending on the types of fertilisers, application rates and runoff from cultivated fields.

Table 4.11 Main water sources

Source	No of respondents	%
River	34	65.38
Springs	1	1.92
Borehole	8	15.38
Well	1	1.92
Dam	8	15.38
Total	52	100

Elwan *et al.* (2014) claim that river-water with high nutrient loads of nitrogen (N) and phosphorus (P) can degrade water quality by causing excessive biological growth, altering dissolved oxygen levels, raising pH levels, and reducing biodiversity. According to studies on the quality of the water that were carried out by Alemu and Desta (2017), the Ethiopian river Kulfo has the highest concentrations of calcium cations, followed by sodium, magnesium, and potassium.

Cation exchange capacity of the soil increased with increasing calcium silicate application rates, as stated by Uchida (1973). In a similar vein, Uchida (*ibid*) discovered that an increase in calcium silicate in the soil resulted in increased potassium retention and decreased cation leaching. Pond *et al.* (2007) demonstrated that, in comparison to other sources in England, irrigation water from the river is more susceptible to contamination from treated effluent, livestock manure from surface runoff, and raw sewage. Pond *et al.* (*ibid*) added that ready-to-eat (RTE) vegetables face risks from river waters because pathogen contamination has been shown to be reduced through cooking, peeling, and other processing methods. However, according to Aijuka (2013), ready-to-eat (RTE) vegetables like lettuce should be protected from wildlife, animal waste, runoff, human activity, and sewage or industrial effluent as potential sources of contamination.

4.3.2.4 Methods of drawing water

The results of the study presented in Table 4.12 show that 57.69% draw water from the river to vegetable fields using gravitation and canals, while 23.08% use gravitation and pipes. This is the least costly exercise as only gravitational pressure is pulling water into the field using those two methods mentioned above. Power pumps are used by 17.31% respondents. Power needs electricity or fuel to drive water into the

field which is a much costly exercise. Only 1.92% used other methods to irrigate the farm.

Table 4.12 Methods of drawing water

Method	No of respondents	%
Gravitation and pipes	12	23.08
Gravitation and canals	30	57.69
Power pumps and pipes	9	17.31
Other	1	1.92
Total	52	100

The research conducted by Osma *et al.* (2016) revealed that in the El-Mahmodia region of Egypt, the conveyance and distribution efficiencies achieved by the pipe distribution network (PDN) were superior to those achieved by the canal distribution network (CDN). Satpute *et al.* (2004) provide evidence to support the efficiency finding by discovering that canal distribution networks and pipe distribution networks had overall project efficiencies (OPEs) of 41% and 77%, respectively, in the Amravati District of Maharashtra. Chandewar *et al.* (2018) thought that lower overall project efficiencies of the canal network were linked to higher evaporation losses, higher costs for maintenance, and the possibility of illegal outlets. In contrast, Kulavmode and Valunjkar (2017) believed that the pipe network's overall project efficiency was related to its durability, its capacity to save water, its ability to replace canals, its reduced number of illegal outlets, and its adaptability to work in a new scheme or convert existing canals.

4.3.2.5 Frequency of water availability

The results of the study presented in Table 4.13 show that 34.62% of the respondents get water for irrigation on daily basis, 50.00% get water on weekly basis, while 11.54% get water on monthly basis. Only 3.85% get water at irregular intervals. The availability of water will also determine the intervals of irrigation and water use efficiency.

Table 4.13 Frequency of water availability

Frequency	No of respondents	%
Daily	18	34.62
Weekly	26	50.00
Monthly	6	11.54
Other	2	3.85
Total	52	100

The findings of the study by Nkgapele *et al.* (2011) demonstrated that at the Syferkuil Experimental Farm (SEF) in Limpopo, irrigation intervals of three to four days yield the highest cucumber yields. This suggests that the quantity and quality of vegetables could be improved with the right amount and frequency of irrigation. In contrast, Ishmail *et al.* (2007) found that at Ishigaki Island in Japan, the highest yield achieved with a 1-day irrigation frequency was 10% higher than that achieved with a 3-day irrigation frequency. Kori and Umesh (2020) found that canal head reach regimes had higher crop yields than tail-end regimes in another study.

The use farrow irrigation by most farmers in the study area may seem to be beneficial, but it is noted that the method is water-use inefficient, and the quality of water from the river may be questionable because water could be exposed to various hazards that may degrade cropping lands, such as effluent from factories, sewage runoff, and rooftop runoff. Water is becoming a scares commodity such that furrow irrigation is becoming a challenge to water saving techniques.

4.3.3 Human resource utilisation

This section presents the results on how the respondents interact with farm workers. It describes among others the type of workers employed, issues of workers residence, female workers, youth and how they impact on the sustainability of vegetable production.

4.3.3.1 Class of workers employed.

The results of the study presented in Table 4.14 show that 48.08% of the farmers employed workers on the vegetable farms, and are a mixture of youth, male and females, 26.92% are females while 19.23% are males; only 5.77% indicated that they do not employ. The number of workers employed vary with seasons.

Table 4.14 Class of workers employed.

Class	No of respondents	%	Cum. %
Males	10	19.23	19.23
Females	14	26.92	46.15
Mix	25	48.08	94.23
None	3	5.77	100.00
Total	52	100.00	

The study conducted by Olakojo (2016) found that during harvest, farmers are more likely to employ female labourers and pay them higher wages during harvest in Nigeria. Similarly, farmers are significantly less likely to employ male labourers and pay them lesser wages. According to Swamikannan and Jeyalakshmi (2015) agricultural sector is the largest employer of women in rural India and 73% of the female work force toils in the agricultural sector. In another study, Balakrishnan and Anilkumar (undated) found that women may participate in every aspect of agricultural labour, however they are unable to access certain benefits alone without the assistance of their male counterparts.

4.3.3.2 Type of workers employed.

The results of the study presented in Table 4.15 show that 59.62% of the farmers employed workers on seasonal basis; 19.23% employed permanent workers. Those who get labour from family members (7.69%) and own labour (7.69%).

Table 4.15 Type of workers employed.

Type	No of respondents	%	Cum.%
Seasonal	31	59.62	59.62
Permanent	10	19.23	78.85
Family members	4	7.69	86.54
Self-labour	4	7.69	94.23
None	3	5.77	100.00
Total	52	100.00	

The study by Anwar *et al.* (2011) showed that employees' performance is strongly correlated with job security and rewards, but not with job uncertainty. Simply put, permanent employees will perform better than seasonal or temporary workers who are unable to take advantage of such benefits. Unsal-Akbiyik *et al.* (2012) provide evidence to back up this finding by emphasising once more that seasonal farm

workers are less emotionally invested in their jobs than permanent workers. This is because seasonal workers have a perception of job insecurity that is higher than that of permanent workers. Devereux and Tavener-Smith (2019) state that seasonal farm workers in the Northern Cape are more likely to experience food insecurity and its severity during low-employment winter months than during high-employment summer months. Simply put, seasonal farm workers are more likely than permanent farm workers to experience food insecurity.

4.3.3.3 Employment for women

As presented in Table 4.16 most of the respondents (48.08%) use a combination of male and female, and youth because they all possess different skills in terms of contributions on the vegetable farms, 19.23% of the respondents prefer males and 26.92% hire females, while those who do not are 5.77% only. The number of jobs created for women is not in line with the government policy of empowering more women in many spheres of community structures.

Table 4.16 Employment for women

Jobs	No of respondents	%
Male	10	19.23
Female	14	26.92
Combination of both	25	48.08
None	3	5.77
Total	52	100

Verick (2014) asserts that India's development is driven by and influenced by the availability of female labour. In response to higher labour inputs, economies may expand more quickly as more women enter the workforce. Elborgh-Woyteck *et al.* (2013) added that increasing female labour force participation would increase GDP by 5 percent in the United States, 9 percent in Japan, 12 percent in the United Arab Emirates, and 34 percent in Egypt. USAID (2011) observed that expanding women's opportunities can have a significant impact on the lives of their families. The benefits spread across families and generations when women's incomes rise. Women spend a greater proportion of their income on their children's health and nutrition, laying the groundwork for their children's cognitive and physical development throughout their lives.

4.3.3.4 Employment for youth

The results of the study presented in Table 4.17 show that 13.46% of the youth benefit in terms of jobs created as a result of the existence of the vegetable plots, and a combination of adult and youth is at 50.00% of jobs created; only 11.54% farmers did not hire anyone, and this could be due to affordability, or their farms are not big to require staff recruitment, 21.15% of adults are hired.

Table 4.17 Employment for youth

Jobs	No of respondents	%
Adults	11	21.15
Youth	7	13.46
Combination of both	26	50.00
None	6	11.54
Other	2	3.85
Total	52	100

According to Abdullah and Sulaiman (2013), there is a widespread perception in Malaysia that the agricultural sector is a hard job with low pay, that it does not guarantee a bright future for those with a tertiary education, and that it encourages young people to look for glamorous jobs in the city. Nonetheless, Nyoni (2012) contends that youngsters in Zimbabwe's country regions have consistently depended on agriculture. Additionally, farming has provided young people with unique opportunities and challenges ever since the country's land reform program.

4.3.3.5 Issues of workers' residence

The results presented in Table 4.18 show that most workers (84.62%) do not reside at workplace they travel daily to and from work while, 5.77% stay on farmer's residence and 7.69% hire from nearby homestead. The worker's residents determine commitment towards work, so that they do not knock off early on grounds of long-distance travel and not tire themselves on their way to work.

Table 4.18 Issues of workers' residence

Issue	No of respondents	%
Travel daily	44	84.62
On farm residence	3	3.77
Hiring nearby	4	7.69
Other	1	1.92
Total	52	100

According to the study of Van Ommeren and Gutierrez-i-Puigarnau (2009), workers in the Netherlands who commute 40 kilometres, or more are 12 percent more likely to miss work than those who commute 10 kilometres or less. This indicates that workers' productivity suffers when they must travel a long distance to work. Cerqueira and Loureiro (2019) discovered that absenteeism rises in tandem with commute time and distance. Cerqueira and Loureiro (*ibid*) assert that, when the road conditions improve, absenteeism decreases. In other words, effective commitment is negatively impacted by poor route conditions, while intrinsic motivation is positively impacted by favourable route conditions. As a result, employees who travel frequently face numerous challenges.

According to the study's findings, the use of a combination of male and female workers, adults, and youth may result in a more sustainable system by ensuring complementarity in task performance and tapping on the energy of the youth.

4.3.4 Fertiliser management systems

This section presents the results on how the respondents utilise fertilisers and their impact on sustainability. The scope of results covers among others soil sampling, type of fertilisers, method of fertiliser application, quantity of fertilisers and the frequency of application.

4.3.4.1 Soil sampling

The results of the study in Table 4.19 reveal that the majority of respondents 63.46% do not take soil sample to determine the fertility or degradability of the soil, while 36.54% take the soil samples. In the absence of taking soil samples the production potential may gradually decline because this may lead to the incorrect application of fertilisers.

Table 4.19 Soil sampling

Response	No of respondents	%
Yes	19	36.54
No	33	63.46
Total	52	100.00

Chandini *et al.* (2019) claim that soil analysis and testing are carried out to guarantee that fertilisers are applied in accordance with the results. According to Chandini *et al.* (*ibid*) farmers will be able to apply fertilisers at a cost-effective rate, from the appropriate source, rate, location, and time, to reduce a variety of hazards that affect crops and the environment.

4.3.4.2 Frequency of soil sampling

The results of the study in Table 4.20 show that 67.31% of respondents are not sure when did they last took soil samples on their vegetable farms, followed by 15.38% who indicated soil samples were taken long ago, 9.62% indicated that samples are taken every two years, 1.92% only took samples annually, and 5.77% seasonally. The findings tell that soil samples are not collected frequently enough to detect changes in their vegetable fields, and this could affect crop yields or fertiliser requirements.

Table 4.20 Frequency of soil sampling

Frequency	No of respondents	%
Seasonal	3	5.77
Annual	1	1.92
Every 2 years	5	9.62
Other/long ago	8	15.38
Not sure	35	67.31
Total	52	100.00

Soil sampling is supposed to take place between crops, according to Hartz (2007). Reid (2016) claims that most farms should conduct soil sampling once every three years, which typically corresponds to once in the rotation. Ruhl (2020) supports this viewpoint by reiterating that soil sampling for nutrient analysis should occur every one to three years, or when crop rotation occurs.

4.3.4.3 Type of fertilisers used.

The results of the study in Table 4.21 show that 65.38% of the respondents used both organic and inorganic fertilisers on vegetables, and the rest of the farmers 34.62% used inorganic fertilisers.

Table 4.21 Type of fertilisers used.

Type	No of respondents	%
Inorganic fertilisers	18	34.62
Both	34	65.38
Total	52	100.00

Kashino (1990) stated that the use of inorganic fertilisers, which are found to be doubling or tripling crop yields in Japan in the short term, is heavily reliant on modern agriculture's high yields. The breakdown of organic fertilisers (plant residues and animal waste) to release nutrients for plants takes time. Organic fertilisers have a low nutrient content in comparison to the volume of materials that must be spread across the field and transformed to compensate for deficiencies. This assertion is backed up by Samarayanake and Ulpathakumbura (2021), who argued that using organic fertilisers exclusively results in lower yields, varying composition, bulkiness, and high handling costs. Farouque and Takeya (2007), on the other hand, stated that integrated soil fertility (ISF) and nutrient management (NM) is a crucial requirement for increasing crop production in Bangladesh and maintaining higher yields over time. The experiment that Samarayanake and Ulpathakumbura (2021) carried out revealed that the addition of both organic and inorganic nitrogen to cucumbers increased plant growth, yield, and quality in Sri Lanka, as well as soil fertility. According to the research that was carried out in the Pakdasht regions of Iran and was carried out by Massah and Azadegan (2016), the excessive application of chemical fertilisers for mono-cropping results in compaction because of the accumulation of mineral salts, a reduction in the size and number of soil macro-pores, and an increase in bulk density and penetration resistance.

Pahalvi *et al.* (2021) discovered that heavy metals like copper and arsenic can build up in the soil system from chemical fertilisers. Wazir *et al.* (2018) on the other side demonstrated that various household organic fertilisers improved potato and pea crop growth and yield in Pakistan. Kalbani *et al.* (2016) provide support for this idea.

stating once more that organic fertilisers made from agro-fish pellet and chicken manure had a significant impact on the quantity and quality of tomato fruits in the United Arab Emirates. Islam *et al.* (2012) found that in Bangladesh, cow dung would produce the most leaves, root length, and yield per hectare of lettuce. The research done by Garko *et al.* (2021) noted that the application of 9 tons per hectare of poultry manure to sweet corn in Nigeria resulted in significantly higher growth indices.

4.3.4.4 Quantity of fertilisers used.

The results in Table 4.22 show that 40.38% the respondents used 20-50kg/ha of fertilisers to boost the growth rate and production potential of vegetable crops they are cultivating, and 21.15% used 10-15kg/ha of fertilisers, 19.23% used 100-150kg/ha, while only 1.92% used 151-200kg/ha of fertilisers; 11.54% did not use fertilisers at all, while 5.77% used undisclosed measurements to boost the growth rate and production potential of their crops(e.g. crop rotation, inter-cropping, and cover crops).

Pahalvi *et al.* (2021) claim that the Netherlands use 665.6 kg/ha of fertiliser, followed by Egypt with 624.8 kg/ha and Turkey with 100.4 kg/ha.

Table 4.22 Quantity of fertilisers used

Quantity /ha	No of respondents	%
10-15kg/ha	11	21.15
20-50kg/ha	21	40.38
100-150kg	10	19.23
151-200kg	1	1.92
Other	3	5.77
None	6	11.54
Total	52	100.00

According to research carried out by Xaba and Masuka (2013), an increase in the amount of fertiliser applied results in an increase in the yield of onion and tomatoes per hectare of 0.634 kg and 0.477 kg, respectively. Savci (2012), however contends that chemical fertilisers will pollute the environment through salinity in the soil, heavy metal accumulation, nitrate accumulation, water eutrophication, and the greenhouse effect because of polluted air caused by nitrogen and sulphur.

4.3.4.5 Methods for applying fertilisers

The results in Table 4.23 show that 57.69% of the respondents used band placement as an application method for both organic and inorganic fertilisers on vegetables. Those who broadcasted their fertilisers are 28.85% while 13.46% used fertigation.

Table 4.23 Methods for applying fertilisers

Method	No of respondents	%	Cum.%
Broadcast	15	28.85	28.85
Band placing	30	57.69	86.54
Fertigation	7	13.46	100.00
Total	52	100.00	

The best results would be achieved by banding both N and P below the seed, according to Mahler (2001). Relf *et al.* (2021), reiterate that concentrating phosphorus in the band would provide plants with what they require, despite the fact that the soil would fix much of it. Parish *et al.* (2015) say that spreading fertilisers after bedding can make them work less because the fertiliser falls into the middle of the beds instead of the sides of the beds. Relf *et al.* (2021) discovered that broadcasting would increase phosphorus fixation in Virginia in areas where fertilisers are incorporated into the soil. In contrast, Parish *et al.* (2015) argued that when broadcast fertiliser is applied prior to bedding, the subsequent bedding operation concentrates the broadcast fertiliser in the bed profile's crop area, producing comparable results. Research by Mahler (2001) demonstrates that, only under ideal conditions in the Idaho State of Moscow, N and P broadcast applications produce yields comparable to banded applications. Bly *et al.* (2019) in another version concluded that the potential for sweet corn yield in South Dakota increased the benefits of banding P. Banding and broadcasting P yielded the same at yields less than 2.5 t/ha, but at 5 t/ha, banding P had a 188 kg/ha yield advantage over broadcasting P.

It can be concluded that lack of collection of soil samples to assess the soil's fertility may lead to lack of understanding of the soil, which may result in a less sustainable vegetable production, and the degradation of the environment through soil acidification, soil salinization, and contamination of groundwater from the constant use of chemical fertilisers.

4.3.5 Pest and disease management systems

This section presents the results on how the respondents manage and control pests and diseases on vegetables. The scope of the work covers methods of control, and quantity of chemicals used, and their impact on sustainability.

4.3.5.1 Pest and disease control methods

One hundred percent of the respondents use chemicals to control pests and diseases on vegetable crops. They regard chemicals as their most effective way to control pest and diseases and taking note of the withdrawal periods. When chemical pesticides are used to grow vegetables (potato, tomato, bitter gourd, and chilly) in Nepal, studies by Jha (2009) showed that these crops made more money than other crops. Mahmood *et al.* (2016) and Pandya (2018) provide evidence to back up this finding when they argue that, by controlling serious pests, chemical pesticides improve crop productivity and encourage faster plant growth, thereby benefiting the economy and meeting demand. Contrary to this, Mahmood *et al.* (*ibid*) further argue that chemical pesticides may also have a negative impact on the environment because they may result in the loss of biodiversity. In a similar vein, Roychowdhury *et al.* (2014) believed that chemical pesticides were the main factor in land degradation, soil fertility loss, and genetic changes in plant populations, food poisoning, and other health issues that eventually led to cancer. Glover-Amengor *et al.* (1998) provide evidence to back up this argument, emphasising once more that food crops and water may be contaminated with chemical pesticides, which could harm human health.

4.3.5.2 Quantity of chemicals used for pest control

The results presented in Table 4.24 show that 63.46% of the respondents used chemicals on vegetables as per recommendation, 23.08% used 1-2 litres per hectare depending on the type of crops they have cultivated; 3.85% of the used 3-4 litres in a hectare while 9.62% do not know the measurements or the quantities they used because of poor record keeping.

Table 4.24 Quantity of chemicals used for pest control

Quantity /ha	No of respondents	%	Cum. %
1-2 L per ha	12	23.08	23.08
3-4 L per ha	2	3.85	26.92
Don't know	5	9.62	36.54
As recommended	33	63.46	100.00
Total	52	100.00	

According to Jha (2009), Cole crops should use 0.68 kg of pesticides per hectare for optimal results. Kaur *et al.* (2018) claim that pesticides use in Punjab has resulted in numerous environmental issues, including pesticide poisoning, insecticide resistance, a resurgence of pests, and effects on non-target organisms.

In the study area it is noted that all the farmers applied chemicals to control pests and diseases on vegetables. There is evidence that using pesticides to manage plant diseases and pests increases crop output. However, injudicious use of chemicals may result in a less sustainable production system. As it is bad for both the environment and people, excessive chemical use may result in a less sustainable production system. It is recommended that farmers should be trained on how to use chemicals to safeguard the environment and themselves. The promotion of IPM and organic farming as more sustainable practices is also crucial.

4.3.6 Soil resource management systems

This part of the work presents the results on how vegetable farmers manage soil in their vegetable plots. The scope of the work covers methods of cultivation, frequency of cultivation, control of soil erosion and their impacts on sustainability.

4.3.6.1 Tillage systems used

The results of the study in Table 4.25 show that 84.62% of the respondents use conventional tillage system to cultivate vegetables; 9.62% use minimum tillage while 5.77% use a no-till method. Conventional tillage system has both benefits and disadvantages. The benefits of using conventional tillage method include easy incorporation of fertiliser, less management, and the elimination of soil compaction.

Table 4.25 Tillage systems used

System	No of respondents	%	Cum. %
Conventional	44	84.62	84.62
No-till	3	5.77	90.38
Minimum tillage	5	9.62	100.00
Total	52	100.00	

The findings of Mitchell *et al.* (2009) are that conventional tillage is advantageous when used primarily to level, smooth, and furrow the land in preparation for surface gravity irrigation. Conventional is also important for getting rid of weeds and pests, adding, or releasing nutrients, making the soil texture suitable for seed sowing, seed germination, and allowing seedling roots to easily penetrate it. Mitchell *et al.* (*ibid*), however found that the practice is costly due to the increased need for labour and machinery, as well as the increased likelihood of soil erosion if poorly managed. Gathala *et al.* (2012) provide support for these findings, by stating that conventional tillage incurs high costs and generally generates low net profits due to the extensive use of tractor power, high consumption of fuel, water, and elevated emissions of greenhouse gases. Lange and Moriya (2004) claim that conventional tillage, which involves disturbing the soil, results in the destruction of the structure of the soil, increased compaction, a high rate of mineralisation of organic matter in the soil, decreased soil fertility, soil loss, and desertification.

4.3.6.2 Practices to combat soil erosion

The results of the study in Table 4.26, show that majority of the respondents 71.15% use contour planting as their means to fight against the effect of soil erosion on vegetable plots. Those who use “cover crops” and “mulching” the same number of responses are 9.62% each in terms of the practices of combatting soil erosion on the plots. Only 3.85% of the respondents use a no-till method while 5.77% used other methods.

Table 4.26 Practices to combat soil erosion

Method	No of respondents	%	Cum. %
No-till	2	3.85	3.85
Contour planting	37	71.15	75.00
Cover crops	5	9.62	84.62
Mulching	5	9.62	94.23
Other	3	5.77	100.00
Total	52	100.00	

When compared to farming up or down hills, the USDA (2013) claims that contour farming can reduce soil erosion by as much as fifty percent. Moyo (2013) adds that dead level contours have been shown to reduce fertiliser loss, power and time consumption, machine wear, labour costs, ease harvesting, and enhance the farm's appearance. According to the research by Sasola *et al.* (undated), contours can maintain valuable topsoil on sloping fields, improve water quality by regulating sedimentation, and speed up water infiltration and retention. In contrast, Zhang *et al.* (2000) discovered that the China's Mt Gongga region had an average erosion rate of 4900t/km²/a of soil on cultivated steep slopes without contours.

4.3.6.3 Frequency of land cultivation

The results of the study presented in Table 4.27 show that 88.46% of the respondents cultivate their land on seasonal bases depending on the time the vegetable crop allows for maximum production, 5.77% cultivate on annual basis, normally used by farmers who depend on the rain for irrigation. The “No till” farmers are 3.85% and only 1.92% are other.

Table 4.27 Frequency of land cultivation

Frequency	No of respondents	%	Cum. %
Annually	3	5.77	5.77
Seasonal	46	88.46	94.23
No-tillage	2	3.85	98.08
Other	1	1.92	100.00
Total	52	100.00	

The study findings by Ampadu *et al.* (2017) show that soil under continuous cultivation is typically compacted, especially in the subsoil, in comparison to the soil along the White-Volta River in Ghana that has been left uncultivated. According to Ernest and

Mbah (2015), continuously cultivated plots in Imo State, Nigeria, deplete organic matter faster than fallow plots. Chilcott *et al.* (2007) support this finding, when repeating that constant development and editing of soils bring about a decrease in soil natural carbon and soil nitrogen and can prompt diminished crop yields.

Conventional tillage system is widely used in the study area. It has also been noted that the conventional tillage system makes use of tractor power which disturbs the soil, and the resulting effects may include the destruction of soil structure, increased soil compaction, formation of plough pan and increased mineralisation of organic matter.

The study's findings also revealed that most farmers used contour planting to prevent soil erosion. Contour planting is one of the conservation farming approaches that could lead to a more sustainable production system. It is recommended that farmers should receive training on conservation farming.

4.3.7 Weed control management system

This section presents the results on how the respondents manage and control weeds on their vegetable plots. The scope of the work covers among others method of weed control, frequencies of weed control and how the methods impact on sustainability.

4.3.7.1 Methods of weed control

The respondents agree that weed challenges are a major concern to most vegetable farmers. The results in Table 4.28 show that 73.08% use manual method to control weeds on vegetable farms, while 19.23% use chemical means, and only 5.77% use cultural method of weed control, while 1.92% use biological method.

Table 4.28 Methods of weed control

Method	No of respondents	%	Cum. %
Cultural method	3	5.77	5.77
Chemical	10	19.23	25.00
Biological	1	1.92	26.92
Manual	38	73.08	100.00
Total	52	100.00	

According to DAF (undated), manual weed control is more effective because it involves manually pulling the weed out of the soil, including its roots. A hand hoe, on

the other hand, can cut or dig out the weed's stem below the surface to expose its root system.

4.3.7.2 Frequency of weed control

The results of the study in Table 4.29 show that 63.46% of the respondents do weed control regularly when weed becomes noticeable amongst the vegetables, 21.15% do it twice per season using either of the methods mentioned, while 5.77% do it once per season, and some do it sometimes (5.77%). Only 3.85% do it at other times.

Table 4.29 Frequency of weed control

Frequency	No of respondents	%	Cum. %
Once per season	3	5.77	5.77
Twice per season	11	21.15	26.92
Regularly	33	63.46	90.38
Sometimes	3	5.77	96.16
Other	2	3.85	100.00
Total	52	100.00	

Degri *et al.* (2017) claim that in Gombe State, Nigeria, a three-weeding after sowing (WAS) was found to be more effective at controlling weeds, flea beetles, fruit damage, and increasing okra fruit yield. Mensa *et al.* (2020) in another version discovered that weeding three to five times as frequently at intervals of ten days was more convenient and economically feasible for weed control in an onion field at Arba Minch in southern Ethiopia under irrigation conditions. El Naim *et al.* (2010) in a different study found that in the Sudanese state of Kordofan, weeding three times at 2, 4, and 6 weeks after sowing is best for roselle plant height, leaf area index, number of branches, and yield per unit area. Mekonnen *et al.* (2017) found that at Sirinka in Northern Ethiopia, two hand weeding and hoeing at 2 and 5 weeks after emergence (WAE) of cowpea crop produced the lowest total weed dry weight and the highest weed control efficacy.

Weed control is mainly manual. The use of hands or hand hoes is required for manual weed management. The utilisation of human labour and readily accessible tools as opposed to the use of herbicides, is seen as making the process more environmentally friendly.

4.3.8 Financial management systems

This section presents the results on how the respondents manage their finances. The work covers among others income generated from sales of vegetables, overall expenditure, income generated by women and youth, records kept by the respondents, quantity of vegetables used for home consumption, and impacts on sustainability.

4.3.8.1 Income generated from sale of vegetables

The results of the study presented in Table 4.30 revealed that 50.00% of the respondents managed to generate income between R1000-R5000 per season for the sales of the vegetables; 21.15% earned R6000-R10000 from vegetables, 13.46% earned R11000-R20000 and 15.38% earned more than R21000.

Table 4.30 Income generated from sale of vegetables

Income	No of respondents	%	Cum. %
R1000-R5000	26	50.00	50.00
R6000-R10000	11	21.15	71.15
R11000-R20000	7	13.46	84.62
> R21000	8	15.38	100.00
Total	52	100.00	

Farming, above old age pension, wages, remittances, family business, and other non-farm income, is the primary source of household income in rural South Africa, according to Machethe (2004). Ibrahim *et al.* (2013) added that farmer income is a major factor in the adoption of agricultural innovations. Because any fixed investment requires capital, the farmer's income will drive the adoption of new farming practices.

4.3.8.2 Income generated by women

The results of the study presented in Table 4.31 show that 21.15% of females were able to generate between R1000-R5000 per vegetable production season, 11.15% were able to generate an income of between R6000-R10000, 3.85% each generated R11000-R20000 and >R21000, respectively.

Table 4.31 Income generated by women

Income	Male	%	Female	%	Total
R1000-R5000	15	28.85	11	21.15	26
R6000-R10000	5	9.62	6	11.50	11
R11000-R20000	5	9.62	2	3.85	7
>R21000	6	11.50	2	3.85	8
Total	31	59.62	21	40.38	52

According to Negash (2006), as more women receive benefits from the projects, money is more likely to be reinvested in the family and to be used to educate daughters. Wikipedia (2010) added that microenterprise support services in the Dominican Republic targeted more women in 1992 due to women's tendency to devote more of their income to their households than men do.

4.3.8.3 Income generated by youth

The results of the study presented in Table 4.32 show that only 7.69% of youth between the age bracket of <18 and 31-35 years old benefited R6000-R21000 and more per season. There is a lot that still need to be done to woe young individuals to participate more on farming. The government, NGO, private sector needs to play a central role on motivating the youth.

Table 4.32 Income generated by youth

Age (Years)	Income								Total	%
	R1000- R5000	%	R6000- R10000	%	R11000- R20000	%	> R21000	%		
<18	1	1.92	0	0.00	0	0.00	0	0.00	1	1.92
26-30	1	1.92	0	0.00	0	0.00	0	0.00	1	1.92
31-35	2	3.85	1	1.92	1	1.92	2	3.85	6	11.54
36-40	1	1.92	0	0.00	0	0.00	2	3.85	3	5.77
41-44	1	1.92	1	1.92	0	0.00	1	1.92	3	5.77
45-60	4	7.69	2	3.85	1	1.92	1	1.92	8	15.38
>61	16	30.77	7	13.46	5	9.62	2	3.85	30	57.69
Total	26	50.00	11	21.15	7	13.46	8	15.88	52	100.00

Nyoni (2012) asserts that youth will be drawn to agriculture if supportive policies geared toward them create an environment that encourages them to enter the

industry. According to Ngongi (2012), to appeal to young people, agriculture needs to be rebranded by investing in education, developing market infrastructure, and enhancing the business environment in ways that will increase incomes and expand the agricultural value chain.

4.3.8.4 Use of income received from vegetables

Majority of farmers according to the results presented in Table 4.33 shows that 46.15% use most of their income from vegetables on inputs (fertilisers and pesticides); 30.77% on labour costs and 19.23% on machinery while 3.85% spent their income on things other than those already mentioned.

Table 4.33 Use of income received from vegetables

Income	No of respondents	%	Cum. %
Labour	16	30.77	30.77
Consumables(Fert/seeds/pesticides)	24	46.15	76.92
Machinery	10	19.23	96.15
Other	2	3.85	100.00
Total	52	100.00	

Osuji *et al.* (2014) in the study, demonstrated that mechanisation and the use of farm inputs like fertilisers, herbicides, pesticides, and improved seeds contributed to a rapid increase in farmer productivity of 3.98 percent between 1990 and 2001 in the Nigerian state of Imo. Das *et al.* (2010) found that the use of pesticides reduced crop losses and ensured food security, while hybrid seeds contributed to a yield advantage of 15-20% in West Bengal.

4.3.8.5 Overall expenditure on vegetables

The results of the study presented in Table 4.34 show that 36.54% spent less than R5000 on inputs and labour to produce vegetables; 19.23% of the respondents spent nothing; 15.38% spent up to R7000 while 17.31% spent up to R10000; and 7.69% spent up to R15000. Only 3.85% spent other unspecified amounts.

Table 4.34 Overall expenditure on vegetables

Expenditure	No of respondents	%
<R5000	19	36.54
R5000-R7000	8	15.38
R8000-10000	9	17.31
R11000-R15000	4	7.69
Other	2	3.85
None	10	19.23
Total	52	100

According to a study by Kumbhakar and Bokusheva (2009), constraints on farm expenditures could result in an average output loss of 20% in three Russian regions. On the other side, Ali and Abushad (2014) however contend that highly productive farmers would require the appropriate inputs at the appropriate times, in the appropriate quantities, and at reasonable prices.

4.3.8.6 Percentage of vegetables used for home consumption

The results of the study presented in Table 4.35 show that 92.31% of the respondents use up to 0-10% of their vegetables for home consumption, 1.92% use 11-20%; 3.85% use more than 21% and another 1.92% use other unspecified amounts. Feed reserved for home consumption help beats food insecurity amongst households that these farmers represent.

Table 4.35 Percentage of vegetables used for home consumption

Percentage	No of respondents	%	Cum. %
0-10%	48	92.31	92.31
11-20%	1	1.92	94.23
> 21%	2	3.85	98.08
Other	1	1.92	100.00
Total	52	100.00	

Kpodo *et al.* (2015) claim that several non-communicable and chronic diseases, including cardiovascular diseases, hypertension, diabetes, gastrointestinal diseases, and obesity, can be avoided by eating a lot of vegetables. According to Deloitte (2016), the ratio of vegetable consumption, waste rates, and relative shares of sales ought to remain constant if the rate of consumption and production are to be equal. Because the farmer must meet the needs of the household before selling, as asserted

by Xaba and Masuka (2013), a larger household would discourage the sale of vegetables.

4.3.8.7 Records kept by farmers

The results of the study presented in Table 4.36 show that 40.38% do not keep records; about 23.08% keep all records of farming activities on the farm; 17.31% keep financial records, those who keep input records are 11.54% while 3.85% keep records for yield and only 1.92% keep records for planting dates and other aspects each. This means that most of farmers are aware of the important role farm records play in farm management.

Table 4.36 Records kept by farmers

Records	No of respondents	%	Cum. %
Finance	9	17.31	17.31
Inputs records	6	11.54	28.85
Planting dates	1	1.92	30.77
Yields	2	3.85	34.62
All above	12	23.08	57.69
Other	1	1.92	59.62
None	21	40.38	100.00
Total	52	100.00	

Hadebe and Van der Westhuizen (2015) say that farming records are useful for keeping track of and determining which aspects of farming are profitable and which are not. These records can also be used to make decisions about what to do next that will make more money. Observations made by Kabesiime (2011) are that the most significant factor in the successful performance of Uganda's small businesses is the upkeep of accurate accounting records. According to Kabesiime (*ibid*), good accounting records are a requirement for the company to register because they demonstrate compliance with the law and effective administration of value added tax (VAT).

The study's findings revealed that income generation by farmers serves as a stimulus toward vegetable production. One of the key components of sustainability is income. The participation of fewer youth in vegetable production and sales is a cause for concern, because this may discourage other young people from venturing into vegetable farming.

4.4 Conclusions and recommendations

The objective of the study was to characterise vegetable production systems of small-scale farmers.

The demographic information gathered from this study shows that there are more male farmers than female farmers. This situation implies that decision making may tend to favour males than females. The study also revealed that there are older farmers than youth. Limited young farmers' participation is anticipated to have an adverse effect on succession rates and jeopardise the sustainability of vegetable production in the study area.

Experience and high education levels are positive factors in the study area which in turn boosts vegetable production and sustainability. The presence of experienced and educated farmers may assist in the transfer of gained knowledge and insight into new technologies.

Land for vegetable production ranges from less than 1 to 2 hectares, and will probably enhance the sustainability of vegetable production, since farmers will manage smaller areas of land with ease.

Almost all farmers in the study area use furrow irrigation which may seem to be beneficial, however, the method is water-use inefficient. Water is becoming a scarce commodity such that furrow irrigation is becoming a challenge to water saving techniques. It is recommended that farmers should be trained in adopting some water- use-efficient irrigation systems.

Weed control is mainly manual. The use of hands or hand hoes is required for manual weed management. The utilization of human labour and readily accessible tools, as opposed to the use of herbicides, is seen as making the process more environmentally friendly.

All farmers applied chemicals to control pests and diseases on vegetables. There is evidence that using pesticides to manage plant diseases and pests increases crop yield. However, injudicious use of chemicals may result in a less sustainable production system as it is bad for environment and people. It is recommended that farmers should be trained on how to use chemicals to safeguard the environment and

themselves. The promotion of Integrated Pest Management and organic farming as more sustainable practices is also crucial.

Conventional tillage system is widely used in the study area. It has also been noted that the conventional tillage system makes use of tractor power which disturbs the soil, and the resulting effects include the destruction of soil structure, increased soil compaction, formation of plough pan and increased mineralisation of organic matter. It is recommended that farmers should receive training on conservation farming.

Soil sampling is one of the most important aspects which assist farmers in understanding the fertility status of soils. Lack of soil sample collection to assess soil fertility in the study area is a challenge which may lead to a less sustainable vegetable production, because of environmental degradation through soil acidification, soil salinization, and contamination of groundwater from the constant use of chemical fertilisers.

The combination of male and female workers, adults, and youth in the study area may result in a more sustainable system by ensuring complementarity in task performance and tapping on the energy of the youth. It is recommended that farmers should be trained on the implementation of different pieces of labour regulations.

Income generation by farmers serves as a stimulus toward vegetable production. One of the key components of sustainability is income. The participation of fewer youth in vegetable production and sales is a cause for concern, because this may discourage other young people from venturing into vegetable farming.

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Chapter 5

Vegetable production systems and consumption patterns as the determinants of food security amongst small-scale farmers of Limpopo Province, South Africa.

Abstract

The study was conducted in six villages situated in the four municipalities within the two districts of the Limpopo Province in South Africa. The study investigated vegetable production systems and consumption patterns as determinants of food security amongst small-scale vegetable farmers. A multi-stage random sampling technique was used to select 52 respondents for this study. Sample size was calculated using Slovin's formula. Data was collected through a questionnaire and other information through direct observation. Data was analysed using the statistical package for social sciences. The study revealed that 65.38% of the participants were males 42.31% had an average age of 51-61 years and had 5-10 years farming experience. The study shows that male respondents 63.46% had secondary education and are more than females, and 71.16% had dependants ranging from five to above nine per household. The majority 92.31% own land for vegetable cultivation, and more respondents who own land are males while 65.38% cultivating vegetables on land size ranging from 1-2 hectares. Most farmers (71.15%) cultivated a variety of vegetables; 90.38% grew vegetable to generate income; 38.46% grow vegetables because the market for vegetables is available. The study also revealed that 44.23% used drying method to preserve vegetable seeds; 90.38% used single cropping system for vegetables, and they practiced intensive vegetable production system. Vegetable preparation for food is characterised by 71% who use boiling as a cooking method while 55.77% used tomato and onion to enhance vegetable flavour and also used salt to enhance vegetable taste. The study noted that 48.07% experienced pest infestation and high inputs costs as the main constraints in vegetable production. Vegetable consumption is characterised by 40.38% who consumed vegetables once per week; the 51.92% preferred to eat leafy vegetables than other vegetables. Most of the respondents (55.77%) were encouraged to eat vegetables that were appropriately cooked. The study also noted that adult women (38.46%) consume vegetable in the family, and they consumed 50-100g of vegetable per day. The study shows that 57.69% preserved vegetables by drying, because it is the cheapest method. The results of the study show that a variety of vegetables produced, and preservation are the main determinants of food security in the study area.

Keywords: Vegetable production systems, consumption patterns, determinants, food security, small-scale farmers.

5.1 Introduction

Food insecurity remains a challenge in sub-Saharan Africa. This is so in that the ever-growing human population demands more and higher quality foods (Ojiewo *et al.*, 2015). Grutzmacher *et al.* (2012) argue that a lower quantity and variety of vegetables in the home are associated with food insecurity. Musemwa *et al.* (2013) stated that the rapid rise in food prices and the slower rise in household income are the root causes of food insecurity in South Africa. On the other hand, it is thought that young people's decreased consumption of vegetables is linked to food insecurity. Ibeanu *et al.* (2010) claim that food security in a household is only possible if all family members have constant physical and financial access to food that is adequate, safe, acceptable, and nutritious to meet their daily needs.

The objective of this chapter is to present the results on the determinants of food security amongst small-scale vegetable farmers of Limpopo Province, in South Africa. The chapter presents among others the results on vegetable production systems, vegetable preservation methods, preparation methods and vegetable consumption patterns as determinants of food security.

5.2 Materials and methods

5.2.1 The study area

The study was carried out in the three villages of Makhado Municipality in Vhembe District, namely, Ha-Mphaila, Luvhada and Mamuhoyi; two villages of Ba-Phalaborwa Municipality in Mopani District, namely, Gravelote and Seloane, and one village of Greater Letaba Municipality in Mopani district, namely, Mokwakwaila. This study area of six villages is referred to as area B.

The Makhado Municipality is in the northern part of Limpopo Province (coordinates latitude 23° 00' 00" S and longitude 29° 45' 00" E), approximately 100km from the Zimbabwean border along the N1 Route. The municipality is predominately rural due to the vastness of rural populace. The Municipal area is 7605, 06 km², which translates into 760506 ha in size, and approximately 416728 people are currently residing within the municipality (IDP, 2022/23- 2026/7).

The Greater Letaba Municipality is in the north-eastern quadrant of the Limpopo Province (coordinates latitude $23^{\circ}53'56''\text{S}$ and longitude $30^{\circ}23'8.9''\text{E}$). Greater Letaba Municipality is bordering Greater Tzaneen to the south, Greater Giyani to the east, Molemole to the west and Makhado to the North (IDP, 2010/11). The land area of the municipality extends to approximately 1891 km^2 , with the population of 218030 (IDP, 2020/21). According to (IDP, 2010/11), Greater Letaba Municipality is characterised by varied topography, population densities (low in the south and relatively dense in the north-east), prolific vegetation in the south (timber) and sparse in the north (bush veld).

The Ba-Phalaborwa Municipality is in the Eastern part of the Limpopo Province. It borders the Kruger National Park in the East, the Greater Giyani Municipality in the North, the Greater Letaba Municipality in the North-West, the Greater Tzaneen Municipality in the West and the Bohlabela Municipality in the South (IDP, 2020-2021). The GPS coordinates of Ba Phalaborwa are (latitude $-23^{\circ} 56' 34.76''\text{S}$) and (longitude $31^{\circ} 08' 27.85''\text{E}$). It is 220km from Polokwane and Mbombela and serves as a central gateway to the Greater Limpopo Transfrontier Park through the Giryondo Border (IDP, 2022-2027). The Municipality has a geographical area of 7461.6 km^2 including the Kruger National Park, and a population of 150 637 people (IDP, 2016/17-2017/18).

5.2.2 The sample

A total of 52 small-scale vegetable farmers were randomly sampled using a multi-stage cluster sampling procedures in which the stage one sampling was done at District level, stage two at the municipality level and third stage at the Agricultural Service centres level. Chapter three showed how the sample was calculated from the population, using the Stovin's formula. Two Municipal Districts (Vhembe and Mopani) were purposively selected, and one Municipality from Vhembe district was sampled, namely, Makhado while two Municipalities from Mopani District were sampled, Greater Letaba and Ba-Phalaborwa. Data base of six villages, namely, Ha-Mphaila, Luvhada, Mamuhoyi, Gravelotte, Seloane and Mokwakwaila was used to sample small-scale vegetable farmers. The 52 small-scale vegetable farmers for this objective, constituted about 20% of the total number of farmers (261) who were

interviewed. The 20% small-scale vegetable farmers were uniformly spread over the five objectives of this thesis.

5.2.3 Data collection and analysis

A questionnaire was used to collect data from the respondents. The respondents were asked to supply information among others on demographical factors, vegetable production systems, preservation methods, preparation methods and consumption patterns as determinants of food security. The raw data were analysed and interpreted into meaningful information using statistical package for social sciences (SPSS, 2015).

5.3 Results and discussions

This chapter presents the results on the vegetable production systems and consumption patterns as determinants of food security by small-scale farmers in the study area. The results among others include demographic information, vegetable production systems, preservation methods, preparation methods and consumption patterns as determinants of food security in the study area.

5.3.1 Demographical information

5.3.1.1 Gender of the respondents

The study has revealed that 65.38% respondents in the study were males, and 34.62% were females as presented in Table 5.1. This indicates that there are disparities in terms of males and females who participate on agricultural activities. This could be because females were still marginalised in terms of access to land in the country when these farmers were settled in the study area.

Table 5.1 Gender of the respondents

Gender	No of respondents	%	Cum. %
Male	34	65.38	65.38
Female	18	34.62	100.00
Total	52	100.00	

According to Muzari (2016), gender inequality is also higher in the most impoverished countries. Simply put, according to Muzari (*ibid*), gender inequality strongly correlates with higher hunger rates. Results of the study that was carried out by Akram-Lodhi

and Komba (2018) estimated that, over the course of ten years, removing the gender gap in Tanzania would free approximately 80000 people from poverty each year. According to Quisumbing and Maluccio (2000), women's assets have a positive and significant impact on expenditure allocations for the next generation, such as for education and clothing for children. Akamin *et al.* (2017) offer support for this idea and argued that increased female participation in vegetable farming results in significant increases in vegetable production in Cameroon's humid tropics. This is because female farmers are more technically adept than their male counterparts. Another possibility is that women are more concerned about vegetable production, particularly AIVs, which is directly related to household food security.

Danzie and Dasmani (2010) found that farms managed by female farmers were found to be more efficient and closer to the potential output defined by meta-frontier production function approach than farms owned by males. This finding is supported by FAO (2018), which found that Zambian women could increase yields by 20-30% if they had the same access to productive resources as men. Mukasa and Salami (2015) however found that female-managed agricultural lands in Nigeria, Tanzania, and Uganda are on average less productive than their male counterparts.

5.3.1.2 Age of the respondents

The results of the study as presented in Table 5.2 show that 23.08% of the respondents were aged between 51-60 years old, followed by 19.23% respondents aged 26-30, and 19.23% over the age of 61 years. The ages of between 51 and over 61 years is an indication that the farming population is aging. The study reveals that the respondents see agriculture as the business of the aged, unless they based their focus on other potential attraction.

Table 5.2 Age of the respondents

Age(yrs)	No of respondents	%	Cum.%
21-25 Years	1	1.92	1.92
26-30 Years	10	19.23	21.15
31-35 Years	6	11.54	32.69
36-40 Years	6	11.54	44.23
41-50 Years	7	13.46	57.69
51-60 Years	12	23.08	80.77
> 61 Years	10	19.23	100.00
Total	52	100.00	

Mathivha (2012) says that young people in South Africa think agriculture is old-fashioned, low-class, and only for the elderly and poor in rural areas. It also doesn't offer many opportunities to make money. Because older people will not be able to pass on their knowledge to the next generation, this may have a negative effect on the country's food production. As stated by Akamin *et al.* (2017), vegetable production in Cameroon tends to become less technically efficient as the farmer gets older. This is because older farmers tend to be less knowledgeable and less open to new technologies and ideas. According to Naamwintome and Bagson (2013), youth participation in agricultural activities in Ghana is limited due to limited youth control over financial returns.

Haruna *et al.* (2019) suggested that providing youth in North Central Nigeria with the right opportunities could positively affect the country's economy. Swarts and Aliber (2013) believe that one factor contributing to the youth unemployment crisis in South Africa is young people's reluctance to participate in agricultural activities. They also believe that the already low levels of agricultural activities in rural areas are likely to drop even further, jeopardising any hope for rural development in the future. Guo *et al.* (2015), on the other hand, found that aging has a statistically significant negative impact on employment shares in Chinese agriculture.

5.3.1.3 Education status of respondents

The results in Table 5.3 show that 40.38% of the respondents attended formal education up to secondary education level, 19.23% a Diploma qualification, 17.31% possess degree qualification, 9.62% primary education, and 13.46% have no formal

education. This study indicates that majority of respondents who participated on agricultural activities are having qualifications and some able to read and write. This indicates that the educated respondents see agriculture as a sector that can play a major role in the economy in terms of income generation, job creation, poverty reduction and food security.

Table 5.3 Educational status of respondents

Status	No of respondents	%	Cum.%
No School	7	13.46	13.36
Primary	5	9.62	23.08
Secondary	21	40.38	63.46
Diploma	10	19.23	82.69
Degree	9	17.31	100.00
Total	52	100.00	

Butt *et al.* (2011) found that Pakistan's rate of development would be greater the higher the percentage of educated people. Akamin *et al.* (2017) claim that vegetable production is more efficient in Cameroon for farmers with at least a secondary education than for farmers with only a primary education or no education at all. Xaba and Masuka (2013) back up this finding, reiterating that the profitability of vegetable production in Swaziland would increase by E0, 304 with each additional year of education.

Oduro-Ofori *et al.* (2014) offer a different viewpoint, pointing out that agricultural output rises in proportion to education level, with secondary school education yielding the highest returns. Ibrahim *et al.* (2013) claim that, the farmer's capacity and propensity to adopt novel farming concepts and methods are consequently enhanced by their high level of education. In a similar vein, Xaba and Masuka (*ibid*) are of the opinion that farmers' natural talents and inherent entrepreneurial qualities can be unlocked through education.

5.3.1.4 Land size for cultivation

The results in Table 5.4 show that 67.31% of the respondents cultivate an area of 1-2ha, while 3.85% cultivated on a 3-4ha area of land, and 13.46% on an area between 0.5-1ha, and 15.38% on an area more than 5ha. These results show that majority of

farmers (80.77%) cultivate in areas ranging between 0.5-2 hectares meaning that there are more small-scale vegetable producers.

Table 5.4 Land size for cultivation

Land size	No of respondents	%	Cum.%
0.5-1 ha	7	13.46	13.46
1-2ha	35	67.31	80.77
3-4ha	2	3.85	84.62
>5ha	8	15.38	100.00
Total	52	100.00	

As stated by Akamin *et al.* (2017), as Cameroon's farm sizes grow, farmers become less technically effective in vegetable production. This is because managing larger farms is more challenging than managing smaller farms. In a similar vein, Akamin *et al.* (*ibid*) argue that the majority of low-income farmers struggle with a lack of technical know-how and insufficient capital. The vastness of the land cannot possibly accommodate these resources.

On the other hand, the studies that Herera *et al.* (2021) carried out found that little land size was the reason for food uncertainty in the rural communities of Upper east Madagascar. To put it simply, Herera *et al.* (*ibid*) are of the assessment that food insecurity diminishes with expanding land size, and that farmers with large land sizes have lower likelihood of food weakness.

Olayemi (2012) discovered that when most farmers cultivate small plots, food production will likely remain subsistence-level, necessitating farmers' diversification into non-farming pursuits to ensure food security. According to the study carried out by Gyau *et al.* (2014), adequate land access in Cameroon reduces rural people's susceptibility to hunger and poverty and influences their capacity to invest in productive activities.

5.3.1.5 Farming experience

The results presented in Table 5.5 show that 30.77% of the respondents have less than 5 years of experience in farming with vegetables; 34.62% have 5-10 years of experience; 7.69% have 11-15 years, while 25% have over 21 years of experience and 1.92% have 16-20 years of experience. The farmers with experience become

acquainted with the new technologies used to increase the production potential of the area like hydroponics.

Table 5.5 Farming experience

Experience(yrs)	No of respondents	%	Cum.%
<5 years	16	30.77	30.77
5-10 Years	18	34.62	65.38
11-15 Years	4	7.69	73.08
16-20 Years	1	1.92	75.00
>21 years	13	25.00	100.00
Total	52	100.00	

It was observed that the majority of these respondents seem to have not grown with their experience in vegetable farming. It is likely that they will remain emerging for longer period.

According to Chawda (1978), education is less valuable than experience. Combining knowledge and experience creates momentum for agriculture's advancement and achievement of desired goals. Guo *et al.* (2015) provide support for this assertion when arguing that young farmers who intend to give up farming had a lower agricultural output in China than elderly farmers who did not intend to abandon farming. This is because younger farmers are more likely to work in non-agricultural industries and older farmers have more production experience.

Gyampoh *et al.* (2009) add that farming issues in Ghana's rural areas have been largely solved by utilizing traditional knowledge and practices that have been learned through experience and oral transmission. Seleti and Tlhompho (2014) discovered that when developing agricultural technology for South Africa's rural areas, it is beneficial to combine scientific knowledge with community or Indigenous knowledge systems (IKS) from women.

5.3.1.6 Education status of youth

The results of the study depicted in Figure 5.1 show that among the respondents with secondary education level, the majority are aged between 41 and 50 years. The study also revealed that there are very few young individuals with diplomas and degrees.

These young people will be able to adopt new technology and they may be able to transfer it to the elders who they are used to because their literacy level is higher.

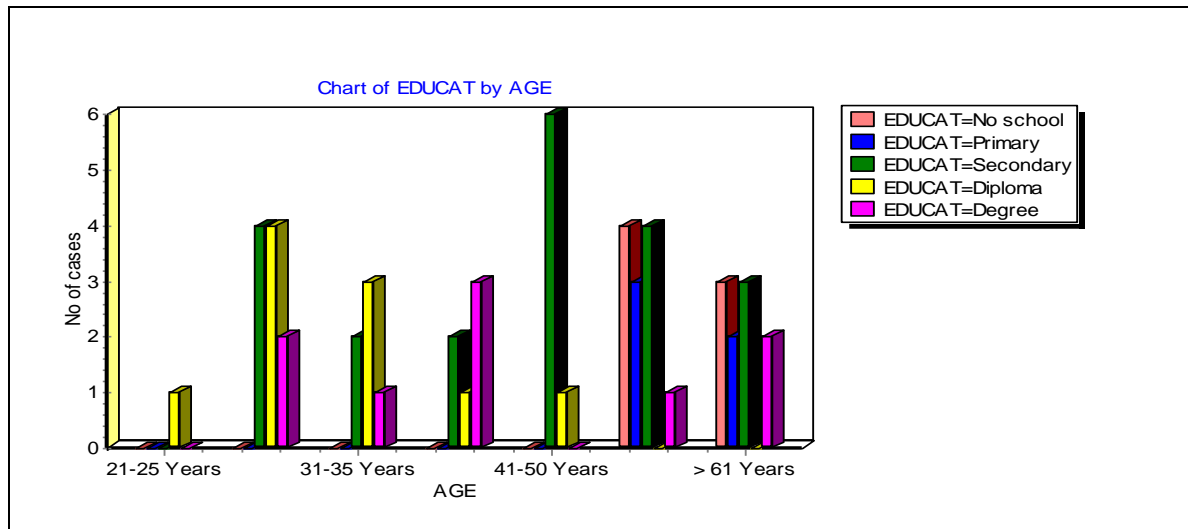


Figure 5 1 Educational status of youth

According to Nyoni (2012), youth in Zimbabwe generally believe that white collar jobs are more appealing, and that agriculture is only for retirees or the uneducated. In the synthesis report for the sub-Saharan countries, SACAU (2013) said that young people in Madagascar think farmers are weak and poor, that young people in Malawi think farmers are old, illiterate people with nothing to do, and that young people in Zambia and South Africa think farming is the last option they have after trying everything else and failing. The educated youth must shift their perception to see agriculture as a means of providing income for those who are unable to generate other forms of income, jobs for the unemployed, and food security issues.

5.3.1.7 Education status of women

The results of the study presented in Table 5.6 show that women constitute 34.62% of the respondents compared to 65.38% men. About 23.08% women attained secondary to tertiary level education. This trend may pose challenges when it comes to decision making, bargaining power and adoption of technologies.

Table 5.6 Education status of women

Status	Male	%	Female	%	Total	%
No School	3	5.77	4	7.69	7	13.46
Primary	3	5.77	2	3.85	5	9.62
Secondary	15	28.85	6	11.54	21	40.38
Diploma	6	11.54	4	7.69	10	19.23
Degree	7	13.46	2	3.85	9	17.31
Total	34	65.38	18	34.62	52	100.00

According to Ashford (2012), the lower status of women in general and the lower priority given to the education of girls prevent women in many traditional societies from realising their full potential. Roudi-Fahimi and Moghadam (2003) add that, as female education declines in the Middle East and North Africa, fertility rises, population increases, infant and child mortality rise, and family health declines. Additionally, children or daughters of uneducated mothers are less likely to enrol in school and graduate with a higher level of education. On the other side, Konate (2010), however contends that education for women and girls has a significant impact on the socioeconomic development of a society in Mali because these members of the population serve as the foundation and support for their families. Similarly, to this, Agenor, and Canuto (2013) reiterated that, educated mothers in Brazil typically possess more bargaining power within the household regarding the allocation of financial resources within the family.

5.3.1.8 Types of access to land

The results of the study presented in Table 5.7 show that 59.62% of the respondents indicated that they own the land for vegetable production, 26.92% are leasing the land and 13.36% produce vegetable on communal land. Access to land for cultivation of vegetable is an important physical resource without which it will be difficult to have food security in the study area. Access to land through leasing, as observed by the researcher, in the study area is an arrangement made between the lessee and the plot owner or the relatives of the owner who passed on or retired from practicing vegetable production.

Table 5.7 Types of access to land

Type	No of respondents	%	Cum.%
Leasing	14	26.92	26.92
Own land	31	59.62	86.54
Communal	7	13.36	100.00
Total	52	100.00	

Gyau *et al.* (2014) say that owning land encourages people to use natural resources in a sustainable way, builds more equitable relationships with the rest of society, and contributes to sustainable development. USAID (2011) found that the offspring of ladies who own property in Nepal are two times more bound to be sufficiently sustained than youngsters experiencing childhood in landless families. It has also been shown that mothers who own land are better able to feed their children food that is richer in nutrients and ensures their children's health and well-being.

5.3.1.9 Access to land by gender

The results of the study presented in Table 5.8 show that 65.38% of the respondents are males and 34.62% are females. The results of this study confirm the findings of other researchers that show that ownership of land is biased to favour male.

Table 5.8 Access to land by gender

Ownership	Male	%	Female	%	Total	%
Leasing	10	19.23	4	7.69	14	29.92
Own land	21	40.38	10	19.23	31	59.62
Communal	3	5.77	4	7.69	7	13.46
Total	34	65.38	18	34.62	52	100.00

The purpose of the comparison is to reveal the disparities in terms of forms of land ownership for both male and female. This indicates that men generally still hold ground in terms of land ownership as compared to females, hence their dominance on agricultural activities.

Panther and Arekapudi (undated) claim that many land tenure systems are gender-biased, favouring male community or family members with primary rights.

According to Quisumbing and Maluccio (2000), women worldwide have less access to land than men do, and when women do own land, according to Sexsmith *et al.* (2017), it frequently tends to be small of lower quality and has less stable tenure. Muzari (2016), supporting this assertion found that women in sub-Saharan African countries are five times less likely than men to own land. Mukasa and Salami (2016) also reiterated that land constraints (i.e. unequal land tenure systems and property rights), restricted access to advisory system resources; exclusions from financial markets and credit, are among the global factors that discriminate against women.

Research results by Quisumbing and Smith (2007) recommended that resources controlled by women significantly affect expenditure allocations towards the future, like schooling and children's clothing. Muzari (*ibid*) further showed that the underperformance of rural areas in many sub-Saharan African nations is partly caused by unequal access to resources by women.

This implies that more women should be empowered on land ownership to lessen reliance by women on their spouses for food security, income, and poverty reduction. Owning land influences agricultural production, according to Xaba and Masuka (2013), as farmers who do not own land may be reluctant to develop and maintain it. Such farmers might experience challenges in getting loans for farming purposes since they can't involve the land as a guarantee as they don't have title deed for it.

5.3.1.10 Qualifications related to agriculture

The results of the study presented in Table 5.9 show that 28.85% have no qualifications related to agriculture, 26.92% have other qualifications other than agricultural related one, and 26.92% have certificates that are related to agriculture. Those respondents with diplomas and degrees are 11.54% and 3.77%, respectively. Respondents who have agricultural qualifications are better placed to adopt new technologies because they are relevantly qualified.

Table 5.9 Qualifications related to agriculture

Qualification	No of respondents	%	Cum.%
Certificate	14	26.92	26.92
Diploma	6	11.54	38.46
Degree	3	5.77	44.23
Other	14	26.92	71.15
None	15	28.85	100.00
Total	52	100.00	

In the Tugela Ferry Irrigation scheme of KwaZulu-Natal, Mazia (2013) found that smallholder farmers' lack of education remained a major obstacle to the adoption of modern farming practices. However, according to Padhy and Jena (2015), education and training can alter farmers' attitudes and broaden their mental horizons. In addition, Mazia (*ibid*) reported that farmers with a higher level of education were more likely to adopt new technology.

According to Xaba and Masuka (2013), an additional year of education would result in a profit increase of E0, 304 for vegetable production in Swaziland. This is because people with a high level of education are more likely to analyse and interpret information than people with low levels of education or none. Studies by Oduro-Ofori *et al.* (2014) concluded that education is crucial to increasing agricultural productivity. The assessment by Oduro-Ofori *et al.* (*ibid*) further indicated that formal education broadens a farmer's knowledge base, non-formal education provides farmers with hands-on training and improved farming practices, and informal education keeps farmers up to date on new innovations and concepts.

5.3.1.11 Number of dependents

The results of the study presented in Table 5.10 show that those respondents with up to “3-4” and “5-6” dependents are equal (25%) each; the 17.31% had between 7-8 dependents, while 5.77% had more than 9 dependents, and the 9.62% have 1-2 dependents. The higher number of dependents may be of assistance to the respondent in providing labour for vegetable production, however these days it may be difficult as the dependents may be engaged in schooling or other activities that take them away from home.

Table 5.10 Number of dependents

Number	No of respondents	%	Cum.%
1-2	5	9.62	9.62
3-4	13	25.00	34.62
5-6	13	25.00	59.62
7-8	9	17.31	76.92
>9	3	5.77	82.69
None	9	17.31	100.00
Total	52	100.00	

According to Olayemi (2012), the more dependents a household has in Osun State, Nigeria, the more likely it is that they provide manual labour for family farms. On the other hand, larger families often have a negative influence on household food security and significantly increase the probability of poverty (Olayemi, *ibid*). Herera *et al.* (2021), who reaffirmed that food insecurity rises with the number of individuals in households in Madagascar's rural areas, confirm this assertion. In other words, large families will have an impact on both the amount of food consumed and the nutritional health of each member of the household. However, Xaba and Masuka (2013) believe that the size of the household will impede the sale of vegetables because the farmer must first meet home consumption demands. Large family size is a symptom that the nearby environment and land are deteriorating due to excessive access to natural resources, according to Haq *et al.* (2010). It is known that big family sizes result in high human population, which will eventually exhaust natural resources and reduce the ability of ecosystems to maintain life (Haq *et al.*, *ibid*).

The study's findings revealed that farmers in the study area are equipped with experience, education and have land that ensure food security, however participation of youth is low with the implication of food insecurity due to increasing number of aging farmers.

5.3.2 Vegetable production systems and food security

This section presents the results of how the respondents cultivate their vegetables and how the production practices impact on food security. The scope of the work covers among others land size, vegetable farming systems, types of vegetables, methods of preserving seeds, production constraints, and factors that influence vegetable production.

5.3.2.1 Land size for vegetables

The results of the study presented in Table 5.11 show that 44.23% use 1-2ha as a proportion of the land size reserved specifically for vegetable production: the 21.15% use 4-6ha area of land, 17.31% use 3-4ha. Only 9.62% use other areas for vegetable production, while 7.69% use less than a hectare for the purpose.

Table 5.11 Land size for vegetables

Land size (ha)	Number of Respondents	%	Cum %
<1	4	7.69	7.69
1-2	23	44.23	51.92
3-4	9	17.31	69.23
4-6	11	21.15	90.38
Other	5	9.62	100.00
Total	52	100.00	

In Cameroon, when farm sizes increase, farmers become less technically proficient in growing vegetables, according to Akamin *et al.* (2017). Larger farms are more challenging to manage than small ones, which explains why. Similarly, to this, Akamin *et al.* (*ibid*) suggested that most farmers in low-income nations are constrained by a lack of resources, including money and technical know-how. These resources are insufficiently linked to expansive land areas.

5.3.2.2 Types of vegetables grown

The results of the study presented in Table 5.12 show that 50.00% of the respondents cultivate a variety of vegetables like, root vegetables, fruit, leafy vegetables, flowers, and stem crops on crop rotation basis, the 25.00% concentrate on fruit vegetables, the 13.46% concentrate on leafy vegetables, and 11.54% on root crops.

Table 5.12 Types of vegetables grown

Type	No of respondents	%	Cum.%
Root	6	11.54	11.54
Fruit	13	25.00	36.54
Leaf	7	13.46	50.00
All the above	26	50.00	100.00
Total	52	100.00	

Observations are that diversity of vegetables are grown by most farmers in the study area. According to research by Sheereen and Banu (2016), crop diversification was seen as one of the key strategies for reducing risks and eradicating food poverty in India. This assertion is corroborated by Hile *et al.* (2016), who reaffirmed that sustainable diversified agricultural systems are considered as very profitable and that the right component diversity boosts productivity per unit area and lowers production costs in Pune District of Maharashtra.

5.3.2.3 Specific vegetables cultivated

The results of the study show that 71.15% cultivate a variety of vegetables mentioned in Table 5.13. Those planting Spinach are (7.69%), and butternut are (7.69%). Those planting cabbage and tomatoes are 5.77% each. The respondents also mentioned that cabbage production has challenges regarding pest control and also as a gross feeder crop. Although on crop rotation some other crops were used to generate income, food security, and poverty and job creation in the study area.

Table 5.13 Specific vegetables cultivated

Vegetable	No of respondents	%	Cum.%
Cabbage	3	5.77	5.77
Spinach	4	7.69	13.46
Tomato	3	5.77	19.23
Butternut	4	7.69	26.92
All above	37	71.15	98.08
Other	1	1.92	100.00
Total	52	100.00	

In the Pune District of Maharash, crop diversification, according to Hile *et al.* (2016) was seen as a shift from traditionally grown, less profitable crops to more profitable crops. Since the crops of cauliflower, cabbage, and tomato were found to be labour-intensive and high paying per unit area in the Kullu District of Himachal Pradesh, their intensity led to an increase in employment and total income. According to Sheereen and Banu (2016), crop diversification in favour of high-value vegetables is emerging as a promising source of income enhancement, employment generation, poverty alleviation, and export promotion in India.

5.3.2.4 Reasons for growing vegetables

The results of the study presented in Table 5.14 show that 90.38% of the respondents grow vegetables for income generation, and 3.85% produce for home consumption, those who want to access funds, attract government funds and other are each 1.92%. The results of this study show that most respondents generate their income from vegetables.

Table 5.14 Reasons for growing vegetables

Reason	No of respondents	%	Cum.%
Income	47	90.38	90.38
Home consumption	2	3.85	94.23
Access funds	1	1.92	96.15
Attract gov-funds	1	1.92	98.08
Other	1	1.92	100.00
Total	52	100.00	

The study by Patel *et al.* (2016) found that income-generating activities (IGAs) improved people's overall livelihood status in India's Tikamgarh District. Human capital, physical capital, natural capital, social capital, financial capital, and food security all improved as a result. When compared to the other three capitals in the Chitsanza ward of Zimbabwe, income generating activities significantly contributed to human and social capitals, as stated by Toperusa (2010). Ndhleve *et al.* (2013) support this assertion, by going on to say that increasing wages and boosting employment opportunities could help households in the Eastern Cape meet their food needs by raising household incomes and encouraging projects that generate income.

5.3.2.5 Factors influencing vegetable farming

The results of the study presented in Table 5.15 show that 38.46% of the respondents are encouraged by the availability of markets to keep them attached to vegetable farming activities, 26.92% of them are encouraged by the suitability of soil for crop cultivation. The 23.08% are encouraged by the availability of water on daily basis, and 7.69% by the suitability of climatic conditions. Only 3.85% indicated other things motivated them to keep them going on vegetable cultivation.

Table 5.15 Factors influencing vegetable farming

Factor	No of respondents	%	Cum.%
Suitable soil	14	26.92	26.92
Suitable climate	4	7.69	34.62
Availability of water	12	23.08	57.69
Availability of Market	20	38.46	96.15
Other	2	3.85	100.00
Total	52	100.00	

According to Persuric and Ban (2016), eating vegetables is associated with the idea of leading a healthy lifestyle. In this regard, it has been determined that customers' attitudes toward food and health are the primary factors determining their demand for vegetables, and consequently the market's supply. Similarly, the appropriateness of the soil is another element that affects vegetable production. According to Fagwalawa *et al.* (2015), loamy soil in Northern Nigeria produced the finest tomatoes, followed by compound soil, sandy soil, and clay soil. Vegetable farming will be impacted by the availability of water for irrigation. Crop yields were higher in canal head reach regimes than in tail-end regimes, according to Kori and Umesh (2020)'s research. This is true because there is more irrigation water available at the canal's head than at its tail.

5.3.2.6 Preservation methods of vegetable seeds

The results of the study presented in Table 5.16 show that 44.23% use drying method to preserve vegetable seeds, the 11.54% each use open area storage and freezing/cooling: the 3.85% each use canning and cow dung treatment. While only 1.92% use salt treatment. It was observed that most farmers tend to preserve seeds of their own because seeds are usually expensive.

Table 5.16 Preservation methods of vegetable seeds

Method	No of respondents	%	Cum.%
Drying	23	44.23	44.23
Open area storage	6	11.54	55.77
Cow dung treatment	2	3.85	59.62
Canning	2	3.85	63.46
Cow urine treatment	3	5.77	69.23
Common salt	1	1.92	71.15
Freezing/cooling	6	11.54	82.69
Other	9	17.31	100.00
Total	52	100.00	

According to Vertucci and Roos (1991), drying vegetable seeds often lengthens their shelf lives without compromising their viability or vigour. According to research findings by Patra *et al.* (2016), shade drying of chilli seeds that were taken right away from the plant produced the highest germination percentage and vigour index when compared to sun- and freeze-drying. Kurubetta *et al.* (2018) discovered that, in contrast to solar drying, oven drying had the lowest or no effect on the germination of chilli seeds.

5.3.2.7 Challenges facing vegetable production

The results of the study presented in Table 5.17 show that 26.92% of the respondents experience production costs as their major constraint, the 21.15% experience theirs as pests, 9.62% theirs as water shortage, the 7.69% theirs as lack of markets for their products, those experiencing theft of products and harsh climate are 3.85% each.

Table 5.17 Challenges facing vegetable production

Challenge	No of respondents	%	Cum.%
Shortage of water	5	9.62	9.62
Harsh climate	2	3.85	13.46
Pests	11	21.15	34.62
Production costs	14	26.92	61.54
Theft	2	3.85	65.38
Markets	4	7.69	73.08
All above	14	26.92	100.00
Total	52	100.00	

According to Dossa *et al.* (2016), among other things, vegetable producers in Nigeria's Plateau state encountered significant difficulties due to a lack of access to water lifting equipment and high input costs. Insect pests were found to be the main barrier to vegetable production in Lesotho, according to studies by Sebitia *et al.* (2021). Phophi and Mafongoya (2017) linked globalization and lax biosecurity controls at the South African borders to the spread of insects and diseases. Ayyogari *et al.* (2014), on the other hand, believed that West Bengal's pest and disease outbreaks were mostly caused by climate change.

5.3.2.8 Methods of planting vegetables

The results of the study presented in Table 5.18 reveal that two methods of planting vegetables are used, direct planting is used by 25.00% and transplanting by 75.00%

of the respondents. It was observed that transplanting practice is either from seedling trays or seed beds.

Table 5.18 Methods of planting vegetables

Method	No of respondents	%	Cum.%
Direct sowing	13	25.00	25.00
Transplanting	39	75.00	100.00
Total	52	100.00	

According to Khaembah and Nelson (2016), transplanting has the benefit of making it simple to reach the desired plant population. The study by Singh *et al.* (2019) found that transplanting over direct sowing boosted mustard seed production by 15-20% in India. According to Gavric and Omerbegovic (2020), sweet corn cultivated in Bosnia utilizing transplanting had more ear length and mass than crops grown by direct sowing. Similar findings were made by Lee *et al.* (2021), who discovered that in the Korean climate, transplanted rapeseed produced higher yields than directly seeded rapeseed.

5.3.2.9 Systems of planting vegetables

The results of the study presented in Table 5.19 show that the majority (90.38%) of the respondents use single cropping system for planting vegetables; 5.77% use intercropping system on their farms, and 3.85% use relay system.

Table 5.19 Systems of planting vegetables

System	No of respondents	%	Cum.%
Single cropping	47	90.38	90.38
Intercropping	3	5.77	96.15
Relay cropping	2	3.85	100.00
Total	52	100.00	

According to study findings by Ibironke (2010), *Amaranthus hybridus* plant heights were at their highest in solo or single cropping 5-7 weeks after planting (WAP) in Ondo State, Nigeria. Like this, Ibironke (*ibid*) also said that *Amaranthus hybridus* solitary cropping had a greater edible yield when compared to mix crops.

In a different study, Mbong *et al.* (2021) discovered that growing fluted pumpkins alone or in a single crop reduced the occurrence and severity of leaf spot disease in

Cameroon compared to growing fluted pumpkins intercropped with the Giant French variety of plantain. In addition to the drawbacks of intercropping, Smith, and Liburd's research (2021) shows that when host crops are combined with non-host crops, insects with a specific host, like pests that only attack cruciferous crops, are more easily decreased in number. Odeniyi (2021) reaffirmed that intercropping in two rows of tomato plants with one row of cowpea in Ondo, Western Nigeria, produced higher net returns than sole or single cropping of tomato and cowpea, respectively.

5.3.2.10 Vegetable farming systems

The results of the study presented in Table 5.20 show that 48.08% of the respondents use intensive farming system to cultivate their vegetables, 34.62% use extensive systems, 5.77% use backyard farming and 1.92% use other methods.

Table 5.20 Vegetable farming systems

System	No of respondents	%	Cum.%
Backyard	3	5.77	5.77
Organic farming	5	9.62	15.38
Intensive farming	25	48.08	63.46
Extensive farming	18	34.62	98.08
Other	1	1.92	100.00
Total	52	100.00	

Intensive cultivation, according to Kumar (undated), is a farming method wherein an increase in agricultural production is only possible by using more labourers and capital on a given plot of land. According to Nipun (undated), it is the continuous cultivation of crops on the same piece of land. On the other hand, extensive cultivation, according to Kumar (*ibid*), is a farming method in which increasing agricultural production is only possible by expanding the area of land under cultivation. According to Nipun (*ibid*), extensive farming enables the farmer to migrate from one piece of land to another. According to Niemiera (2018), the benefit of intense cultivation is that it minimises unused space because it aims to have something growing in every area of the garden all the time during the growing season. However, Sial *et al.* (2021) suggested that such intensive agricultural practices would not be sustainable due to the increased use of chemical inputs, injudicious exploitation of natural resources, and poor soil health management.

The study's findings revealed that preservation of own seeds is one of the methods adopted by farmers in the study area to ensure seed supply for vegetables that are adapted and difficult to source from suppliers. Growing a variety of vegetables is a risk-aversion strategy employed by farmers in the study area to ensure a steady supply of food.

5.3.3 Vegetable preparation systems and food security

This section presents the results of how the respondents prepare vegetables. The work covers among others preparation methods, methods of enhancing vegetable taste, methods of enhancing vegetable flavour, and sources of information for cooking vegetables.

5.3.3.1 Methods of vegetable preparation

As presented in Table 5.21 the majority of respondents (71.15%) prepare vegetables by boiling, 13.46% by steaming, and 7.69% by stir-frying; only 5.77% of the respondents roasted their vegetable before it is served, and 1.92% of them by blanching.

Table 5.21 Methods of vegetable preparation

Method	No of respondents	%	Cum.%
Steaming	7	13.46	13.46
Boiling	37	71.15	84.62
Stir-frying	4	7.69	92.31
Blanching	1	1.92	94.23
Roasting	3	5.77	100.00
Total	52	100.00	

Increased boiling time could decrease the ash content, total carotenoid content (TCC), total anthocyanin content (TAC), total polyphenol content (TPC), and radical scavenging capabilities of red amaranth and red skin potato, according to research by Kamrunnaher *et al.* (2019). On the other hand, Kamrunnaher *et al. (ibid)* also suggested that red amaranth and red skin potato's pH value and water solubility index (WSI) could increase with longer boiling times. According to Saikia and Mahanta (2013), steaming vegetables was the best method for preserving phytochemicals and antioxidant qualities, followed by microwave cooking.

5.3.3.2 Methods of enhancing vegetable flavour

The results of the study as presented in Table 5.22 show that 55.77% enhance vegetable flavour by adding tomatoes and onions, the 36.54% add spices to enhance flavour of vegetables, and 1.92% add mushroom as way of enhancing flavour, while 1.92% use other flavourings to enhance the flavour.

Table 5.22 Methods of enhancing vegetable flavour

Method	No of respondents	%	Cum.%
Spices	19	36.54	36.54
Mushroom	1	1.92	38.46
Tomato and onion	29	55.77	94.23
Other	3	5.77	100.00
Total	52	100.00	

Tomato, onion, and spices not only add flavour but also have several health advantages. The phenolic compounds in tomatoes are employed as anti-allergic, anti-inflammatory, and anti-microbial agents, according to Hedges and Lister (2005). Due to its ability to prevent platelet aggregation, the yellow jelly surrounding tomato seeds has been discovered to be a stroke and heart attack preventative. According to Bhowmik *et al.* (2012), the tomato's lycopene content is an essential antioxidant that aids in the battle against the growth of malignant cells. A study finding by Sharma (2014) revealed that, using onions as flavour enhancers also improves asthmatics' lung functions, avoids cardiovascular diseases, lowers the danger of blood clots, and guards against stomach cancer and stomach infections.

5.3.3.3 Methods of enhancing vegetable taste

The results presented in Table 5.23 show that 55.77% of the respondents use salt to enhance the taste of vegetables and 15.38% use spices, the 13.46% use oil to enhance taste to the vegetables, 9.62% use grounded groundnuts to enhance taste to some of the vegetables. In the study area it was noted that farmers know which vegetables are good together with groundnuts (e.g., pumpkin leaves with groundnuts).

Table 5.23 Methods of enhancing vegetable taste

Method	No of respondents	%	Cum.%
Spices	8	15.38	15.38
Salt	29	55.77	71.15
Oil	7	13.46	84.62
Groundnuts	5	9.62	94.23
Soup	3	5.77	100.00
Total	52	100.00	

Lv *et al.* (2015) found that spicy foods are beneficial for weight loss, lowering the risk of cancer, and preventing obesity. According to Umaine (2011), sodium, which is found in salt, is essential for controlling fluid balance and blood pressure. However, Durack *et al.* (2008) showed that excessive salt consumption in some individuals may lead to major health issues such as hypertension and cardiovascular illnesses (CVD).

5.3.3.4 Source of information on cooking vegetables

The results of the study presented in Table 5.24 show that 34.62% of the respondents got the information on cooking vegetables from home, by watching the elders cook, 30.77% from women clubs; the 7.69% from home economics, and the 26.92% found the information on cooking from other sources.

Table 5.24 Source of information on cooking vegetables

Source	No of respondents	%	Cum.%
Women clubs	16	30.77	30.77
Home economics	4	7.69	38.46
Home education	18	34.62	73.08
Other	14	26.92	100.00
Total	52	100.00	

According to Gyampoh *et al.* (2009), traditional knowledge and practices passed down orally from generation to generation and acquired over time via experience have been crucial in resolving farming issues in rural Ghana. In developing agricultural technology for South Africa's rural communities, Seleti and Tlhompho (2014) discovered that there is benefit in fusing community or Indigenous knowledge systems (IKS) from women with scientific information.

The study's findings revealed that preparation methods are being used in the study area to promote vegetable consumption. The findings also indicated that women's

groups and home education programs are the primary information sources for vegetable preparation techniques. Women's clubs that discuss vegetable preparation inspire the community to value vegetables as a significant food source.

5.3.4 Vegetable consumption patterns and food security

This section presents the results on how the respondents consume vegetables. The scope of the work covers among others the type of vegetable preferred, daily quantity taken, factors that influence vegetable intake, members of the family that consume vegetables, participants view about vegetable intake, and sources of information on vegetable consumption.

5.3.4.1 Frequency of vegetable consumption

The results of the study presented in Table 5.25 show that 40.38% of the respondents consume vegetables once per week, while 23.08% consume daily, the 7.69% consume once per month, and 28.85% consume some other times.

Table 5.25 Frequency of vegetable consumption

Frequency	No of respondents	%	Cum.%
Daily	12	23.08	23.08
Once per week	21	40.38	63.46
Once per month	4	7.69	71.15
Other	15	28.85	100.00
Total	52	100.00	

Higher vegetable intake has been associated with a lower risk for a variety of cancers, claim Reynolds *et al.* (2000) in their study. Five portions or more per day were encouraged by the national Cancer Institute. According to Deloitte (2016)'s research, Australians with lower incomes consumed fewer vegetables overall and of a smaller variety. In a different version, Deloitte (*ibid*) added that obstacles to improving vegetable consumption include people's misconceptions about the amounts of food they actually eat and a lack of understanding about recommended vegetable intake. According to Ruel *et al.* (2005), households with higher incomes consume more vegetables overall and a wider variety of vegetables than households with lower incomes. Ogundari and Arifalo (2013) confirmed that in Nigeria, wealthier households respond to the demand for vegetables more quickly than poorer households, which lends support to this finding.

5.3.4.2 Source of information on vegetable consumption

The results of the study presented in Table 5.26 show that 23.08% of the respondents get their information regarding the consumption of vegetables from Home Economists in the Department of Agriculture and Rural Development and the other 23.08% get their information from Health Professionals; the 21.15% got information on Radio and 21.15% got theirs from other sources; 3.85% got information from schools, and 7.69% from dieticians.

Table 5.26 Source of information on vegetable consumption

Source	No of respondents	%	Cum.%
School	2	3.85	3.85
Health professionals	12	23.08	26.92
Dieticians	4	7.69	34.62
Radio	11	21.15	55.77
Home economics	12	23.08	78.85
Other	11	21.15	100.00
Total	52	100.00	

Health professionals, such as dietitians, are taught to comprehend the connection between food and health throughout the human life cycle and are skilled at explaining this connection to the public, claims EFAD (2012). On the other hand, according to Knye (2008), extension economists are experts who focus on the family as an ecosystem, ensure that people's interactions with their environments are improved, and motivate people to manage resources effectively so that their families can meet their needs for food, shelter, and clothing.

5.3.4.3 Personal views on vegetable intake

The results presented in Table 5.27 show that 40.38% of the respondents eat vegetables because they believe they are sources of vitamins, 38.46% of them believe that consuming vegetables promote digestion, they are sources of vitamins, and prevent diseases, the 13.46% indicated that vegetables promote digestion when taken, the 7.69% indicated that vegetables prevent diseases. The respondents have realised the importance of vegetable consumption, some citing those vegetables are healthier than meat, while others citing that meat causes heart diseases and high blood pressure.

Table 5.27 Personal views on vegetable intake

Response	No of respondents	%	Cum.%
Promote digestion	7	13.46	13.46
Source of vitamins	21	40.38	53.85
Prevent diseases	4	7.69	61.54
All above	20	38.46	100.00
Total	52	100.00	

Vegetables are abundant providers of several nutrients, including vitamins, trace minerals, dietary fibre, and phytochemicals, particularly antioxidants, according to Slavin and Lloyd (2012).

5.3.4.4 Specific vegetable preferences

The results of the study presented in Table 5.28 show that 51.92% of the respondents prefer to eat leafy vegetables more than other type of vegetables, 3.85% prefer root vegetables, 9.62% prefer fruit vegetables, and 34.62% prefer all different types of vegetables. The higher preference of leafy vegetables is because they are abundant and readily available in the study area.

Table 5.28 Specific vegetable preferences

Preferences	No of respondents	%	Cum.%
Leafy vegetables	27	51.92	51.92
Root vegetables	2	3.85	55.77
Fruit vegetables	5	9.62	65.38
All above	18	34.62	100.00
Total	52	100.00	

African leafy vegetables are historically consumed by South Africans, according to Voster *et al.* (2007a). According to research by Arasaretnam *et al.* (2018), in addition to vitamin C, green leafy vegetables also contain significant amounts of other vital micronutrients. Aslam *et al.* (2020) 's assertion that green leafy vegetables have good nutritional value and can be used for medical purposes since they include a variety of phytochemicals, antioxidants, dietary fibres, minerals, and vitamins supports this idea.

5.3.4.5 Factors encouraging vegetable intake

The results presented in Table 5.29 show that 55.77% of the respondents are encouraged to consume vegetables when they are correctly cooked, and 23.08% indicated that they are encouraged when vegetables are served with meat, and the 13.46% like to eat raw vegetables, and 7.69% used other unspecified aspects to encourage them to take more vegetables.

Table 5.29 Factors encouraging vegetable intake

Factor	No of respondents	%	Cum.%
Vegetable served with meat	12	23.08	23.08
Correctly cooked	29	55.77	78.85
Eat raw vegetables	7	13.46	92.31
Other	4	7.69	100.00
Total	52	100.00	

Food is unlikely to be consumed unless it is well prepared and enticing owing to its appearance, texture, and nutritional value, claims ACS Distance Education (undated). According to Miglio *et al.* (2008), steaming vegetables are more enticing because they keep a better textural quality than boiling ones and have less discolouration overall. Fabbri and Crosby (2015) underlined that steaming appears to be the optimum technique of vegetable preparation to maintain the nutritional quality, lending credence to this argument.

5.3.4.6 Factors discouraging vegetable intake

Table 5.30 show that 63.46% of the respondents do not like vegetables which are badly prepared, and 25.00% feel discouraged to take vegetables repeatedly, while 11.54% when served without meat. The bad preparation of vegetables can be addressed through training in vegetable preparation and recipes by the professionals such as Home Economists, and Health Professionals. This may contribute towards the increased intake.

Table 5.30 Factors discouraging vegetable intake

Factor	No of respondents	%	Cum.%
Repeated consumption	13	25.00	25.00
Serve without meat	6	11.54	36.54
Bad preparation	33	63.46	100.00
Total	52	100.00	

Cooking abilities have been deteriorating and being devalued in a larger population, according to Meah and Watson (2011), which is worrying for health consequences. According to Brasington *et al.* (2022), who provided evidence to back this study, those who are less adept at cooking are less likely to consume a diet that is both healthful and balanced.

5.3.4.7 Family members consuming vegetables

Amongst the family members as presented in Table 5.31, adult females (38.46%) are the main consumers of vegetables, followed by 23.08% adult males, the 19.23% of the respondents indicated that all categories consume vegetables, while 5.77% indicated pregnant females, the 5.77% indicated young females and 7.69% young males.

Table 5.31 Family members consuming vegetables

Family Members	No of respondents	%	Cum.%
Young females	3	5.77	5.77
Young males	4	7.69	13.46
Adult females	20	38.46	51.92
Adult males	12	23.08	75.00
Pregnant females	3	5.77	83.77
All above	10	19.23	100.00
Total	52	100.00	

According to reports from Canada, women consume vegetables more frequently than males (Perez, 2002). All these research support Al-Otaibi (2014)'s observation that 40–80% of Saudi Arabian female university students consume five servings of vegetables each day. Most women use blogs as a source of knowledge regarding food preparation, according to studies by Bissonnette-Maheux *et al.* (2015), and women continue to be predominantly responsible for food purchasing and preparation in most families compared to other family members. The study by Ibnouf and Ibnouf (2016) found that women in the Western Sudan are solely responsible for food preparation, processing, and preservation, as well as daily food consumption quantity and quality. Oguntibeju *et al.* (2013), who anticipated that since mothers typically have high control over food, support this study by assuming that when mothers with high vegetable consumption consume vegetables at home during meals that are shared with children, vegetables would be available and cultivated at home.

5.3.4.8 Vegetable intake per day

The results of the study presented in Table 5.32 show that 42.31% of the respondents consume 50g-100g of vegetables per day, the 23.08% respondents consume between 101g-150g per day, whereas the 17.31% consume between 151g-200g per day, the 9.62% consume less than 50g, while 7.69% consume more than 200g per day. Observations are that vegetable intake by most of the respondents is still far below the recommended rate of 400g per day by the WHO.

Table 5.32 Vegetable intake per day

Intake/day	No of respondents	%	Cum.%
<50g	5	9.62	9.62
50-100g	22	42.31	51.92
101-150g	12	23.08	75.00
151-200g	9	17.31	92.31
>201g	4	7.69	100.00
Total	52	100.00	

Higher vegetable intake has been associated with a lower risk for a variety of cancers, claim Reynolds *et al.* (2000), in their study. Five portions or more per day were encouraged by the national Cancer Institute. According to Deloitte (2016) research, persons with lower incomes in Australia consume a smaller volume and diversity of vegetables. In a different version, Deloitte (*ibid*) said that obstacles to improving vegetable consumption include a lack of awareness of the necessary intake of vegetables and people's misconceptions about how much food they actually eat. According to Oguntibeju *et al.* (2013), eating a lot of vegetables can cut the risk of developing most cancers by 20%. This includes malignancies of the oesophageal, stomach, pancreatic, bladder, and cervical lining. High vegetable intake may protect against cardiovascular diseases (CVDs), according to Nielsen *et al.* (2014). According to Yang and Keding (2009), there are 2.7 million deaths worldwide each year that are primarily due to inadequate vegetable consumption.

5.3.4.9 Vegetable intake per day by age

The study reveals that (42.31%) of the respondents of all age categories consume 50g-100g of vegetables per day as outlined in Table 5.33. The 23.08% of the respondents of the same aged group consume between 101g- 150g, followed by 17.30% who consume 151g-200g and 7.69% who consume over 200g. Even though

the majority (48.08%) of the respondents are consuming 101-201g of vegetables per day, it is still below the 400g recommended by the WHO.

Table 5.33 Vegetable intake per day by age

AGE(yea rs)	<50g	%	50-100g	%	101-150g	%	151-200g	%	>201g	%	Total	%
21-25 yrs	0	0.00	1	1.92	0	0.00	0	0.00	0	0.00	1	1.92
26-30 yrs	1	1.92	6	11.54	2	3.85	1	1.92	0	0.00	10	19.23
31-35 yrs	1	1.92	4	7.69	0	0.00	1	1.92	0	0.00	6	11.54
36-40 yrs	0	0.00	1	1.92	3	5.77	1	1.92	1	1.92	6	11.54
41-50 yrs	0	0.00	2	3.85	2	3.85	3	5.77	0	0.0	7	13.46
51-60 yrs	0	0.00	7	13.46	3	5.77	1	1.92	1	1.92	12	23.08
> 61 yrs	3	5.77	1	1.92	2	3.85	2	3.85	2	3.85	10	19.23
TOTAL	5	9.62	22	42.31	12	23.08	9	17.31	4	7.69	52	100.00

According to studies by Tapsell *et al.* (2014), a nutritious diet that includes more vegetables for adults may help overweight people in Western nations lose weight. In a different interpretation, Fanos and Belew (2015) proposed that in Ethiopia, the population should be referred to as “at risk community” if less than 75% of the youngsters eat vitamin A-rich vegetables at least three times per week. According to Oguntibeju *et al.* (2013), children of mothers with high rates of vegetable consumption are more likely to consume vegetables often than those of mothers with low rates of vegetable consumption.

The study’s findings revealed that adults are the main consumers of vegetables in the study area. Chances are high that vegetables may be consumed by the entire family if adults are the main consumers.

5.3.5 Vegetable preservation systems and food security

This section presents the results on how the respondents preserve vegetables, and how the preservation systems impact on food security. The scope of the work covers among others preservation methods, reasons for preserving vegetables, sources of information and challenges.

5.3.5.1 Vegetable preservation methods

The results of the study presented in Table 5.34 show that 57.69% use drying as a vegetable preservation method, while 38.46% use freezing, the 1.92 % use irradiation and the 1.92% use preservatives. In the study area, drying is the most used method because of abundant sunshine. The respondents use this method because they say it is readily applicable, cheap, and more reliable.

Table 5.34 Vegetable preservation methods

Method	No of respondents	%	Cum.%
Drying	30	57.69	57.69
Freezing	20	38.46	96.15
Irradiation	1	1.92	98.08
Preservative	1	1.92	100.00
TOTAL	52	100.00	

Bighaghire *et al.* (2020) 's laboratory study revealed that all preservation techniques, aside from sun drying, decreased the number of micronutrients by 20–80%. According to Kiharason *et al.* (2017), drying pumpkin fruit was found to enhance β -carotene and protein while decreasing the amount of minerals and calories. Wahengbam and Patel (2014)'s research, on the other hand, found that sun drying vegetables preserved more nutrients than oven drying.

According to Sonkamble and Pandhure (2017), shade drying is superior to sun drying and oven drying in terms of maintaining the nutritional value of vegetables. The total phenolic and flavonoid contents of vegetables were found to be higher by the freeze-drying approach than by the traditional heat-dry method, according to Hung and Duy (2012)'s report. Oni *et al.* (2015) provided additional support for these findings by reiterating that freeze-drying appears to preserve mineral content, anti-nutritional chemicals, and the overall composition of dried vegetables better than other drying techniques.

5.3.5.2 Reasons for preserving vegetables

The study results presented in Table 5.35 show that 61.54% of the respondents preserve vegetables to extend its shelf life for use in the future with minimal nutritional value degradation, the 36.54% indicated that preservation promotes sustenance of

vegetable usage, and 1.92% indicated other reasons. This preservation also serves as a strategy to provide for the times of scarcity to prevent food insecurity.

Table 5.35 Reasons for preserving vegetables

Reason	No of respondents	%	Cum.%
Promote sustainability	19	36.54	36.54
Extend shelve life	32	61.54	98.08
Other	1	1.92	100.00
Total	52	100.00	

One strategy for lowering food waste from decaying is to extend shelf life. A more secure global food system would come from minimising all food waste and loss through preservation, claim Martindale and Schiebe (2017). Ibeanu *et al.* (2010) cite food preservation as a key strategy for reducing household hunger by keeping locally produced staples accessible and reasonably priced throughout the off-season. According to Ibeanu *et al. (ibid)*, a family is only food secure when all its members always have physical and financial access to enough wholesome food to meet their daily needs. If postharvest surpluses are adequately kept, all of these are achievable.

5.3.5.3 Source of information on vegetable preservation

The results presented in Table 5.36 show that 59.62% of the respondents got the information on vegetable preservation from Extension Officers, the 17.31% from the radio, while 3.85% from relatives, and the 19.23% did not get information from any source. It is observed that in the study area the respondents are guided by the extension officers which follows a support value chain by the Department of Agriculture and Rural Development.

Table 5.36 Source of information on vegetable preservation

Source	No of respondents	%	Cum.%
Radio	9	17.31	17.31
Relatives	2	3.85	21.15
Extension officers	31	59.62	80.77
None	10	19.23	100.00
Total	52	100.00	

In Tanzania and Malawi, information and knowledge are viewed as the new factors of production that are essential to resolving any society's economic and social issues, according to Mchombu (2003). Similarly, to this, Abu-alhaija and Ghanma (undated) showed that the extension and information sharing significantly increased farmers' adoption of new management technologies, which could result in an increase in agricultural production and improve farmers' incomes in the villages of Jericho, Palestine.

5.3.5.4 Challenges facing vegetable preservation

The results of the study presented in Table 5.37 show that 40.38% of the respondents are facing other unspecified challenges in preserving their vegetables, the 23.08% face unfavourable climate as a challenge, the 25.00% face lack of facility and the 11.54% lacked time to preserve their vegetables. Observations are that climatic factors and other factors will always be a challenge and that farmers should be trained to manage information on weather and being innovative in developing other methods.

Table 5.37 Challenges facing vegetable preservation

Challenge	No of respondents	%	Cum.%
Unfavourable climate	12	23.08	23.08
Lack of facility	13	25.00	48.08
Lack of time	6	11.54	59.62
Other	21	40.38	100.00
Total	52	100.00	

The study' findings revealed that preservation of vegetables is used by most of the farmers as a strategy to reduce food waste and ensure food supply year-round.

5.4 Conclusions and Recommendations

The objective of the study was to investigate vegetable production systems and consumption patterns as determinants of food security amongst small-scale vegetable farmers.

Farmers in the study area are equipped with experience, education and have land that ensure food security; however, participation of youth is low with the implication of food insecurity due to increasing number of aging farmers.

Preservation of own seeds is one of the methods adopted by farmers in the study area to ensure seed supply for vegetables that are adapted and difficult to source from suppliers. Growing a variety of vegetables is a risk-aversion strategy employed by farmers in the study area to ensure a steady supply of food.

The preparation methods are being used in the study area to promote vegetable consumption. The findings also indicated that women's groups and home education programs are the primary information sources for vegetable preparation techniques. Women's clubs that discuss vegetable preparation inspire the community to value vegetables as a significant food source. However, it is important to advocate for vegetable preparation techniques that retain essential nutrient elements.

Adults are the main consumers of vegetables in the study area. Chances are high that vegetables may be consumed by the entire family if adults are the main consumers. To improve vegetable intake rates to the 400g/day recommended by the WHO, individuals must be educated about the health benefits of vegetables.

Preservation of vegetables is used by most of the farmers as a strategy to reduce food waste and ensure food supply year-round.

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Chapter 6

Climate change mitigation strategies by small-scale vegetable farmers towards a sustainable supply and resilient from food shortages in the Limpopo Province of South Africa.

Abstract

A study was conducted in five villages, four from Thulamela municipality and one in Maruleng municipality. The objective of the study was to analyse climate change mitigation strategies adopted by small-scale farmers towards a sustainable vegetable production and resilient from food shortages in Limpopo Province. A multi-stage random sampling technique was used to select 52 respondents for this study. The size of the sample was calculated using Slovin's formula. Data was collected through a structured questionnaire and direct observations. Data was analysed using the statistical package for social sciences. Results of the study revealed that more (53.85%) women participate in vegetable production. The study also shows that 59.62% are middle-aged and elderly. The 90.38% had no qualification in agriculture. The 67.31% cultivate their crops on 1-2ha. The 81.76% have ability to adapt to climate change. The 88.46% rate decrease in quality of irrigation water, decrease in soil fertility and increased soil erosion as factors that lead to land degradation due to climate change. The 86.54% view drought, high temperatures and more pests as rare events as a result of climate change. The 61.54% experienced a slight decrease in summer rainfall patterns. The adaptation to change in summer rainfall is mitigated by planting drought resistance vegetable crops and irrigating frequently to adapt to that change. The 61.54% experienced increased pest infestation due to climate change and they noticed an increase in the use of pesticides to adapt. An increase in winter temperature was noticed by 80.77% of farmers and 67.32% adapt by growing cool season vegetables. Changes in summer temperatures was noticed by 90.30% who experienced an increase in summer temperatures due to climate change. Strategies in response to climate changes include knowing about the importance of weather and climate change forecasts. The 57.69% say forecasting helps them to plan planting dates, others say it helps them to make a choice of vegetable varieties and to project rainfall distribution. The 84.62% use Radio and TV as their main source of information about weather and climate. Farmers in the study area apply Climate-smart agriculture technologies including crop rotation by 71.15%, others use mixed cropping, mulching, no till, crop residue, contours to counter the impact of climate change. They also use climate smart agriculture for increased productivity, 51.92% use hybrid seeds, pesticides, and fertilisers. The CSA soil fertility technologies are the use of manure (52%), others use crop residue and mulching. Types of fertilisers used, 63.46% use both organic and inorganic

fertilisers. Water saving technologies feature 50% who use water harvesting technology as a way of saving water, few use mulching for soils to retain moisture longer. The 59.62% of the respondents use ridges/terraces to control soil erosion, and others use contour planting, other use grass strips. Risks posed by climate change are identified amongst others as reduced crop yield, reduced amount of rain, floods and rise in temperatures. The 63.46% minimise risks by using crop diversification and use hybrid seeds. The study shows that farmers in the study area are aware of the climate change and the related factors. They are also applying CSA technologies as mitigation strategies to ensure sustainable food supply. However, there is a need to support small-scale farmers with improved technologies for them to be able to mitigate and cope with climate change challenges.

Key Words: Climate change, mitigation strategies; climate-smart agriculture, small-scale vegetable farmers.

6.1 Introduction

Vegetables continue to be a crucial part of the human diet since they are the only source of nutrients, vitamins, and minerals. Vegetables of high quality and yield are mostly produced because of favourable environmental circumstances and farmer-related factors. Vegetables, like other crops, are impacted by the effects of climate change, according to Ayyogari *et al.* (2014). Maximum vegetable yield is thought to be limited by extreme temperatures, a lack of irrigation water, disease and pest infestation, increased acidity, soil erosion, lower soil fertility, and changes in the growing season (Prasad & Chakravorty, 2015). Studies by Nkonya *et al.* (2011) found that in sub-Saharan Africa (SSA), the use of sustainable land and water management (SLWM) methods for climate change adaptation is still low. The objective of this chapter was to examine and present results of data collected in the experience of the respondents in terms of climate change mitigation by small-scale vegetable farmers towards a sustainable vegetable production in the Limpopo Province of South Africa.

6.2 Materials and methods

6.2.1 The study area

The study was carried out in the four villages of Thulamela Municipality, in the Vhembe District, namely, Rambuda, Mutshenzheni, Maraxwe and Matombotswuka and one village of Maruleng Municipality of the Mopani District, namely, Lorrain. This study area is referred to as area C.

Thulamela Municipality is in the northern part of Limpopo Province (coordinates latitude 22° 58' 15.87" S and longitude 30° 27' 38.67" E). The Municipality shares boundary in southeast with Collins Chabane Municipality while sharing the borders with Musina Municipality in the northeast and Makhado Municipality in the west. The Municipality covers an area of 5935km², which translates into 593500ha in size (IDP 2020/21-2022/23). The Municipality has a population of 602819 of people currently residing (IDP 2010/11-2012/13).

Maruleng Local Municipality is in the South-eastern quadrant of the Limpopo Province within the Mopani District Municipal area. The GPS coordinates of the area are, latitude 24° 21' 8.99"S; and longitude 30° 56' 29.99" E. The Municipality is bordered by the greater Kruger national Park to the east, the Ba-Phalaborwa and Tzaneen Municipality to the north, the Lepelle Nkumpi Municipality to the west, and Tubatse and Bushbuckridge to the south (IDP 2011-2016). Maruleng Municipality covers an area of 3247km² and has a population of 107247 people (SDF, 2017).

6.2.2 The sample

A total of 52 small-scale vegetable farmers were randomly sampled using a multi-stage cluster sampling procedures in which the stage one sampling was done at District level, stage two at the municipality level and third stage at the Agricultural Service Centre (ASC) level. Chapter three showed how the sample was calculated from the population, using the Slovin's formula. Two Municipal Districts (Vhembe and Mopani) were purposively selected and one Municipality from each of the two districts, and two local municipalities were sampled, namely, Thulamela and Maruleng. Data base of five villages from the two Municipalities were used to sample small-scale vegetable farmers. The villages involved are Rambuda, Maraxwe, Mutshenzheni and Matombotswuka in Thulamela Municipality and Sekororo in

Maruleng Municipality. The 52 small-scale vegetable farmers for this objective, constituted about 20% of the total number of farmers (261) who were interviewed. The 20% small-scale vegetable farmers were uniformly spread over the five objectives of this thesis.

6.2.3 Data collection and analysis

A questionnaire was used to collect data from the respondents, direct observation was also used to collect information in the study area. Secondary information was collected from published and unpublished documents. The respondents were interviewed to supply information among others on demographical factors, climatic factors affecting their vegetables, impacts of climate change on their crops, abilities to adapt to climate change, unfamiliar climate events observed, changes in rainfall patterns, changes in temperatures, pests and diseases, and adaptation strategies. The raw data were analysed and interpreted into meaningful information using statistical package for social sciences (SPSS, 2015).

6.3 Results and discussions

6.3.1 Demographical information

6.3.1.1 Gender of the respondents

The results of the study presented in Table 6.1 show that 53.85% were females and are participating in agricultural activities, and 46.15% were male counterparts. The government is interested in involving or encouraging more women to participate in agricultural projects, and in that case, it is achieving its objectives with vegetable growers in the study area.

Table 6.1 Gender of the respondents

Gender	Number of respondents	%	Cum.%
Male	24	46.15	46.15
Female	28	53.85	100.00
Total	52	100.00	

Regardless of the amount of economic development any country has attained, Prakash (1999) claim that women are crucial to rural and agricultural development in

most Asian-Pacific nations. Women are the foundation of the growth of rural and national economies in Mozambique, according to Mugele *et al.* (2013). In Thulamela Municipality in the Vhembe District, the study findings by Raidimi (2014) also demonstrated that women make significant contributions to agriculture and are primarily responsible for ensuring the food security and nutritional status of their household members. In terms of the amount of time and days they spend working on farms, they engage in more farm work than men do.

6. 3.1.2 Respondents' age

The study results presented in Table 6.2 show that 30.77% and 28.85% are middle age (51-60 years) and the elderly (>60 years) participate in agricultural projects. Few younger respondents seemed to have no interest in agricultural activities. The government should play a major role to lure these youth towards agriculture by providing some form of funding for youth in agriculture and bursaries for children who want to pursue agriculture as a career at universities.

Table 6.2 Respondents' age

Age	Number of respondents	%	Cum.%
< 18	1	1.92	1.92
26-30	4	7.69	9.62
31-35	3	5.77	15.38
36-40	5	9.62	25.00
41-50	8	15.38	40.38
51-60	16	30.77	71.15
> 61	15	28.85	100.00
Total	52	100.00	

Mathivha (2012) claims that South African youth view agriculture as outdated, of low status, providing little prospects for financial gain, and being exclusively designated for the elderly and the underprivileged in rural areas. According to Alene *et al.* (2000), the likelihood of farmers in African nations adopting new practices is adversely correlated with their age. This is because as people age, their tendency to be cautious or risk-averse grows.

6. 3.1.3 Education status of women

The results of the study presented in Table 6.3 show that female respondents (36.54%) had attended school up to secondary education as compared to 25.00% of their male counterparts; the 13.46% females have primary education and 7.69% are males, 9.62% males have diploma qualification and 3.85% are females. Only 1.92% males had a degree qualification, while another 1.92% males have not attended any formal education. In this study more women are educated than men. Better literacy level assists in adoption of climate smart technologies.

Table 6.3 Education status of women

Status	Male		Female		Total	
	N	%	N	%	N	%
No school	1	1.92	0	0	1	1.92
Primary	4	7.69	7	13.46	11	21.15
Secondary	13	25.00	19	36.54	32	61.54
Diploma	5	9.62	2	3.85	7	13.46
Degree	1	1.92	0	0	1	1.92
Total	24	41.15	28	53.85	52	100.00

Purohit *et al.* (2015) assert that the prosperity of a country depends on the prosperity of its women. According to Roudi-Fahimi and Moghadam (2003), family health improves and fertility, population growth, infant and child mortality decrease as female education increases in the Middle East and North Africa. Additionally, children or daughters of educated mothers are more likely to enrol in school and pursue higher levels of education. On the other hand, Konate (2010) notes that because women and girls are the foundation and pillars of their families, their education has a significant impact on the socioeconomic growth of a society in Mali. Agenor and Canuto (2013) note that educated mothers in Brazil typically have more negotiating leverage within the household regarding the division of financial resources within the unit. According to Butt *et al.* (2011), Pakistan's rate of development would increase with a higher percentage of educated citizens. Farmers who are educated can easily embrace new farming techniques, according to Ibrahim *et al.* (2013).

6. 3.1.4 Education status of youth.

In this study, as presented in Table 6.4, it was found that only 11.31% of the respondents are the youth between the ages of 18 to 35 years. A course of concern

is that their number is low. It could be that the educated youth section of the population has focused on other activities that are non-agricultural as a means of income generation, job creation, food security and poverty reduction. The challenge is that the elder farmers may not have replacement or succession plan. The trend presents an uncertain future for agriculture because the youth of the study area seem to be less interested in agriculture. This is explained by many plots that belong to elderly farmers that are lying fallow as observed in the study area.

Table 6.4 Education status of youth

Age(yrs)	No		Primary		Secondary		Diploma		Degree		Total	
	Schooling											
	N	%	N	%	N	%	N	%	N	%	N	%
< 18	0	0.00	1	1.92	0	0.00	0	0.00	0	0.00	1	1.92
26-30	0	0.00	1	1.92	2	3.85	1	1.92	0	0.00	4	7.69
31-35	0	0.00	0	0.00	2	3.85	1	1.92	0	0.00	3	5.77
36-40	0	0.00	0	0.00	2	3.85	2	3.85	1	1.92	5	9.62
41-50	0	0.00	0	0.00	7	13.46	1	1.92	0	0.00	8	15.38
51-60	1	1.92	3	5.77	11	21.15	1	1.92	0	0.00	16	30.77
> 61	0	0.00	6	11.54	8	15.38	1	1.92	0	0.00	15	28.85
Total	1	1.92	11	21.15	32	61.54	7	13.45	1	1.92	52	100.00

According to Nyoni (2012), young people in Zimbabwe have a prevalent notion that agriculture is only for the uneducated or retirees, and that white collar jobs are more enticing. According to SACA (2013)'s synthesis report for the sub-Saharan countries, youths in Madagascar see farmers as a helpless and underprivileged group, those in Malawi see farming as a job for elderly and illiterate people who have nothing better to do, and youths in Zambia and South Africa see farming as their last resort after having tried everything else and failed. It is necessary to change the way that the educated youth think about agriculture so that they see it as a means of providing food, income for those who lack other sources of income, and jobs for the unemployed.

6.3.1.5 Types of access to land by women

The results of the study presented in Table 6.5 show that 40.38% of the female respondents say that they have ownership of land compared to 38.46% males, and 7.69% of females are cultivating on communal land and 5.77% are leasing as compared to 3.85% males leasing and 3.85% males accessing communal land. This case is different from other cases where male farmers are dominant, it could seem females in this study area are more empowered than males in accessing land for farming.

Table 6.5 Types of access to land by women

Type	Male(N)	%	Female(N)	%	Total (N)	Total%
Leasing	2	3.85	3	5.77	5	9.62
Own land	20	38.46	21	40.38	41	78.84
Communal	2	3.85	4	7.69	6	11.54
Total	24	46.15	28	53.85	52	100.00

The community leadership deserves praise for empowering women by giving them access to land in order to better the lives of women across the nation. People who have access to land are more likely to practice sustainable resource management, establish more just relationships with other members of society, and support sustainable development. According to USAID (2011), children in land-owning households in Nepal are twice more likely to receive appropriate nutrition than children living in landless homes. Further evidence suggests that mothers who own land are better equipped to provide their children with healthier food and ensure their well-being.

6.3.1.6 Land size for vegetable cultivation

The results of the study presented in Table 6.6 show that 67.31% of the respondents cultivate their crops on 1-2ha area of land, and 19.23% cultivated crops on 0.5-1ha area of land, while 5.77% of the respondents on 3-4ha area of land. Only 7.69% of the respondents had >5ha area of land on which crops are cultivated. The reason why most of the respondents are cultivating on 1-2ha of land in the study area is because most of this land size was demarcated for the farmers in the irrigation schemes. Although this land is used for vegetables it must be stated that, as it was observed, the land is also used to produce other crops such as maize, groundnuts,

etc. In some cases, the land is sub-divided to accommodate other crops while catering for vegetables in the same season.

Table 6.6 Land size for vegetable cultivation

Size (ha)	Number of respondents	%	Cum.%
0.5-1ha	10	19.23	19.23
1ha-2ha	35	67.31	86.54
3ha-4ha	3	5.77	92.31
>5ha	4	7.69	100.00
Total	52	100.00	

In Cameroon, when farm sizes increase, farmers become less technically proficient in growing vegetables, according to Akamin *et al.* (2017). Larger farms are more challenging to manage than small ones, which explains why. Similarly, to this, Akamin *et al.* (*ibid*) suggested that most farmers in low-income nations are constrained by a lack of resources, including money and technical know-how. These resources are insufficiently linked to expansive land areas. On the other hand, research by Herera *et al.* (2021) discovered that rural populations in Northeast Madagascar experienced food insecurity because of small land sizes. In plain terms, Herera *et al.* (*ibid*) believe that farmers with larger plots of land see a reduction in food insecurity. According to Olayemi (2012), if most farmers only produce in small plots, food production is likely to remain at a subsistence level. As a result, farmers may need to diversify into non-farming industries to ensure their own food security. Gyau *et al.* (2014) asserted that appropriate access to land, however, lessens the vulnerability of rural people in Cameroon to hunger and poverty and influences the capacity of the poor to invest in productive activities.

6.3.1.7 Experience in vegetable farming

Table 6.7 presents results which show that 34.62% of the respondents in the study area are cultivating vegetables for more than 21 years, while 26.92% are doing that for 5-10 years, and 19.23% for 11-15 years. The 15.38% are farming for 16-20 years and only 3.85% for less than 5 years. The level of experience argument the low illiteracy level that was identified in section 6.3.1.3.

Table 6.7 Experience in vegetable farming

Experience(yrs)	Number of respondents	%	Cum.%
< 5 years	2	3.85	3.85
5-10 years	14	26.92	30.77
11-15 years	10	19.23	50.00
16-20 years	8	15.38	65.38
> 21 years	18	34.62	100.00
Total	52	100.00	

According to Chawda (1978), experience is more useful than schooling. When experience and expertise are merged, agriculture progress and goal achievement are accelerated. Gyampoh *et al.* (2009) go on to say that traditional knowledge and techniques that have been acquired over time through experience and verbally passed down from generation to generation have been crucial in resolving farming issues in rural Ghana. Seleti and Tlhompho (2014) discovered that integrating community or Indigenous knowledge systems (IKS) from women and scientific knowledge can be beneficial for creating agricultural technologies for South Africa's rural areas.

6.3.1.8 Qualifications related to agriculture

The results of the study presented in Table 6.8 show that 90.38% of the respondents did not have any formal qualification related to agriculture, and 7.69% had certificates related to agriculture, and 1.92% had other qualifications. Although the majority of respondents do not have any formal qualification related to agriculture, the experiences gained does not put them at a disadvantage.

Table 6.8 Qualifications related to agriculture

Qualification	Number of respondents	%	Cum.%
Certificate	4	7.69	7.69
Other	1	1.92	8.62
None	47	90.38	100.00
Total	52	100.00	

According to Mazia (2013), smallholder farmers' lack of education continues to be a significant barrier to their adoption of modern farming practices in Kwazulu-Tugela Natal's Ferry Irrigation Scheme. However, Padhy and Jena (2015) observed that education and training can broaden farmers' perceptions and improve their attitudes.

Similarly, to this, Mazia (*ibid*) added that farmers with higher levels of education were more likely to adopt new technologies. According to Xaba and Masuka (2013), every additional year of schooling will boost the profitability of vegetable cultivation in Swaziland by E0, 304. This is true in that individuals with higher levels of education are more likely than those with lower levels of education or no education at all to analyse and interpret information. According to the study by Oduro-Ofori *et al.* (2014), education is crucial for increasing agricultural productivity because it helps farmers become more knowledgeable, provides them with practical training, and improves their farming techniques. Informal education also helps farmers stay up to date on innovations and new ideas.

6.3.1.9 Number of dependents

The results presented in Table 6.9 show that 42.31% of the respondents had dependents of 5-6, and 28.85% had 3-4 dependents, the 17.31% had 7-8 dependents, and those with 1-2" and >9 dependents are 5.77% each. The results also show that the families are not small and family members can assist with labour required in the production and sale of vegetables especially during school holidays.

Table 6.9 Number of dependents

Number	Number of respondents	%	Cum.%
1-2	3	5.77	5.77
3-4	15	28.85	34.62
5-6	22	42.31	76.92
7-8	9	17.31	94.23
> 9	3	5.77	100.00
Total	52	100.00	

According to Olayemi (2012), the more dependents there are per household in Osun state, Nigeria, the more likely it is that they will be exploited as a source of manual labour for family farms. On the other hand, larger families often have a negative effect on food security in the household and are significantly linked to far higher risks of poverty. In other words, large families will have an impact on both the amount of food consumed and the nutritional health of each member of the family. However, Haq *et al.* (2010) claimed that having a big family size is a symptom that the local ecosystem and land are deteriorating due to having too much access to natural resources.

It is generally accepted that big family sizes result in high human population levels, which will subsequently deplete natural resources and reduce the ability of ecosystems to maintain life.

The study's findings revealed that experience and education levels of farmers in the study area may facilitate adoption of climate mitigation strategy towards a sustainable food supply.

6.3.2 Climate change perceptions and adaptability

This section presents the results on how the respondents view climate and how they adapt to effects of climate change. The scope of the results covers among others, climatic factors, impact of climate change on vegetables, respondent's ability to adapt to climate change, changes brought by climate changes and how they impact on food supply.

6.3.2.1 Climatic factors affecting vegetables

In Table 6.10 the 9.62% of the respondents indicated high temperatures, drought, too excessive rainfall, and low temperatures as the main climatic factors affecting vegetable production in the study area, and 42.31% indicated high temperatures, while 32.69% indicated drought, and 13.46% indicated too much rainfall, and 1.92% indicated low temperatures. Although these are the factors that cannot be controlled, it is pleasing to note that the respondents understand the factors and their impact. All that is needed is to adapt. Increased temperatures, according to Rasul *et al.* (2021), will impact the physiological processes required for crop growth and development, and the final crop output is expected to decrease.

Table 6.10 Climatic factors affecting vegetables

Factor	Number of respondents	%	Cum.%
Too much rainfall	7	13.46	13.46
Drought	17	32.69	46.15
Higher temperatures	22	42.31	88.46
Low temperatures	1	1.92	90.38
All the above	5	9.62	100.00
Total	52	100.00	

According to research by Pramanik *et al.* (2020), when lettuce plants are subjected to warmer temperatures, they prematurely blossom and produce seeds without developing heads. In a similar vein, Pramanik *et al.* (*ibid*) additionally stated that desiccation will occur in several vegetables at temperatures exceeding 40°C.

6.3.2.2 Impact of climate change

The study results in Table 6.11 show that 53.85% of the respondents indicated that crop diseases came as a result of the impact of climate change, and 19.23% indicated pests, the 3.77% soil erosion, 1.92% loss of soil fertility and 1.92% vegetable failure while the 17.31% indicated that all the above. The farmers have to adapt in order to cope with the climate change impact.

Table 6.11 Impact of climate change

Impact	Number of respondents	%	Cum.%
Crop diseases	28	53.85	53.85
Soil erosion	3	5.77	59.62
loss soil fertility	1	1.92	61.54
Pests	10	19.23	80.77
Vegetable failure	1	1.92	82.69
All the above	9	17.31	100.00
Total	52	100.00	

Pests and diseases are the main frequent obstacles to smallholder farmers' ability to produce vegetables, according to Phophi and Mafongoya (2017). These obstacles prevent farmers from increasing crop yields and sustaining food security.

6.3.2.3 Ability to adapt to climate change

In terms of farmers' ability to adapt to the impact of climate change, the results presented in Table 6.12 show that majority of the respondents (65.38%) indicated that their ability is at moderate level, the 19.23% are at low level and 15.38% are at high level. The level of adaptation to climate change in the study area is impressive because the respondents have moderate to high level ability.

Table 6.12 Ability to adapt to climate change

Ability	Number of respondents	%	Cum.%
Low level of ability	10	19.23	19.23
Moderate level of ability	34	65.38	84.62
High level of ability	8	15.38	100.00
Total	52	100.00	

Farmers from nations with limited economic resources, low levels of technology, poor infrastructure, inadequate knowledge, and skills, and unstable or weak institutions, according to Smit and Pilifosova (2018), have little ability to adapt to climate change and are very vulnerable. However, according to a study by Mwaniki (2016), Kanyan farmers are likely to undertake climate change interventions regardless of their age, gender, level of education, or income.

6.3.2.4 Land degradation factors due to climate change

As presented in Table 6.13, the 88.46% of the respondents rate decrease in quality of irrigation water, decrease in soil fertility and increased soil erosion as factors that lead to land degradation due to climate change in the last ten years, and 7.69% indicated that it decreased only in terms of soil fertility, the 1.92% rate quality of irrigation water and 1.92% increased soil erosion. Most of the respondents are knowledgeable about the factors that cause land degradation due to climate change.

Tilahun and Zewide (2021) estimate that each year, climate change causes roughly 20% of the world's farmed regions and millions of hectares of land to degrade. According to Kumar and Das (2014), loss of soil fertility, increased soil erosion, and increased soil acidification are only a few of the many signs of land degradation.

Table 6.13 Land degradation factors due to climate change

Factor	Number of respondents	%	Cum.%
Decreased Quality of Water	1	1.92	1.92
Decreased Soil Fertility	4	7.69	9.62
Increased Soil Erosion	1	1.92	11.54
All of the above	46	88.46	100.00
Total	52	100.00	

6.3.2.5 Unfamiliar climatic events

The results of the study in Table 6.14 show that, 86.54% view drought, high temperatures, and more pests as rare events observed over the past ten years as a result of climate change. The 7.69% indicated high temperature and 3.85% indicated drought, while 1.92% indicated more pests. Although these events come occasionally, the respondents are aware of them, and they develop strategies to adapt, assisted by Government and other institutions.

Table 6.14 Unfamiliar climatic events

Event	Number of respondents	%	Cum.%
Drought	2	3.85	3.85
Higher temperatures	4	7.69	11.54
More pests	1	1.92	13.46
All the above	45	86.54	100.00
Total	52	100.00	

According to Ayyogari *et al.* (2014), crop failures, low yields, decreased crop quality, and an increase in pest and disease issues are frequent under changing climatic conditions and make vegetable farming unprofitable. Prasad and Chakravorty (2015)'s findings that higher temperatures and dry circumstances can inhibit tomato fruit set and onion and okra seed germination, respectively, lend credence to this research.

6.3.2.6 Changes in summer rainfall

The study as presented in Table 6.15 had found that majority of respondents (61.54%) indicated that they experienced a slight decrease in rainfall patterns in summer over the past ten years as a result of climate change, and 19.23% indicated a significant decrease in summer rainfall, 9.62% indicated slight increase and 9.62% indicated significant decrease. Most of the respondents are citing the decrease in summer rainfall patterns.

Table 6.15 Changes in summer rainfall

Change	Number of respondents	%	Cum.%
Slight increase	5	9.62	9.62
Slight decrease	32	61.54	71.15
Significant increase	5	9.62	80.77
Significant decrease	10	19.23	100.00
Total	52	100.00	

According to Roffe and Fitchett (2020) 's research, the Hadley cell's growth and the steady relocation of the major climatic systems responsible for South Africa's summer rainfall are to blame for the low rainfall totals.

6.3.2.7 Adaptation to changes in summer rainfall

The results of the study presented in Table 6.16 show that 53.85% of respondents use drought resistant vegetables to adapt to change of rainfall patterns in summer, and 36.54% irrigated frequently to adapt to that change, and 5.77% use contour ridges for control of soil erosion and water harvesting, the 1.92% use raised beds and 1.92% use all the above. It is noticeably clear that farmers in the study area are capable of adapting plants to changes in summer rainfall.

Different vegetable cultivars have different mechanisms of tolerating water deficits. In contrast, other vegetables would tolerate drought by maintaining high tissue water potential in the event of soil water shortages, according to Kumar *et al.* (2012). Some vegetables have the capacity to grow quickly and complete their lifecycle earlier before the development of serious soil water deficits. Ly (2022) discovered that while certain crops can enhance cell flexibility and decrease cell size, others can build deep root systems to withstand heat and low water levels. De Peyster (2016) asserts that some varieties might use less water than others.

Table 6.16 Adaptation to changes in summer rainfall

Method	Number of respondents	%	Cum.%
Use of Drought resistant crops	28	53.85	53.85
Use more irrigation	19	36.54	90.38
Use of raised beds	1	1.92	92.31
Use of contour ridges	3	5.77	98.08
All the above	1	1.92	100.00
Total	52	100.00	

6.3.2.8 Changes in pest infestation

The study results presented in Table 6.17 show that 61.54% of the respondents indicated that there were increase in pest infestation on vegetables that has come as a result of climate change over the past ten years, and 19.23% indicated other in levels of pest infestation as a result of the impact of climate change, the 9.62% indicated no change in pest attack because of climate change, also 9.62% indicated decrease in pest infestation.

Table 6.17 Changes in pest infestation

Change	Number of respondents	%	Cum.%
No changes	5	9.62	9.62
Increased pest infestation	32	61.54	71.15
Decreased pest infestation	5	9.62	80.77
Other	10	19.23	100.00
Total	52	100.00	

Vegetable production in Kenya is typically constrained by insect pests and diseases, according to Macharia *et al.* (2013) and Macharia (2015). This claim is corroborated by Abang *et al.* (2014) 's research, which emphasised that pests, and caterpillars are the main obstacles to the growth of several vegetable crops. According to Sithanantham *et al.* (2005), caterpillar pests could account for 70–90% of Eastern African crops' losses.

6.3.2.9 Adaptation to pest infestation

The results of the study presented in Table 6.18 show that 61.54% of the respondents have seen an increased use of pesticides to adapt to pest infestation, 9.62% decreased use of pesticides, 9.62% use of pest resistant vegetables, and 19.23% indicated others.

Table 6.18 Adaptation to pest infestation

Method	Number of respondents	%	Cum.%
Decreased use of pesticides	5	9.62	9.62
Increased use of pesticides	32	61.54	71.15
Use of pest resistant vegetables	5	9.62	80.77
Other	10	19.23	100.00
Total	52	100.00	

A class of chemicals known as pesticides guard crops by eliminating insects and pests. When pesticides are employed, crop losses may decrease by 35-42%, according to Sitaramaraju *et al.* (2014). However, Mahmood *et al.* (2016) found that excessive pesticides use has a negative influence on the ecology and may even cause the extinction of species because most pesticides kill unintended creatures. In a similar vein, Sitaramaraju *et al. (ibid)* indicated that insect resistance may develop as a result of repeated pesticides use. When pesticides are used excessively or improperly, Phophi and Mafongoya (2017) found that they can potentially have a negative impact on one's health.

6.3.2.10 Changes in growing season

The results in Table 6.19 show that 46.15% realised a decrease in the length of growing season during the past 10 years, and 38.46% realised an increase in growing season, the other (13.46%) indicated that they realised none in terms of the length of the growing season and 1.92% realised other changes.

According to Edoga (2007), the length of the growing season is calculated by deducting the beginning and ending dates of the rainy season. The length of the growing season, in the opinion of Haruna and Murtala (2019), is the period during which rainfall distributions are optimal for crop germination and full development. In a different interpretation, the growing season, according to EPA (2016), is the period during which plants grow.

Table 6.19 Changes in growing season

Change	Number of respondents	%	Cum.%
None	7	13.46	13.46
Longer growing season	20	38.46	51.92
Shorter growing season	24	46.15	98.08
Other	1	1.92	100,00
Total	52	100.00	

6.3.2.11 Adaptation to changes in growing season

In terms of adaptability on the change of the length of growing season presented in Table 6.20, the 67.31% indicated that they grow short season vegetables, and 21.15% grow vegetables all year round. Those who grow long season vegetables and other responses are 5.77% each.

Table 6.20 Adaptation to changes in growing season

Method	Number of respondents	%	Cum.%
Grow vegetables all year round	11	21.15	21.15
Grow short season vegetables	35	67.31	88.46
Grow long season vegetables	3	5.77	94.23
Other	3	5.77	100.00
Total	52	100.00	

In comparison to cultivars that take a long time to mature, short season vegetables allow the farmer to harvest from the plants over a much longer period (Walker, 2017). However, a prolonged growing season can enable the farmer to produce a variety of crops or reap many harvests from the same field (EPA, 2016).

6.3.2.12 Changes in winter temperatures

The results in Table 6.21 show that 80.77% of the respondents noticed increased winter temperatures over the past decade, and 17.31% noticed a decrease, and 1.92% did not notice anything.

Table 6.21 Changes in winter temperatures

Change	Number of respondents	%	Cum.%
None	1	1.92	1.92
Increased temperatures	42	80.77	82.69
Decreased temperatures	9	17.31	100.00
Total	52	100	

6.3.2.13 Adaptation to changes in winter temperatures

In terms of adaptation to winter temperatures as presented in Table 6.22, majority of the respondents (67.31%) indicated that they grow cool season vegetables, 25.92% grow frost tolerant crops for that purpose and 5.77% grow crops under cover.

Table 6.22 Adaptation to changes in winter temperatures

Method	Number of respondents	%	Cum.%
Grow cool season vegetables	35	67.31	67.31
Grow frost tolerant vegetables	14	26.92	94.23
Grow vegetable under cover	3	5.77	100.00
Total	52	100.00	

Cool season vegetables including carrot, cabbage, broccoli, spinach, Swiss chard, and green lettuce, according to Kolech and Tiruneh (2010), make significant contributions to the human diet as sources of vitamin A, which is necessary for the health of the skin and other tissues.

6.3.2.14 Changes in summer temperatures

The results of the study presented in Table 6.23 show that 90.38% of the respondents noticed an increase in summer temperatures as a result of climate change, and 5.77% noticed a decrease and 3.85% no changes.

Table 6.23 Changes in summer temperatures

Change	Number of respondents	%	Cum.%
No changes	2	3.85	3.85
Summer temperature increased	47	90.38	94.23
Summer temperature decreased	3	5.77	100.00
Total	52	100.00	

According to Prasad and Chakravorty (2015), higher temperatures can significantly diminish tomato yields and result in lower-quality fruits. Increased temperatures, according to Rasul *et al.* (2021), will impact the physiological processes required for crop growth and development, and the final crop output is expected to decrease. Pramanik *et al.* (2020) 's studies showed that increased temperatures cause lettuce plants to prematurely blossom and produce seeds without developing heads. Similarly, to this, Pramanik *et al.* (*ibid*) added that desiccation in many vegetables will occur at temperatures exceeding 40°C.

6.3.2.15 Adaptation to changes in summer temperatures

The results of the study in Table 6. 24 shows that 34.62% of the respondents increase the rate of irrigation in response to the increase in summer temperatures, and 28.85% increase the irrigation frequencies, while 26.92% use temperature resistant crops, and 9.62% grow vegetables under cover.

Table 6.24 Adaptation to changes in summer temperatures

Method	Number of respondents	%	Cum.%
Grow undercover crops	5	9.62	9.62
Increase irrigation rate	18	34.62	44.23
Increases irrigation frequencies	15	28.85	73.08
Grow temperature resistant crops	14	26.92	100.00
Total	52	100.00	

Ezekiel *et al.* (2012) claim that irrigation has made it feasible to produce greater and more consistent yields in arid and semi-arid locations, where crop productivity without irrigation is unavoidable. On the other hand, Mitra *et al.* (2015) discovered that pumping irrigation water from rivers during droughts causes streamflow levels to drop, which then results in water scarcity. Like the previous point, it has been found that excessive irrigation using the ground water aquifer can not only lower ground water levels but can also reduce streamflow levels at locations where the stream and aquifer are connected.

6.3.2.16 Local authorities' concern

The study results as presented in Table 6.25 show that 92.31% of the respondents indicated that their local authorities were concerned about the damage to the environment by veld fires, soil mining and tree cutting, and 7.69% of them indicated that they seemed not to be concerned at all.

Table 6.25 Local authorities' concern

Response	Number of respondents	%	Cum.%
Yes	48	92.31	92.31
No	2	7.69	100.00
Total	52	100.00	

Traditional leaders have a variety of responsibilities in South Africa, some of which are important for the environment. Controlling access to land and natural resources is one of these duties. According to Mwalukomo (2008), in the past, grass weavers in Qwaqwa requested chiefs' approval before harvesting grass for whatever reason. Adu-Gyamfi (2011) asserts that the chief's responsibility in Ghana's Asante society is to guard and allot land to community members. The cultural consensus is that

because land will be handed to subsequent generations, human's usage of it is transient and not permanent.

The study's findings revealed that farmers in the study area have experienced negative impacts of climate change, and this may mean that farmers are struggling to produce vegetables under these conditions.

6.3.3 Strategies in response to climate change

This section presents the results of different strategies adopted by the respondents in response to various climatic factors. The scope of the work covers among others, the use of weather forecast in vegetable production, sources of weather information, climate smart technologies used, water saving technologies and how they impact on food supply.

6.3.3.1 Importance of weather and climate forecast

In Table 6.26 the results show that 57.69% of the respondents indicated that climate and weather forecast help farmers to plan on the appropriate vegetable production planting dates, and 17.31% indicated that it helps them make choices in terms of vegetable varieties one should plant for higher production, while 13.46% of the respondents indicated that it helps to project rainfall distribution and 7.69% indicated that it is used for the projections of temperature variations and 3.85% indicated that all the above are relevant in all respect. Planting time is one of the most important decisions that vegetable producers need to make, since it affects yield, pest's infestation, season of harvest and market price.

Table 6.26 Importance of weather and climate forecast

Importance	Number of respondents	%	Cum.%
Planning planting dates	30	57.69	57.69
Make choices on vegetable varieties	9	17.31	75.00
Project rainfall distribution	7	13.46	88.46
Project temperature variations	4	7.69	96.15
All the above	2	3.85	100.00
Total	52	100.00	

According to research by Budathoki *et al.* (2004), onion sets planted in Nepal on July 26th generated the greatest average marketable onion bulb per plot. In a different

interpretation, Mollah *et al.* (2015) discovered that planting onions in Bangladesh on November 15th resulted in the highest seed output and highest quality seed harvest. According to research by Islam *et al.* (undated), planting grafted tomato plants in Bangladesh on October 20th resulted in the lowest bacterial wilt and maximum production.

6.3.3.2 Source of information on climate and weather

Regarding the respondents' source of information related to climate change and weather forecast as presented in Table 6.27, the majority (84.62%) of the respondents use radio and television as their main source information, 9.62% use extension officers to guide them in that regard, and for the 5.77% other sources play a role.

Table 6.27 Source of information on climate and weather

Source	Number of respondents	%	Cum.%
Radio and TV	44	84.62	84.62
Extension officers	5	9.62	94.23
Other	3	5.77	100.00
Total	52	100.00	

6.3.3.3 CSA technologies applied

The results presented in Table 6.28 show that majority of respondents (71.16%) use crop rotation as Climate-Smart Agriculture (CSA) to counter against impact of climate change, and other farmers use various methods: - mixed cropping (1.92%), mulching (5.77%), no till (1.92%), crop residue (7.69%) as cover, contour planting (9.62%) and other (1.92%). Crop rotation is regarded as a major practice that assists in reducing recurrent of diseases and pest.

Table 6.28 CSA Technologies applied

Technology	Number of respondents	%	Cum.%
Crop rotation	37	71.16	71.16
Mixed cropping	1	1.92	73.08
Mulching	3	5.77	78.85
No till	1	1.92	80.77
Crop residue	4	7.69	88.46
Contour planting	5	9.62	98.08
Other	1	1.92	100.00
Total	52	100.00	

Crop rotations, according to Power (1987), disrupt the weed and insect cycles that are frequently linked to monoculture, reduce the population and activity of some pathogenic soil organisms, improve air-water interactions in the soil, and may even improve soil structure. According to Hoorman *et al.* (2009), legume crops like peas and beans are included in crop rotations to provide nitrogen because of their natural ability to fix atmospheric nitrogen into a form that can be used by future crops. Crop rotation had a substantial impact on aggregate soil stability, total nitrogen, total organic carbon, total basal respiration, total microbial biomass, total organic carbon, and total active carbon, according to Aziz *et al.* (2011) 's study.

6.3.3.4 Technologies for increased productivity

The results of the study presented in Table 6.29 show that 51.92% of the respondents use hybrid seeds, pesticides, and fertilisers in terms of the CSA technologies to improve vegetable productivity, and 23.08% use hybrid seeds, while 13.46% use pesticides, and 11.54% use fertilisers. The increase in crop productivity assists in generation of more income and improved food security.

Table 6.29 Technologies for increased productivity

Technology	Number of respondents	%	Cum.%
Use hybrid seeds	12	23.08	23.08
Use pesticides	7	13.46	36.54
Use fertilisers	6	11.54	48.08
All the above	27	51.92	100.00
Total	52	100.00	

6.3.3.5 CSA Soil fertility technologies

About 52.00% of the respondents as reflected in Table 6.30, use manure for soil fertility as CSA technology for vegetables, and 36.54% plough back the plant residue, 7.69% use mulching and 3.85% use all of the above for higher production output.

Table 6.30 CSA soil fertility technologies

Technology	Number of respondents	%	Cum.%
Plough back plant residues	19	36.54	36.54
Add manure	27	51.92	88.46
Mulching	4	7.69	96.15
All the above	2	3.85	100.00
Total	52	100.00	

According to the findings of a study conducted by Dikinya and Mufwanzala (2010), the application of chicken manure results in a significant increase in exchangeable bases (ECs), nitrogen, and phosphorus, which in turn increases soil fertility. Gyapong and Ayisi (2015) also stated that applying manure to the soil is an efficient and effective method for halting the loss of nutrients through harvesting, runoff, erosion, leaching, and other soil pathways. Iqbal *et al.* (2021) provide support for this assertion, stating that the slow release of nutrients in manure reduces the likelihood of nitrate leaching.

6.3.3.6 Types of fertilisers

In terms of types of fertilisers used in the study area the results presented in Table 6.31 shows that 63.46% of the respondents use both organic and inorganic fertilisers on their plots, 32.69% use inorganic and 3.85% use organic fertilisers.

Table 6.31 Types of fertilisers

Type	Number of respondents	%	Cum.%
Organic	2	3.85	3.85
Inorganic	17	32.69	36.54
All the above	33	63.46	100.00
Total	52	100.00	

The experiment by Samaranyake and Ulpathakumbura (2021) showed that the combination of organic and inorganic nitrogen on cucumbers increased plant growth, yield, and quality as well as soil fertility in Sri Lanka. As opposed to this, Samarayanake and Ulpathakumbura (*ibid*) made the case that using just organic fertilisers results in lower yields of cucumber, a variety of compositions, bulkiness, and high handling costs. But according to Farouque and Takeya (2007), increasing crop output and maintaining greater yields over time in Bangladesh require integrated soil fertility (ISF) and nitrogen management (NM). According to a study by Massah and Azadegan (2016), in Iran's Pakdasht region, using chemical fertilisers excessively in a single application for mono-cropping promotes compaction due to the build-up of mineral salts, the reduction of soil macro-pore size and number, and an increase in bulk density and penetration resistance.

6.3.3.7 Quantity of fertiliser applied

As presented in Table 6.32 the 46.15% of the respondents applied 300kg-500kg of fertiliser on vegetables per hectare, the 36.54% applied 100kg-200kg, the 5.77% were not sure and 11.54% applied others.

Table 6.32 Quantity of fertiliser applied

Quantity	Number of respondents	%	Cum.%
100-200kg	19	36.54	36.54
300-500kg	24	46.15	82.69
Not sure	3	5.77	88.46
Other	6	11.54	100.00
Total	52	100.00	

According to studies by Xaba and Masuka (2013), an increase in the quantity of fertilisers applied by 1 kg leads to an increase in the yield of onions and tomatoes per hectare of 0.634 kg and 0.477 kg, respectively. On the other hand, Savci (2012) contended that the excessive and careless use of chemical fertilisers will result in the environmental pollution in the form of soil salinity, the build-up of heavy metals, the accumulation of nitrate, water eutrophication, and the greenhouse effect as a result of air that is contaminated with nitrogen and sulphur.

6.3.3.8 Water saving technologies

The results in Table 6.33 show that 50.00% of the respondents use water harvesting as a way of water saving technology in their vegetable plots, the 17.31% use mulching, the 13.46% use a recommended plant spacing, the 11.54% use irrigation technology, the 3.85% use all of the above, 1.92% use pit planting", and 1.92% use other. Observations are that majority of the farmers use water from dams.

Table 6.33 Water saving technologies

Technology	Number of respondents	%	Cum.%
Mulching	9	17.31	17.31
Water harvesting	26	50.00	67.31
Pit planting	1	1.92	69.23
Irrigation technology	6	11.54	80.77
Plant spacing	7	13.46	94.23
Other	1	1.92	96.15
All above	2	3.85	100.00
Total	52	100.00	

Water harvesting is the activity of gathering and storing water for beneficial uses from diverse sources (Bocek *et al.*, 2002). According to the report by Balooni *et al.* (2008) water harvesting, in the form of check dams, reportedly helps farmers in Kerala State of India overcome their water shortage during the summer irrigation season. This research is backed up by Jain (2019), who reaffirmed that Gujara's water harvesting through check dams reduces the need for water from subterranean sources and makes it possible for ground water levels to be sustained rather than reduced.

6.3.3.9 Methods of controlling soil erosion

The results presented in Table 6.34 show that 59.62% of the respondents use ridges/terraces to control soil erosion, 30.77% use contour planting, 5.77% use grass strips and 3.85% used other methods.

Table 6.34 Methods of controlling soil erosion

Method	Number of respondents	%	Cum.%
Ridges/terraces	31	59.62	59.62
Contour planting	16	30.77	90.38
Grass strips	3	5.77	96.15
Other	2	3.85	100.00
Total	52	100.00	

Due to its ability to reduce runoff, soil loss, and nutrient loss in Southern Mali, Traore and Birhanu (2019) discovered that contour ridge tillage (CRT) is a better method of managing soil and water than conventional tillage. In the Sichuan Basin of China, Zhang *et al.* (2004) found that downslope contour ridge tillage might reduce soil erosion by 84% as opposed to downslope flat tillage's 77% reduction.

6.3.3.10 Experience in CSA technologies

In terms of experience of farmers using CSA technologies as shown in Table 6.35 the 34.62% of the respondents have 5-10 years of experience, the 28.85% have more than 20 years, the 26.92% have 11-15 years and the 9.62% have less than 5 years. CSA experience in the study area ranges from 5- 20 years, which shows that the respondents are well vested with CSA technologies. However, the respondents may have been employing these technologies unaware that they have to do with CSA.

Table 6. 35 Experience in CSA technologies

Experience (yrs)	Number of respondents	%	Cum.%
< 5 years	5	9.62	9.62
5-10 years	18	34.62	44.23
11-15 years	14	26.92	71.15
> 20 years	15	28.85	100.00
Total	52	100.00	

According to Barkai and Levhari (1973), efficiency and experience are positively correlated with agricultural yield. Ainembabazi and Mugisha (2013) 's study findings showed that farming expertise is most valuable in the early phases of adopting a specific technology, while farmers are still assessing its potential benefits until they are convinced that the benefits justify the efforts invested.

6.3.3.11 Risks posed by climate change

The results of the study presented in Table 6.36 show that 36.54% of the respondents indicated that the risks posed by climate change on vegetables includes reduced yield, the 32.69% indicated a decline in the amount of rainfall, the 11.54% indicated floods, and the 13.46% rise in temperature, while 5.77% indicated that all of the above. The risks identified in the study area confirm the impact of climate change already outlined in the early section of this chapter.

Table 6.36 Risks posed by climate change

Risk	Number of respondents	%	Cum.%
Reduced yield	19	36.54	36.54
Decline in rainfall	17	32.69	69.23
Floods	6	11.54	80.77
Rise in temperature	7	13.46	94.23
All the above	3	5.77	100.00
Total	52	100.00	

Scheelbeek *et al.* (2018) found that the increasing ambient temperature, salt, and decreased water availability due to climate change all result in lower yields of vegetables and legumes. Schlenker and Roberts (2006) lending support to this finding, reaffirmed that vegetable yields will rise up to the optimal temperature, but temperatures above the thresholds quickly become damaging and that the slope of

yield drop above the optimum temperature is substantially higher than the incline below it.

6.3.3.12 Management of risks

In terms of managing risks as presented in Table 6.37 the 63.46% of respondents indicated that they use crop diversification to minimise the risks posed by climate change, the 34.62% use hybrid seeds, 1.92% used other.

Table 6.37 Management of risks

Response	Number of respondents	%	Cum.%
Diversification	33	63.46	63.46
Use hybrid seeds	18	34.62	98.08
Other	1	1.92	100.00
Total	52	100.00	

According to research by Sheereen and Banu (2016), crop diversification was seen as one of the key strategies for reducing risks and eradicating food poverty in India. Hile *et al.* (2016) lending support to this finding, reaffirmed that sustainable diversified agricultural systems are considered very profitable, and the right component diversity boosts productivity per unit area and lowers production costs in the Pune District of Maharashtra.

The study's findings revealed that farmers have strategies that they have adopted to mitigate and to cope with different climate change factors in a bid to develop a sustainable food supply.

6.4 Conclusions and recommendations

The objective of the study was to analyse climate change mitigation strategies adopted by small-scale farmers towards a sustainable vegetable production and resilient from food shortages.

Farmers in the study area have experienced negative impacts of climate change, this may mean that farmers are struggling to produce vegetables under these conditions. Farmers have strategies that they have adopted to mitigate and to cope with different climate change factors in bid to develop a sustainable food supply.

Experience and education levels may facilitate adoption of climate mitigation strategy towards a sustainable supply.

The experience and education help farmers to mitigate climate change challenges related to crop adaptation to withstand a particular climatic condition and how to mitigate towards climate change or climate change effects in its broader sense. Although these farmers are doing their best to implement the mitigation strategies to continue producing vegetables, they need support from different stakeholders to enable them to respond without delay in the planning and implementation. Proper strategies to sustain vegetable production are needed. The Extension Service should introduce new technologies and innovations to farmers to be up to date with changes. This phenomenon is global and cannot be addressed by these farmers alone, these farmers are playing their part, and hence they need support through policy, training, resources and support from those in relevant positions.

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Chapter 7

The potential of African Indigenous Vegetables towards the formation of a commercial, nutritional, and sustainable production system in the Limpopo Province of South Africa

Abstract

The study was conducted in five villages, the three villages in Vhembe District, and two villages in Mopani District. The objective of the study was to assess the potential of African Indigenous Vegetables (AIVs) towards the formation of a commercial, nutritional and sustainable production system. A total of 53 small-scale vegetable farmers were randomly sampled using a multi-stage cluster sampling procedure. Sample size was calculated using Slovin's formula. Data was collected by means of a questionnaire and analysed using descriptive statistics. The study revealed that more women (64.15%) participated in the production of AIVs. The 54.72% of the respondents supplied AIVs all-year round. Some respondents (49.06%) grow AIVs for home consumption, while 64.15% are encouraged to grow AIVs because they are adapted to the area, easy to grow and have short growing period. About 60% of the respondents indicated that AIVs are highly consumed by adults and pregnant women in the families. The study revealed that 90.57% of the respondents could harvest and sell 1-2 tons of AIVs per season. About 57% of the respondents benefited from all types of markets, local, farm stalls and high value markets. The study showed that 86.79% of the farmers in the study area received support from the Department of Agriculture and Rural Development, in the form of advice, and production inputs. The results of the study confirm that there is a potential for the formation of a nutritional and a commercial production system from AIVs in the study area because the market of AIVs is growing.

Key Words: *African indigenous vegetables, commercial, nutritional, sustainable production system.*

7.1 Introduction

The strain on agriculture to produce more nutritious food in larger quantity from the planet's limited land resources is growing as global population continues to rise. According to Ebert (2014), the under-utilisation of many African indigenous vegetables (AIVs) may be the cause of the rising demand on African farmers to produce more and healthier food. In addition to being underutilised, African indigenous vegetables, according to Weinberger and Msuya (2004), are valuable because they may be used throughout the year in production systems. Similarly, it

has been discovered that African indigenous vegetables contain vitamins and minerals that are absent from most exotic vegetables (Okello *et al.*, 2015). This implies that their increased consumption can result in more sales revenues for the rural areas and less malnutrition among the rural poor households.

The objective of this chapter is to investigate the potential of AIVs towards the formation of a commercial, nutritional, and sustainable production system in the study area. The chapter presents among others the results on farmers' perceptions on AIVs, participation in market activities, production of AIVs, harvesting quantities, support accessibility and consumptions of AIVs.

7.2 Materials and methods

7.2.1 The study area

The study was carried out in the two villages of Thulamela Municipality, Vhembe District, namely, Tshiombo and Rambuda, one village of Musina Municipality, Vhembe District, namely, Ha-Gumbu and two villages of Greater Giyani Municipality, Mopani District, namely, Hlaneki and Guwela. This study area is referred to as area D.

Thulamela Municipality is in the northern part of Limpopo Province (coordinates latitude 22° 58' 15.87" S and longitude 30° 27' 38.67" E). The Municipality shares boundary in southeast with Collins Chabane Municipality while sharing the borders with Musina Municipality in the northeast and Makhado Municipality in the west. The Municipality covers an area of 5835km², which translates into 58 350ha in size (IDP, 2020/21-2022/23). The Municipality has a population of 602819 people (IDP, 2010/11-2012/13).

Greater Giyani Municipality is in the far north of Limpopo Province (with coordinates 23° 21' 58.756" S 30° 48' 14.209" E), and borders in the east with Kruger National Park and Ba-Phalaborwa on the west with Makhado and in the north with Thulamela local municipalities (IDP, 2021/2022). Greater Giyani local municipality covers an area of 4172km² or 41 720ha, and has a population of 256300 people (IDP, 2022/23)

Musina Municipality is in the northern part of Limpopo Province (coordinates 23° 20' 17" S 30° 02' 30" E), and is bordering Mozambique in the east, Botswana, and Zimbabwe in the north. The municipality is bounded by Makhado to the south,

Thulamela on the east and Blouberg municipality to the southwest (IDP, 2020/21). Musina local municipality covers an area of approximately 7577km², which translates into 75 770 ha, and has a population of 132009 people (IDP, 2021/22).

7.2.2 The sample

A total of 53 small-scale vegetable farmers were randomly sampled using a multi-stage cluster sampling procedures in which the stage one sampling was done at District level, stage two at the municipality level and third stage at the Agricultural Service Centres level. Chapter three showed how the sample was calculated from the population, using the Slovin's formula. Two Municipal Districts (Vhembe and Mopani) were purposively selected, and two Municipalities from Vhembe District were sampled, namely, Musina and Thulamela while one Municipality from Mopani District was sampled, namely, Greater Giyani. Data base of five villages (Tshiombo, Rambuda, Ha-Gumbu, Hlaneki and Guwela) was used to sample small-scale vegetable farmers. The 53 small-scale vegetable farmers for this objective, constituted about 20% of total number of farmers (261) who were interviewed. The 20% small-scale vegetable farmers were uniformly spread over the five objectives of this thesis.

7.2.3 Data collection and analysis

Data was collected by means of questionnaire through interviewing the 53 sampled small-scale farmers. Data collected was analysed using SPSS (2015).

7.3 Results and discussions

7.3.1 Demographical information

7.3.1.1 Participation by women

The results of the study as presented in Table 7.1 show that 64.15% of women in the study area participate in AIVs production, and their male counter parts were only 35.85%. The high number of women participating in AIV production is because of the deliberate empowerment Government policy that insists that women should be given priority in accessing agricultural activities. It was also noted that the participants in the study area are producing vegetables in Government-established irrigation schemes.

Table 7.1 Participation by women

Participation	N	%	Cum %
Male	19	35.85	35.85
Female	34	64.15	100.00
Total	53	100.00	

According to Deeksha (2014), if given the chance, women farmers may play a crucial role in promoting sustainable agriculture because they have rich experience with cropping patterns, irrigation, pest control, and soil management practices. Joshi (2018), who supports this notion, claimed that if women had the same access to productive resources as males, they could increase yield by 20–30% and increase agricultural output by 2.5% in underdeveloped nations.

7.3.1.2 Participation by youth

The study shows that there are more adults participating in AIVs production in the study area because the study results presented in Table 7.2 show that only 11.32% of the youth in age bracket of 18-35 years are participating in AIVs production. The situation of few youths participating in the production of vegetables begs a question of whether there will be anyone taking over the production of the vegetables when the elders reach a stage when physically they are unable to carry on with farming. There could be other factors that discourage the youth in this area to participate in the production of AIVs, such as other attractive opportunities that encourage them.

Table 7.2 Participation by youth

Age	N	%	Cum. %
18-21 years	1	1.89	1.89
26-30 years	2	3.77	5.66
31-35 years	3	5.66	11.32
36-40 years	6	11.32	22.64
41-44 years	4	7.55	30.19
45-54 years	17	32.08	62.26
55-60 years	20	37.74	100.00
Total	53	100.00	

According to the study results by Tarekegn *et al.* (2022), the main obstacles to youth engagement in agriculture in Southern Ethiopia are the seasonality of agricultural income, fear of risk and unpredictability in agriculture, and lack of starting capital.

According to Uwaoma (2018), Nigerian youth believed that farming was the domain of the poor, illiterate, elderly, and rural people, which was demeaning.

7.3.1.3 Participation by gender and age

Nowadays the Government policies supporting farmers are inclining in the support of youth and women. This confirms the results of the study presented in Table 7.3 which show that 61.15% of the respondents are women participating in the production of AIVs, and 56.61% of the elders are elderly women while only 11.33% are the youth in the 18-35 years age bracket.

Table 7.3 Participation by gender and age

Age (yrs)	Male		Female		Total	
	N	%	N	%	N	%
18-21 years	0	0.00	1	1.89	1	1.89
26-30 years	1	1.89	1	1.89	2	3.77
31-35 years	1	1.89	2	3.77	3	5.66
36-40 years	2	3.77	4	7.55	6	11.32
41-44 years	0	0.00	4	7.55	4	7.55
45-54 years	7	13.21	10	18.87	17	32.08
55-60 years	8	15.09	12	22.64	20	37.74
Total	19	38.85	34	61.15	53	100.00

7.3.1.4 Education status of the youth

The study results as presented in Table 7.4 revealed that majority of the respondents (50.94%) who have secondary qualifications are in their middle and old age, only 11.33% are in the youth bracket and have secondary education and diploma. The results of this study could be indicating that youth is not interested in practicing agriculture production. This could be due numerous factors such as other attractive career paths and the interest or desire to work in urban areas. This challenge could be addressed amongst other things by government encouraging more youth to take part on such programmes by awarding bursaries to those wanting to further their qualification in agriculture and also to encourage them by providing funding for the young farmers in agriculture.

Table 7.4 Education status of the youth

Age Yrs	None		Primary		Secondary		Diploma		Degree		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
18-20	0	0.00	0	0.00	1	1.89	0	0.00	0	0.00	1	1.89
26-30	0	0.00	0	0.00	1	1.89	1	1.89	0	0.00	2	3.77
31-35	0	0.00	0	0.00	1	1.89	2	3.77	0	1.92	3	5.66
36-40	0	0.00	0	0.00	6	11.32	0	0.00	0	0.00	6	11.32
41-44	0	0.00	0	0.00	0	0.0	0	0.00	0	0.00	0	0.00
45-54	0	0.00	0	0.00	3	5.66	1	1.89	0	0.00	4	7.55
55-60	0	0.0	2	3.77	10	18.87	3	5.66	2	3.77	17	32.08
>61	6	11.32	8	15.09	5	9.43	0	0.00	1	1.89	20	37.74
Total	6	11.32	10	18.87	27	50.94	7	13.21	3	5.66	53	100.00

According to Akamin *et al.* (2017), Cameroonian farmers who have at least completed secondary education are more effective at producing vegetables than those who have just completed primary education or none. This claim is corroborated by Xaba and Masuka (2013), who confirmed that each additional year of schooling will raise the profitability of vegetable cultivation in Swaziland by E0.304. This is true in that individuals with higher levels of education are more likely than those with lower levels of education or no education at all to analyse and interpret information.

7.3.1.5 Types of access to cultivated land

In the study area, there are three types of access to land, ownership, leasing and use of communal land. Access to land is very important in the production of vegetables and it was found that 92.45% have access to land through ownership. It is also noted that land owned is given to participants through PTO, and the land for communal use could be in danger because of unsecured tenure and may be taken away due to other demands for land. Unsecured tenure makes it difficult for farmers to access funding.

Table 7.5 Types of access to cultivated land

Type	N	%	Cum.%
Leasing	2	3.77	3.77
Own land	49	92.45	96.23
Communal	2	3.77	100.00
Total	53	100.00	

Land ownership affects agricultural output, according to Xaba and Masuka (2013), because landless farmers may be hesitant to maintain and develop their property.

According to a study by Gebreeyosus *et al.* (2019), farmers in Northern Ethiopia are more inclined to invest in conservation and land enhancement initiatives if they have some certainty that they are the legal owners of the land in question. This conclusion is corroborated by Kousar *et al.* (2015), who found that in rural Pakistan, secured property rights tend to increase per-capita spending and lower household poverty.

7.3.1.6 Access to land by gender

The results of the study presented in Table 7.6 show that majority of women (58.49%) have access to land ownership as compared to their male counterparts (33.96%), 3.77% females are leasing the land, 1.89% male lease and 1.89% produce on communal land. This is as a result of women empowerment in the area and opportunities created for these women to also access various forms of funding and support.

Table 7.6 Access to land by gender

Access	Gender				Total
	Male	%	Female	%	
Own land	18	33.96	31	58.49	92.45
Leasing	1	1.89	2	3.77	5.66
Communal	1	1.89	0	0.00	1.89
Total	20	37.74	33	62.26	100.00

According to Mishra and Sam (2016), having access to assets, like land in Nepal, gives women financial security and strengthens their negotiating power in the household, giving them more control over decisions that have an impact on their life (such as childbearing). This finding is corroborated by Valera *et al.* (2018), who discovered that women's participation in decisions regarding farming, livelihood, and household activities is positively impacted by their ownership of land titles in India.

In a different version, Hasanbasri *et al.* (2021) indicated that owning land in Sub-Saharan Africa might improve the wealth of future generations through inheritance, as well as make it easier to access the credit markets through usage as collateral, access to liquidity through rent and sale, and inheritance. According to USAID (2011),

children in land-owning households in Nepal are twice more likely to receive appropriate nutrition than children living in landless homes. Further evidence suggests that mothers who own land are better equipped to provide their children with healthier food and ensure their well-being.

7.3.1.7 Land size for vegetable cultivation

There are several schools of thoughts that argue that land size for production is important. Others argue that the bigger the size of land, the more production of produce or income, others argue that small land size is good because it is manageable and can be effectively utilised. These findings as presented in Table 7.7 shows that 64.15% are farming on an area of 1-2ha.

Table 7.7 Land size for vegetable cultivation

Size(ha)	N	%	Cum.%
0.5- 1ha	10	18.87	18.87
1-2ha	34	64.15	83.02
3-4ha	2	3.77	86.79
>5ha	7	13.21	100.00
Total	53	100.00	

According to research done by Sikwela and Mushunje (2013), in the Eastern Cape and KwaZulu Natal, the likelihood of being a member of the Farmer Support Programmes (FSP) improves as the amount of the allotted land increases up to a specific threshold. In other words, receiving funding from the FSP is biased in favour of smallholder farmers and is proportionately larger for larger farms.

7.3.1.8 Indigenous vegetables commonly grown in the area

Majority of the respondents (69.81 %,) as presented in Table 7.8 plant Okra, African night shade and mustard, and 16.98% only cultivate okra, 9.43% African night shade and 3.77% mustard. Besides the mentioned vegetable types, it was observed that in most of the road stalls, there are farmers who are also selling other vegetable types like pumpkin leaves and flowers as well as Amaranthus. It was observed that diversification of African indigenous vegetables is common in the study area.

Table 7.8 Indigenous vegetables commonly grown in the area

Type	N	%	Cum.%
Okra	9	16.98	16.98
African Night shade	5	9.43	26.42
Mustard	2	3.77	30.19
All above	37	69.81	100.00
Total	53	100.00	

According to research by Mango *et al.* (2018), households in central Malawi with higher crop diversification intensities are more likely to have a varied diet, are generally more secure in their food sources and income and can thus meet their households' food needs. According to Mango *et al.* (*ibid*), crop diversification increases food security by increasing the quantity and variety of food stocks as well as income through the sale of crops made from a variety of growing crop species, which in turn improves consumption habits.

7.3.1.9 Experience in vegetable farming

The respondents in the study area have experience in vegetable production ranging from 5 to 21 years as presented in Table 7.9. It can be concluded that the farmers in the study area are well experienced.

Table 7.9 Experience in vegetable farming

Experiences	N	%	Cum.%
< 5 years	7	13.21	13.21
5-10 years	15	28.30	41.51
11-15 years	7	13.21	54.72
16-20 years	6	11.32	66.04
>21 years	18	33.96	100.00
Total	53	100.00	

According to the findings of a study by Ainembabazi and Mugisha (2014), agricultural expertise in Uganda is mostly helpful in the early phases of adopting a particular technology, while farmers are still investigating its potential benefits until they are assured that the benefits justify the efforts invested.

According to Chawda (1978), experience is more beneficial than additional education, and the combination of experience and knowledge helps agriculture advance and achieve its goals. Guo *et al.* (2015) provided evidence to support their claim in

suggesting that older farmers in China who do not want to retire had higher agricultural productivity than younger farmers who intend to abandon farming. The reason for this is that older farmers have more production experience, whilst young farmers are more likely to work in non-agricultural businesses. Gyampoh *et al.* (2009) go on to say that traditional knowledge and techniques that have been acquired over time through experience and verbally passed down from generation to generation have been crucial in resolving farming issues in rural Ghana.

7.3.1.10 Qualifications related to agriculture

Most of the respondents (94.34%) have no qualifications related to Agriculture, 1.89% have a certificate and 3.77% other qualifications. Table 7.10 reflects the findings of the study. Despite the qualifications related to agriculture, the respondents are well experienced as they have an experience of 5 years and above. During these years they might also have undergone a lot of training.

Table 7.10 Qualifications related to agriculture

Qualification	N	%	Cum.%
Certificate	1	1.89	1.89
Other	2	3.77	5.66
None	50	94.34	100.00
Total	53	100.00	

Gowda and Dixit (2015) discovered that farmers in the southern Indian state of Karuataka who had higher educational levels understood advisories better, responded to them more quickly, and shared information with other farmers more frequently than those who had lower levels of education.

According to Xaba and Masuka (2013), every additional year of schooling would result in an increase of E0.304 in the profitability of vegetable production in Swaziland. This is true because individuals with higher levels of education are more likely than those with lower or no levels of education to analyse and understand information. According to the study by Oduro-Ofori *et al.* (2014), education is crucial for increasing agricultural productivity because it helps farmers become more knowledgeable, provides them with practical training, and improves their farming

techniques. Informal education also helps farmers stay up to date on innovations and new ideas.

7.3.1.11 Number of dependants

Majority of respondents (45.28%) have 5-6 dependants and 16.98% have more than 9 dependants, 13.21% have 7-8 dependants, 15.09% have 3-4 dependants and 9.43% had 1-2 dependants as presented in Table 7.11. The higher the number of dependents, the higher the likelihood of using extra hands for production of vegetables.

Table 7.11 Number of dependants

Dependants	N	%	Cum.%
1-2	5	9.43	9.43
3-4	8	15.09	24.53
5-6	24	45.28	69.81
7-8	7	13.21	83.02
>9	9	16.98	100.00
Total	53	100.00	

The more dependents there are per household in Osun state, Nigeria, according to Olayemi (2012), the more likely it is that they will be exploited as a source of manual labour in family farming. On the other hand, larger families often have a negative influence on household food security and are significantly linked to far higher risks of poverty. In other words, large families will have an impact on both the amount of food consumed and the nutritional health of each member of the family. However, Haq *et al.* (2010) claimed that having a big family size is a symptom that the local ecosystem and land are deteriorating due to having too much access to natural resources. It is generally accepted that big family sizes result in high human population levels, which will subsequently deplete natural resources and reduce the ability of ecosystems to maintain life.

The implication of a low number of youths in the study area is that there may be a problem in the takeover or continuation of AIVs production. It is not clear why youth is not participating in large numbers.

7.3.2 Farmer's perception on indigenous vegetables

This section presents the results of farmer's views about AIVs. The scope of the work covers among others, sources of information regarding AIVs, knowledge of AIVs, Characteristics of AIVs, factors encouraging farmers to grow AIVs, and their impacts on the development of a sustainable, nutritional and commercial production system.

7.3.2.1 Source of information regarding African Indigenous Vegetables

As presented in Table 7.12, the majority of the respondents (69.81%) indicated that agricultural extension is the main source of relevant information on the cultivation of AIVs. About 20.75% of them get information from the radio broadcasting on matters related to agricultural production, 1.89% from the health officials and 7.55% from other sources.

Table 7.12 Source of information regarding AIVs

Source	N	%	Cum.%
Radio	11	20.75	20.75
Health official	1	1.89	22.64
Agriculture Extension	37	69.81	92.45
Other	4	7.55	100.00
Total	53	100.00	

Agriculture extension service, in accordance with Danso-Abbeam *et al.* (2018), is one of the key systems for addressing rural poverty and food insecurity because it could transfer technology, support rural adult learning, help farmers solve problems, and engage farmers actively in the agricultural knowledge and information system. According to research by Lee *et al.* (2020), efficient agricultural extension services have a considerable impact on crop production, gross domestic product, and profitable activities in Uganda's rural areas. Similarly, to this, research by Raidimi and Kabiti (2019) found that agricultural extension can support long-term food security by educating farmers and enabling them to make educated choices.

7.3.2.2 The growing cycle of AIVs

Four weeks is regarded as the main growing cycle for AIVs as indicated by the majority of the respondents (69.81%) in the study area, 24.53% indicated 3 weeks as

the growing cycle, 3.77% indicated two months and 1.89% indicated others as reflected in Table 7.13.

Table 7.13 The growing cycle of AIVs

Cycle	N	%	Cum %
3 weeks	13	24.53	24.53
4 weeks	37	69.81	94.34
>2 months	2	3.77	98.11
Others	1	1.89	100.00
Total	53	100.00	

7.3.2.3 Knowledge about AIVs

Majority of respondents (94.34%) have knowledge about AIVs, and 1.89% have less knowledge as reflected in Table 7.14. It is the opinion of the researcher that these farmers are best positioned to adopt advanced technologies about AIVs.

Table 7.14 Knowledge about AIVs

Response	N	%	Cum%
Less	1	1.89	1.89
Moderate	29	54.72	56.61
High	21	39.62	96.23
Non	2	3.77	100.00
Total	53	100.00	

According to Florianczyk *et al.* (2012)'s study, the efficiency of Polish farmers is highly correlated with knowledge. The findings demonstrate that farmers who have had more formal agricultural training typically operate larger farms with greater revenues (Florianczyk *et al.*, *ibid*).

7.3.2.4 Characteristics of AIVs

About 57% of respondents indicated that AIVs are adapted to various climatic conditions and different soil types as reflected in Table 7.15. The results of the study show that farmers in the study area are well informed about the characteristic of AIVs.

Table 7.15 Characteristics of AIVs

Characteristics/Response	N	%	Cum%
Difficult to grow	6	11.32	11.32
Easy to grow	15	28.30	39.62
Poorly adapted	2	3.77	43.39
Well adapted	30	56.60	100.00
Total	53	100.00	

According to Khan and Khan (2014), in order to have a sustainable vegetable output, vegetables should be produced in the locations that, according to a land suitability analysis, are most suited for their growth. According to Jain *et al.* (2020), vegetable production should be driven by the compatibility of biophysical and irrigation characteristics rather than the suitability of socioeconomic elements in order to maintain a stable ecosystem.

7.3.2.5 Factors encouraging farmers to grow AIVs

Majority of respondents (64.15%) as presented in Table 7.16 are encouraged to grow AIVs because they have short growing season, are easy to grow, well adapted, there is a good market and are good vegetables.

Table 7.16 Factors encouraging farmers to grow AIVs

Response	N	%	Cum.%
Short growing season	5	9.43	9.43
Easy to grow	3	5.66	15.09
Well adapted	1	1.89	16.98
Good Market	7	13.21	30.19
Good vegetables	3	5.66	35.85
All above	34	64.15	100.00
Total	53	100.00	

According to Bullock *et al.* (2000), the existence of farmer's markets helps small vegetable growers maintain their businesses and can also provide them with a higher profit than selling to wholesalers, food processors, or major grocery chains because middlemen are cut out of the marketing process.

7.3.2.6 Factors discouraging farmers to grow AIVs

The main factor that discourages farmers from growing AIVs in this study area is lack of sufficient market for AIVs as reflected in Table 7.17.

Table 7.17 Factors discouraging farmers to grow AIVs

Factor	N	%	Cum.%
Difficult to grow	1	1.89	1.89
No market	30	56.60	58.49
Other	22	41.51	100.00
Total	53	100.00	

Most smallholder farmers, according to Baloyi (2010), are situated in rural areas devoid of formal markets or agro-processing businesses. These farmers must sell their vegetables to the local population, sometimes at lesser rates, or pay more to transport their goods to towns. Sikwela and Mushunje (2013) pointed out that South African smallholder farmers' agricultural products are among those that are lost after production because farmers cannot reach better-paying markets.

The results of the study revealed that AIVs are good vegetables that are well-adapted, simple to grow, have a short growing season, and have markets. This confirms that AIVs can be developed into a sustainable, nutritional, and profitable production systems.

The results of the survey also revealed that the Extension Officers are the main source of information on AIVs. Farmers have a greater possibility of developing a profitable and sustainable agricultural system as more pertinent information becomes available to them.

7.3.3 Farmers participation in AIVs market activities

This section presents the results of how farmers participate in AIVs market activities. The scope of the work covers several aspects namely: availability of market for AIVs, income generating AIVs, season for supplying AIVs, and how they impact on the development of a sustainable and nutritional system.

7.3.3.1 Markets available for AIVs

The results of the study presented in Table 7.18 show that the majority of the respondents (56.60%) indicated that they benefit from all different types of markets (local markets, farm stalls, high value markets, and other markets), 26.42% benefit from local markets, 5.66% have created farm stalls, 3.77% benefited from high value markets and 7.55% from other markets. The researcher's observation is that farmers

use local markets and stalls for selling mustard, while okra is packaged in boxes of 2-4kg and sent to high value market in Johannesburg.

Table 7.18 Markets available for AIVs

Response	N	%	Cum.%
Local market	14	26.42	26.42
Stalls	3	5.66	32.08
High value market	2	3.77	35.85
Other	4	7.55	43.40
All above	30	56.60	100.00
Total	53	100.00	

The absence of dependable markets has been identified as one of the major challenges facing South African smallholder farmers, and most of them obtain low prices by selling their produce at local markets or at their farm gates, according to DAFF (2012).

7.3.3.2 Reasons for not supplying to high value markets

Majority of respondents (56.60%) indicated that they have other unspecified reasons hindering them from supplying high value markets. About 26.42% indicated that high value market requires large quantities of supplies which farmers cannot supply given the small sizes of their plots they have under cultivation. About 7.55% indicated time delay on payments which is another reason. The 5.66% of the respondents indicated that high value markets require consistency of supply which is difficult with small scale and subsistence farmers. Only 1.89% indicated that high value markets are strict on quality, and sometimes higher quality becomes a major stumbling block for smaller farmers. Table 7.19 reflects the findings of the study.

Table 7.19 Reasons for not supplying to high value markets

Reason	N	%	Cum.%
Strict on quality	1	1.89	1.89
Consistency	3	5.66	7.55
Pay delays	4	7.55	15.09
Need large quantities	14	26.42	41.51
Contract	1	1.89	43.40
Other	30	56.60	100.00
Total	53	100.00	

According to Dias (2011), in order for a small vegetable farmer in the United States to expand into a more commercial business, he/she requires money for better seeds, hired labour, and equipment to remain a dependable supplier and to deliver a steady flow of higher-quality vegetables. The Esteenskul smallholder farmers' inability to consistently produce the quantities of agro-products required by high-value markets, on the other hand, has been attributed in large part to poor levels of technological efficiency, according to Matthews *et al.* (2015). The claim is reinforced by DAFF (2012), which repeated that most South African smallholder farmers lack the financial and marketing capabilities necessary to compete on a level playing field with food processors and fresh product marketplaces.

7.3.3.3 Seasons for supplying AIVs to the markets

The majority (54.72%) of the respondents indicated that they supply AIVs all year round, while 35.85% do it in winter, 7.55% do it in autumn, and 1.89% do it in summer. Table 7.20 reflects the findings of the study. The all-year round production of AIVs is because the study area is situated in warm climatic zone that is frost free.

Table 7.20 Season for supplying AIVs to the markets

Season	N	%	Cum.%
Autumn	4	7.55	7.55
Winter	19	35.85	43.40
Summer	1	1.89	45.28
All year round	29	54.72	100.00
Total	53	100.00	

The results of the study by Ferdous *et al.* (2016) showed that farmers who are able to satisfy their daily vegetable requirements in most months of the year are attributable to a year-round supply of vegetables, suggesting an improvement in food security and a decrease in malnutrition in rural parts of Bangladesh.

7.3.3.4 Income generating AIVs

As presented in Table 7.21 most of the respondents (58.49%) indicated that mustard is the main AIVs generating income for the farmers, 41.51% indicate that okra is next in line as income generator.

Table 7.21 Income generating AIVs

AIVs	N	%	Cum.%
Okra	22	41.51	41.51
Mustard	31	58.49	100.00
Total	53	100.00	

The results of the study revealed that The Extension Officers are the main source of information on AIVs. Farmers have a greater possibility of developing a profitable and sustainable agricultural system as more pertinent information becomes available to them.

Farmers have markets for their AVIs in the study area, produce all-year round and this create an opportunity for growth and future trading prospects for small-scale farmers.

This indicates that significant work needs to be done to persuade AIV farmers to move into a system of production that is commercialised and sustainable.

7.3.4 Production of AIVs

This section presents the results on the production of AIVs. The aspects to be covered include the purpose of growing AIVs, production inputs, sources of fertilisers, type of labour, sources of advice and how they impact on the development of a sustainable, nutritional and commercial production system.

7.3.4.1 Main purpose of growing AIVs

The findings of the study show that all farmers, as reflected in Table 7.22 grow AIVs for home consumption and commercial purposes.

Table 7.22 Main purpose of growing AIVs

Purpose	N	%	Cum.%
Home consumption	26	49.06	49.06
Commercial purpose	19	35.85	35.85
All above	8	15.09	100.00
Total	53	100.00	

According to Dutra *et al.* (2018), home consumption production should be promoted since it can create food security by facilitating access to and availability of nutrient-dense food as well as a steady supply of adequate food. According to Dias (2011),

the primary causes of the 25% increase in fresh vegetable intake in the United States between 1977 and 1999 were rising health consciousness and the nutritional benefits of vegetables.

7.3.4.2 Production inputs used for AIVs production

The findings of the study show that all farmers, as reflected in Table 7.23 use pesticides and organic fertilisers in the production of AIVs.

Table 7.23 Production inputs used for AIVs production

Input	N	%	Cum.%
Pesticides	1	1.89	1.89
Organic fertilisers	1	1.89	3.77
All above	51	96.23	100.00
Total	53	100.00	

According to Kalbani *et al.* (2016), organic fertilisers made from agro-fish pellets and chicken manure had a substantial impact on the number of flowers and fruit quality of tomatoes in the United Arab Emirates. In a different study, Islam *et al.* (2012) discovered that cow dung could produce the most lettuce per hectare in Bangladesh in terms of leaves, root length, and yield. According to research done by Jha (2009), when chemical pesticides are used in Nepal, vegetable production (potato, tomato, bitter melon, and chili) generates greater earnings than other types of crops. These findings are supported by Mahmood *et al.* (2016) and Pandya (2018) who claimed that chemical pesticides increase crop yield and encourage plants to develop more quickly, which boosts the economy and satisfies consumer demand.

7.3.4.3 Sources of chemical fertilisers

The majority (58.49%) of the respondents get their chemical fertilisers from Government, Cooperatives and retail stores, 32.08% obtain chemical fertilisers from cooperatives, 5.66% from government, and 3.77% from retail stores as shown in Table 7.24. It has been noted that fertilisers obtained from Government are given through farmer support programmes, while from retail stores and cooperatives, they buy.

Table 7.24 Sources of chemical fertilisers

Source	N	%	Cum.%
Government	3	5.66	5.66
Cooperatives	17	32.08	37.74
Retail stores	2	3.77	41.51
All above	31	58.49	100.00
Total	53	100.00	

Strong agricultural cooperatives and other producer groups, according to FAO (2012), can provide their members with a wide range of services, including access to natural resources, information, communication, fertilisers, seeds, an output market, and technologies for training. According to observations made by Prakash (2003), in order to avoid a food supply crisis related to population growth, Japanese agricultural cooperatives that are unable to offer their members a variety of services would rather turn to the distribution of fertilisers, credit, and the purchase of products for national food stocks.

7.3.4.4 Type of organic fertilisers used

The results in Table 7.25 show that the respondents use poultry and kraal manure as well as home-made compost.

Table 7.25 Type of organic fertilisers used

Type	N	%	Cum.%
Kraal manure	15	28.32	28.32
Poultry manure	17	32.08	60.38
Home-made compost	4	7.55	67.92
Other	6	11.32	79.25
All above	11	20.75	100.00
Total	53	100.00	

In Nigeria's Anambra State, the growth and yield of Amaranthus increase with higher rates of chicken manure treatment, according to research done by Okoli and Nweke (2015). In a different study, Onwu *et al.* (2018) discovered that a higher rate of chicken manure treatment resulted in a stronger residual response by boosting the production of okra at a farm in Makurdi, Nigeria. All the benefits of using poultry manure as an organic fertiliser can be ascribed to the soil's improved physical and biological characteristics, which in turn boost the plant's ability to absorb nutrients.

7.3.4.5 Sources of organic fertilisers

Most (52.83%) farmers in the study area as presented in Table 7.26 source organic fertilisers from neighbours, 26.42% source from home, and 7.55% were given by neighbours, while 9.43% sourced organic fertilisers from other means.

Table 7.26 Sources of organic fertilisers

Source	N	%	Cum.%
Buy from neighbours	28	52.83	52.83
Home sourced	14	26.42	79.25
Buy from cooperatives	2	3.77	83.02
Given by neighbours	4	7.55	90.57
Other	5	9.43	100.00
Total	53	100.00	

According to research by Kiptot *et al.* (2006), farmers in Western Kenya exchanged technological resources and information with friends and neighbours more closely along family links than physically. According to the FAO (2017), farmer-to-farmer exchanges have a great deal of potential to increase the technical proficiency of small producers, hence raising their output and helping to lower rural poverty.

7.3.4.6 Type of labour used on the farm

Majority of the respondents (60.38%) used hired labour as compared to 39.62% who are using family labour. Table 7.27 reflects the findings of the study. It was noted that the higher number of employed labours are mostly people from outside South Africa. This observation may be explaining the reason why people in the area engage in other activities which are not agricultural related. This observation is even though the family sizes of the respondents are reasonably big to provide family labour.

Table 7.27 Type of labour used on the farm

Type	N	%	Cum.%
Family labour	21	39.62	39.62
Hired	32	60.38	100.00
Total	53	100.00	

According to a study by Omotesho *et al.* (2014), the use of hired labour on farms and the level of food security in Kwara State, Nigeria, are positively correlated. In other words, it is likely that the households of farmworkers will have access to food. Similar

results were found by Kloss and Petrick (2018), who found that in the small and medium-scale agrarian structures of France and Germany, farms with a higher share of hired labour are more productive than family farms.

7.3.4.7 Source of advice on AIVs farming

Extension officials from the Department of Agriculture and rural Development are the main source of advice towards growing of AIVs, as indicated by 50.94% of the respondents, 26.42% get their advice from Extension Officers, farmers, and traders, 16.98% from other farmers, 1.89% indicated traders as the source and 3.77% from other sources as presented in Table 7.28.

Table 7.28 Source of advice on AIVs farming

Source	N	%	Cum.%
Extension officer	27	50.94	50.94
Other farmers	9	16.98	67.92
Traders	1	1.89	69.81
Other	2	3.77	73.58
All above	14	26.42	100.00
Total	53	100.00	

In order to give farmers mental flexibility to adopt new farming technology, agricultural extension officers, according to Hendriks and Green (1999), impart agricultural knowledge and skills and communicate research and experimentation findings to farmers. According to Ibrahim *et al.* (2013), the adoption of novel farming techniques increases with the frequency of extension contacts. According to Qamar (2005), the transfer of knowledge and skills should be demand-based and non-formal with a focus on enhancing farmers' quality of life.

Farmers in the study have support on production of AIVs through advice from Extension Officers, and production inputs from various stakeholders. As the essential information and input support become available to farmers, they have a better chance of creating a sustainable agricultural system.

7.3.5 Harvest and marketing quantities of vegetables

This section presents the results on harvests and marketing quantities of African Indigenous Vegetables. The work to be covered include among others, the quantities harvested and sold, market place, harvesting frequencies, distance to the market,

type of measurement per price, mode of transport, marketing constraint and how they impact on the development of a sustainable, nutritional and commercial system.

7.3.5.1 Quantities harvested and sold

Majority of respondents (90.57%) harvested 1-2 tons of AIVs for the market, 9.43% harvested 3-5 tons. Table 7.29 reflects the findings of the study.

Table 7.29 Quantities harvested and sold

Quantity (ton)	N	%	Cum.%
1-2 tons	48	90.57	90.57
3-5 tons	5	9.43	100.00
Total	53	100.00	

Thomson (2004) asserts that there is a connection between yield and household income. According to Thomson (*ibid*), a 10% improvement in overall agricultural productivity would boost small-scale farmers' earnings by 5% in Asia. In Cambodia, a 10% increase in yields led to an 8.8% rise in household incomes for dry-season cultivation and a 4.4% increase for wet-season cultivation. On the other side, increasing agricultural productivity is crucial for reducing hunger and poverty. Irz *et al.* (2001) made the case that since poorer households spend a larger percentage of their incomes on food than wealthier households, an increase in output tends to lower food prices, which helps consumers and all net food purchasers.

7.3.5.2 Harvesting frequency

The results of the study presented in Table 7.30 show that 39.62% of producers harvest once per week and another 39.62% harvest once in two-weeks, while 20.75% harvest once per month.

Table 7.30 Harvesting frequency

Frequency	N	%	Cum.%
Once per week	21	39.62	39.62
Once in two-weeks	21	39.62	79.25
Monthly	11	20.75	100.00
Total	53	100.00	

According to Ratna and Thakur (2015), the use of the latest technology influences the quality and output of vegetables.

7.3.5.3 Main market places for AIVs

The results in Table 7.31 show that 54.72% of respondents sell AIVs in the villages, 28.30% in the farm stalls, and 16.98% sell in both villages and farm stalls.

Table 7.31 Main market places for AIVs

Market	N	%	Cum.%
Villages	29	54.72	54.72
Farm stalls	15	28.30	83.02
All above	9	16.98	100.00
Total	53	100.00	

Farm direct marketing offers no limitations for sales volume, no standard pack or quality, and access to market data, according to Bruch and Ernst (2010). Farm direct marketing is widespread, according to AlbertaAg (2013), since more and more health-conscious consumers want to eat regional foods that are selected and packed when they are at their freshest. These people are curious about the origins of their food and the people who make it. Customers are willing to pay more for food that they perceive to be fresh and nutritious.

7.3.5.4 Types of contract market

Almost all (98%) of the respondents have no reliable market for AIVs in that they have neither written nor oral agreement with the buyers.

The results of the study by Mulatu *et al.* (2017) show that farmers in Ethiopia's Central Rift Valley who engaged in contract vegetable farming earned more money than farmers who did not. In India's Gherkin village, according to Prasad *et al.* (2013), contract farming ranked highly in terms of guaranteed price, guaranteed income, ready market, easy conveyance, and improved employment at the local level.

Drollette (2009) discovered, however, that farmers without marketing contracts incur market or pricing risks as a result of the health of the economy, trade policies, and changes in consumer income, market forces, and currency rates. However, MacDonald *et al.* (2004) noted that marketing contracts are significant to farmers in

that they eliminate price uncertainty and risk of loss if commodity prices decrease, but they also give up the chance to profit if prices rise.

7.3.5.5 Type of measurement per price

The majority (56.60%) use the number of leaves as a measure per price, and 5.66% use a crate per price and 1.89% charge a price for a bag, while 35.85% use all of the above measurement per price of produce. Table 7.32 reflects the findings of the study.

Table 7.32 Type of measurement per price

Measurement/price	N	%	Cum.%
Number of leaves	30	56.60	56.60
Crates	3	5.66	62.26
Number of bags	1	1.89	64.15
All above	19	35.85	100.00
Total	53	100.00	

7.3.5.6 Distance to the market

The majority (73.58%) of the respondents travel less than 50km to the market since they sell AIVs at the farm stalls and local villages, 3.77% travel 51-100km, and 18.87% travel more than 100km, and 3.77% indicated other unspecified distances as presented in Table 7.33.

Table 7.33 Distance to the market

Distance	N	%	Cum.%
< 50 km	39	73.58	73.58
51-100km	2	3.77	77.36
>100km	10	18.87	96.23
Other	2	3.77	100.00
Total	53	100.00	

According to Buckmaster (2012)'s research, market participation and the availability of vegetables both decline as the distance to the vegetable market grows. Additionally, market participation and vegetable supply both decline as input market distance increases. On the other hand, local food systems, according to Martinez *et al.* (2010), have a beneficial effect on the local economy since customers in a given

area would buy more food from nearby sources and more of the money they spend would stay in their local community.

According to Link and Ling (2007), consuming locally grown food reduces the carbon footprint of that food because less fuel is burned during transportation. Similarly, to this, Link and Ling (*ibid*) discovered that local food systems have a greater capacity to support sustainable practices in the communities in which they are practiced than industrial food systems.

7.3.5.7 Mode of transport to the market

Most (60.38%) of the respondents used hired transport for AIVs to the market, 24.53% indicated that transport is non-existent and 15.09% have own transport to the market. Table 7.34 reflects the findings of the study.

Table 7.34 Mode of transport to the market

Mode	N	%	Cum.%
Own transport	8	15.09	15.09
Hired transport	32	60.38	75.47
None	13	24.53	100.00
Total	53	100.00	

According to a study by Ajiboye and Afolayan (2009), better transportation will motivate farmers in rural areas to work hard in order to boost productivity, and income, as well as reduce unemployment, and poverty levels. This claim is confirmed by Gbam (2017), who discovered that transportation plays a crucial role in the distribution of agricultural commodities and aids farmers in developing markets, increasing the value of their products, and minimising spoilage and wastage. According to Baloyi (2010), since vegetables are so perishable, there should be a sense of urgency in their marketing. In order to keep the value of their farm-fresh status, vegetables should be transported as swiftly and effectively as feasible. In a similar vein, Ogunleye *et al.* (2018) discovered that the development of Nigeria's agriculture industry is positively impacted by the country's road transport infrastructure.

7.3.5.8 Major marketing constraints

Most (43.40%) of the respondents indicated that low market price for AIVs is their main challenge because they do not have control over the markets unless if the produce is sold locally as they put the price for the produce currently on sale, and 22.64% have low market prices, transport costs, poor roads, lack of markets, lack of transport and others as major marketing constraints they encounter. The 3.77% have other constraints, and 15.09% hampered by transport cost, while 1.89% indicate poor roads to the market and another 1.89% view lack of transport as a constraint to the market. The results are presented in Table 7.35.

Table 7.35 Major marketing constraints

Constraint	N	%	Cum.%
Low market price	23	43.40	43.40
Transport cost	8	15.09	58.89
Poor roads	1	1.89	60.38
No transport	1	1.89	62.26
No markets	6	11.32	73.58
Other	2	3.77	77.36
All above	12	22.64	100.00
Total	53	100.00	

Makal *et al.* (2017) claim that the reason farming in West Bengal is becoming less and less profitable is not just due to disease and bad weather, but also because production costs are rising while commodity prices are falling. According to Shankar *et al.* (2017)'s analysis, the size of the farm and the general issues with selling vegetables in Jharkhand's farmers' markets are inversely related. Simply put, the bigger the farm, the less trouble they have in general selling at farmers' markets.

7.3.5.9 Income generated by youth

The study found that the participation of the youth is low, however the youth of between the age of 18 and 35 years have generated an income of R10001- R20 000 but this is lower than that is generated by the adults. Figure 7.1 reflects the findings.

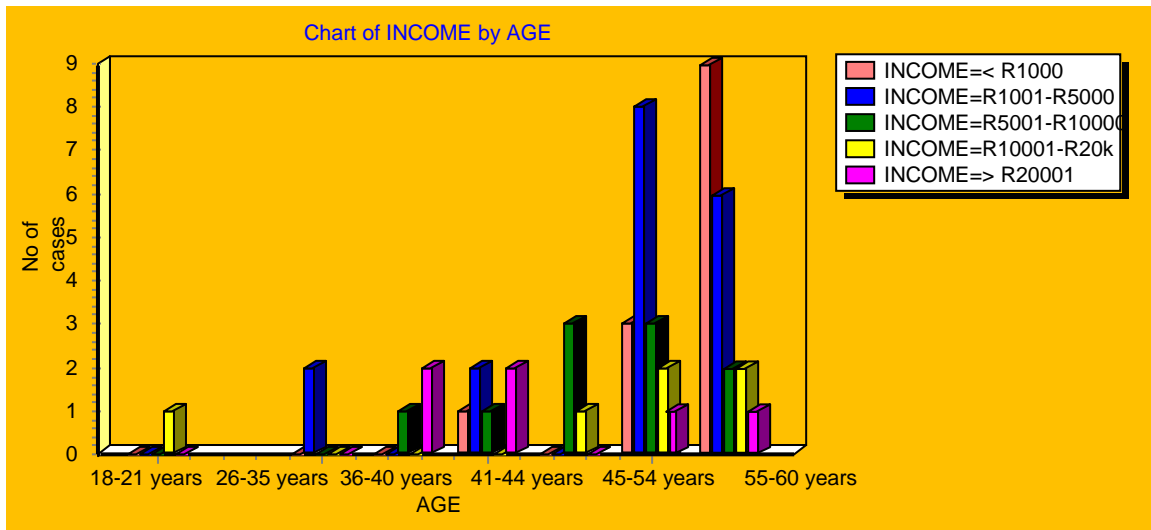


Figure 7.1 Income generated by youth

Nyoni (2012) asserts that young people will be drawn to agriculture when favourable conditions for entering the industry are provided with policies that are centred on youth. According to Ngongi (*ibid*), agriculture needs to be rebranded as a whole to appeal to young people. This will include spending money on education, developing market infrastructure, and enhancing the business climate in ways that will increase incomes and broaden the agricultural value chain.

7.3.5.10 Income generated by women

The study as presented in Figure 7.2 found that females have generated more income from AIVs than their male counterparts, but majority of these women generated income between R1001-R5000 per season, as compared to males where more men generated income less than a R1000 per season. The study revealed the good work done by these women on income generation for the families, food security, poverty reduction and job creation.

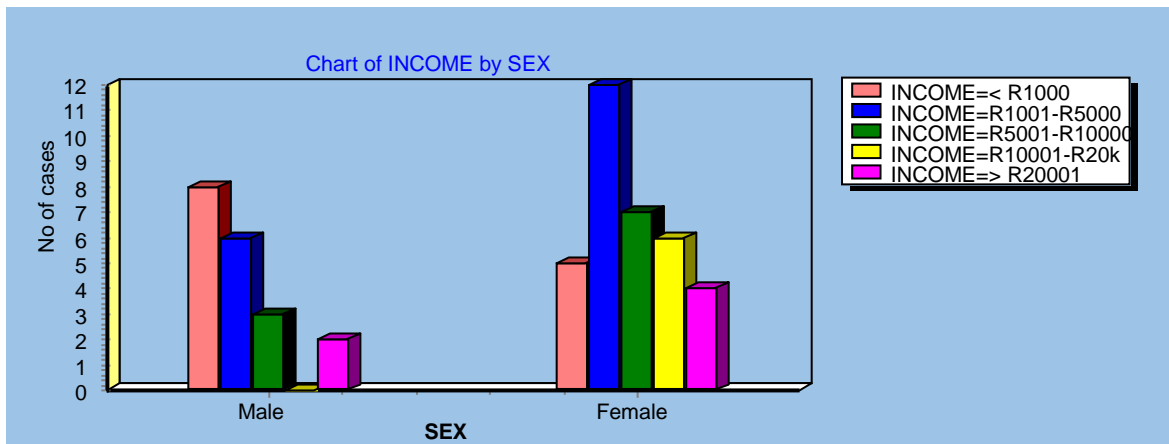


Figure 7.2 Income generated by women

According to Negash (2006), as more women receive benefits from the projects, money is more likely to be reinvested in the family and daughters are more likely to receive an education. Suwena and Budhi (2021)'s study found that female farmers' incomes contribute 38.61% to Bali's economy. This indicates that women have demonstrated a significant contribution to the welfare of families, communities, and the economy.

Farmers in the study area produce reasonable quantities of AIVs per season and there is room for improvement to produce more and to address the challenges encountered.

7.3.6 Support accessibility

This section presents the results on how the respondents access support for AIVs production. The aspects to be covered include type of support, source of support, farmer's satisfaction and how they impact on the development of a nutritional and sustainable production system.

7.3.6.1 Structural support for AIVs production

Most (86.79%) of the respondents get support from the Department of Agriculture. Table 7.36 reflects the findings of the study. Observations are that the Department of Agriculture and Rural Development plays a big role in supporting smallholder farmers since they are settled in Government-established irrigation schemes /projects.

Table 7.36 Structural support for AIVs production

Support	N	%	Cum.%
Traditional authority	5	9.43	9.43
Cultural groups	1	1.89	11.32
Civic Organisation	1	1.89	13.21
Agricultural Office	46	86.79	100.00
Total	53	100.00	

According to Greenberg *et al.* (2018), from 2010/11 to 2016/17, the Comprehensive Agricultural Support Programme (CASAP), Provincial Equitable Share (PES), Ilima/Letsema, and Fetsa tlala (End-Hunger) helped 833 439 South African smallholder farmers. According to Thagwana (2009) and Van Averbeke (2012), the Revitalisation of Smallholder Irrigation Schemes (RESIS) in Limpopo aims to revitalise irrigation schemes in terms of leadership, management, and productivity as well as in terms of infrastructure. According to Van den Berg (2013), a comprehensive strategy for the revival of the agriculture sector is required for any good ideas that government agencies, and local and international organisations are having for irrigation schemes and smallholder agricultural developments.

7.3.6.2 Type of support towards AIVs production

The results of the study presented in Table 7.37 show that 37.74% of the respondents get support such as fertilisers, pest control and advice towards the production of AIVs and 32.08% get on fertilisers, 22.64% received advice, while 7.55% received support on pest control.

Table 7.37 Type of support towards AIVs production

Support	N	%	Cum.%
Fertilisers	17	32.08	32.08
Pest control	4	7.55	39.62
Advices	12	22.64	62.26
All above	20	37.74	100.00
Total	53	100.00	

In most African countries, according to Sianjase and Seshamani (2013), agricultural input subsidies (for seeds and fertilisers) are gaining support as a pro-poor policy approach aimed at lowering poverty, improving household food security, and increasing crop productivity among smallholder farmers.

7.3.6.3 Farmers' satisfaction from support received

The 50.94% of the respondents are moderately satisfied with the support they get from the community structures including the various government structures, 22.63% were less satisfied, 13.21% were highly satisfied and 13.21% were not satisfied at all. Table 7.38 reflects the findings of the study. Observations are that the state tries to cover many smallholder farmers at a time in order to promote food security.

Table 7.38 Farmers' satisfaction from support received

Response	N	%	Cum.%
Highly satisfied	7	13.21	13.21
Moderately satisfied	27	50.94	64.15
Less satisfied	12	22.64	86.79
Not satisfied	7	13.21	100.00
Total	53	100.00	

Commercial, smallholder, and subsistence farmers in South Africa today receive less support from the state than their counterparts in any industrialised nation in the world, claim Sikwela and Mushunje (2013), citing DAFF (2010). Aliber and Hall (2016) found that while budgetary allocations for smallholder farmer support in South Africa have grown significantly over the past 15 years, the distribution and use of those resources result in few farmers benefiting and a minimal overall impact. The study by Sikwela (2013), on the other hand, demonstrates that participation in any agricultural support program in the Eastern Cape and KwaZulu-Natal has a considerable positive influence on smallholder farmers' income and welfare. Additionally, it was discovered that farmers helped by farmer support programmes (FSP) have better access to markets than farmers who work independently. This discovery is backed up by research from Fusani *et al.* (2016), who confirmed that the farmer input support program (FISP) raised household crop revenue in Zambia's Choma and Monze districts by 30.8% and overall household income by 13.9% between the 2013–14 and 2014–15 crop seasons.

7.3.7 Consumption of African Indigenous Vegetables(AIVs)

This section presents the results on the consumption of AIVs, and how they impact on the development of a sustainable, nutritional, and commercial production system.

The aspects to be covered are consumption rates, and family members who consume AIVs.

7.3.7.1 Consumption rate of AIVs

The 39.62% of the respondents consume AIVs daily, 35.85% indicated 3 times per week, while 16.98% indicated twice per week, and 7.55% consume AIVs on weekly bases. Table 7.39 reflects the findings of the study. Increased consumption rates of vegetable have some health benefits.

Table 7.39 Consumption rate of AIVs

Rate	N	%	Cum.%
Daily	21	39.62	39.62
Weekly	4	7.55	47.17
Twice per week	9	16.98	64.15
3 times per week	19	35.89	100.00
Total	53	100.00	

According to Rekhy and McCochie (2014), providing vegetables as snacks throughout the day and incorporating them in all meals enhances the likelihood that people would eat them. According to Oberti *et al.* (2014)'s study, Algerians who ate more vegetables had higher levels of vitamin E and B9, reduced blood pressure, and lost weight if they were pre-obese. According to Bogers *et al.* (2007), pregnant women who consume a lot of folate-rich foods (i.e., vitamin B9) had a decreased risk of having children with neural tube abnormalities.

7.3.7.2 Members of the family consuming AIVs

Most (60.38%) of the respondents indicated all the family members consume AIVs, 30.19% indicated adult women, 5.66% indicated adult men, and 3.77% indicated pregnant women. Table 7.40 reflects the findings of the study.

Table 7.40 Members of the family consuming AIVs

Member	N	%	Cum.%
Adult women	16	30.19	30.19
Adult men	3	5.66	35.85
Pregnant women	2	3.77	39.62
All above	32	60.38	100.00
Total	53	100.00	

According to Nicklett and Kadell (2013), chronic diseases are more common among older persons (such as diabetes, heart disease, and cancer). The consumption of vegetables in later life has been linked to a lower cancer mortality rate, according to Johnson *et al.* (1998).

The study's finding revealed that AIVs are consumed in the study area and are part of a source of nutritious food.

7.4 Conclusions and recommendations

The objective of the study was to assess the potential of African Indigenous Vegetables (AIVs) towards the formation of a commercial, nutritional and sustainable production system.

The implication of a low number of youths in the study area is that there may be a problem in the takeover or continuation of AIVs production. It is not clear why youth is not participating in large numbers. It is recommended that there should be programmes developed to encourage the youth to get interested in the production of AIVs. It is also recommended that a study be conducted on why the youth is not interested in AIVs production.

The results of the study revealed that AIVs are good vegetables that are well-adapted, simple to grow, have a short growing season, and have markets. This confirms that AIVs can be developed into a sustainable, nutritional, and profitable production systems.

The results of the survey also revealed that the Extension Officers are the main source of information on AIVs. Farmers have a greater possibility of developing a profitable and sustainable agricultural system as more pertinent information becomes available to them.

Farmers have markets for their AIVs in the study area and produced all-year round and this create an opportunity for growth and future trading prospects for small-scale farmers. This indicates that significant work needs to be done to persuade AIV farmers to move into a system of production that is commercialised and sustainable.

Farmers in the study have support on production of AIVs through advice from Extension Officers, and production inputs from various stakeholders. As the essential

information and input support become available to farmers, they have a better chance of creating a sustainable agricultural system.

Farmers in the study area produce reasonable quantities of AIVs per season and there is room for improvement to produce more and to address the challenges encountered.

AIVs are consumed in the study area and are part of a source of nutritious food. Consumption of AIVs can also be promoted by formation of cooking clubs and vegetables consumption festivals.

The results of the study show that African Indigenous Vegetables (AIVs) are produced, consumed and sold in markets in the study area, hence it confirms the potential for the formation of a nutritional and commercial production system.

There are other vegetables not listed in this study that can be explored for commercial production. There is a need to conduct adaptive research on them so that their performance under intensive conditions be evaluated.

The dynamics expressed through the results of this study give an indication that African Indigenous Vegetables have a potential towards commercial system for generation of income, job creation and contribution to nutrition.

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Chapter 8

The opportunities and constraints of a wide adaptation to organic vegetable production systems by small-scale farmers of the Limpopo Province in South Africa

Abstract

The study was conducted in the eight villages, three of Vhembe District, and five villages of Mopani District. The objective of the study was to identify and analyse the opportunities and constraints of a wide adaptation to organic vegetable production systems by small-scale farmers. A total of 52 small-scale vegetable farmers were randomly sampled using a multi-stage cluster sampling procedure. Sample size was calculated using Slovin's formula. Data was collected through a questionnaire and analysed using the SPSS. The female respondents (55.77%) participated in vegetable production. The study shows that 21.15% of women attended secondary level education. The study shows that farmers in the study area have experience ranging from 11-21 years. The study also revealed that 61.54% of the respondents have access to land they own, lease and communal use. The study also showed that the respondents have dependents ranging from 1-above 9 in number. The study shows that farmer use fertilisers, crop rotation and practicing intercropping in order to promote soil fertility. The study shows that the respondents apply livestock manure, poultry manure and other types to boost their vegetables. It was also revealed that farmers are aware that pesticides are not healthy, and they use protective clothing, and wash their hands with soap after use. Weed is controlled manually. The respondents agreed that organic market has a potential of growth, while others say there is shortage of local organic markets. The study revealed that 80.77% of the respondents considered organic farming (OF) as more profitable, and 78.85% say that it saves on production costs. The study showed that 75.00% of the respondents believed that organic products fetch higher prices. About 53.85% had moderate knowledge of organic farming, while 65.38% were ready to receive technical skills on organic farming (OF). The study captured that 75% viewed conversion to organics as expensive while 44.23% were willing to convert to organic farming in the near future. The results of this study show that there are opportunities in farming on organic vegetables if the constraints and difficulties identified in the study area are dealt with.

Key Words: Organic vegetables, opportunities, adaptation, constraints.

8.1 Introduction

The rate in which human population is growing has put more pressure on the supply side of food. The language of supply has changed its tone to more food and more to meet the demand. In almost all the rural development agenda, food security, malnutrition, hunger, and food insecurity will always form part of the discussions. According to Omotesho *et al.* (2014) food security exists when all people, always, have physical, social, and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Roychowdhury *et al.* (2014) noted that in the past 50 years, pesticides and chemical fertilisers have been used to increase agricultural productivity.

Kashino (1990) stated that high yields of modern agriculture are heavily dependent on the use of inorganic fertilisers since they are found to be doubling or tripling yields of crops in Japan in the short term. In the view of Aryal *et al.* (2016) if pesticides are not used, around 25% of the crops will be lost through damage by insects. This idea is supported by Mahmood *et al.* (2016) and Pandya (2018) who posit those chemical pesticides improve crop productivity as well as promote the faster growth to plants, thus improve the economy, and satisfy the demands, through the control of serious pests.

On the other hand, Roychowdhury *et al.* (2014) reported that dependency on chemical fertilisers and chemical pesticides for future agricultural growth will result in further loss of soil quality, acidification of soil, ground water contamination and hence loss of biodiversity. In the same way, chemical fertilisers and pesticides that are sprayed on vegetables pose toxicity to human body. Hence the advocacy for organic farming. Sivaraj *et al.* (2017) view organic farming (OF) as an approach to agriculture which is aiming at creating integrated, environmentally, and economically sustainable agricultural production systems. The objective of this chapter is to identify and analyse the opportunities and constraints of a wide adaptation to organic vegetable production systems by small-scale farmers towards a vibrant commercial enterprise in Limpopo. The chapter presents among others the results on farmers' perceptions of their demographical factors, how they improve soil fertility and control pests, their attitudes, beliefs, access to information and intentions towards organic farming (OF).

8.2 Materials and Methods

8.2.1 The study area

The study was carried out in the three villages of Collins Chabane Municipality, Vhembe District (i.e., Tshikonelo, Dovheni and Makumeke), one village of Ba-Phalaborwa Municipality, Mopani District (i.e., Seloane) and one village of Maruleng Municipality, Mopani district (i.e., Sekororo), and three villages of Greater Tzaneen Municipality, Mopani District (i.e., Haenertzberg, Solani and Julesburg). This study area is referred to as area E.

Collins Chabane Municipality is in the Northern part of Limpopo Province (coordinates 22° 35' S and 30° 40' E). It is 191 km from the city of Polokwane. The Municipality is part of Vhembe District, and is situated between Greater Giyani, Thulamela, and Makhado municipalities. To the north-east its borders extend to Mozambique and on the south-east to Kruger National Park. The Municipal land area covers 5467.22km², with a population of approximately 347974 inhabitants (IDP, 2018/19).

The Ba-Phalaborwa Municipality is in the Eastern part of the Limpopo Province. It borders the Kruger National Park in the East, the Greater Giyani Municipality in the North, the Greater Letaba Municipality in the North-West, the Greater Tzaneen Municipality in the West and the Maruleng Municipality in the South (IDP, 2020-2021). The GPS coordinates of Ba-Phalabora are (latitude -23° 56' 34.76" S) and (longitude 31° 08' 27.85" E). It is 220km from Polokwane and Mbombela and serves as a central gateway to the Greater Limpopo Transfrontier Park through the Giriyondo Border (IDP, 2022-2027). The Municipality has a geographical area of 7461.6 km² including the Kruger National Park, and a population of 150 637 people (IDP, 2016/17-2017/18).

Maruleng Local Municipality is in the South- eastern quadrant of the Limpopo Province in the Mopani District Municipal. The GPS coordinates of the area are latitude 24° 21' 8.99"S; and longitude 30° 56' 29.99" E. The Municipality is bordered by the greater Kruger National Park to the east, the Ba-Phalaborwa and Tzaneen Municipality in the north, the Lepelle-Nkumbi Municipality to the west, Tubatse and Bushbuckridge to the south (IDP 2011-2016). Maruleng Municipality covers an area of 3247km² and has a population of 107247 people (SDF, 2007).

Greater Tzaneen Municipality is located in the eastern quadrant of Limpopo Province in the Mopani District (coordinates 23⁰ 49' 146" S and 30⁰ 8' 9.006" E). It is bordered by Polokwane to the west, Greater Letaba to the north, Ba-Phalaborwa and Maruleng to the east and Lepelle-Nkumbi to the south (IDP, 2021/22). The municipality covers an area of 3240 km² with the population of 390 095 people. The area has relatively favourable agro-ecological conditions with an average annual rainfall of 902,49mm (Bunce, 2020).

8.2.2 The sample

A total of 52 small-scale vegetable farmers were randomly sampled using a multi-stage cluster sampling procedures in which the stage one sampling was done at District level, stage two at the municipality level and third stage at the Agricultural Service Centres level. Chapter three showed how the sample was calculated from the population, using the Slovin's formula. Two Municipal Districts (Vhembe and Mopani) were purposively selected, and three Municipalities from Mopani District were sampled (i.e. Greater Tzaneen, Ba-Phalaborwa and Maruleng) while one Municipality from Vhembe District was sampled (i.e. Collins Chabane). Data base of eight villages (Tshikonelo, Dovheni, Makumeke, Haenertzberg, Solani, Julesburg and Sekororo) was used to sample small-scale vegetable farmers. The 52 small-scale vegetable farmers for this objective, constituted about 20% of the total number of farmers (261) who were interviewed. The 20% small-scale vegetable farmers were uniformly spread over the five objectives of this thesis.

8.2.3 Data collection and analysis

A questionnaire was used to collect data from the sampled respondents. The respondents were asked to supply information among others on demographical factors, how they improve soil fertility and control pests, their attitudes towards organic farming, their beliefs about organic farming, how they access organic farming information, and their intentions to convert to organic farming (OF). The raw data was analysed and interpreted into meaningful information using statistical package for social sciences (SPSS, 2015).

8.3 Results and discussions

8.3.1 Demographical information of respondents

8.3.1.1 Women participation on vegetable production

The study found that majority of females (55.77%) participated on vegetable production as compared to 44.23% of male participants. Table 8.1 reflects the findings of the study. Higher number of women participations is in line with Government policy prescripts of women empowerment.

Table 8.1 Women participation on vegetable production

Gender	N	%	Cum.%
Male	23	44.23	44.23
Female	29	55.77	100.00
Total	52	100.00	

According to research by Druschke and Secchi (2014), women in Iowa are substantially more likely than men to support collaboration and land protection. Unay-Gaihard and Bojnec (2021) reported that women farmers show greater sensitivity towards environmental activities and are more involved with organic farming, sustainable agricultural practices, and alternative agriculture relative to male farmers. The study by Akamin *et al.* (2017) found that greater female involvement in vegetable growing in Cameroon's humid tropics has a significant positive impact on vegetable production. This is true because female farmers are more technically proficient than male farmers. The other reason might be that women are more interested in vegetable production, which is related to household food security, particularly with indigenous African vegetables (AIVs).

8.3.1.2 Participation by youth

The study found that participation by young section of the community is very scanty. It captures 11.54% of age between 26 years 35 years old, the 19.23% are at their middle age of between 41-50 years, while 19.23% are between 51-60 years and the 36.54% who are elders. Table 8.2 reflects the findings of the study. Youth participation on agricultural production needs serious attention from the Government

in terms of providing funds for the youth and bursaries for those who want to pursue agriculture as a career and business.

Table 8.2 Participation by youth

Age	N	%	Cum.%
26-30 years	3	5.77	5.77
31-35 years	3	5.77	11.54
36-40 years	7	13.46	25.00
41-50 years	10	19.23	44.23
51-60 years	10	19.23	63.46
>61 years	19	36.54	100.00
Total	52	100.00	

Mathivha (2012) claims that South African youth view agriculture as outdated, of low status, providing little prospects for financial gain, and exclusively designated for the elderly and the underprivileged in rural areas. According to Alene *et al.* (2000), the likelihood of farmers in African nations adopting new practices is adversely correlated with their age. This is because as people age, their tendency to be cautious or risk-averse grows.

8.3.1.3 Participation by age and gender of the respondents

The results of the study presented in Table 8.3 show that 55.77% are female respondents while 44.23% are males. In the youth category the results show that 11.54% are young female and males between the ages of 26-35 years. Youth participation is low and female participation is higher.

Table 8.3 Participation by age and gender of the respondents

Age	Male (N)	%	Female (N)	%	Total	%
26-30 years	2	3.85	1	1.92	3	5.77
31-35 years	1	1.92	2	3.85	3	5.77
36-40 years	4	7.69	3	5.77	7	13.46
41-50 years	1	1.92	9	17.31	10	19.23
51-60 years	5	9.62	5	9.62	10	19.23
>61 years	10	19.23	9	17.31	19	36.54
Total	23	44.23	29	55.77	52	100.00

8.3.1.4 Education status of women

The results of this study show that education levels of women are higher than of males in all levels of education except the diploma level where males are more. Table 8.4 reflects the findings of the study.

Table 8.4 Education status of women

Status	Male (N)	%	Female(N)	%	Total	%
No school	1	1.92	5	9.62	6	11.54
Primary	3	5.77	4	7.69	7	13.46
Secondary	7	13.46	11	21.15	18	34.62
Diploma	9	17.31	4	7.69	13	25.00
Degree	3	5.77	5	9.62	8	15.38
Total	23	44.23	29	55.77	52	100.00

The empowerment of women can only be accomplished through education, according to Sundaram *et al.* (2014)'s research. According to Oztunc *et al.* (2015), raising the educational status of women in the Asian Pacific region can lower infant mortality and women's fertility rates, which in turn quickens the spread of education for the following generation.

This indicates that improved female education has the potential to alter long-standing perceptions of women's place in the workforce. In a similar vein, Sharma (2017) argues that female education in India is crucial for the future of the nation because it is women who are discovered to be the first teachers of their children.

8.3.1.5 Education status of youth

The study results show that 11.54% of the respondents are in the youth bracket of 26-35 years and have qualifications ranging from secondary school to degree. Table 8.5 reflects the findings of the study. This trend seems to be indicating that the youth is not interested in farming and there could be other factors contributing to this behaviour.

Table 8.5 Education status of youth

Age(years)	26-30yr		31-35yr		36-40 yrs		41-50 yrs		51-60 yrs		>61 yrs		Total	
Qualification	N	%	N	%	N	%	N	%	N	%	N	%	N	%
No school	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	6	11.54	6	11.54
Primary	0	0.0	0	0.0	0	0.0	2	3.85	4	7.69	1	1.92	7	13.46
Secondary	1	1.92	0	0.0	2	3.85	2	3.85	4	7.69	9	17.31	18	34.62
Diploma	0	0.0	2	3.85	4	7.69	3	5.77	2	3.85	2	3.85	13	25.00
Degree	2	3.85	1	1.92	1	1.92	3	5.77	0	0.0	1	1.92	8	15.38
Total	3	5.77	3	5.77	7	13.46	10	19.23	10	19.23	19	36.54	52	100.00

According to Nyoni (2012), young people in Zimbabwe have a prevalent notion that agriculture is only for the uneducated or retirees, and that white-collar jobs are more enticing. According to SACAU (2013)'s synthesis report for the sub-Saharan countries, youths in Madagascar see farmers as a helpless and underprivileged group, those in Malawi see farming as a job for elderly and illiterate people who have nothing better to do, and youths in Zambia and South Africa see farming as their last resort after having tried everything else and failed. It is necessary to change the way that educated youth think about agriculture so that they see it to solve problems with food security, unemployment, and income generation.

8.3.1.6 Forms of access to land

The study found that majority of respondents (61.54%) owned the land they are practicing agriculture, as compared to 17.31% leasing and 21.15% cultivating on communal land. Figure 8.6 reflects the findings of the study. Observation is that this land is owned through PTO.

Table 8.6 Forms of access to land

Access	N	%	Cum%
Own land	32	61.54	61.54
Leasing	9	17.31	78.85
Communal	11	21.15	100.00
Total	52	100.00	

Land ownership affects agricultural output, according to Xaba and Masuka (2013), because farmers who do not own land may be hesitant to develop and manage it. According to Akram *et al.* (2019), owner-farmers in Pakistan who have secure rental

agreements for land invest more in enhancing their land and production than those who have unsecured lease arrangements. Accordingly, decisions farmers make to invest in land and increase productivity are influenced by land use rights. In a different study, Kousar *et al.* (2015) discovered that in rural Pakistan, secured property rights tended to raise per capita spending, increase farm output, and lower household poverty.

8.3.1.7 Forms of access to land by gender

The study found that majority of respondents owning land are women in terms of owning, leasing and communal use as reflected in Figure 8.1. The trend seems to be changing to favour women in accessing land for farming.

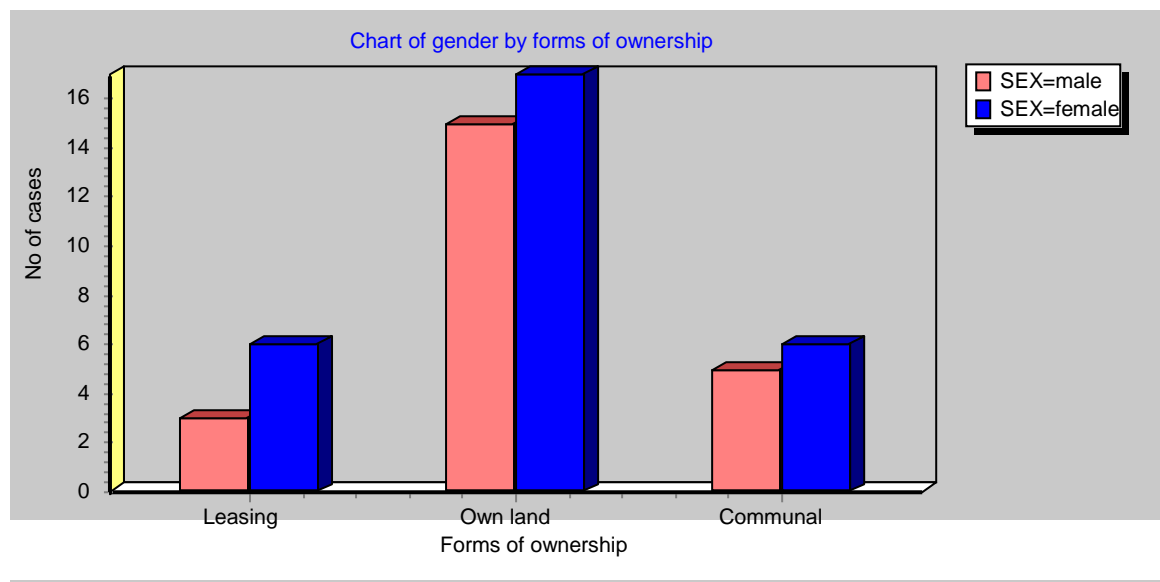


Figure 8.1 Forms of access to land by gender

According to research by Slavchevska *et al.* (2016), gender disparities in land ownership are less pronounced in sub-Saharan nations where women's legal rights are protected to a greater extent. Similarly, to this, Mutangadura (2004) noted that as women handle the majority of farm work, the more land they own and manage in Southern Africa, the more food there will be for each home and the more crops there will be for export. This will shield women against eviction in the event of a divorce or widowhood. According to USAID (2011), children in land-owning households in Nepal are twice more likely to receive appropriate nutrition than children living in landless homes. Further evidence suggests that females who own land are better equipped to

offer their children healthier food and ensure their well-being. According to research by Agarwal *et al.* (2021), women in rural India had a much higher likelihood of inheriting land as widows than as daughters. In a different interpretation, Yokying and Lambrecht (2019) assert that male landowners in Northern Ghana are noticeably more likely than female landowners to have agency and achieve in agriculture.

8.3.1.8 Size of land for cultivation

The study revealed that about 32.69% of the respondents were cultivating their crops on a 1-2ha area of land, 25.00% of the respondents cultivating on a 0.5-1ha area of land, 21.15% on a >5ha and 21.15% on 3ha-4ha area of land. Table 8.7 reflects the findings of the study.

Table 8.7 Size of land for cultivation

Size	N	%	Cum %
0.5ha	13	25.00	25.00
1-2ha	17	32.69	57.69
3-4ha	11	21.15	78.84
>5ha	11	21.15	100.00
Total	52	100.00	

According to the analysis of Xaba and Masuka (2013), Swaziland's profitability would increase by E0.22 for every additional 0.4ha planted with vegetable. According to a different interpretation, Ren *et al.* (2019) contend that growing the size of a farm relates to a statistically significant drop in the amount of fertiliser and pesticides used per hectare, which has obvious advantages for environmental protection. Bekele (2003) hypothesises, however, that small family farms may be more productive, efficient, and manageable than large family farms since they will put in more labour preparing plots, weeding, and harvesting than large farmers who rely on hired labour.

8.3.1.9 Experience in vegetable farming

The study results, as reflected in Table 8.8 found that experience of the respondents' ranges from 5 years to 21 years, which augers well with the production of vegetables in the study area. These experiences may serve as a conducive environment for the transfer of technology and conversion from conventional to organic vegetable production.

Table 8.8 Experience in vegetable farming

Experience	N	%	Cum.%
< 5 years	10	19.23	19.23
5-10 years	13	25.00	44.23
11-15 years	15	28.85	73.08
16-20 years	7	13.46	86.54
> 21 years	7	13.46	100.00
Total	52	100.00	

According to Chawda (1978), experience is more useful than schooling. When experience and expertise are merged, agriculture progress and goal achievement are accelerated. Gyampoh *et al.* (2009) go on to say that traditional knowledge and techniques that have been acquired over time through experience and verbally passed down from generation to generation have been crucial in resolving farming issues in rural Ghana. In developing agricultural technology for South Africa's rural communities, Seleti and Tlhompho (2014) discovered that there is a benefit in fusing community or Indigenous knowledge systems (IKS) from women with scientific information.

8.3.1.10 Qualifications related to agriculture

Most of the respondents (80.77%) do not have any qualification related to agriculture, but this situation is not a cause for concern because they are well experienced in vegetable production. Table 8.9 reflects the findings of the study.

Table 8.9 Qualifications related to agriculture

Qualifications	N	%	Cum.%
Certificate	6	11.54	11.54
Diploma	2	3.85	15.38
Degree	2	3.85	19.23
Non	42	80.77	100.00
Total	52	100.00	

People with higher levels of education are more likely than those with lower or no education to analyse and interpret agricultural data, claim Xaba and Masuka (2013). According to research by Oduro-Ofori *et al.* (2014), output rises in Kumasi as the educational level rises, with secondary school education having the highest returns on agricultural productivity. According to Oduro-Ofori *et al. (ibid)*, education broadens a farmer's horizons, non-formal education gives him practical training and better

farming techniques, and informal education keeps farmers up to date with emerging innovations and ideas and enables them to exchange their own first-hand knowledge.

8.3.1.11 Number of dependents

A family size of the respondents in the study area ranges from 2 to 9, but most of the respondents (69.76%) have family size ranging from 3-9 dependents. Higher numbers of dependents are of value in providing labour for vegetable production, if they are available. Table 8.10 reflects the findings of the study.

Table 8.10 Number of dependents

Dependents	N	%	Cum%
1-2	11	21.15	21.15
3-4	19	36.54	57.69
5-6	11	21.15	78.84
7-8	6	11.54	9.38
>9	5	9.62	100.00
Total	52	100.00	

Large household sizes, according to Xaba and Masuka (2013), inhibit the sale of produce because the farmer must first meet household consumption demands. The more dependents there are per household in Osun State, Nigeria, according to Olayemi (2012), the more likely it is that they will be used as a source of manual labour for family farming. On the other hand, larger families often have a negative influence on household food security and significantly increase the likelihood that a family would become impoverished. Herera *et al.* (2021), who maintained that food insecurity rises with the number of persons in families in Madagascar's rural areas, confirm this theory. In other words, large families will have an impact on both the amount of food consumed and the nutritional health of each member of the family.

The high number of women participating in vegetable production in the study area may create opportunity for government to support organic farming, since women are a priority in accessing agricultural activities.

8.3.2 Fertilisers and pest control methods

This section presents the results on the use of fertilisers and methods of pest control. The results cover the kind of fertilisers used, kind of organic fertilisers, pest control methods, weed control methods, and the danger of chemicals.

8.3.2.1 Soil fertility preservation method

About 37% of the respondents apply fertilisers in order to maintain soil fertility, 28.85% use crop rotation for the same purpose, 3.77% use intercropping to mitigate against soil degradation, 1.92% use other methods, and 25.00% use all of the above, in respect of the methods used to maintain soil fertility and to mitigate against soil degradation. Table 8.11 presents the findings of the study.

Table 8.11 Soil fertility preservation method

Method	N	%	Cum%
Fertilisation	19	36.54	36.54
Crop rotation	15	28.85	65.39
Intercropping	3	5.77	71.16
Tillage	1	1.92	73.08
Others	1	1.92	75.00
All above	13	25.00	100.00
Total	52	100.00	

Crop rotation, according to Dang and Hung (2021), preserves and enhances soil fertility by increasing crop residue and root system variety, which in turn alters soil microbial activities and enhances soil health and ecological interactions. Another version by Dong *et al.* (2012) revealed that improving soil fertility in China's red soil region using adequate organic fertiliser is a crucial management strategy.

8.3.2.2 Kind of fertilisers used

Majority of respondents (65.38%) indicated that they used both chemical and organic fertilisers to keep their soil well nourished, 23.08% used chemical fertilisers and 11.54% used organic fertilisers only. The use of organic fertilisers creates a basis for possible conversion to organic farming. Table 8.12 reveals the findings of the study.

Table 8.12 Kind of fertilisers used

Kind	N	%	Cum%
Chemical	12	23.08	23.08
Organic	6	11.54	34.62
Both	34	65.38	100.00
Total	52	100.00	

By combining organic and inorganic nitrogen on cucumber plants, Samaranayake and Ulpathakumbura (2021) were able to increase cucumber plant growth, yield, and quality while also increasing soil fertility in Sri Lanka. Alternatively, Wazir *et al.* (2018) demonstrated that several home organic fertilisers improved growth and yield responses in both potato and pea. Kalbani *et al.* (2016) lend support to this hypothesis and reaffirmed that fertilisers made from chicken manure and agro-fish pellet had a substantial impact on the number of flowers and quality of tomato fruits in the United Arab Emirates.

8.3.2.3 Kind of organic fertilisers used

Majority of respondents (53.85%) use kraal manure to nourish their soil and to mitigate against soil degradation, 21.15% use poultry manure and 21.15% use both kraal and poultry manure while 3.85% use others. Table 8.13 reflects the findings of the study.

Table 8.13 Kind of organic fertilisers used

Kind	N	%	Cum%
Livestock manure	28	53.85	53.85
Poultry manure	11	21.15	75.00
Compost	0	0.00	75.00
Others	2	3.85	78.85
All above	11	21.15	100.00
Total	52	100.00	

According to the results of a study by Islam *et al.* (2012), cow dung would produce the most lettuce per hectare in Bangladesh in terms of leaves, root length, and yield. According to the research by Garko *et al.* (2021), Nigerian sweet maize experienced noticeably superior growth indices after receiving 9 t/ha of poultry manure.

8.3.2.4 Methods of pests and diseases control

Majority of respondents (76.92%) used chemicals to control pests and diseases, the 3.85% of the respondents used biological method of control while 19.23% used integrated pest management in terms of pest and disease control on vegetables. Table 8.14 reveals the findings of the study.

Table 8.14 Methods of pests and diseases control

Methods	N	%	Cum.%
Biological control	2	3.85	3.85
Chemical control	40	76.92	80.77
Integrated pest management	10	19.23	100.00
Total	52	100.00	

Chemical pesticides, according to Roychowdhury *et al.* (2014), are the primary cause of food poisoning, and other health issues that result in cancer, land degradation, loss of soil fertility, and genetic changes in plant populations. In a different version, Kumar and Pandey (2021) pointed out that natural pesticides/bio-pesticides (those that are biological in nature) are authorized in organic agricultural systems, but they should only be used if there is no other option and must be avoided as much as possible.

8.3.2.5 Weed control on vegetable plots

About 64% of the respondents use manual weed control on their farms as compared to 1.92% who graze their livestock on the farms infested to get rid of weeds, the 5.77% use herbicides, and 5.77% use crop rotation for the same purpose, while 23.08% use all the above to combat weeds. Table 8.15 reflects the findings of the study.

Table 8.15 Weed control on vegetable plots

Method	N	%	Cum%
Manual	33	63.46	63.46
Grazing	1	1.92	65.38
Herbicides	3	5.77	71.15
Crop rotation	3	5.77	76.92
All above	12	23.08	100.00
Total	52	100.00	

DAF (undated) claims that manual weed management is efficient since it removes the entire weed, including its roots, from the soil whereas a hand hoe can dig out or cut the weed's stem below the earth and expose the root structure.

8.3.2. 6 Danger of using chemicals

Use of chemicals for weed, pest and disease control tend to pose hazards to both humans, animals, plants, and soil, and leads to land degradation. That is why the majority of respondents (98.08%) agree that chemicals need to be handled with care

citing the danger of the pain it can inflict on humans, while 1.92% are ignorant of the danger of chemicals to humans. Figure 8.2 reflects the findings of the study.

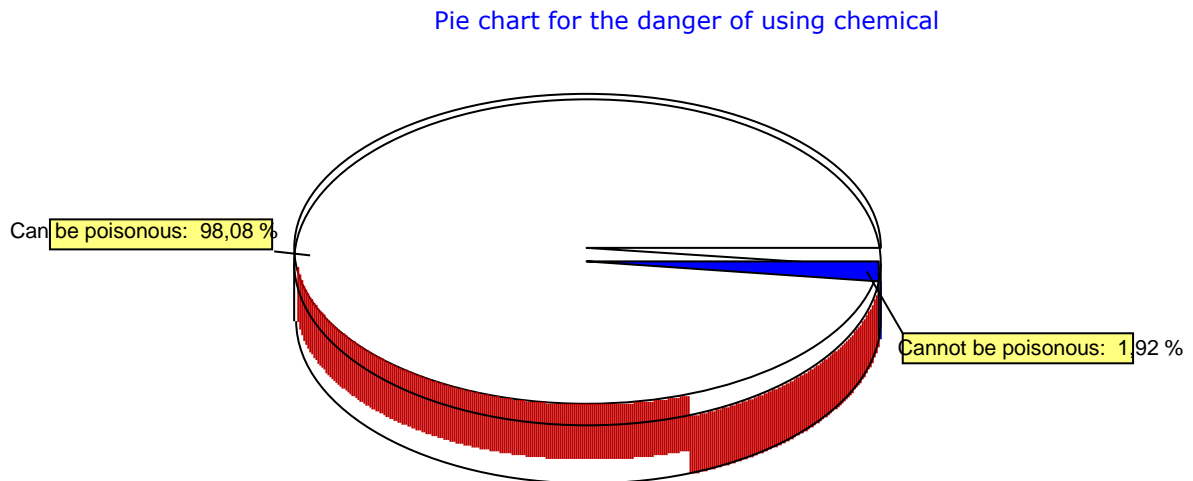


Figure 8.2 Danger of using chemicals

According to research by Lutap and Atis (2013), intensive pesticide use, and exposure have led to a chronic health issue that has affected vegetable producers in Ilocos Norte. According to Glover-Amengor *et al.* (1998), chemical residues may contaminate water, food crops, and other sources, and when consumed by people, they may have negative health effects.

8.3.2.7 Safety use of chemicals

About 48.08% of the respondents indicated that there is a need to use protective clothing when handling chemicals, the 23.08% wash hands after handling chemicals to help reduce the risk, again another 23.08% use all the above as a precautionary measure to be safe from toxic chemicals, and 5.77% they avoid using chemicals to avert the danger caused by chemicals. Figure 8.3 reflects the findings of the study.

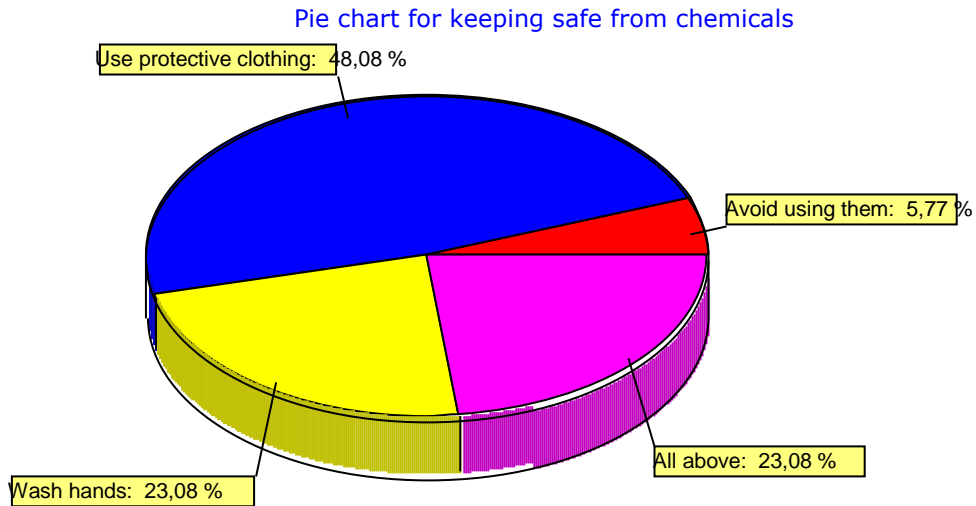


Figure 8.3 Safety use of chemicals

No matter the design, all protective gear, according to Khalil (2015), reduces the wearer's capacity to accomplish specific tasks in comparison to their actual performance without the equipment. In other words, the equipment causes a drop in performance and an increase in the amount of time required to complete the work. Alapati and Shaik (2017), on the other hand, believe protective clothing is highly functional, appropriate, and acceptable only when it offers protection to the wearer without posing health risks or impeding productivity.

Farmers are aware that chemicals are hazardous, and they wore protective clothing and washed their hands with soap after handling them. With the growing fear of toxic substances, the adoption rates of organic farming are projected to rise.

Weed control is mainly manual. The use of hands or hand hoes is required for manual weed management. The utilization of human labour and readily accessible tools, as opposed to the use of herbicides, is seen as making the process more environmentally friendly.

8.3.3 Farmers attitudes towards Organic Farming (OF)

This section presents the results on the attitude of farmers towards organic farming. The scope of the results covers among others, attitude towards markets, yields, health benefits, consultancy, costs of chemicals and consumer's willingness.

8.3.3.1 OF as a thing of the past

There are farmers who believe that OF is an old-fashioned way of production because one is not allowed to use inorganic fertilisers and chemicals. That is why 63.46% agree that OF is the thing of the past as reflected in Table 8.16.

Table 8.16 OF as a thing of the past

Response	N	%	Cum. %
Strongly disagree	1	1.92	1.92
Disagree	9	17.31	19.23
Not sure	6	11.54	30.77
Agree	33	63.46	94.23
Strongly agree	3	5.77	100.00
Total	52	100.00	

According to Rana (2018), many OF approaches are applicable to other agricultural systems, including traditional agriculture employed in developed nations like India. However, according to Seilan (2011), OF does not employ synthetic pesticides and instead focuses on creating healthy, rich soil, producing toxic-free agricultural products, and restoring the balance of the soil's nutrients.

8.3.3.2 Lack of local markets for organic vegetables

About 42% of the respondents indicated there is lack of local market for organic produce, 3.85% strongly agree. Those not sure are 30.77%, and 23.08% disagree. The response from the respondents which indicates that there is lack of local markets for organic produce needs to be addressed by educating producers and consumers about organic farming, and that stringent entry requirements should be facilitated by those able to assist. Table 8.17 reflects the findings of the study.

Table 8.17 Lack of local markets for organic vegetables

Response	N	%	Cum %
Disagree	12	23.08	23.08
Not sure	16	30.77	53.85
Agree	22	42.31	96.16
Strongly agree	2	3.85	100.00
Total	52	100.00	

In Tamil Nadu, India, fewer people are interested in purchasing organic products than in purchasing inorganic ones, according to SriRithi *et al.* (2018). The fact that organic consumers are sporadic buyers and frequently switch between utilising organic and inorganic items results in low product purchase levels. Similarly, to this, Ozguven (2012) cited the high cost, lack of availability, satisfaction with conventional food, lack of trust, the little selection, and low perceived value as the main deterrents for customers in Izmir from purchasing organic food.

8.3.3.3 Chemical fertilisers are expensive

Majority of respondents (73.08 %,) indicated that chemical fertilisers are expensive and unaffordable and 21.5% strongly agree while 5.77% are not sure. Table 8.18 reflects the findings of the study. The expensive chemical fertilisers may serve as an opportunity to switch over from conventional to organic farming.

Table 8.18 Chemical fertilisers are expensive

Response	N	%	Cum%
Not sure	3	5.77	5.77
Agree	38	73.08	78.85
Strongly agree	11	21.15	100.00
Total	52	100.00	

According to the study by Thapa (2011), crop productivity in the farming sector of Nepal is probably going to decrease as fertiliser prices rise, with an elasticity of 0.19. According to a study by Khan *et al.* (2010), as fertiliser costs rise in Pakistan, agricultural output likewise decreases as a result of farmers' inability to pay higher rates for fertiliser.

8.3.3.4 Organic fertilisers are not affordable

About 42% of the respondents indicated that they agree that organic fertilisers are unaffordable, 30.77% not sure and 23.08% disagree and 3.85% strongly agree in terms of the cost of organic fertilisers being unaffordable. Table 8.19 reflects the findings of the study. Observations are that farmers' attitudes play an important role when it comes to resourcing of organic fertilisers. This response of the farmers to say organic fertilisers are not affordable may be due to their bulkiness, dirty and need to

be worked into the soil differently from chemical fertilisers which are applied through band placement.

Table 8.19 Organic fertilisers are not affordable

Response	N	%	Cum.%
Disagree	12	23.08	23.08
Not sure	16	30.77	53.85
Agree	22	42.31	96.15
Strongly agree	2	3.85	100.00
Total	52	100.00	

Amarasinghe (2016)'s research revealed that the majority of Kalutara households are hesitant to use biodegradable garbage inside their houses to create homemade compost. Biodegradable wastes like plant litter and kitchen scraps are instead burned. According to CalRecycle (2020), California discards about 10 million tons of organic wastes annually, making up 25% of the landfill's composition. According to Ahmad *et al.* (2016), recycling, composting, and the use of organic fertilisers that are readily available locally to improve soil fertility may lessen the production costs (i.e., lower yields and greater labour costs) associated with growing crops organically.

8.3.3.5 Pesticides are healthy

About 52% of the respondents disagree that pesticides are healthy for both humans and animals, 23.08% agree that pesticides are healthy, 21.15% are not sure. This means that most respondents disagree with the statement. It is important to always take precautionary and safety measures, handling chemicals in whatever form. Table 8.20 reflects the findings of the study.

Table 8.20 Pesticides are healthy

Response	N	%	Cum%
Strongly disagree	1	1.92	1.92
Disagree	27	51.92	53.84
Not sure	11	21.15	74.99
Agree	12	23.08	98.08
Strongly agree	1	1.92	100.00
Total	52	100.00	

Chemical pesticides have been linked to the destruction of biodiversity, according to Mahmood *et al.* (2016), who also suggested that they may have a harmful impact on

the environment. Similarly, to this, Roychowdhury *et al.* (2014) believed that chemical pesticides were the primary cause of food poisoning, various health issues that result in cancer, loss of soil fertility, genetic changes in plant populations, and land degradation. Glover-Amengor *et al.* (1998) reaffirmed that chemical pesticides may contaminate water supplies, food crops, and other sources that humans may consume and result in health issues, which lends weight to this theory.

8.3.3.6 Organic farming (OF) is profitable

Majority of respondents (80.77%) agree that OF is more profitable than conventional farming and 9.62% strongly agree. About 5.77% are not sure and 1.92% disagree and another 1.92% strongly disagree. Table 8.21 reflects the findings of the study.

Table 8.21 Organic farming is profitable

Response	N	%	Cum%
Strongly disagree	1	1.92	1.92
Disagree	1	1.92	3.84
Not sure	3	5.77	9.61
Agree	42	80.77	90.38
Strongly Agree	5	9.62	100.00
Total	52	100.00	

The study's findings corroborate those of Sohail *et al.* (2021), who discovered that in actual conditions with price premiums, organic agriculture in Pakistan is significantly more profitable than conventional agriculture, with (22-35% greater net present value) and higher benefit-cost ratios (20-24%). The findings of the study by Pham and Shively (2018), which show that organic vegetable production by Vietnamese smallholders appears to be economically competitive with conventional farming, lend support to this viewpoint.

8.3.3.7 No pesticides more pest infestation

About 44% of the respondents are not sure whether if you do not use pesticides, you will have high infestation of pests, 40.38% agree and 7.69% disagree while 7.69% strongly agree. Table 8.22 reflects the findings of the study. Observation made from the study area revealed that farmers are controlled by set of beliefs that use of chemicals is the only solution to pests and disease infestation.

Table 8.22 No pesticides more pest infestation

Response	N	%	Cum%
Disagree	4	7.69	7.69
Not sure	23	44.23	51.92
Agree	21	40.38	92.30
Strongly agree	4	7.69	100.00
Total	52	100.00	

Pesticides have proven valuable, says Nguyen *et al.* (2018), by boosting vegetable production in Vietnam's Central Highlands, lowering the prevalence of insect-borne and endemic diseases, and safeguarding plants. On the other hand, Birkhofer *et al.* (2016) reported that organic farmers are only permitted to use practices that negatively affect pest populations, such as tillage, promotion of crop inhabitants for natural enemies, promotion of non-crop inhabitants for natural enemies, and use of specific organic pesticides.

8.3.3.8 Availability of organic fertilisers and pesticides

Majority of respondents (63.46%) agree that organic fertilisers and pesticides are readily available, 19.23% strongly agree, 1.92% strongly disagree and 7.69% disagree and 7.96% are not sure. Table 8.23 reflects the findings of the study.

Table 8.23 Availability of organic fertilisers and pesticides

Response	N	%	Cum%
Strongly agree	1	1.92	1.92
Disagree	4	7.69	9.61
Not sure	4	7.69	17.30
Agree	33	63.46	80.76
Strongly agree	10	19.23	100.00
Total	52	100.00	

Vegetal insecticides, according to Stoleru and Sellitto (2016), are the available insect-specific insecticides of natural origin that are used to draw or repel insects, render them sterile or kill them, as well as to interfere with their growth or reproduction. Similarly, to this, Kumar and Pandey (2021) found that bio-pesticides are available as the plant- or animal-derived extracts that control insects through non-toxic means such as insect repellents, insect regulators, and secondary metabolites. They are only employed when all other techniques, including cultural, biological, and biotechnological ones, have failed to control insects. However, organic fertilisers are

discovered to be easily accessible. The production costs associated with growing crops organically, such as lower yields and greater labour expenses, may be reduced, according to Ahmad *et al.* (2016), by recycling, composting, and using locally accessible organic fertilisers to boost soil fertility.

8.3.3.9 Conversion to Organic Farming (OF) is expensive

Majority (75.00%) of the respondents agree that conversion into organic farming is expensive, (11.54%) not sure, (9.62%) strongly agree and (3.85%) disagree. Table 8.24 reflects the findings of the study. The view is that conversion to organic farming is complex, time consuming and labour intensive. The process towards conversion to organic farming makes people to go up and down to satisfy the requirements of conversions.

Table 8.24 Conversion to OF is expensive

Response	N	%	Cum.%
Disagree	2	3.85	3.85
Not sure	6	11.54	15.39
Agree	39	75.00	90.39
Strongly agree	5	9.62	100.00
Total	52	100.00	

According to Nettier *et al.* (2012), some farms cannot afford the higher production expenses because the profits from the sale of organic goods in France are insufficient. The findings of a study by Sipilainen and Lansink (2005) indicate that the technical efficiency of Swedish farmers first declines when the conversion to organic farming begins and that it only starts to increase after 6-7 years from switching over. However, Kundu (undated) believes that converting to organic farming can assist farmers and employers create enough jobs in the agricultural labour market by paying each employee a living wage while also adhering to the unorganised employees' social security norms.

8.3.3.10 Organic products are healthier for the family

About 83% of the respondents agree that organic products are healthier for the family, 11.54% are not sure, 3.85% disagree and 1.92% strongly agree. Table 8.25 reflects the findings of the study. The organic produce is regarded as health because there is

a belief that less or no chemicals are used and therefore the produce is not contaminated.

Table 8.25 Organic products are healthier for the family

Response	N	%	Cum.%
Disagree	2	3.85	3.85
Not sure	6	11.54	15.54
Agree	43	82.69	90.08
Strongly agree	1	1.92	100.00
Total	52	100.00	

According to a study by Ghoreishi (2021), organic farm products are essential for improving Canadians' health and play a crucial part in safeguarding the environment by lowering soil erosion and water pollution. Sohail *et al.* (2021), who reaffirmed that vegetables cultivated organically are enhanced with nutrients and are also safe for ingestion because they are exposed to fewer residues of non-organic pesticides, confirm this claim.

8.3.3.11 Income generation from Organic Farming (OF)

The results of the study show that 44.23% agree that OF can generate good income for the farmers, 1.92% strongly agree, the 32.69% are not sure of the income it can generate for the farmers, while 19.23% disagree and another 1.92% strongly disagree. Table 8.26 reflects the results of the study. The positive response by respondents creates a platform where OF can be promoted.

Table 8.26 Income generation from OF

Response	N	%	Cum.%
Strongly Disagree	1	1.92	1.92
Disagree	10	19.23	21.15
Not sure	17	32.69	53.85
Agree	23	44.23	98.08
Strongly Agree	1	1.92	100.00
Total	52	100.00	

8.3.3.12 Yield from OF

There is always a belief that yields from organic farming are low because chemicals are not used. This is confirmed by the responses of the 59.61% respondents who agree and strongly agree that organic yields are too low, as reflected in Table 8.27.

Table 8.27 Yield from OF

Response	N	%	Cum.%
Disagree	6	11.54	11.54
Not sure	15	28.85	40.38
Agree	20	38.46	78.85
Strongly agree	11	21.15	100.00
Total	52	100.00	

Lower organic crop yields are less of an issue, according to Sohail *et al.* (2021), than it is for society to learn to recognise the key advantages of organic farming, such as increased economic, social, and environmental sustainability.

8.3.3.13 Consumers' willingness to pay good price for organic products

The results of the study show that 40.38% agree that consumers are willing to pay good price for organic products and another 40.38% are not sure while 17.31% disagree and 1.92% strongly agree. Observation made is that educated and informed consumers about organic produce are willing to pay high price, and those who are not exposed to the value of organic products will remain doubtful as reflected in Table 8.28.

Table 8.28 Consumers' willingness to pay good price for organic products

Response	N	%	Cum.%
Disagree	9	17.31	17.31
Not sure	21	40.38	57.69
Agree	21	40.38	98.08
Strongly agree	1	1.92	100.00
Total	52	100.00	

The food farmed organically tastes better and has a better mix of vitamins and minerals than food grown conventionally, according to a study by Thippeswamy (2013). Further noted is the link between eating organic food and a lower risk of heart attacks, strokes, cancer, bowel cancer, and many other ailments.

8.3.3.14 Organic farmers live in harmony with nature

About 49% of the respondents agree and strongly agree that organic farmers live in harmony with nature as reflected in Table 8.29. This could be because the respondents are not using chemicals which are harmful to nature.

Table 8.29 Organic farmers live in harmony with nature

Response	N	%	Cum %
Strongly disagree	1	1.92	1.92
Disagree	9	17.31	19.23
Not sure	17	32.69	51.92
Agree	19	36.54	88.46
Strongly agree	6	11.54	100.00
Total	52	100.00	

The Herald (2021) claims that rather than battling nature with chemical inputs, farming flourishes when it cooperates with regional ecosystems, enhancing soil and plant quality through readily available biomass and biodiversity. Like what Siddique *et al.* (2014) said, this goal can be attained by utilising low external inputs, labour- and knowledge-intensive farming, and environmentally friendly approaches.

8.3.3.15 Accessibility to advice and consulting on OF is difficult

Respondents (63.46 %) in this study agree and strongly agree that to obtain advice and consulting regarding OF is difficult. Table 8.30 reflects the findings of the study. The reason for shortage of consultancy and advisory services on organic farming could be that such services are scares.

Table 8.30 Accessibility to advice and consulting on OF is difficult

Response	N	%	Cum%
Disagree	1	1.92	1.92
Not sure	18	34.62	36.54
Agree	25	48.08	84.62
Strongly agree	8	15.38	100.00
Total	52	100.00	

The findings of a study by Agapieva *et al.* (2015) revealed that Bulgarian organic farmers continually demand specialised consulting services in order to comply with the stringent requirements of organic farming and the supply of high-quality goods.

According to a study by Mahindaratne and Min (2019), the characteristics of the channel and the information demand of Sri Lankan vegetable farmers have a significant impact on their information-seeking behaviour (ISB). The difficulties faced by organic farmers in Lithuania in acquiring agricultural consulting services, according to Tamuliene *et al.* (2017), are farmers' preferences for consultation content, duration, and methodologies.

8.3.3.16 Organic vegetable production is good business

The 51.92% of the respondents agree that producing organic vegetables within five years will be a good idea in terms of generating the required income for the farmers, jobs for the jobless, and production of healthy vegetables which are of better quality, 25.00% are not sure, 13.46% disagree and 9.62% strongly agree. Table 8.31 reflects the findings of the study.

Table 8.31 Organic vegetable production is good business

Response	N	%	Cum%
Disagree	7	13.46	13.46
Not sure	13	25.00	38.46
Agree	27	51.92	90.38
Strongly agree	5	9.62	100.00
Total	52	100.00	

Ndungu (2015) claims that the organic vegetable production method in Kenya's Kiambu and Kajiado Counties is a good concept because it has a better gross margin than the conventional method. According to a study by Thippeswamy (2013), food cultivated organically tastes better and has a higher ratio of vitamins and minerals than food farmed conventionally. Additionally, consuming organic food has been linked to a decreased risk of heart attacks, strokes, cancer, bowel cancer, and many other disorders. In a different interpretation, Amarnath and Sridhar (2012)'s economic research shows that in Tamil Nadu, the net income per hectare from organic products is larger than that from conventional ones.

According to the study's results, some farmers consider organic farming as an outdated because of its low yields, lack of informational resources, lack of local markets, and unaffordable and unavailability of organic fertilizers and because of their

bulkiness. These attitudes can be a barrier to a successful adoption of organic farming.

The study's findings also showed that most respondents consider organic farming as profitable, an excellent business, with farmers living in peace with the environment and with products that were healthy for families. These positive attitudes towards organic farming can lead to possibility rapid establishment of a successful organic farming system.

8.3.4 Farmers' beliefs about OF

This section presents the results on the beliefs of farmers about Organic farming. The scope of the work covers among others, beliefs about markets for organic produce, importance of skills, regulatory requirements, income from OF and prices of organic produce.

8.3.4.1 OF saves on production costs

The majority (78.85%) of respondents indicated that organic farming saves on production costs, and saving on cost is important, 17.31% indicated that saving on cost is neither important nor unimportant, and 3.85% considered saving on cost as very important. Table 8.32 reflects the findings of the study. Organic farming saves on production costs because it does not use expensive chemicals and inorganic chemicals which farmers are complaining about.

Table 8.32 OF saves on production costs

Response	N	%	Cum.%
Neither important nor unimportant	9	17.31	17.31
Important	41	78.85	96.15
Very important	2	3.85	100.00
Total	52	100.00	

According to a study by Shrestha *et al.* (2014), growing vegetables organically in the Kathmandu Valley is generally less expensive than growing them conventionally. Offermann and Nieberg (2000) contend that, in most European nations, the total expenses of organic farms are, on average, just marginally cheaper than those of equivalent conventional farms, which lends weight to this argument.

8.3.4.2 Organic produce fetches higher prices

The 75.00% of the respondents indicated that organic produce fetches higher price as important, 21.15% indicated neither important nor unimportant, and the 1.92 % say unimportant and another say it is very important. Figure 8.4 reflects the findings of the study.

According to a study by Ndungu (2015), all vegetables in Kenya's Kiambu and Kajiado Counties were more expensive when they were organic than when they were conventional. Offermann and Nieberg (2000)'s findings lend credence to this theory when indicating that the average premium prices of organic potatoes in most European countries are typically 50–500% more than those for conventionally grown potatoes.

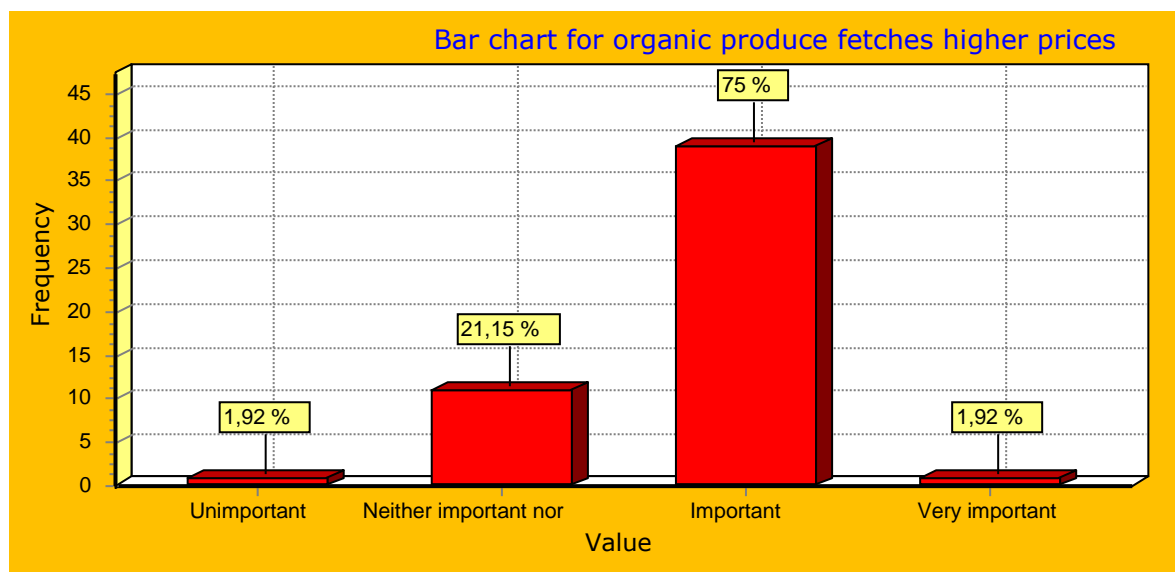


Figure 8.4 Organic produce fetches higher prices

8.3.4.3 Organic produce increases farm income

About 67.31% indicated that organic produce increases farm income as important, 25.00% indicated as neither important nor unimportant, 5.77% unimportant and 1.92% very important. Figure 8.5 reflects the findings of the study.

According to the findings of a study conducted by Sarker and Itohara (2009), organic farmers in Bangladesh's Tangail District have better financial stability than conventional farmers due to higher price premiums and lower production costs.

According to Dharmadasa *et al.* (2019), Sri Lanka's transition to organic farming increases smallholder farmers' income, profitability, and production while ensuring environmental sustainability.

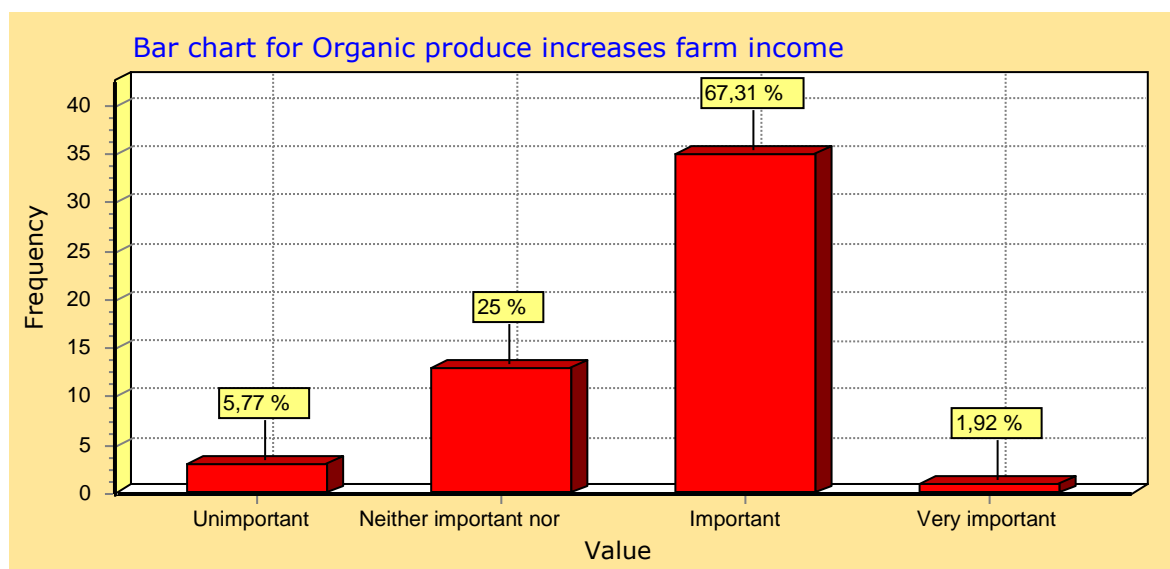


Figure 8.5 Organic produce increases farm income

8.3.4.4 Organic markets have potential of growth

About 67% of respondents regarded the potential growth of organic markets as important, while 28.85% regarded market growth as neither important nor unimportant. Table 8.33 reflects the findings of the study.

Table 8.33 Organic markets have potential of growth

Response	N	%	Cum%
Unimportant	1	1.92	1.92
Neither Import nor unimportant	15	28.85	30.77
Important	35	67.32	98.09
Very important	1	1.92	100.00
Total	52	100.00	

According to a survey by Higa (2011), consumers buy organic products because they believe they are safer, healthier, and tastier than non-organic alternatives. In a similar fashion, Cachero-Martinez (2020) claimed that the absence of chemicals that could be hazardous to health and the absence of synthetic additives are aspects that

consumers view as advantageous and that this results in organic products having a higher quality.

8.4.4.5 OF is not a modernised way of farming

About 50.00% of respondents regard the OF as important, 42.31% as neither important nor unimportant, 7.69% as unimportant. Table 8.34 reflects the findings of the study. Table 8.34 reflects the findings of the study.

Table 8.34 OF is not a modernised way of farming

Response	N	%	Cum%
Unimportant	4	7.69	7.69
Unimportant nor important	22	42.31	50.00
Important	26	50.00	100.00
Total	52	100.00	

Rana (2018) holds the view that many practices utilised in organic farming are not unique to different agricultural systems, including the ancient agriculture performed in old nations like India. However, several rules and certification programs serve as the foundation for OF. Reddy (2009), who contends that organic farming is an old idea that has only been marginalised by large-scale chemical-based farming practices that have dominated food production over the previous 45 years, supports this idea.

8.3.4.6 Technical skills for organic farming

The results show that the majority (80.77%) see the need for technical skill. Table 8.35 presents the findings of the study. The researcher's observation is that technical skills of farmers play an important role in the adoption rate of organic farming.

Table 8.35 Technical skills for organic farming

Response	N	%	Cum%
Very unimportant	1	1.92	1.92
Unimportant	2	3.85	5.77
Neither import nor unimportant	8	15.38	21.15
Important	39	75.00	95.15
Very Important	2	3.85	100.00
Total	52	100.00	

According to research by Kumari *et al.* (2018), attitudes toward organic farming among farmers in Salempur and Batpar Rani increased from 6.7% before training to 23.34% after it. This is evidence that farmers are more likely to adopt organic agricultural practices when they have the necessary technical abilities. Samantary (2016) contends that in the Ganjam District, the proportion of farmers with knowledge of organic farming increased from 7.50% prior to training to 26.67% following training, which lends weight to this viewpoint.

8.3.4.7 Regulatory requirements for OF

About 71% regard meeting regulatory requirements for certification by organic farmer as important and very important. Table 8.36 reflects the findings of the study.

Table 8.36 Regulatory requirements for OF

Response	N	%	Cum %
Unimportant	3	5.77	5.55
Neither important nor unimportant	12	23.08	28.85
Important	34	65.38	94.23
Very important	3	5.77	100.00
Total	52	100.00	

According to the organic policy impact study by Uhunamure *et al.* (2021), most organic farmers in Limpopo (88.4%) agreed that the criteria for organic farming are overly prescriptive, and 74.6% of the farmers said it is difficult to achieve organic certification. According to Vogl *et al.* (2005), the legislative requirements for organic farming can only be satisfied by allowing for regional definitions, local identity, and innovations. This is because organic farming was founded in the South, not the North, and as a result, regional agricultural systems must support regional standards and regional quality control systems. It should be avoided, according to Vogl (*ibid*), for the North to design and assess organic farming systems using only northern notions and practices.

8.3.4.8 Meeting the amount of work required for OF

The 71.15% of the respondents regard meeting the amount of work required for OF as important, 23.08% regard as neither important nor unimportant, 5.77% regard as very important and unimportant. Table 8.37 reflects the findings of the study. The researcher's observation is that an organic farmer is faced with the responsibility of

looking after the environment and not merely practicing agriculture for the purpose of obtaining a harvest.

Table 8.37 Meeting the amount of work required for OF

Response	N	%	Cum.%
Unimportant	3	5.77	5.77
Neither import nor unimportant	12	23.08	28.85
Important	34	65.38	94.23
Very Important	3	5.77	100.00
Total	52	100.00	

A simple substitution of synthetic fertilisers and other chemical inputs with organic inputs does not constitute organic farming, claim Kumari *et al.* (2018). Samantaray (2016) views organic farming as a thorough management strategy to enhance the well-being of the land, air, water, animals, plants, and all living microorganisms. An organic farmer, to put it simply, coexists peacefully with the environment.

The study's results revealed that the majority of respondents thought OF increased farm income, its produce fetched high prices, saved on production costs, and had a growing market. People use their beliefs as guidance while making decisions. The likelihood that OF will be taken into consideration soon will probably depend on how much importance is placed on it.

The study's results also revealed that farmers regard it crucial to have technical skills, comply with regulations, and complete the amount of work linked with organic farming. Due these requirements farmers regard entry to organic farming as being difficult.

8.3.5. Information seeking and communication about OF

This section presents the results on how organic farming information spread among farmers. The scope of the work covers knowledge level of Organic farming, and discussions regarding organic farming.

8.3.5.1 Knowledge level regarding OF

Most of the respondents (53.85%) have moderate knowledge, while (7.69%) have little knowledge and (9.62%) are well informed regarding OF as reflected in Table

8.38. Observation is that most of the farmers still need training in order to be more efficient in organic practices.

Table 8.38 Knowledge level regarding OF

Response	N	%	Cum%
Not informed at all	14	26.92	26.92
Only little	4	7.69	34.61
Moderately	28	53.85	88.46
Well informed	5	9.62	98.08
Very well informed	1	1.92	100.00
Total	52	100.00	

According to the results of the study by Palada *et al.* (2020), training for farmers in the eastern Samar region of the Philippines led to a 33.14% improvement in their knowledge level as measured by the difference between their pre-test and post-test scores. This conclusion is reinforced by Kumari and Khanduri (2019), who contend that workshops and on-the-job training are crucial components of growing capacity in the area of agricultural research, extension, and development. In a similar vein, Yaseen *et al.* (2015) showed that most farmers in Pakistan transitioned from low-income to medium and medium to high-income through capacity building.

According to a study by Noor and Dola (2011), the capacity building benefits Malaysian Peninsular farmers in terms of better job quality, more plentiful output, cost and time savings, increased income, and improved networking. Oluwole *et al.* (2021)'s contention that farmers in Oyo State, Nigeria, were more technically effective than farmers without extension connections supports this viewpoint.

8.3.5.2 Discussion regarding Organic Farming (OF)

About 37% of the respondents indicated that they sometimes hold discussions regarding OF as form of information sharing, 28.8% indicated they never hold discussions, 25.00% indicated that they often discuss and 1.92% very often. Table 8.39 reflects the findings of the study. The researcher noted that discussion by farmers is another way of information sharing.

Table 8.39 Discussion regarding OF

Response	N	%	Cum%
Never	15	28.85	28.85
Seldom	4	7.69	3.544
Sometimes	19	36.54	73.08
Often	13	25.00	98.08
Very often	1	1.92	100.00
Total	52	100.00	

According to Kamrudin *et al.* (2015), knowledge exchange in the agricultural industry is an important activity that can assist farmers in increasing their output. Rusuli and Tasmin (2010) provide support for this theory by asserting that the success of information-sharing activities within an organisation could enhance customer services, introduce new goods to the market, and lower operating expenses. In a different study, Kormawa *et al.* (2004) discovered that the size of the farm could be a determinant of whether farmers decide to share information about new technologies with other farmers. To put it simply, farmers who have reasonably large vegetable farms are more likely to talk about and exchange information about vegetables with others.

According to the study's findings, the respondents have a basic understanding of organic farming and sometimes hold discussions about it. Regular conversations and a moderate level of understanding could act as catalysts for the adoption of organic farming.

8.3.6 Intentions and interventions

This section presents the results on the likelihood that farmers will do organic farming in the near future.

8.3.6.1 Likelihood of organic vegetable production in the future

The 75.00% of the respondents indicated that they are likely and very likely going to do organic vegetable production in the future as reflected in Table 8.

Table 8.40 Likelihood of organic vegetable production in the future

Response	N	%	Cum %
Very likely	16	30.77	30.77
Likely	23	44.23	75.00
Undecided	7	13.46	88.46
Unlikely	6	11.54	100.00
Total	52	100.00	

According to study findings by Raval (2018), farmers' decisions to switch to organic farming are largely influenced by environmental awareness, promising market prospects, visible economic rewards, and health consciousness. When farmers adopt organic farming, motivating factors like profit, health, and soil fertility play a significant role. According to Veisi *et al.* (2017), economic reasons, health and safety concerns, and environmental concerns are the primary motivators for farmers' conversions to organic farming in Iran, whereas social and ethical considerations are regarded as less important. In a different interpretation, research by Krishnan (2002) found that farmers in Central Kerala place more value on soil health and fertility than moral, financial, and social considerations when converting to organic agricultural practices. Unay-Gaihard and Bojnec (2021) found that farms are more likely to switch from conventional to organic when women are involved with decision-making.

According to the study's findings there is a desire from the farmers to convert to organic farming. It is recommended that relevant authorities and organisations should create an environment for the establishment of organic farming that address local needs and requirements that accommodates farmers of the status in the study area.

8.4 Conclusions and recommendations

The objective of the study was to identify and analyse the opportunities and constraints of a wide adaptation to organic vegetable production systems by small-scale farmers.

The high number of women participating in vegetable production in the study area may create opportunity for government to support organic farming, since women are a priority in accessing agricultural activities.

Farmers are aware that chemicals are hazardous, and they wore protective clothing and washed their hands with soap after handling them. With the growing fear of toxic substances, the adoption rates of organic farming are projected to rise.

Weed control is mainly manual. The use of hands or hand hoes is required for manual weed management. The utilization of human labour and readily accessible tools, as opposed to the use of herbicides, is seen as making the process more environmentally friendly.

According to the study's results, some farmers consider organic farming as an outdated because of its low yields, lack of informational resources, lack of local markets, and unaffordable and unavailability of organic fertilizers and because of their bulkiness. These attitudes can be a barrier to a successful adoption of organic farming.

The study's findings also showed that the majority of respondents consider organic farming as profitable, an excellent business, with farmers living in peace with the environment and with products that were healthy for families. These positive attitudes towards organic farming can lead to possibility rapid establishment of a successful organic farming system.

The study's results revealed that the majority of respondents thought OF increased farm income, its produce fetched high prices, saved on production costs, and had a growing market. People use their beliefs as guidance while making decisions. The likelihood that OF will be taken into consideration soon will probably depend on how much importance is placed on it.

The study's results also revealed that farmers regard it crucial to have technical skills, comply with regulations, and complete the amount of work linked with organic farming. Due these requirements farmers regard entry to organic farming as being difficult.

According to the study's findings, the respondents have a basic understanding of organic farming and sometimes hold discussions about it. Regular conversations and a moderate level of understanding could act as catalysts for the adoption of organic farming.

According to the study's findings there is a desire from the farmers to convert to organic farming. It is recommended that relevant authorities and organisations local needs and requirements that accommodates farmers of the status should create an environment for the establishment of organic farming that address in the study area.

It is therefore recommended that government should facilitate establishment of local organic markets, conduct health campaigns, conduct organic farming advocacy, and mediate cost benefits analysis to the farmers.

Based on the findings, it is concluded that there are more opportunities to organic farming in the study area.

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Chapter 9

General conclusions and recommendations

The literature review on vegetable production systems confirms that there are categories of farmers from small scale to communal whose practices differ in terms of scale of operation. The literature review gives us a picture of global, national and local vegetable production, constraints and consumption patterns of vegetables. This review has assisted in finding the knowledge gap that needs to be filled on sustainable vegetable production systems by small scale farmers of Limpopo Province in South Africa. Vegetables are crops that require a lot of care from the farmers in terms of supplying water for irrigation, fertilisers and protection from weeds, diseases and pests.

The objective of the study was to identify vegetable production systems and consumption patterns as determinants of food security in the study area. The understanding of the characteristics of farmers and vegetable production systems is important in order to create a knowledge base through which improvements and interventions can be made. The understanding of the demographics and perceptions of the farmers is important when new technologies are to be introduced. If there is an understanding and assessment of the situation, the introduction of new technologies can easily be introduced, knowing that there are certain constraints, and appropriate interventions can be introduced.

The objective of the study was to investigate vegetable production systems and consumption patterns as determinants of food security amongst small-scale vegetable farmers. The assessment and understanding of vegetable production systems and consumption patterns, are linked with knowledge and experience, land and other resources. The biggest concern identified is the water use system which are dominated by farrow irrigation which is known to be a water use inefficient system. It is important that the authorities should consider introducing water use efficient irrigation systems such as drip irrigation because water availability is becoming a problem because of high demand and that the rivers are running low and the dams are also at low capacity due to climate change. The vegetable consumption patterns are, according to this study, show that there is production throughout the year and seasons of scarcity are provided for through preservation of vegetables. Vegetables

are therefore contributing to food security. It is important that these farmers should be assisted by means that could encourage them to produce and consume vegetables, linking them with supermarket stores and unexplored markets.

The objective of the study was to identify and analyse climate change and mitigation strategies adopted by small-scale farmers towards a sustainable vegetable production and resilient from food shortages in the study area. The study reveals that farmers in the study area are facing and feeling the impact of climate change. They experience rare events such as drought, floods, unpredictable rainfall and extreme temperatures. They also have learned to adapt and mitigate against the impact of climate change, especially on the extreme temperatures and decrease and increased amount of rainfall. Their adaptation strategies in response to climate change, is assisted by weather and climate information they get from Television and Radio, they apply conservation agricultural practices which range from soil fertility, water saving and increased production. The study found that farmers have moderate ability to adapt to climate change. Most of the conservation practices can be used as climate change adaptive strategies such as crop rotation, mulching, contour planting, and application of organic matter. The study concluded that the main climatic factors affecting farmers in the study area are higher temperatures, drought and pest infestations. It is therefore recommended that farmers should be prepared well to respond to climate change and trained on water harvesting technologies, use of pest and drought resistant varieties, conservation tillage, and crop rotation systems.

Proper strategies to respond and to sustain vegetable production are needed. The Extension Service should introduce new technologies and innovations to farmers in order to be up to date with changes. This phenomenon is global and cannot be addressed by these farmers alone, these farmers are playing their part, and hence they need support through policy, training and resources from those in positions to can offer support.

The objective of the study was to investigate the potential of African indigenous vegetables towards the formation of a commercial, nutritional and sustainable production system in the study area. The African Indigenous vegetables are also produced in the study area. Those who are producing and selling African Indigenous Vegetables are generating reasonable income and there is a potential to expand to commercial scale. Only three African indigenous vegetables (i.e. mustard, okra and

night shade) in the study area are grown for local and national markets. There are other types of famous vegetables which can be explored for commercialisation, especially those that grow as weed and in the wild besides those that are already in production under irrigation. The potential to produce them commercially is big. These are vegetables which do well under rain-fed conditions and need to be tested on how they perform under irrigation, and this is where adaptive research comes in. This research can also look at production practices, seed production and preservation methods, diseases, and pests of these vegetables. Local experimentation may be done with other African vegetables like Amaranthus, spider plant, kale, bitter melon, pumpkin leaves, etc. It is also recommended that there be campaigns to promote these African vegetables for commercialisation because they are adapted to local conditions, and they are super vegetables that contain better nutrients than the exotic vegetables.

The objective of the study was to analyse the opportunities and constraints of a wide adaptation to organic vegetable production systems by small-scale farmers towards a vibrant commercial enterprise in Limpopo. Organic vegetable production is also practiced in the study area. The current study looked at the opportunities and constraints of a wide adaptation to organic vegetable production system. Organic farming is slowly being adopted but farmers are worried about the long time it takes and the high costs associated with the process of conversion from conventional to organic farming. They are aware that it is a profitable business, saves production costs and fetches high price. The other constraint is the link to the markets (local and national) that can buy their organic produce. The assistance is therefore needed in areas of markets, capacity building and facilitation to register as organic farmers and most important is the creation of enabling environment through provision of new knowledge, repair of aging bulk irrigation infrastructure, mobilisation of both farmers and officers to jointly tackle the problems, formation of farmer organisations and the introduction of strategic partners, especially in marketing. Most farmers are ready to undergo organic vegetable production training, they view pesticides as dangerous to human health, and they noticed that chemical fertilisers are expensive, consider organic farming as profitable, and they associate organic products with high price and profitability. It is recommended that the department and relevant organisations should use this opportunity to establish and replicate organic farming in the province. It is a high time to conduct campaigns for this farming either face-to-face, or through radio

and TV. Organic farming has proved to be cost-effective, and farmers live in harmony with nature. The study also concluded that there are more opportunities than challenges in organic farming.

The results of the study reveal that there are issues which cut across all vegetable production systems mentioned above and are lumped together in this chapter on general conclusions and recommendations.

The conditions created for vegetables attract weeds infestation. The study found that weed is one of the challenges that vegetable farmers are facing in the study area. The majority of the farmers use manual weed control methods (i.e. hand weeding and hoeing), while others were using herbicides. Manual weeding is recommended for its effectiveness since weeds are removed with their roots or cut from below the soil unlike herbicides which, in the case of vegetables should be selective for grass and not broad leaf weeds. Hence farmers still have to manually control weeds. The challenge with the method is that it is labour intensive, especially when weeds are controlled regularly under irrigation. On the other hand, the use of chemicals on vegetables, may pose hazards to both workers and the consumers. Chemicals will also require capacity building on the side of workers in terms of care, quantity measurements, and time of application. It is recommended that farmers should continuously undergo training because chemicals are constantly changed, and some are removed from the shelves. It is also recommended that other biological and cultural cost-effective methods may be used to control weeds, such as mulching and cover crops. Local experimentation is needed around these methods, and demonstration plots may also be revived to prove the effectiveness of these methods at field level.

Irrigation water plays an important role in vegetable production, more so that most of the vegetables are not grown under dryland conditions. In this study most farmers use furrow irrigation system with few using drip irrigation. Furrow irrigation method has a low water use efficiency. It is therefore recommended that farmers should be introduced to water-use efficient systems such as drip systems. Water shortage is very serious in the study area, especially under climate change conditions. Switching over to drip will reduce water shortage and allow farmers to have water every day of the week. However changing to drip systems will require an overhaul of the water conveying system because currently water comes through canals and then diverted

to the farrows. It is recommended that water engineers should determine cost benefit analysis of drip irrigation with electric power and furrow irrigation with gravitation and low water efficiency, to come up with the informed decision on whether to switch over or not. The study also identified that the main sources of irrigation water are rivers that are passing by. The quality of water from the river is also questionable, especially for vegetable farmers. It is recommended that water from the river be tested, as it might be contaminated with chemicals and wastewater from the sewage.

The application of fertilisers should be informed by the soil test results. The study found that soil health is not a priority in the study area. The study showed that soil samples were not frequently collected, and farmers were not aware when last was samples taken from their plots. The scenario suggests that soil degradation in the study area may be at a higher level. The study recommended that soil laboratories and soil testing programmes should be revived in each local municipality.

The study found that both chemical and organic fertilisers were used for vegetable cultivation. The application rates of chemical fertilisers in the study area were very low in that they are very expensive such that most of the small-scale vegetable farmers could not afford to buy chemical fertilisers hence they apply low quantities in a bit to save costs on fertilisers. On the other hand, reduced application rates were an advantage to sustainable soil management since excess chemicals are the main source of soil degradation. It is recommended that campaigns should be conducted to support farmers for their positive move of assigning value to organic fertilisers as against inorganic fertilisers.

Management of pest and disease is of utmost important in vegetable production. The study found that farmers in the study area have only one method of controlling pests and diseases. Farmers use more chemicals than any other method. Pesticides are effective in controlling pests, but they are harmful to both humans and animals. Vegetables are consumed fresh and may have chemical residues that are found active in vegetable. Agricultural practitioners, through the right channels have a responsibility to advice on the vegetable-related value chain and its associated hygiene standards to ensure that generations find life out of food, and not life-threatening food from agricultural production. There are many more sustainable vegetable production practices that farmers can apply towards the control of pests

and diseases, such as crop rotation, mixed cropping, fallowing, pest resistant varieties, cultural methods, and biological methods.

Farmers in the study area use conventional tillage system on seasonal basis. Conventional tillage is a system of subjecting land to a number of implements, at a cost before a crop is established. These implements will keep the land clean, however they are expensive, and they are also destructive to soil structure, microorganisms, soil organic matter, and create plough pans. It is high time to advocate for those methods that are cost effective, such as conservation tillage/no-till or minimum tillage.

The study found that farmers grow vegetables for the purpose of income generation. It is however noted that lack of market contracts, unstable market prices, bad roads and transportation are a challenge to most farmers. Bad roads lead to damage on vegetables which get bruised along the way and adversely affect the quality of the vegetables in transit to the markets. It is recommended that the Department should ensure that access roads to farming areas are well maintained, the department can also assist by teaching farmers on the use of social media apps that deal with markets and prices as well as assisting with access to markets by helping them to meet the market requirements such as traceability and phytosanitary.

The study revealed that there is a scanty participation by youth in agriculture. The study concluded that there is no succession plan in most of the farming communities. It is recommended that there should be programmes and campaigns to attract as many young people to farming as possible. Programmes such as Youth in Agriculture and Rural Development (YARD) should be revitalised and sustained. Agricultural teachers in collaboration with school governing bodies should establish school gardens (if water is available) to enable learners acquire practical skills while still in schools. The Department of Education in collaboration with the Department of Agriculture can re-establish and equip agricultural focused schools in each District so that they prepare more learners towards agriculture. The Department of Education can adopt a slogan of “One school one garden” in a bid to encourage participation of youth in agriculture.

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Annexure: Questionnaires

Appendix A: Chapter 4 Questionnaire for Area A

Characterisation of vegetable production systems by small-scale farmers in rural areas of Limpopo Province of South Africa

Questionnaire No:

Information leaflet:

My name is David Nndineni Mathobo. I am one of the PhD students in Sustainable Agriculture with the University of the Free State. This survey is part of the study. People who are participating in this survey are those who are willing to contribute towards the development of the rural communities of Limpopo Province. The information they provide should be a true reflection of how farmers of Limpopo work their plots. Farmers are expected to provide information voluntarily and willingly with the aim of contributing towards the study, and knowing that the results of this study will help improve their farming horizons in the near future.

Instructions:

Answer all the questions honestly. Please note, information provided will be treated with the highest degree of confidentiality. Mark the appropriate block with an X or write your answer in the space provided, where applicable.

Participant consent:

I, agree to take part in the aforementioned survey. I understand that my responses to this survey will be treated with the strictest confidentiality. I further understand that I will not receive any compensation for taking part in this study.

Signature:

Date:

Section A: Demographic information

Respondent name: _____

Contact number: _____

Date: _____

Name of farm/plot No: _____

Area/location of farm/plot: _____

1. Gender of respondent

	Mark with X
(a) Male	
(b) Female	

2. What is your home Language? 1.

	Mark with X
(a) Tshivenda	
(b) Tsonga	
(c) Pedi	
(d) Other (specify.....)	

3. Age of the respondent

	Mark with X
(a) Younger than 18	
(b) 18-21	
(c) 22-25	
(d) 26-30	
(e) 31-35	
(f) 36-40	
(g) 41-44	
(h) 45-54	
(i) 61 or older	

4. What is your highest level of education?

	Mark with X
(a) Never been to school	
(b) Primary	
(c) Secondary	
(d) Diploma	
(e) Degree	
(f) Other (specify).....	

5. Do you own land?

	Mark with X
(a) Yes	
(b) No	

6. How do you access the land?

	Mark with X
(a) Leasing	
(b) Own land	
(c) Communal land	

7. What is the size of your Land?

	Mark with X
(a) 0.5- 1ha	
(b) 1-2 ha	
(c) 3-4ha	
(d) 5ha and more	

8. How many years have you been engaged in Agriculture?

	Mark with X
(a) < 5 years	
(b) 5-10 years	
(c) 11-15 years	
(d) 16-20 years	
(e) >20 years	

9. Do you have any experience in Vegetable farming?

	Mark with X
(a) Yes	
(b) No	

10. How many years have you been growing Vegetables?

	Mark with X
(a) Less than 5 years	
(b) 5- 10 years	
(c) 11-15 years	
(d) More than 20 years	
(e) Other (specify.....	

11. Do you have a qualification related to farming?

	Mark with X
(a) Yes	
(b) No	

12. If yes to Q11, please indicate the qualification.

	Mark with X
(a) Certificate	
(b) Diploma	
(c) Degree	
(d) Other (specify.....	

13. Do you have any dependant?

	Mark with X
(a) Yes	
(b) No	

14. If Yes, indicate the number of dependants

Section B: Water resource management systems

15. Do you have access to water for irrigation?

	Mark with X
(a) Yes	
(b) No	

16. Do you have enough water for irrigation?

	Mark with X
(a) Yes	
(b) No	

17. What type of irrigation system do you use on Vegetables?

	Mark with X
(a) Drip	
(b) Furrow	
(c) Overhead/sprinkler	
(d) Other (specify.....)	

19. What is your source of irrigation water?

	Mark with X
(a) River	
(b) Springs	
(c) Borehole	
(d) Well	
(e) Dam	
(f) Other (specify.....)	

20. How is irrigation water going to your farm or fields?

	Mark with X
(a) Gravitation and pipes	
(b) Gravitation and canals	
(c) Power Pumps and pipes	
(d) Others (specify.....)	

21. How often is water available in your plot?

	Mark with X
(a) Daily	
(b) Weekly	
(c) Monthly	
(d) Quarterly	
(e) Any other (specify.....)	

22. How often do you irrigate vegetables?

	Mark with X
(a) Once per week	
(b) Twice per week	
(c) Once in two weeks	
(d) Once per month	
(e) Other (specify.....)	

23. Do you experience water shortage in your plot?

	Mark with X
(a) Yes	
(b) No	

24. Which water shortage adaptation systems do you use on your farm/plot?

	Mark with X
(a) Drought tolerant vegetables	
(b) Drip Irrigation	
(c) Conservation Tillage	
(d) Others (specify.....)	

Section C: Human resources management systems

25. How many Workers do you use on the farm/plot?

Gender	Number
(a) Males	
(b) Females	
(c) None	

26. What type of workers do you use on the farm?

	Mark with X
(a) Seasonal/casual	
(b) Permanent	
(c) Family worker	
(d) Self-labour	
(e) Other (specify....)	

27. What age of workers do you use on farm? **(Mark with X)**

Age	Males	Females
(a) Adults		
(b) Youth		
(c) Both		
(d) Other (specify...)		

28. What is your overall expenditure on labour per season?

	Mark with X
(a) <R5000	
(b) R5000- R7000	
(c) R8000-R10000	
(d) R11000- R15000	
(e) Other (specify.....)	

29. How do workers associate with the farm/plot?

	Mark with X
(a) Travel daily	
(b) Stay on farm cortege	
(c) Stay on hired accommodation	
(d) Other (specify...)	

Section D: Fertiliser management systems

30. Do you take soil samples?

	Mark with X
(a) Yes	
(b) No	

31. If Yes, how often do you take soil samples?

	Mark with X
(a) Seasonal	
(b) Annual	
(c) After two years and above	
(d) Others (specify....	
(e) Not Applicable	

32. Do you apply fertilisers on vegetables?

	Mark with X
(a) Yes	
(b) No	

33. If Yes, What type of fertilisers do you use on Vegetables?

	Mark with X
(a) Organic	
(b) Inorganic	
(c) Both	
(d) Other (specify.....	

34. Do you measure Fertilisers to be used on vegetables?

	Mark with X
(a) Yes	
(b) No	

35. How much fertilisers do you apply on vegetables per hectare?

	Mark with X
(a) 10- 15kg	
(b) 20-50kg	
(c) 100-150 kg	
(d) 150- 200kg	
(e) Other (specify.....	

36. Which method of fertiliser application do you use on Vegetable?

	Mark with X
(a) Broadcast	
(b) Foliar	
(c) Band placing	
(d) Fertigation	
(e) Other (specify.....	

Section E: Pest and disease management systems

37. Do you encounter pests and diseases on Vegetables?

	Mark with X
(a) Yes	
(b) No	

38. Which method of Pest and Disease control do you use on Vegetables?

	Mark with X
(a) Chemical(insecticides)	
(b) Cultural (fire or hand)	
(c) Biological(nature)	
(d) Integrated pest management (IPM)	

39. Do you use chemicals on vegetables?

	Mark with X
(a) Yes	
(b) No	

40. How much chemicals do you apply on Vegetables?

	Mark with X
(a) 1-2 litres per hectare	
(b) 3-4 litre per hectare	
(c) Not known	
(d) As recommended	

41. Do you wash vegetables before selling or use?

	Mark with X
(a) Yes	
(b) No	

42. Do you practice crop rotation?

	Mark with X
(a) Yes	
(b) No	

Section F: Soil resource management systems

43. Do you cultivate /till the soil?

	Mark with X
(a) Yes	
(b) No	

44. Which tillage practices do you apply?

	Mark with X
(a) Conventional Tillage	
(b) No-Till	
(c) Minimum Tillage	
(d) Others (specify.....)	

45. Do you protect the soil against erosion?

	Mark with X
(a) Yes	
(b) No	

46.If Yes, which practices do you apply to prevent soil erosion?

	Mark with X
(a) No-Till/Minimum tillage	
(b) Contour planting	
(c) Cover crops	
(d) Mulching	
(e) Wind breaks	
(f) Other (specify.....)	

47.Is your land having grass strips or contours?

	Mark with X
(a) Yes	
(b) No	

48.Do you remove /burn Vegetable residues or feed animals after harvest?

	Mark with X
(a) Yes	
(b) No	

49. How often do you cultivate your land?

	Mark with X
(a) Annually	
(b) Seasonally	
(c) No Tillage	
(d) Others (specify....)	

Section G: Weed management systems

50.Do you experience weed problems on Vegetables?

	Mark with X
(a) Yes	
(b) No	

51.Which methods of weed control do you use on Vegetables?

Weed control Method	Mark with X
(a) Cultural (cultivar selection /crop rotation/sowing time/mulch/fire	
(b) Chemical(herbicides)	
(c) Biological(nature/enemies)	
(d) Manual/ by hand/hand hoe	
(e) Others (specify.....)	

52.How often do you control weed on Vegetables in a season?

	Mark with X
(a) Once per season	
(b) Twice	
(c) Always	
(d) Some times	
(e) Others (specify.....)	

Section H: Financial management systems

53. Do you sell Vegetables?

	Mark with X
(a) Yes	
(b) No	

54. Do you have a market for your Vegetables?

	Mark with X
(a) Yes	
(b) No	

55. Do you have contract with the market?

	Mark with X
(a) Yes	
(b) No	

56. How much do you receive from sales of Vegetables?

	Mark with X
(a) R1000-R5000	
(b) R6000-R10000	
(c) R11000-R20000/season	
(d) Other (specify).....	

57. In your opinion, are Vegetables generally Profitable than other crops?

	Mark with X
(a) Yes	
(b) No	

58. How much of the Vegetable do you use for home consumption?

	Mark with X
(a) 0-10%	
(b) 11-20%	
(c) More than 20%	
(d) Others (specify).....	

59. Do you keep farm records?

	Mark with X
(a) Yes	
(b) No	

60. What type of records do you keep?

	Mark with X
(a) Finance records	
(b) Input records	
(c) Planting dates	
(d) Yields	
(e) Others (specify.....)	

61. Do you pay cash for inputs?

	Mark with X
(a) Yes	
(b) No	

62. What percentage of your income goes to the following areas of Vegetables?
Supply 1-4 to indicate percentages (4=Highest %, 1=lowest %)

- (a) Labour costs _____
- (b) Consumables (e.g. fertilizers, pesticides) _____
- (c) Machinery (e.g tractors) _____
- (d) Personal salary-----

Appendix B: Chapter 5 Questionnaire for Area B

Questionnaire No:

Vegetable production systems and consumption patterns as the determinants of sustainable food security among small scale farmers of Limpopo Province in South Africa.

Information leaflet:

My name is David Nndineni Mathobo. I am one of the PhD students in Sustainable Agriculture with the University of the Free State. This survey is part of the study. People who are participating in this survey are those who are willing to contribute towards the development of the rural communities of Limpopo Province. The information they provide should be a true reflection of how farmers of Limpopo work their plots. Farmers are expected to provide information voluntarily and willingly with the aim of contributing towards the study, and knowing that the results of this study will help improve their farming horizons in the near future.

Instructions:

Answer all the questions honestly. Please note, information provided will be treated with the highest degree of confidentiality. Mark the appropriate block with an X or write your answer in the space provided, where applicable.

Participant consent:

I, agree to take part in the aforementioned survey. I understand that my responses to this survey will be treated with the strictest confidentiality. I further understand that I will not receive any compensation for taking part in this study.

Signature:

Date:

Section A: Demographic information

Respondent name: _____

Contact number: _____

Date: _____

Name of farm/plot No: _____

Area/location of farm/plot: _____

1. Gender of respondent

	Mark with X
(a) Male	
(b) Female	

2. What is your home Language?

	Mark with X
(a) Tshivenda	
(b) Tsonga	
(c) Sepedi	
(d) Other (specify.....	

3. Age of the respondent

	Mark with X
(a) Younger than 18	
(b) 18-20	
(c) 21-25	
(d) 26-30	
(e) 31-35	
(f) 36-40	
(g) 41-50	
(h) 51-60	
(i) 61 or older	

4. What is your highest level of education?

	Mark with X
(a) Never been to school	
(b) Primary	
(c) Secondary	
(d) Diploma	
(e) Degree	
(f) Other (specify.....	

5. Do you own land?

	Mark with X
(a) Yes	
(b) No	

6. How do you access the land?

	Mark with X
(a) Leasing	
(b) Own land	
(c) Communal land	

7. What is the size of your Land?

	Mark with X
(a) 0.5- 1ha	
(b) 1-2 ha	
(c) 3-4ha	
(d) 5ha and more	

8. How many years have you been engaged in Agriculture?

	Mark with X
(a) <5years	
(b) 5-10 years	
(c) 11-15 years	
(d) 16-20 years	
(e) >20 years	

9. Do you have any experience in Vegetable farming?

	Mark with X
(a) Yes	
(b) No	

10.If yes to Q9,how many years have you been growing Vegetables?

	Mark with X
(a) < 5 years	
(b) 5- 10 years	
(c) 11-15 years	
(d) More than 20 years	
(e) Other specify.....	

11. Do you have a qualification related to farming?

	Mark with X
(a) Yes	
(b) No	

12.If yes to Q11, please indicate the qualification.

	Mark with X
(a) Certificate	
(b) Diploma	
(c) Degree	
(d) Other (specify).....	

13.Do you have any dependant?

	Mark with X
(a)Yes	
(b) No	

14.If Yes, indicate the number of dependants

Section B: Vegetable production systems and sustainable food security

15. Do you grow Vegetables?

	Mark with X
(a) Yes	
(b) No	

16. What Proportion of land (ha) do you use for vegetable production?

	Mark with X
(a) < 1ha	
(b) 1-2ha	
(c) 3-4 ha	
(d) 5-6ha	
(e) Any other (specify).....	

17. In your opinion, is the area you grow vegetables enough?

	Mark with X
(a) Yes	
(b) No	

18. If No to Q17, select the preferred area you would like to grow vegetables

	Mark with X
(a) < 1ha	
(b) 1-2ha	
(c) 3-4 ha	
(d) 5-6ha	
(e) Any other (specify).....	

19. What type of vegetables do you grow?

Types of Vegetables	Mark with X
(a) Root	
(b) Fruit	
(c) Leaf	
(d) Flower	
(e) Stem	
(f) Other (specify...)	

20. If you grow vegetables, specify the names of Vegetables you grow in your area

	Mark with X
(a) Cabbage	
(b) Spinach	
(c) Tomato	
(d) Butternut	
(e) Onions	
(f) Others (specify.....)	

21. Are there any other vegetable crops you want to grow in the future? And which vegetable crops? And for what reason?

22. If you grow vegetables, what are the main reasons for growing Vegetables?

	Mark with X
(a) Income Generation	
(b) Home Consumption	
(c) Access to funding	
(d) Attracts Government support	
(e) Any other (specify).....	

23. If you grow Vegetables, what encourages you to grow vegetables?

	Mark with X
(a) Suitable soil	
(b) Suitable climate	
(c) Availability of water	
(d) Availability of market	
(e) Any other (specify).....	

24. Do you preserve Vegetable seeds?

	Mark with X
(a) Yes	
(b) No	

25. If yes, how do you preserve vegetable seeds for future planting?

	Mark with X
(a) Drying	
(b) Open area storage	
(c) Cow dung treatment	
(d) Sealed container storage	
(e) Cow urine treatment	
(f) Common salt treatment	
(g) Freezing/Cooling	
(h) Other (specify).....	

26. Which problems do you encounter in Vegetable production in your area?

	Mark with X
(a) Shortage of water	
(b) Unfavourable Climate	
(c) Damage by pest	
(d) High cost of inputs	
(e) Theft	
(f) Lack of market	
(g) Others (specify).....	

27. Which method of growing Vegetable do you use?

	Mark with X
(a) Direct sowing (<i>in situ</i>)	
(b) Transplanting	
(c) Other (specify.....)	

28. Which system of growing Vegetables do you use?

	Mark with X
(a) Single cropping	
(b) Intercropping	
(c) Relay cropping	
(d) Other (specify.....)	

29. Which Vegetable Farming System is used in your area?

	Mark with X
(a) Backyard vegetable Farming	
(b) Organic Vegetable farming	
(c) Intensive vegetable farming	
(d) Extensive Vegetable farming	
(e) Intensive Vegetable farming	
(f) Other (specify.....)	

Section C: Vegetable preparation methods and sustainable food security

30. Which method of vegetable preparation do you prefer?

	Mark with X
(a) Steaming	
(b) Boiling	
(c) Stir-frying	
(d) Blanching	
(e) Roasting	
(f) Stewing	
(g) Baking	
(i) Other (specify.....)	

31. Do you cook vegetable?

	Mark with X
(a) Yes	
(b) No	

32. How do enhance Flavour of Vegetable when cooking?

	Mark with X
(a) Spices	
(b) Mushroom	
(c) Ginger	
(d) Garlic	
(e) Tomato and Onion	
(f) Others (specify.....	

33. How do you enhance vegetable taste?

	Mark with X
(a) Spices	
(b) Salt	
(c) Oil	
(d) Grounded nuts	
(e) Soup	
(f) Others (specify.....	

34. What is your source of information on Vegetable cooking methods?

	Mark with X
(a) Women clubs	
(b) Home economists	
(c) Home education	
(d) Other (specify....	

Section C : Vegetable consumption patterns and sustainable food security

35. Do you consume vegetables?

	Mark with X
(a) Yes	
(b) No	

36. How often do you consume Vegetables?

	Mark with X
(a) Daily	
(b) Once per week	
(c) Once per months	
(d) Others (specify.....	

37. Do you have knowledge on how much Vegetable one should consume?

	Mark with X
(a) Yes	
(b) No	

38.If Yes, what is your source of information on Vegetable intake?

	Mark with X
(a) School	
(b) Health professionals	
(c) Dieticians	
(d) Radio	
(e) Home economist	
(f) Others (specify....	

39. In your opinions, what are the benefits of Vegetable intake?

	Mark with X
(a) Promote digestion	
(b) Supply Vitamins	
(c) Prevent diseases	
(d) Others (specify.....	

40.Which vegetables do you prefer the most?

	Mark with X
(a) Leafy vegetables	
(b) Root vegetables	
(c) Fruit vegetables	
(d) Others (specify.....	

41.What encourages you to consume Vegetables?

	Mark with X
(a) When Vegetables are served with meat	
(b) When correctly cooked	
(c) When eating raw vegetables	
(d) Others (specify.....	

42.What discourages you from eating vegetables regularly?

	Mark with X
(a) Repeated consumption of one vegetable type	
(b) Serving vegetable without meat	
(c) Bad preparation	
(d) Others (specify.....	

43.What category of family members consume vegetable the most?

	Mark with X
(a) Young females	
(b) Young males	
(c) Adult females	
(d) Adult males	
(e) Pregnant females	
(f) Other (specify.....	

44. What is your amount of Vegetable intake per day?

	Mark with X
(a) < 50g (less than 5 table spoons)	
(b) 50 -100g (5-10 table spoons)	
(c) 100 -150g (10-15 Table spoons)	
(d) 150-200g (15-20 Table spoons)	
(e) >200g (more than 20 table spoons)	
(f) Others (specify.....)	

Section D: Vegetable preservation methods and sustainable food security

45. Do you preserve Vegetables in your area?

	Mark with X
(a) Yes	
(b) No	

46. What is your source of information about Vegetable Preservation?

	Mark with X
(a) Radio	
(b) Relatives	
(c) Extension officers	
(d) Other (specify.....)	

47. Which method of edible Vegetable preservation do you use in your area?

	Mark with X
(a) Drying	
(b) Freezing	
(c) Canning	
(d) Pickling/Fermentation	
(e) Irradiation/Pasteurisation/Expose to Gama rays	
(f) Addition of chemicals	
(g) Other (specify.....)	

48. Why do you prefer a particular method chosen in Q47?

	Mark with X
(a) Method is readily applicable	
(b) Cheap method	
(c) More reliable method	
(d) Other (specify.....)	

49. What is your reason for preserving Vegetables?

	Mark with X
(a) Promote sustainability	
(b) Extend storage life of product	
(c) Other (specify.....)	

50. Do you encounter any challenge with vegetable Preservation?

	Mark with X
(a) Yes	
(b) No	

51. If Yes, which challenge do you encounter with Vegetable Preservation?

	Mark with X
(a) Unfavourable climate	
(b) Lack of facilities	
(c) Lack of time	
(d) Other (specify.....)	

Appendix C: Chapter 6 Questionnaire for Area C

Questionnaire No:

Climate change mitigation strategies by small scale vegetable farmers towards a sustainable supply and resilient from food shortages in the Limpopo Province of South Africa.

Information leaflet:

My name is David Nndineni Mathobo. I am one of the PhD students in Sustainable Agriculture with the University of the Free State. This survey is part of the study. People who are participating in this survey are those who are willing to contribute towards the development of the rural communities of Limpopo Province. The information they provide should be a true reflection of how farmers of Limpopo work their plots. Farmers are expected to provide information voluntarily and willingly with the aim of contributing towards the study, and knowing that the results of this study will help improve their farming horizons in the near future.

Instructions:

Answer all the questions honestly. Please note, information provided will be treated with the highest degree of confidentiality. Mark the appropriate block with an X or write your answer in the space provided, where applicable.

Participant consent:

I, agree to take part in the survey. I understand that my responses to this survey will be treated with the strictest confidentiality. I further understand that I will not receive any compensation for taking part in this study.

Signature:

Date:

Section A: Demographic information

Respondent name: _____

Contact number: _____

Date: _____

Name of farm/plot No: _____

Area/location of farm/plot: _____

1. Gender of respondent

	Mark with X
(a) Male	
(b) Female	

2. What is your home Language?

	Mark with X
(a) Tshivenda	
(b) Tsonga	
(c) Pedi	
(d) Other (specify.....	

3. Age of the respondent

	Mark with X
(a) Younger than 18	
(b) 18-20	
(c) 21-25	
(d) 26-30	
(e) 31-35	
(f) 36-40	
(g) 41-50	
(h) 51-60	
(i) 61 or older	

4. What is your highest level of education?

	Mark with X
(a) Never been to school	
(b) Primary	
(c) Secondary	
(d) Diploma	
(e) Degree	
(f) Other (specify.....	

5. Do you own land?

	Mark with X
(a) Yes	
(b) No	

6. How do you access the land?

	Mark with X
(a) Leasing	
(b) Own land	
(c) Communal land	
(d) Other(specify.....	

7. What is the size of your Land?

	Mark with X
(a) 0.5- 1ha	
(b) 1-2 ha	
(c) 3-4ha	

(d) 5ha and more	
------------------	--

8. How many years have you been engaged in Agriculture?

	Mark with X
(a) <5 years	
(b) 5-10 years	
(c) 11-15 years	
(d). 16-20 years	
(e) >20 years	

9. Do you have any experience in Vegetable farming?

	Mark with X
(a) Yes	
b) No	

10.If yes to Q9,how many years have you been growing Vegetables?

	Mark with X
(a) < 5 years	
(b) 5- 10 years	
(c) 11-15 years	
(d) More than 20 years	
(e) Other (Specify.....	

11. Do you have a qualification related to farming?

	Mark with X
(a) Yes	
(b) No	

12.If yes to Q11, please indicate the qualification

	Mark with X
(a) Certificate	
(b) Diploma	
(c) Degree	
(d) Other (specify).....	

13.Do you have any dependant?

	Mark with X
(a) Yes	
(b) No	

14.If Yes, indicate the number of dependants

Section B: Climate change perspectives, constraints and adaptation

15. Are you concerned about Climate Change?

	Mark with X
(a) Yes	1
(b) No	2

16. During the last 10 years, have you observed any changes in your environment which have not occurred before?

	Mark with X
(a) Yes	
(b) No	

17. If Yes, what kind of events have you observed which had not occurred in your area before?

Events	Occurrence (YES/NO)	Frequency (how many times in 10yrs)
(a) Drought		
(b) Higher temperatures		
(c) Low temperatures		
(d) Floods		
(e) Severe crop Pests		

18. Have you noticed any change in the rainfall patterns in summer season over the past 10 years?

	Mark with X
(a) Yes	
(b) No	

19. What change of rainfall patterns has occurred in Summer over the past 10 year?

	Mark with X
(a) No change	
(b) Rainfall slightly increased	
(c) Rainfall Slightly decreased	
(d) Rainfall Significantly increased	
(e) Rainfall Significantly decreased	
(f) Others (specify....	

20. How have you adapted Vegetable production system to the change indicated above?

	Mark with X
(a) I use Drought resistance Vegetables	
(b) I use More Irrigation water	
(c) I use raised beds for drainage	
(d) I use Sunken beds to harvest water	
(e) I use Contour ridges to control erosion	
(f) Others (specify.....	

21 .Have you observed any Change in Pest attach on Vegetables over the last 10 years?

	Mark with X
(a)Yes	
(b) No	

22.What change on Vegetable pest attach has occurred over the last 10 years?

	Mark with X
(a) No change	
(b) Increased Pest attach	
(c) Decreased Pest attach	
(d) Others (specify.....)	

23.How have you adapted Vegetable production system to the change indicated above?

	Mark with X
(a) Increased use of Pesticides	
(b) Decreased use of Pesticides	
(c) I use Pest resistant Vegetables	
(d) Others (specify.....)	

24.Did you observe any change in length of Vegetable Growing season over the past 10 years?

	Mark with X
(a) Yes	
(b) No	

25.What is you view on the length of the growing season for Vegetable over the past 10 years?

	Mark with X
(a) No change	
(b) Increased Growing season	
(c) Decreased growing season	
(d) Others (specify.....)	

26. How have you adapted Vegetable production system to the change indicated above?

	Mark with X
(a) I Grow Vegetable all year round	
(b) I Grow Short Season Varieties	
(c) I grow Long season Varieties	
(d) Others (specify.....)	

27.Have you noticed any change in the Winter temperatures over the past 10 years?

	Mark with X
(a) Yes	
(b) No	

28. What change in Winter temperatures has occurred over the past 10 years?

	Mark with X
(a) No change	
(b) Winter Temperatures Increased	
(c) Winter Temperatures Decreased	
(d) Others (specify.....)	

29. How have you adapted Vegetable production system to the change indicated above?

	Mark with X
(a) I grow Cool season Crops	
(b) I grow Frost tolerant crops	
(c) I grow vegetables under cover	
(d) Others (specify.....)	

30. Have you noticed any change in the summer temperatures over the past 10 years?

	Mark with X
(a) Yes	
(b) No	

31. What change in summer temperatures has occurred over the past 10 years?

	Mark with X
(a) No change	
(b) Summer Temperatures have Increased	
(c) Summer Temperatures have Decreased	
(d) Others (specify.....)	

32. How have you adapted Vegetable production system to the change indicated above?

	Mark with X
(a) I grow Vegetables under cover	
(b) I increase Irrigation rate	
(c) I increase Irrigation frequencies	
(d) Grow Temperature resistant Varieties	
(e) Others (specify.....)	

Section C: Vegetable production strategies in response to climate change

33. Do you receive weather and climate forecasting information?

	Mark with X
(a) Yes	
(b) No	

34. From which sources do you get Climate and weather forecast?

Sources of Information	Mark with X
(a) Radio and TV	
(b) Extension Officers	
(c) Researchers	
(e) Newspapers	
(f) Own Observations	

(g) Others (specify.....	
--------------------------	--

35. Do you use Weather and Climate forecast information in Vegetable production?

	Mark with X
(a) Yes	
(b) No	

36. How important is weather /Climate Forecast information to Vegetable Production?

	Mark with X
(a) To plan the planting dates	
(b) Choice of Vegetable varieties	
(c) To project rainfall distribution	
(d) To project Temperature variations	
(e) Others (specify.....	

37. Which Main climatic factors affect vegetable production in your area?

Climatic factors	Mark with X
(a) Too much rainfall	
(b) Drought	
(c) Higher temperatures	
(d) Low temperatures	
(e) Others (specify.....	

38. Is there any warning system in your area?

	Mark with X
(a) Yes	
(b) No	

39. How do you receive warnings about climatic factors?

	Mark with X
(a) Radio	
(b) TV	
(c) Internet	
(d) Other (specify.....	

40. Which impacts of climate change do you experience with Vegetable?

Impacts	Mark with X
(a) Crop disease	
(b) Soil erosion	
(c) Loss of soil fertility	
(d) Infestation by uncommon pests	
(e) Vegetable failure	
(f) Others (specify.....)	

41. What is the level of your ability to adapt to impacts of Climate Change indicated above?

	Mark with X
(a) Low ability	
(b) Moderate ability	
(c) Higher ability	
(d) Other (specify.....)	

42. Which Climate Smart Agricultural (CSA) Technologies do you practice in your area?

Climate Smart Technologies	Mark with X
(a) Crop rotation	
(b) Mixed cropping	
(c) Mulching	
(d) Zero Tillage/minimum tillage	
(e) Crop cover/crop diversity	
(f) Crop residue incorporation	
(g) Contour farming	
(h) Other (specify.....)	

43. How many years have you been practicing CSA Technologies?

	Mark with X
(a) < 5 years	
(b) 5- 10 years	
(c) 11-15 years	
(d) More than 20 years	
(e) Other (specify.....)	

44. Are you concerned about water saving or water use efficiency?

	Mark with X
(a) Yes	
(b) No	

45. Which water saving Technology do you use in your area?

	Mark with X
(a) Mulching(that holds moisture)	
(b) Water harvesting	
(c) Pit planting	
(d) Irrigation Technology (specify...)	
(e) 25 cm Spacing	
(f) Other (specify.....)	

46. Do you apply fertilisers on vegetables?

	Mark with X
(a) Yes	
(b) No	

47. What type of fertiliser do you apply on Vegetables?

	Mark with X
(a) Organic Fertilisers	
(b) Chemical Fertilisers	
(c) Others (specify.....)	

48. What amount of fertilisers do you apply on Vegetables?

	Mark with X
(a) 100 -200Kg per hectare	
(b) 300-500kg per hectare	
(c) Not Sure	
(d) Others (specify.....)	

49. Which soil fertility CSA Technology do you use in vegetable production?

	Mark with X
(a) Plough back plant residues	
(b) Add manure	
(c) Mulching	
(d) Others (specify.....)	

50. Do you protect soil from erosion?

	Mark with X
(a) Yes	
(b) No	

51. Which soil erosion protective method do you use in your area?

	Mark with X
(a) Ridges/terraces	
(b) Contour planting	
(c) Wind breaks	
(d) Grass strips	
(e) Other (specify.....)	

52. Are you willing to increase vegetable Productivity in your plot?

	Mark with X
(a) Yes	
(b) No	

53. Which CSA Technology do you use to increase Vegetable productivity?

	Mark with X
(a) Use Hybrid seeds	
(b) Use pesticides	
(c) Use fertilisers	
(d) Other (specify.....)	

54. Do you find Climate change to be posing risks in Vegetable?

	Mark with X
(a) Yes	
(b) No	

55. Which risks are posed by Climate change in Vegetable production in your area?

	Mark with X
(a) Reduced Yields	
(b) Decline in Rainfall	
(c) Floods	
(d) Rise in temperatures	
(e) Others (specify.....)	

56. How do you manage risks posed by Climate Change?

	Mark with X
(a) Diversification of Vegetables	
(b) Insurance	
(c) Use hybrid seeds	
(d) Other (specify.....)	

57. What actions have you been taking to respond to temperatures and drought?

	Mark with X
(a) Changed vegetable type	
(b) Changed Vegetable variety/cultivar	
(c) Changed fertilisers	
(d) Increased irrigation	
(e) Reduced amount of land	
(f) Mixed Cropping	
(g) Crop diversification	
(i) Others (specify....)	

58. How would you rate changes in your land since last 10 years? **(Mark with X)**

	Improved/ Increased	Not changed	Worse/ decreased	Don't know
(a) Quality of irrigation water				
(b) Land/soil fertility				
(c) Land /soil salinity				
(d) Ground water table				
(e) Soil erosion				
(f) Land water logging				
(g) Quality of drinking water				

Section D:Policy initiatives promoting climate smart agriculture

59.Does Local Authority of your area concerned about damage to environment?

	Mark with X
(a) Yes	
(b) No	

60.Explain how your local authority regulates uncontrolled fire burning?

.....

61. Explain how your local authority regulates soil mining?

.....

62. Explain how your local authority regulates tree felling?

.....

Appendix D: Chapter 7 Questionnaire for Area D

The potential of African Indigenous Vegetables towards the formation of a commercial, nutritional and sustainable production system in the Limpopo Province of South Africa

Questionnaire No:

Information leaflet:

My name is David Nndineni Mathobo. I am one of the PhD students in Sustainable Agriculture with the University of the Free State. This survey is part of the study. People who are participating in this survey are those who are willing to contribute towards the development of the rural communities of Limpopo Province. The information they provide should be a true reflection of how farmers of Limpopo work their plots. Farmers are expected to provide information voluntarily and willingly with the aim of contributing towards the study, and knowing that the results of this study will help improve their farming horizons in the near future.

Instructions:

Answer all the questions honestly. Please note, information provided will be treated with the highest degree of confidentiality. Mark the appropriate block with an X or write your answer in the space provided, where applicable.

Participant consent:

I, agree to take part in the survey. I understand that my responses to this survey will be treated with the strictest confidentiality. I further understand that I will not receive any compensation for taking part in this study.

Signature:

Date:

Section A: Demographic information

Respondent name: _____

Contact number: _____

Date: _____

Name of farm/plot No: _____

Area/location of farm/plot: _____

1. Gender of respondent

	Mark with X
(a) Male	
(b) Female	

2. What is your home Language?

	Mark with X
(a) Tshivenda	
(b) Tsonga	
(c) Sepedi	
(d) Other (specify).....	

3. Age of the respondent

	Mark with X
(a) Younger than 18	
(b) 18-21	
(c) 22-25	
(d) 26-30	
(e) 31-35	
(f) 36-40	
(g) 41-44	
(h) 45-54	
(i) 61 or older	

4. What is your highest level of education?

	Mark with X
(a) Never been to school	
(b) Primary	
(c) Secondary	
(d) Diploma	
(e) Degree	
(f) Other (specify).....	

5. Do you own land?

	Mark with X
(a) Yes	
(b) No	

6. How do you access the land?

	Mark with X
(a) Leasing	
(b) Own land	
(c) Communal land	
(d) Other (specify).....	

7. What is the size of land used for Vegetable production?

	Mark with X
(a) 0.5- 1ha	
(b) 1-2 ha	
(c) 3-4ha	
(d) 5ha and more	

8. Do you grow African Indigenous Vegetables on your farm?

	Mark with X
(a) Yes	
(b) No	

9. Which indigenous Vegetables are commonly grown in your plot?

	Mark with X
(a) Okra	
(b) African Night Shade	
(c) Mukwariba(Mastard)	
(d)	
(e)	
(f)	
(g)	

10. How many years have you been engaged in Agriculture?

	Mark with X
(a) <5 years	
(b) 5-10 years	
(c) 11-15 years	
(d). 16-20 years	
(e) >20 years	

11. How many years have you been growing AIVs?

	Mark with X
(a) < 5 years	
(b) 5-10 years	
(c) 11-15 years	
(d) 16-20 years	
(e) >20 years	

12 Do you have a qualification related to farming?

	Mark with X
(a) Yes	
(b) No	

13.If yes to Q12, please indicate the qualification

	Mark with X
(a) Certificate	
(b) Diploma	
(c) Degree	
(d) Other (specify).....	

14.Do you have any dependant?

	Mark with X
(a) Yes	
(b) No	

15.If Yes, indicate the number of dependants

Section B: Farmers' Perception of Indigenous Vegetables (AIVs)

16. Do you have information about AIVs?

	Mark with X
(a) Yes	
(b) No	

17.What is your source of information about AIVs?

	Mark with X
(a) Radio	
(b) Health Officials	
(c) Agricultural Extension	
(d) Others (specify).....	

18.In your view, what is the average growing cycle of AIVs?

	Mark with X
(a) 2 weeks	
(b) 3 weeks	
(c) 4 weeks(one month)	
(d)	

19. How will you rate your knowledge about AIVs?

	Mark with X
(a) Less knowledge	
(b) Moderate knowledge	
(c) Highly knowledgeable	
(d) No knowledge	

20. In your opinion, AIVs have the following characteristics

	Mark with X
(a) Difficult to grow	
(b) Easier to grow	
(c) Poorly adapted	
(d) Well adapted	

21. In your opinion, African Indigenous Vegetables are food:

	Mark with X
(a) For the low-income families	
(b) Food for the rich families	
(c) For all the families	

22. What encourages you to grow AIVs?

	Mark with X
(a) Have short growing season	
(b) Tolerant to diseases	
(c) Easy to grow	
(d) Well adapted	
(e) Has good market	
(f) Its super Vegetable to eat	
(g).....	

23. What discourages you from growing AIVs?

	Mark with X
(a) Difficult to grow	
(b) Have no Market	
(c) Not suited to our environment	
(d) I don't eat	
(e).....	

24. Do you sell African Indigenous Vegetables?

	Mark with X
(a) Yes	
(b) No	

25. If yes, to which market outlet do you sell your African Indigenous Vegetables?

	Mark with X
(a) Local markets	
(b) Retail stores	
(c) Farm gate	
(d) Schools	
(e) Brokers	
(f) High value markets	
(g) Other (specify.....)	

26. Do you have contract with the market?

	Mark with X
(a) Yes	
(b) No	

27. Do you supply African Indigenous Vegetables to high value Markets?

	Mark with X
(a) Yes	
(b) No	

28. If No to Q30, give your reason for not supplying AIVs to High Value markets

	Mark with X
(a) Markets are strict on quality	
(b) They require Consistency in supply	
(c) They delay on Payments	
(d) Require large quantities	
(e) Require contractual agreement	
(f) Other (specify.....	

Section D: Production of African Indigenous Vegetables

29. Do you Grow AIVs throughout the year?

	Mark with X
(a) Yes	
(b) No	

30. Which season of the year do you supply AIVs to your Customers?

	Mark with X
(a) Autumn	
(b) Winter	
(c) Spring	
(d) Summer	
(e) All Year round	

31. Rank your African Indigenous Vegetable in order of importance in income generation

Name of African Indigenous Vegetable	Rank 1= High Low Mark with X	Rank 4=
(a)		
(b)		
(c)		
(d)		
(e)		

32. What is the main purpose of growing AIVs on your farm?

	Mark with X
(a) Home consumption	
(b) Subsistence farming	
(c) Commercial purpose(Selling)	
(d) Others (specify.....	

33. Which type of inputs do you use for AIVs?

	Mark with X
(a) Pesticides	
(b) Organic fertilisers	
(c) Chemical fertilisers	
(d) Irrigation water	

34. What is the source of your Chemical fertilisers?

	Mark with X
(a) Government supplied	
(b) Buy form Cooperatives	
(c) Buy from Shops	
(d) Others (specify.....	

35. Do you use Organic Fertilisers on AIVs?

	Mark with X
(a) Yes	
(b) No	

36. What type of Organic fertilisers do you use on AIVs?

	Mark with X
(a) Kraal manure	
(b) Poultry manure	
(c) Homemade Compost	
(d) Others (specify.....	

37. What is the source of your Organic fertilisers?

	Mark with X
(a) Buy from Neighbours	
(b) Home sourced	
(c) Buy from Cooperatives	
(d) Given by neighbours	
(e) Others (specify.....	

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

	Mark with X
(a) Family labour	
(b) Hired labour	
(c) Exchange labour	
(d) Others (specify....	

39. Where do you receive advices from on AIVS?

	Mark with
(a) Extension Officers	
(b) Other farmers	
(c) Trainings	
(d) Traders	
(e) Home education	

40. Do you grow AIVs under contract?

	Mark with X
(a) Yes	
(b) No	

41. What type of contract do you have?

	Mark with X
(a) Formal	
(b) Informal(Verbal Promise)	
(c) None	

Section E: Harvest and Marketing Quantities

42. During the past THREE years, indicate the Average quantities harvested and sold per season

Name of AIVs	Quantity Harvested(tons)	Quantity sold (tons)	Unit Price (R/Kg)/R/T
(a)			
(b)			
(c)			
(d)			
(e)			

43. During the past THREE years, indicate the average frequency of harvesting in a season

Name of AIVs	Frequency of Harvesting (days/ week)
(a)	
(b)	
(c)	
(d)	

(e)	
-----	--

44. What is your main market place for AIVs?

	Mark with X
(a) Village	
(b) Farm gate	
(c) District Market	
(d) Province	
(e) National Market	

45. To whom do you sell your AIVs?

	Mark with X
(a) Local consumers	
(b) Wholesalers	
(c) Hotels	
(d) Schools	
(e) Retail Stores	
(f) Others (specify....	

46. Which measuring instrument do you use to determine the unit sale for AIVs?

	Mark with X
(a) Scale	
(b) Number of leaves	
(c) Crates	
(d) number of bags	
(e).....	

47. How far is your Market from the farm/garden?

	Mark with X
(a) < 50km	
(b) 51- 100km	
(c) >100km	
(d) Others (specify.....	

48. What is your means of transport to the selling point?

	Mark with X
(a) Own Vehicle	
(b) Hired Vehicle	
(c) None	
(d) animal transport	

49. What are your major marketing constraints of AIVs?

	Mark with X
(a) Low producer price	
(b) Higher transport cost	
(c) Poor roads to Market	
(d) Lack of reliable transport	
(e) Lack of Markets	
(f) Other (specify....	

50. What is your Seasonal income from AIVs?

	Mark with X
(a) <R1000	
(b) R 1001- R5000	
(c) R5001- R10000	
(d) R10001- R20000	
(e) >R20000	

Section F: Support Accessibility

51. Do you receive support towards AIVs production?

	Mark with X
(a) Yes	
(b) No	

52. Which structure supports you regarding AIVs production?

	Mark with X
(a) Traditional authorities	
(b) Cultural groups	
(c) Civic association	
(d) Department of Agriculture(Extension)	
(d) Others (specify...	

53. What type of support do you receive towards AIVs production?

	Mark with X
(a) Fertilisers	
(b) Seeds	
(c) Marketing	
(d) Ploughing	
(e) Irrigation equipment	
(f) Pest control	
(g) Advices	

54. How much Are you satisfied with the support you receive)?

	Mark with X
(a) Highly satisfied	
(b) Moderately satisfied	
(c) Less satisfied	
(d) Not satisfied	
(e) Others (specify.....)	

Section G: Consumption of African Indigenous Vegetables

55. Do you consume African Indigenous Vegetables?

	Mark with X
(a) Yes	
(b) No	

56. How often do you consume African Indigenous Vegetables?

	Mark with X
(a) Daily	
(b) Once per week	
(c) 2 times per week	
(d) 3 times per week	
(e) Once per Month	

57. Which AIVs is used for medicinal purpose and what does it treat?

Name of AIVs	Treatment of.....
(a)	
(b)	
(c)	
(d)	

58. Which member of the family prefer AIVs the most in your area?

	Mark with X
(a) Adult women	
(b) Adult men	
(c) Young males	
(d) Young females	
(e) Pregnant women	

Appendix E: Chapter 8 Questionnaire for Area E

Questionnaire No:

The opportunities and constraints of a wide adaptation to organic vegetable production systems by small scale farmers of the Limpopo Province in South Africa

Information leaflet:

My name is David Nndineni Mathobo. I am one of the PhD students in Sustainable Agriculture with the University of the Free State. This survey is part of the study. People who are participating in this survey are those who are willing to contribute towards the development of the rural communities of Limpopo Province. The information they provide should be a true reflection of how farmers of Limpopo work their plots. Farmers are expected to provide information voluntarily and willingly with the aim of contributing towards the study and knowing that the results of this study will help improve their farming horizons in the near future.

Instructions:

Answer all the questions honestly. Please note, information provided will be treated with the highest degree of confidentiality. Mark the appropriate block with an X or write your answer in the space provided, where applicable.

Participant consent:

I, agree to take part in the survey. I understand that my responses to this survey will be treated with the strictest confidentiality. I further understand that I will not receive any compensation for taking part in this study.

Signature:

Date:

Section A: Demographic information

Respondent name: _____

Contact number: _____

Date: _____

Name of farm/plot No: _____

Area/location of farm/plot: _____

1. Gender of respondent

	Mark with X
(a) Male	
(b) Female	

2. What is your home Language?

	Mark with X
(a) Tshivenda	
(b) Tsonga	
(c) Sepedi	
(d) Other (specify).....	

3. Age of the respondent

	Mark with X
(a) Younger than 18	
(b) 18-20	
(c) 21-25	
(d) 26-30	
(e) 31-35	
(f) 36-40	
(g) 41-50	
(h) 51-60	
(i) 61 or older	

4. What is your highest level of education?

	Mark with X
(a) Never been to school	
(b) Primary	
(c) Secondary	
(d) Diploma	
(e) Degree	
(f) Other (specify).....	

5. Do you own land?

	Mark with X
(a) Yes	
(b) No	

6. How do you access the land?

	Mark with X
(a) Leasing	
(b) Own land	
(c) Communal land	

7. What is the size of your Land?

	Mark with X
(a) 0.5- 1ha	
(b) 1-2 ha	
(c) 3-4ha	
(d) 5ha and more	

8. How many years have you been engaged in Agriculture?

	Mark with X
(a) <5years	
(b) 5-10 years	
(c) 11-15 years	
(d) 16-20 years	
(e) >20 years	

9. Do you have any experience in Vegetable farming?

	Mark with X
(a) Yes	
(b) No	

10. If yes to Q9, how many years have you been growing Vegetables?

	Mark with X
(a) < 5 years	
(b) 5- 10 years	
(c) 11-15 years	
(d) More than 20 years	
(e) Other (specify.....	

11. Do you have a qualification related to farming?

	Mark with X
(a) Yes	
(b) No	

12. If yes to Q11, please indicate the qualification.

	Mark with X
(a) Certificate	
(b) Diploma	
(c) Degree	
(d) Other (specify).....	

13. Do you have any dependant?

	Mark with X
(a) Yes	
(b) No	

14.If Yes, indicate the number of dependants

Section B: Fertilisers and pest control methods

15.How do you preserve soil fertility on your farm?

	Mark with X
(a) Fertilisation	
(b) Crop rotation	
(c) Intercropping	
(d) Tillage	
(e) Others (specify.....	

16. In case Fertilisers are applied, which kind do you use?

	Mark with X
(a) Chemical Fertilisers	
(b) Organic Fertilisers (Manure, compost)	
(c) Both	
(d) Others (specify.....	

17.In case Chemical Fertilisers are applied, do you measure the amount of fertilisers?

	Mark with X
(a) Yes	
(b) No	

18.In case Organic fertilisers are used, can you specify the type?

	Mark with X
(a) Livestock manure	
(b) Poultry manure	
(c) Green manure	
(d) Other (specify....	

19.In case that crop rotation, and/ or intercropping and /or green manure are practiced, do you integrate legumes?

	Mark with X
(a) Yes	
(b) No	

20. Which method do you use to control pests and diseases on vegetables?

	Mark with X
(a) Biological control (non-chemical)	
(b) Chemical control	
(c) Integrated Pest Management(Both)	
(d) Other Method (specify...	

21. In case chemicals are used to control pests, specify the names of chemicals

.....

22. How do you control weeds in your vegetable plot?

	Mark with X
(a) By burning plant residues after harvesting	
(b) By Mechanical control (manual, tillage)	
(c) By grazing through animals	
(d) By chemical herbicides	
(e) By crop rotation and/or Intercropping	

24. Do you know how to Produce Vegetables without use of Chemicals?

	Mark with X
(a) Yes	
(b) No	

25. Can you Rank your knowledge of producing Vegetables without use of Chemicals?

	Mark with X
(a) Less knowledge	
(b) Moderate Knowledge	
(c) Highly knowledgeable	
(d) No Knowledge	
(e) Others (specify.....)	

26. In your opinion, How dangerous Pesticides are to human beings?

	Mark with X
(a) Can be Poisonous	
(b) Cannot poisonous	
(c) Do not know	
(d) Others (specify.....)	

27. How do you keep yourself safe from Pesticides?

	Mark with X
(a) Avoid use them	
(b) Use Protective clothes	
(c) Wash hands with soap after use	
(d) Others (specify.....)	

Section C : Farmers attitudes towards organic farming

Instructions: Mark the appropriate block with an **X**

Attitude statements	Strongly disagree	Disagree	Not Sure	Agree	Strongly agree
28.Organic farming is a step back to farming of the past					
29. Local markets for organic products are not available					
30.Chemical fertilizers are expensive					
31.Organic fertilizers are expensive					
32. Chemical pesticides are not good for the health of people and animals					
33.Organic farming is more profitable than conventional farming					
34.Without using chemical pesticides, high pest infestation can happen					
35.Organic fertilizers and pesticides are available					
36.Organic products are healthier for the family					
37.Conversion into organic farming is expensive					
38.Organic products can be sold for higher prices compared to conventional products					
39.Organic yields are too low					
40.Local consumers would be willing to pay higher prices for organic products					
41.Organic farmers live more in harmony with nature					
42.Obtaining consulting and advices regarding organic farming is difficult					
43. Producing organic vegetables on your farm within the next five years would be a good idea					
44. Producing organic vegetables on your farm within the next five years would be possible					
45. Producing organic vegetables on your farm within the next five years would be more profitable than the conventional farming					

Section D: Farmers beliefs about organic farming

Instructions: Mark the appropriate block with an X for each pair of questions

Behavioural Beliefs	Strongly disagree	Disagree	Not Sure	Agree	Strongly agree
	<i>Very unimportant</i>	<i>Unimportant</i>	<i>Neither important nor unimportant</i>	<i>Important</i>	<i>Very important</i>
46.If you produce organic vegetables, you will save on production costs (pesticides/fertilisers) <i>Saving on production costs is:</i>					
47.If you produce organic vegetables, you will receive higher prices <i>Receiving higher prices is:</i>					
48.If you produce organic vegetables, you will increase farm income <i>Increasing farm income is:</i>					
49.If you produce organic vegetables, you will get opportunities to reach other markets (e.g. markets with higher prices; markets with better prospects compared to the current market) <i>Getting opportunities to reach better markets is:</i>					
50. Producing organic vegetables on your farm is not a modern way of farming.					

Behavioural Beliefs	Strongly disagree	Disagree	Not Sure	Agree	Strongly agree
	<i>Very unimportant</i>	<i>Unimportant</i>	<i>Neither important nor unimportant</i>	<i>Important</i>	<i>Very important</i>
<i>Being modern in farming is:</i>					
51. Producing organic vegetables on your farm can improve soil fertility and soil structure					
<i>Improving soil fertility and soil structure is:</i>					
52. Producing organic vegetables on your farm will protect the environment					
<i>Protecting the environment is:</i>					
53. Producing organic vegetables on your farm will provide healthy food for your family					
<i>Providing healthy food for your family is:</i>					
54. For you, it would be risky to convert to organic vegetable production					
<i>In general, playing it safe is:</i>					
55. You think that you have the technical ability to produce organic vegetables on your farm within the next five years					
56. You think that you can meet the regulations of organic farming on your					

Behavioural Beliefs	Strongly disagree	Disagree	Not Sure	Agree	Strongly agree
	<i>Very unimportant</i>	<i>Unimportant</i>	<i>Neither important nor unimportant</i>	<i>Important</i>	<i>Very important</i>
farm within the next five years					
57. You think that you can meet the amount of work needed for organic farming on your farm within the next five years					

Section E. Information seeking and communication about organic vegetable farming

58. How informed do you feel about organic farming (regulation, certification, inspection, cost, profits, etc.)

	Mark with X
(a) Not at all informed	
(b) Only little	
(c) Moderately	
(d) Well informed	
(e) Very well informed	

59. How often do you discuss about organic vegetable farming?

	Mark with X
(a) Never	
(b) Seldom	
(c) Sometimes	
(d) Often	
(e) Very often	

60. How important is organic vegetable farming as a topic of discussion?

	Mark with X
(a) Very unimportant	
(b) Unimportant	
(c) Neither important nor unimportant	
(d) Important	
(e) Very important	

Section F. Intentions and conversions

61. How likely is it that you will (think seriously to) produce organic vegetables on your farm within the next five years?

	Mark with X
(a) Very likely	
(b) Likely	
(c) Undecided	
(d) Unlikely	
(e) Very unlikely	

62. Do you have the intention to produce organic vegetables on your farm within the next five years?

	Mark with X
(a) Definitely no	
(b) Probably no	
(c) Undecided	
(d) Probably yes	
(e) Definitely yes	

63. For you, is the conversion to organic vegetable farming within the next five years possible?

	Mark with X
(a) Definitely impossible	
(b) Impossible	
(c) Undecided	
(d) Possible	
(e) Definitely possible	