DEVELOPMENT, VALIDATION AND IMPLEMENTATION OF A SUSTAINABLE, NUTRITION-SENSITIVE AGRICULTURE TOOLKIT TO ADDRESS FOOD AND NUTRITION INSECURITY IN LESOTHO

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DECLARATION

I, Lisebo Mothepu, hereby declare that the research work presented in this dissertation is my original work and all the materials used are appropriately acknowledged and explicitly referenced. A reference list is attached to the thesis.

I also confirm that the dissertation has not been submitted in any of its part or entirety for any degree in any other institution of higher learning locally or internationally.

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DEDICATION

I dedicate this dissertation to:

My loving mother Mathulo Mothepu

My one and only son Mothepu Dumisa

My loving sister Matsele Mothepu

Psalm 46:5 "*God is within her; she will not fail."*

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ABSTRACT

Background: Global food prices continue to increase because of natural and human-induced disasters such as climate change and war. As a result, poverty remains relatively high globally, especially in lower-middle-income countries such as Lesotho. Poverty in Lesotho is rated at 49.7% with a staggering 24% of the population experiencing extreme poverty, and it is mostly prevalent in rural areas. Out of the population of over 2 million, approximately half of the populace survives below the poverty-line, and 58, 000 people continue to experience food insecurity. Lesotho ranks at 121st out of 125 countries with sufficient data to calculate 2023 GHI scores. The higher the rank the worse the hunger index. The Global Hunger Index recorded Lesotho's hunger score at 32.4. This is categorised as alarming on the scale ranging from low to extremely alarming. Lesotho has been grappling with chronic food insecurity, with 61% of the population affected living in rural areas and 39% affected living in urban areas due to climate challenges such as heavy rains. In summary, severe food insecurity, decrease agriculture production, poverty, poor nutritional status, and HIV/AIDS decrease the quality of life in Lesotho.

Aim: The main aim of the research study was to develop, validate, and implement, a sustainable nutrition-sensitive agriculture toolkit with two programs: sustainable agriculture and sustainable nutrition-sensitive agriculture. The toolkit was developed for rural small-scale female family farmers to provide for household consumption and local small-scale commerce. The study further aimed to introduce and educate female farmers in agri-business and agro- processing through the use of Greenhouse tunnels underpinned by sustainable agriculture, sustainable local community food systems, and sustainable nutrition-sensitive agriculture to address food and nutrition insecurity and attempt to decrease hunger at the community, household, and individual levels.

Methodology: The sample size was n=126 females participants residing in rural households in the district of Mohale's Hoek, Lesotho. The sample population age ranged from 20 to over 60 years. In this randomised control trial (RCT), a combination of quantitative and qualitative methods were used. The quantitative data was used to determine the interaction between socio-economic conditions, nutritional variety, nutritional competence, food consumption patterns, food security status, and agricultural practices. The qualitative data collection used was an observational research method under naturalistic and controlled observation. This approach involved manipulating and controlling the experimental and intervention research variables to determine cause and effect relationships. The control group participants were from Maqoala n=63, and the intervention group participants were from Mpharane n=63.

The toolkit was developed using relevant literature for addressing poverty, hunger, food insecurity and nutrition insecurity. In addition, the toolkit was also developed using the results obtained from the study through the administered questionnaires: socio-demographic, household hunger scale and household food insecurity access scale, nutrition knowledge and anthropometry measurements for nutritional assessment, food frequency, 24-hour food recall, agricultural and knowledge practices, preparation, and preservation practices. The toolkit comprised of two programs: sustainable agriculture and sustainable nutrition-sensitive agriculture. The toolkit was validated through the Delphi method. The intervention was run for two years, to target three planting and harvesting seasons in both the control and

experimental villages. Both the experimental and control group were allocated Greenhouse tunnels with irrigation systems, temperature control systems, storage facilities and food preparation facilities. The inputs given to each group included the allocation of inputs was seeds that were certified by the government of Lesotho: round cabbage, spinach (Swiss chard), green beans (snap beans), red beetroot, carrots (Nantes), red bell pepper, tomato (stupice), butternut squash, potato (Vivaldi), and brown onion. The experimental group was given the researcher's training manual together with the participants training manual. The experimental group was further trained using the manual. The control group, Maqoala, was given the training manuals, without any training.

Results: Results indicated that all female participants (n=126) headed the households and were caregivers who resided with other people in the households. The majority of the households (61.9%) had one room, 16.7% had two rooms, and 11.9 % had three rooms with no electricity or running water in the houses. Notably, all participants were unemployed, and experienced anxiety over running out of food before having money to buy more. Almost 44% of the participants often had a shortage of money to buy food, and 45.2% of the participants sometimes had a shortage. The average monthly spending on food for 25.4% of the households was R201 to R300, whilst 36.5% of the households on average spent a between R301 to R400 on food each month. All the participants reported having a change in food intake due to decreased accessibility.

Moreover, all the participants indicated that they consumed less food than required and had to cut the size of the food served to children because there was not enough food available. An estimate 89.7% of the participants skipped meals because there was not enough food to eat. The nutrient analysis from the 24-hour food recall indicated dietary inadequacy in energy, protein, calcium, and vitamins A, B6, B12, C, and E. When assessing the dietary diversity, the participants consumed more cereals and starchy foods, as reflected by the high carbohydrate Dietary Reference Intakes (DRIs). The Body Mass Index (BMI) of 4.7% of the participants from Maqoala was in the underweight BMI range compared to 3.1% of participants from Mpharane. The outcomes could also be influenced by a lack of nutrition knowledge as the average knowledge was 52.0%, ranging from 38 to 69% in both Mpharane and Maqoala.

The results highlighted high levels of hunger, food insecurity and nutrition insecurity among the participants. The results supported the development, validation, and implementation of the toolkit through the Delphi method. Firstly, the toolkit focused on sustainable agriculture, planting vegetables, selling vegetables to generate money to buy seeds for the subsequent planting phases, and consumption and preservation of vegetables for households in the control and experimental groups.

The intervention results indicated that Mpharane (experiment group) participants in phase 1, harvested 468 cabbage heads, sold 278 heads, and preserved 189 heads for household consumption. In phase 2, the number of cabbages increased to 612 heads; the participants sold 422 heads and preserved 189 heads for household consumption. In phase 3, 675 cabbage heads were harvested, 485 heads were sold, and 189 were preserved for household consumption. Mpharane had an increase of 144 heads of cabbage from phase 1, 468 heads of cabbage, to phase 2, 612 heads of cabbage, and in phase 3 (675 heads of cabbage), the increase was very low, with 63 heads of cabbage between phase 2 to phase 3.

Maqoala (control group) participants did not sell any of the fresh produce they harvested. Instead, they shared the harvested fresh produce with each other. In phase 1, 567 cabbage heads were harvested, and 567 heads were shared among the n=63 participants for household consumption. In phase 2, the number of cabbage heads harvested increased to 627 heads and all 627 heads were shared among the participants for household consumption. In phase 3, 414 cabbage heads were harvested, and 414 heads were shared among the n=63 participants for household consumption. Maqoala produced a total of 1608 heads of cabbage between phases 1, 2 and 3, and Mpharane produced a total of 1755 heads of cabbage between phases 1, 2 and 3, 147 heads of cabbage more than Maqoala.

The participants from experimental group harvested 519 bundles of spinach in Phase 1. In Phase 2, 834 bundles were harvested, 329 bundles in Phase 1, 644 bundles in Phase 2 were sold, and 189 bundles were preserved for household consumption. The participants harvested 1238 bundles of spinach in phase 3, and 1048 bundles were sold, whilst 189 were preserved for household consumption. The participants in Maqoala harvested 857 bundles of spinach and used all 857 bundles for household consumption. The experimental group had a vast

increase in the bundles of spinach produced in phase 3, with 1238 bundles of spinach compared to phase 1, with 468 bundles, whilst phase 2, produced 612 bundles. The total of the bundles of spinach produced by the experimental group was 2591 bundles between phases 1, 2, and 3, whilst the control group produced 2196 bundles of spinach between phases 1, 2, and 3. The experimental group produced 396 bundles more than the control group. The toolkit introduced and educated the experimental group on agriculture practices, nutrition, and developing market products. At the baseline immediately after the lesson, the participants were assessed and scored 54% in lesson 1, 66% in lesson 2 and 80% in lesson 3. At the endline, the participants were not taught again but were expected to remember the previous lessons and practices they had done during the intervention. There was a decrease in the participants' scores at the endline. The participants scored 43% in lesson 1, 32% in lesson 2 and 65% in lesson 3.

Conclusion: The findings indicated that poverty contributes to hunger, food and nutrition insecurity, and triple burden of malnutrition: undernutrition and overnutrition, and micronutrient deficiency in Lesotho. Food and nutrition insecurity can be addressed by integrating sustainable agriculture and sustainable nutrition-sensitive agriculture. Agriculture holds significant potential as it can contribute to addressing the primary causes of nutrition-related problems, enhance worldwide food accessibility and availability and improve family food security, nutritional value, salary, and female empowerment. For these reasons, a sustainable nutrition-sensitive agriculture toolkit for small-scale female farmers with agri-business and agro-processing components was developed from the Lesotho data and shown to improve household vegetable production and consumption. Agrifood systems contribute to high employment of females worldwide. Agrifood systems also contribute more to the livelihoods of females compared to males, mainly in developing countries. Enriching females and ending gender inequality under agrifood systems can improve the lives of the females and their homes, decrease starvation, increase earnings and strengthen resilience.

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LIST OF ABBREVIATIONS

AI	Adequate Intake
APHA	American Public Health Association
BL	Baseline
BP	Blood Pressure
BMI	Body Mass Index
CFS	Committee on World Food Security
CONSORT	Consolidated Standard of Reporting Trials
COVID-19	Coronavirus Disease of 2019
CSA	Community Supported Agriculture
DD	Dietary Diversity
DDR	Doha Development Round
DESA	Department of Economic and Social Affairs
DRI	Daily Recommended Intake
DUT	Durban University of Technology
EAR	Estimated Average Requirement
ECOSCOC	Economic and Social Council
EER	Estimated Energy
EL	Endline
EU	European Union
FAC	Food Assistant Convention
FAO	Food and Agriculture Organisation
FFA	Framework for Action
FNS	Food and Nutrition Security
FFQ	Food Frequency Questionnaire
FGDS	Food Group Diversity Score
FRC	Faculty Research Committee
FS	Food System
FSIN	Food Security Information Network
FVS	Food Variety Score

GDP	Gross Domestic Product
GHI	Global Hunger Index
GNR	Global Nutrition Report
GR	Green Revolution
GRFC	Global Report on Food Crises
HFIAS	Household Food Insecurity Access Scale
HHS	Household Hunger Scale
HIV	Human Immunodeficiency Virus
HLPE	High Level Panel of Experts
HLTF	High-Level Task Force on Global Food and Nutrition Security
IASA	International Alliance for Sustainable Agriculture
ICN2	Second International Conference on Nutrition
IPC	Integrated Food Security Phase Classification
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGOS	Intergovernmental Organisations
IMF	International Monetary Fund
IPC	Integrated Food Security Phase Classification
IREC	Institutional Research Ethics Committee
LMICs	Low- and middle-income countries
LNDC	Lesotho National Development Corporation
ISAP	International Sustainable Agriculture Project
MDGS	Millennium Development Goal
MRC	Medical Research Council
NARS	Nutrient Adequacy Ratio
NFWP	National Food for Work Programs
NCD	Non-Communicable Disease
NGOS	Non-governmental Organisations
NSA	Nutrition Sensitive Agriculture
POU	Prevalence of Undernourishment
PPPD	Per Person Per Day
RCT	Randomised Controlled Trial

RDA	Recommended Daily Allowances
SA	South Africa
SCFS	Sustainability Community Food Systems
SDSN	Sustainable Development Solution Network
SD	Standard Deviation
SADC	Southern African Development Community
SDSN	Sustainable Development Solutions Network
SDGs	Sustainable Development Goals
SFS	Sustainable Food Systems
SIDS	Small Island Developing States
SPSS	Statistical Package for the Social Sciences
SPRING	Strengthening Partnership, Results, Innovations and Nutrition Globally
SSA	Sub-Saharan Africa
SUN	Scaling Up Nutrition
TB	Tuberculosis
TBM	Triple Burden of Malnutrition
UK	United Kingdom
UNs	United Nations
UNA	United Nations Agencies
UNA	United Nation Agency
UNAI	United Nations Academic Impact
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNSCN	United Nation Standing Committee on Nutrition
UNICEF	United Nations International Children's Emergency Fund
UNGA	United Nations General Assembly
UNFPA	United Nations Population Fund
US	United States
WB	World Bank
WFD	World Food Day
WFP	World Food Program
WSFS	World Food Summit on Food Security

WtHR	Waist to Hip Ratio
WHO	World Health Organisation

CHAPTER ONE: GENERAL INTRODUCTION TO THE DISSERTATION

1.1 INTRODUCTION

The dissertation presents results from both quantitative and qualitative research that was conducted among the Basotho female farmers residing in rural households in Mpharane village and Maqoala village in the district of Mohale's Hoek, Lesotho. This intervention research study was based on developing, validating, and implementing a nutrition-sensitive agriculture (NSA) toolkit with two programs: sustainable agriculture and sustainable NSA. The toolkit was developed for rural small-scale female family farming to provide for household consumption and local small-scale commerce. The intention of the toolkit was to introduce and educate female farmers in agri-business and agro-processing through the use of Greenhouse tunnels underpinned by sustainable agriculture, sustainable local community food systems, and sustainable NSA. These above systems are important to improve food and nutrition insecurity and attempt to end hunger at the community, household, and individual levels.

Furthermore, the dissertation literature review highlights the trajectory of food and nutrition insecurity under the United Nations (UN) and the UN Agencies (UNA) in relation to addressing poverty, hunger, and food and nutrition insecurity in both developed and developing countries at international, national, regional, household, and individual level. Lesotho is one of the members of the UN, and it is faced with a high prevalence of chronic food and nutrition insecurity, so it was important to correlate the research study with the UN's advanced initiatives in addressing food and nutrition security, since the UN has vast supporting research and knowledge on developing programs, projects, innovations, and policies in addressing poverty, hunger and food and nutrition insecurity.

In support of the above information, the UNA, such as the World Bank (WB), Food and Agriculture Organisation (FAO), World Food Program (WFP), International Fund for Agricultural Development (IFAD) and other appropriate sources were used as a source of information. Programs such as 2016-2025 UNs Decade of Action on Nutrition, specifically the UN Decade of Family Farming (2019-2028), Sustainable Development Goals (SDGs) (target 2: Zero Hunger 2030) and other appropriate sources were also utilised in the study as the

foundation of the development of the research innovation study.

In this introductory chapter, the general background of the study is provided, followed by the aims and objectives. It then proceeds to explain the statement problem of the research study, the importance of the research study, and the definition of terms that are commonly used in this dissertation. Lastly, a summary of the framework and structure of the study is provided.

1.2 BACKGROUND TO THE STUDY

Food and nutrition insecurity have been prevalent globally for more than 70 years. The increasing growth of the global population, which was estimated at 8.05 billion in 2023, continues to escalate food and nutrition insecurity in the world (Population Matters 2020: para. 3 line 4). When food insecurity became a global crisis, nations worked together in 1943 to develop materials to address the concept of a "secure, adequate and suitable supply of food for everyone". The problem of food insecurity continued, and in 1972-1974, the world faced a food crisis that resulted in an unstable food supply and high prices on the world market. It soon became obvious that to rectify the global food problem, there would be a need to create a food security insurance scheme. The insurance scheme was intended to assure international access to the physical food supply through development of new policies and programs (FAO 2009b: para. 3 line 1; FAO and WFP 2016: para. 1 line 2).

The Green Revolution (GR) increased food production and physical food supply (food availability) in the 1980s. The GR movement brought about challenges such as decreased buying power by some social groups; this broadened the definition of food security to contain physical and economic obtainability to food supply (Conway 1997, Briggs 2009: 634; Benbi 2017: 77). Moreover, poverty was a major problem that needed to be alleviated, and the development of women was also required. The 1990s highlighted the movement to eradicate or reduce hunger and malnutrition by access to sufficient nutritious food, which meant a food and nutrition-secure world. The same movement was carried into the 2000s. In 2005 the Millennium Development Goals (MDGs) were developed with the same intention to reduce poverty and reduce hunger and malnutrition (FAO 2009a: para. 3 line 2; FAO 2011: 3; FAO and WFP 2016: para. 2 line 2; Sinclair *et al.* 2019: 104).

In 2015, ten years later, the MDGs targets monitoring period ended. Most countries, namely

the developing regions such as Central Africa and Western Asia, failed to reach the international target goals on hunger because of natural disasters, human-induced disasters, and political instability. As a result, the affected populations continued to face increased vulnerability to food insecurity. In the year 2014, before the MDGs came to an end, there were 795 million people who were reported to be undernourished. This implied that one person in every nine people in the world could not consume enough food to sustain an active and healthy life. Most of the undernourished and hungry people were from developing countries and this amounted to approximately 780 million people (von Grebmer *et al*. 2015: 15).

In 2018 the number of hungry people increased to 820 million globally, with 20% of undernourished people coming from sub-regions of Africa, 15% from Southern Asia, 12% from Western Asian and slightly below 7% from the Caribbean and Latin America. In addition, in 2019, there was a slight drop compared to 2018, with seven-hundred and fifty million people, or close to 1 in 10 people globally, experiencing higher levels of food insecurity (WHO 2019, WHO 2020). Action Against Hunger (2022: para. 2 line 2) agreed with the above information by highlighting that after a gradual decrease in hunger globally for almost a decade, there has been an increase in world hunger which has had an impact on 10% of the global population because of the COVID-19 pandemic. From 2019 to 2022, the number of undernourished people increased to 150 million because of crisis such as conflict, climate change, and the COVID-19 pandemic. As a result, there were 828 million people still going hungry in 2023.

Since the MDGs did not accomplish all the set targets fully by the end of 2015, seventeen (17) SDGs with 169 targets were developed to build onto the MDGs to complete what was not achieved by 2030. The SDGs 2 is to address extreme poverty, inequality, and climate change, with the intention to accomplish the Zero Hunger challenge, by 2030. The SDG 2 (Zero Hunger 2030) main goals are to eradicate starvation, accomplish food security, advance nutrition, and support sustainable agriculture. The FAO and WFP (2016: para. 3 line 2) predicted that assisting in sustainable agriculture, investing in small farmers, endorsing gender equality, terminating rural poverty, improving healthy lifestyles and climate transformation could in fact end hunger. Parallel to the above predictions, some of the key factors that could improve food and nutrition security are economic growth, with the inclusion and provision of

opportunities to improve the livelihood of the poor through the enhancement of sustainable agricultural productivity, sustainable NSA practices, creating advanced rural development, reducing greenhouse emission, protecting valuable ecosystems and increasing sustainable food systems in general (Ruel 2013: 24; UNs 2016b: para. 2 line 1).

The SDG indicator 2.1.2 projected that 2 billion individuals globally were experiencing some level of food insecurity (safe, nutritious, and sufficient food), including higher levels of food insecurity, which meant people's food got depleted and sometimes people went without eating for a day or several days. Secondly, tolerable food insecurity means people might not suffer from starvation but may lack constant access to wholesome and adequate food. This exposes people to a greater threat of numerous types of malnutrition and reduced health (WHO 2019: 26). The indicator also showed that even high-income countries lacked consistent availability of nutritious and sufficient food, meaning that 8% of the populace in Europe and Northern America was projected to be food insecure, primarily at moderate levels. In 2020, the FAO (2020b: para. 2 line 1), indicated that 690 million individuals were starving, meaning that 8.95% of the global populace, which was roughly 10 million individuals in a year and almost 60 million in the next five years, would experience hunger. If the current trends continue in terms of food and nutrition insecurity, the world will not accomplish Zero Hunger by 2030, and the number of individuals suffering from hunger will exceed 840 million by 2030.

Food insecurity can be the cause of deteriorated diet quality and therefore escalate the danger of numerous types of malnutrition, possibly causing undernutrition, overweight and obesity. The initial evaluation of the Coronavirus Disease of 2019 (COVID-19) pandemic proposed that there might be an increase in undernourished people from 83 to 132 million people globally in 2020. The nutritional status of the most susceptible populace was predicted to worsen more because of the negative impact of COVID-19 on the well-being and socio-economic status of people. Before COVID-19, food insecurity issues were decreasing, but food insecurity worsened because the pandemic introduced many factors during the lockdowns, which included reduced access to good quality foods, high-priced foods (mostly wholesome fresh foods) and increased intake of ultra-processed foods and as a result, there was a decline in dietary quality globally (Sadeque 2020: para. 2 line 1; UNs 2020: para. 2 line 1). The Committee on World Food Security (CFS) (2021: 5) indicated that COVID-19 had a deep

influence on food security, nutrition (malnutrition) and food systems due to strict lockdowns and physical distancing policies that were put in place in most countries. As a result, economic activities slowed down and food supply chains were interrupted, which then created negative new dynamics in food and nutrition security in terms of availability, accessibility, utilisation, stability, agency, and sustainability.

The WHO (2021) specified that because of COVID-19 in 2020, world hunger worsened, with an estimation of 811 million people being undernourished, a tenth of the global population. This high number indicated that the world would need to make greater efforts to end hunger by 2030. But all is not lost: firstly, transforming food systems, policies, and investment portfolios can assist in achieving food security, improving nutrition and reducing malnutrition. Secondly, scaling weather resilience through food systems and proposing small-scale agriculturalist's extensive admission to weather threat protection and forecast-cased financing can help reduce hunger. Thirdly, intervening along food supply chains to reduce the price of nutritive foods by promoting the planting of bio-fortified harvests or making it easier for fruit and vegetable cultivators to access marketplaces can help decrease nutrition insecurity. Fourthly, tackling poverty by boosting food value chains in deprived societies through modern expertise and guaranteed programs can improve food and nutrition insecurity (FAO 2021: para. 1 line 1; IFAD 2022a: para. 39 line 1; UNs International Children's Emergency Fund 2021: para. 4 line 1; WFP (2021).

1.3 RESEARCH AIM AND OBJECTIVES

The purpose of the study was to introduce and educate rural female farmers about agri-business and agro-processing (agro-food industry) through the use of Greenhouse tunnels. The research study aligned its focus with the trajectory of food and nutrition security under the UN and the UNA in relation to addressing poverty, hunger and food and nutrition insecurity, as indicated in chapter 2 under the literature review, in chapter 3 outlining the methodology, and also in the intervention (NSA toolkit) of the study. Furthermore, the study focused on Sustainable Agriculture, Sustainable NSA and Sustainable Local Food Systems so as to address food insecurity and nutrition insecurity in Mpharane village and Maqoala village in Lesotho.

The main aim of the research study was to develop, validate, and implement a sustainable

NSA toolkit for rural small-scale female family farming to provide for household consumption and local small-scale commerce to improve food and nutrition security.

1.3.1 The specific objectives of the research:

The specific objectives of the study are presented in phases 1-3 and were intended to achieve the following:

i) Phase 1: Pre-implementation of the toolkit (Baseline Study)

- Determine the socio-demographic profile of the families by means of a socio-demographic questionnaire.
- Determine the anthropometric Body Mass Index (BMI), waist circumference and blood pressure using anthropometric measurements.
- Determine the food security status of each of the participants by means of the Household Food Insecurity Access Scale (HFIAS) and the Household Hunger Scale (HHS) questionnaires.
- Determine the nutritional knowledge, attitudes, and behaviours of the participants by means of the Nutrition Knowledge and Nutritional Assessment questionnaire.
- Determine the food variety intake of the participants by completing a Food Frequency questionnaire.
- Determine the participant's dietary intake by completing 3 x 24-Hour Food Recall questionnaires.
- Determine the food intake and the traditional food intake habits in the household by completing the Household agricultural and knowledge practices questionnaire.
- Determine the participants' acceptability levels and production preferences for various crops by completing the Feedback Acceptability questionnaire.
- Determine the participants' knowledge of food preparation and food preservation practices by completing the Food Preparation and Food Preservation Practices questionnaire.

ii) Phase 2: Development, validation, and implementation of the toolkit

Development, validation, and implementation of the NSA toolkit.

- Develop, validate, and implement an intervention toolkit using Greenhouse tunnels to introduce and educate female farmers in agri-business and agro-processing to address

food and nutrition insecurity in Lesotho by incorporating the SGD target 2 (Zero Hunger) aims.

iii) Phase 3: Post-implementation of the toolkit (Endline Study)

Assessment and analysis of the impact of the NSA toolkit.

- Assess and analyse the impact of the toolkit after eight weeks of training on the female farmers' knowledge of agriculture practices, nutrition knowledge and nutrition dietary intake.

1.4. RESEARCH QUESTIONS

The research attempted to answer the following questions:

i. What are the latest innovations the government of Lesotho, researchers and stakeholders intend to implement regarding sustainable agriculture under agri-business and agro-processing to address food and nutrition insecurity in Lesotho through the incorporation of the SGD target 2 (Zero Hunger) aims and other UN and UNA's innovations?

ii. What are the challenges affecting the implementation of these policies and how can the challenges be overcome?

iii. What are the challenges preventing the eradication of food and nutrition insecurity in Lesotho to reach the SDGs (Zero Hunger: Targets 2.1 and 2.2) targets?

1.5 STATEMENT OF THE PROBLEM

There is a clear indication that the world is still faced with the crises of poverty, hunger, food insecurity and nutrition insecurity. This above statement is supported by the summarised literature in this chapter and in chapter two. The Action Against Hunger (2023: para. 2 line 2) and FAO (2022: 100) indicated that globally in 2023, 828 million people were starving, and 150 million people undernourished worldwide between 2019 and 2022 due to contributing factors such as conflict, climate change, and the COVID-19 pandemic. World Food Program (WFP) (2023: para. 1 line 3) predicted that in 2023, 345.2 million globally were food insecure, which was double the number in 2020. Moreover, some of the contributing factors were

higher costs and lower affordability, which meant billions of individuals could not consume nutritious food. The COVID-19 virus has increased the liabilities and shortages of worldwide food systems, and the pandemic has affected 85% of small-scale food producers especially in developing regions (Pogge and Sengupta 2016: 83; FAO and WFP 2016; UNICEF 2017: 16; Webb *et al.* 2018: 361; FAO 2020b: para. 2 line 1; FAO, IFAD, UNICEF, WFP and WHO 2020: 11).

Lesotho is a small, mountainous, landlocked country spanning 30,000m^2, surrounded by its bigger neighbour, South Africa (SA). WFP (2023: para. 1-5) estimated that Lesotho has a population of 2.2 million, with 57% of the population living below the poverty line, which is less than one dollar a day, equivalent to sixteen Maluti and sixty-three lisente. As a result, 508,125 people are food insecure. Seventy-five percent of the population lives in poor rural areas, and unemployment rates are in excess of twenty percent. Lesotho was classified by both the WFP and WB as the least developed lower-middle-income country with an ease of doing business score of 61/100, ranking it at 106th globally. Lesotho's poverty rate is estimated at 49.7% compared to other countries globally. The county is characterised by highland areas, with only eleven percent of the total area being arable. Lesotho lost 7.13% of its Gross Domestic Product (GDP) to long-lasting malnutrition and the GDP stood at USD 2.3 billion while its national GDP per capital was USD 1,270 (WB 2021: para. 2 line 3). The country is confronted with several developmental challenges, which include chronic poverty, food insecurity, and high rates of malnutrition and Human Immunodeficiency Virus (HIV) prevalence. The population infected with HIV is mostly females in Lesotho because of gender- based violence. About 80% of individuals infected with HIV also have tuberculosis (TB) (WFP 2023: para. 1-5).

The above information indicates that there is a food insecurity crisis in Lesotho that needs to be addressed effectively (Government of Lesotho 2016: 5; FAO 2020). Lesotho experienced significant food security challenges due to El-Niño between 2015 to 2017 which resulted in induced drought (irregular climate circumstances comprised of unpredictable floods, and persistent and frequent droughts). As a result, there was crop failure, which led to low income and high food prices, which resulted in 41% of the rural population spending more than half of their wages on food. More than 30% of the populace throughout the ten regions were faced

with excessively high levels of severe food insecurity, since 80% of the populace exists in rural regions and more than 70% of the populace in rural areas are engaged in subsistence farming, which has not performed well for many years due to numerous factors such as rural families lacking access to arable land and for those individuals who do possess arable land, lack of resources to maximise production, such as fertilisers and high-yield seeds (WHO 2020: para. 2 line 1).

According to the Integrated Food Security Phase Classification (IPC) (2022: 6), an estimated 229,000 people around Lesotho in 2022 were categorised under IPC Phase 3 (Crisis) which stands for acute food security. Fifteen percent of the population living in rural areas were under IPC Phase 3 (Crisis). Out of the ten districts in Lesotho, six were categorised under IPC Phase 2 (Stressed) of acute food security and four districts were categorised in IPC Phase 3 (Crisis). One of the contributing factors to food insecurity in Lesotho was climate change which has resulted in delayed rain and excessive rain that destroyed crops and as a result there has been low crop production. Lastly, food insecurity was increased by food prices remaining excessively high in 2021 and 2022.

1.6 SIGNIFICANCE OF THE STUDY

The study aims to close the barriers to communication between Lesotho government policymakers, researchers, non-governmental organisations (NGOs), and the Basotho people, especially the rural communities and rural farmers, by providing valuable communication systems and information regarding the formulation, application and managing the progress of food and nutrition security projects, programs, and interventions. The study will also introduce the practices of sustainable agriculture (agri-business and agro-processing) with the use of Greenhouse tunnels. The outcomes of this research will be made available to assist in the improvement of national interventions to combat food and nutrition insecurity challenges among rural communities by ensuring food and nutrition security through the eradication of chronic poverty, hunger and the triple burden of malnutrition (TBM) in small-scale farmers' households at district and national level. The research will produce various publications from the interventions regarding the nutrition education program, agricultural practices program and food preparation and food preservation program.

This doctoral study will provide resources to the following:

- Increased stable usage of sustainable food production practices that focus on the three pillars of sustainable agriculture (economic, social, and environmental).
- Increased local inputs for family farms through sustainable agricultural practices.
- Increased access to sufficient, reasonable, and nourishing food for all community participants.
- Improved food and agriculture associated with a commercial model (agri-business and agro-processing) that creates occupations and recirculates monetary funds within the community.
- Enhanced living and operational circumstances for farmers and both sustainable food systems and local community food systems.
- Establishment of food and agriculture strategies that support local and sustainable food manufacturing.
- Acceptance of nutritional behaviours that reflect concern about people and environmental and community health.
- Improved understanding of sustainable agriculture productivity and NSA.
- Improved food and nutrition security status at national, regional, household, and individual level.

1.7 KEY TERMS

The research study covers certain vital concepts and theories. Though these concepts are deliberated on in chapter two, this section provides a summarised introduction of the concepts to provide the reader with a sense of what is offered in the following chapters.

1.7.1 Food Security

Akbari *et al.* (2022: para. 2 line 1) clarified that the concept of food security surfaced after World War II between 1939 to 1945 because of the increased demand for food, increasing population, and negative environmental challenges. The word food security was well-defined in the 1970s as “the obtainability and admission to food” (Maxwell and Smith 1992: 54; Shaw 2007: 347; Beaumier and Ford 2010: 196; Ivers and Cullen 2011: 1740S; McGuire and Beerman 2012: 122). With constant investigation over the centuries into food insecurity, the definition

was expanded to explain the consequences for helpless individuals who are food insecure. Carletto, Zezza and Banerjee (2013: 30) further explained that food security is a "multidimensional concept; including the assessment of several measuring indicators that need to be used to capture the various dimensions of food security". The four key points of food security are the obtainability and accessibility of food at an individual level, and the excellence of food and traditional preferences (Matla 2008: 18). The UNs CFS summarised food security as "all people, at all times, having physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life" (International Food Policy Research Institute (IFPRI) 2020: para. 3 line 2).

1.7.2 Nutrition Security

Bilali *et al.* (2019: 3), IFPRI (1996: 12), WB (2007: 2) and CFS (2012: 9), explained nutrition security as always having access to both macronutrients and micronutrients for all household members for adequate nutritional status. Nutrition security happens when there is a combination of food security, a sanitary environment, and acceptable health services, together with appropriate care and feeding practices for every household member. Alkire and Santos (2014: 251) agreed with the above explanation by emphasising that it is not enough just to consume food, but every individual should have continuous admission to a variety of healthy foods, for example, food that contain proteins, carbohydrates, fats, vitamins, and minerals. Besides nutrients, potable water must be accessible as it is associated with a sanitary environment. Lastly, satisfactory health amenities that provide knowledge, resources, skills and healthy active living for all the household members must be available (Misselhorn *et al.* 2012: 7; Ruel 2013: 26).

1.7.3 Food And Nutrition Security

Shetty (2009: 431) and Ruel (2013: 27) explained that nutrition security entails food security and the two terms are sometimes combined together to form the term "Food and Nutrition Security (FNS)" which emphasises both food and health requirements (Gross *et al*. 2000: 2). FAO *et al*. (2017: 21) agreed with the above statements by discussing the coexistence between nutrition security and food security of every individual in the household. Nutritional security is the adequate nutritional consumption of energy, vitamins, proteins, and minerals in a

household at all times. The nutritional security structure concentrates more on the natural requirements of the human body, the biological needs, and the causes of bioavailability (the level at which the nutrients are absorbed and become available to assist in physiological activities). Food security concentrates additionally on the monetary method, meaning how food is produced. This shows that food security is not enough just on its own to maintain a healthy nutritional status. Poor households, poor communities, and poor nations are one of the major targets when it comes to food insecurity and nutritional insecurity (FAO 2020b: para. 3 line 4).

1.7.4 Sustainability

In the year 1987, the UNs Brundtland Commission explained sustainability as the ability to create and survive in the world without diminishing the natural resources for future generations. Sustainability focuses on long-term concepts and ethical theories in accomplishing equality between the present generation and the future generation in relation to a sound environment, society, and healthy economy (UNs 2023a: para. 2 line 1; Diesendorf 2000: 20; Drolet 2015: 478).

1.7.5 Sustainable Development

According to Diesendorf (2000: 21) “sustainable development comprises types of economic and social development which protect and enhance the natural environment and social equity”. Ruggerio (2021: 3) explained sustainable development as building, creating, and growing things in the present that will not harm the planet in the future for the next generation’s needs and wants for survival. Maiwald (2022: para. 1 line 3) highlighted that sustainable development focuses on three dimensions which are ecological, economic, and social. The three dimensions are strongly interdependent and sometimes there is an addition of the fourth dimension, governance (UNs 2023b: para. 2 line 2).

1.7.6 Sustainable NSA

Njoro (2021: para. 1 line 1) defined NSA as a “food-based approach to agricultural development that puts nutritionally rich foods and dietary diversity at the heart of overcoming undernutrition, overnutrition and micronutrient deficiencies”. Schönfeldt, Hall and Pretorius (2017: para. 8 line 2) further explained that nutrition-sensitive agricultural efforts are based on maximising the contribution of agriculture to nutrition by focusing on

sustainable food production that is diverse, nutritious, available, and accessible for every individual, especially those from poor households. In summary, the general objective of NSA is to create a worldwide food system so as to improve the harvest of nutritious food (FAO 2014b: 28; IFPRI 2016: 18; Teague 2017: 7).

1.7.7 Sustainable Agriculture

Krall (2015: 25) explained sustainable agriculture as practices that decrease harmful impacts on the climate, biodiversity, water, soil quality, air, and the health of all human beings by enhancing the practice and quality of soil productivity. Moreover, sustainable agricultural efforts concentrate more on improving the local people's needs, skills, knowledge, and socio-cultural values regarding agriculture practices. Das *et al*. (2020: 23) supported the above definition by explaining that sustainable agriculture was the equilibrium between the need for food production and preservation of environmental ecosystems (Kluson 2008: 3; Washington, DC., United States (US) Congress 1990: para. 4 line 3).

1.7.8 Family Farming

Mariosa *et al*. (2022: para. 6 line 1) described family farming as the major contributor to sustainable development regarding ending starvation and all forms of malnutrition since family farming contributed to more than 90% of all farms globally and produced 80% of the global food by value. FAO (2019: 55) further enlightened that through public policies, family farming can strengthen the environment and as a result contribute positively to the world's food and nutrition security. The UN Decade of Family Farming 2019-2028 is one of the movements created to ensure that family farming is introduced and practised since it can encourage unique farming practices that can enhance food and nutrition security, improve livelihoods of individuals, and restore and maintain natural resources from the environment (FAO and IFAD 2021: para. 1 line 1).

1.7.9 Sustainability Community Food Systems (SCFS)

Gillespie and Smith (2008: 335) described a community food system as the fragment of the food system that is situated in a specific area. In this perspective, the community is usually a geographical place. FAO (2018: 5) elaborated that a sustainable food system is a major contributor to the UNs' SDGs (SDGs). Moreover, food systems can address food security and

nutrition in all forms, and the economic, social, and environmental quality will not be compromised; meaning that the future generation will also experience food and nutrition security.

1.7.10 Agribusiness

Hassanzoy (2019: 2) clarified that the term "agribusiness" was first defined by the two Harvard Economists Johan Davis and Ray Goldberg in 1957 as "the sum total of all operations involved in the manufacture and distribution of farm supplies; production operations on the farm; and the storage, processing, and distribution of farm commodities and items made from them". In simple terms, agribusiness involves all activities in agricultural production. Yumkella *et al*. (2011: 159) further explained that agribusiness is a comprehensive theory that includes input suppliers, agro-processors, traders, exporters, and retailers. Agribusiness offers inputs to farmers and joins them with clients through the financing, handling, processing, storage, transportation, marketing, and distribution of agro-industry products.

1.7.11 Agro-Processing

Agro-processing is the subgroup of manufacturing and processing raw materials with products resulting from the agricultural sector (FAO 1996: para. 2 line 1). Agro-processing is under agro-industry, which comprises all the post-harvest activities that are involved in the transformation, preservation, and preparation of agricultural production for intermediary or final consumption of food and non-food products (Wilkinson and Rocha 2009: 46; Yumkella, *et al*. 2011: 245).

1.8 ASSUMPTIONS

Assumptions made in this study are that:

- Participants were honest in their responses.
- There is TBM due to poor nutrition status among farmers and household members.
- Farmers are not necessarily aware of the nutritional benefits of certain food crops.
- The knowledge of farmers could be improved.
- The female farmers are food insecure.
- Policies are created but not implemented at all or not to their full capacity in

communities.

- There is limited interaction between government policymakers and communities.
- There are limited policies that address gender inequality in farming in Lesotho, especially in the agriculture sector.
- There are limited resources, technology, and knowledge to create a sustainable agriculture system to address food and nutrition security in rural communities.

1.9 CONCEPTUAL FRAMEWORK

The study follows the conceptual framework outlined in Figure 1.1 which Depicts the intervention and objectives of the study.

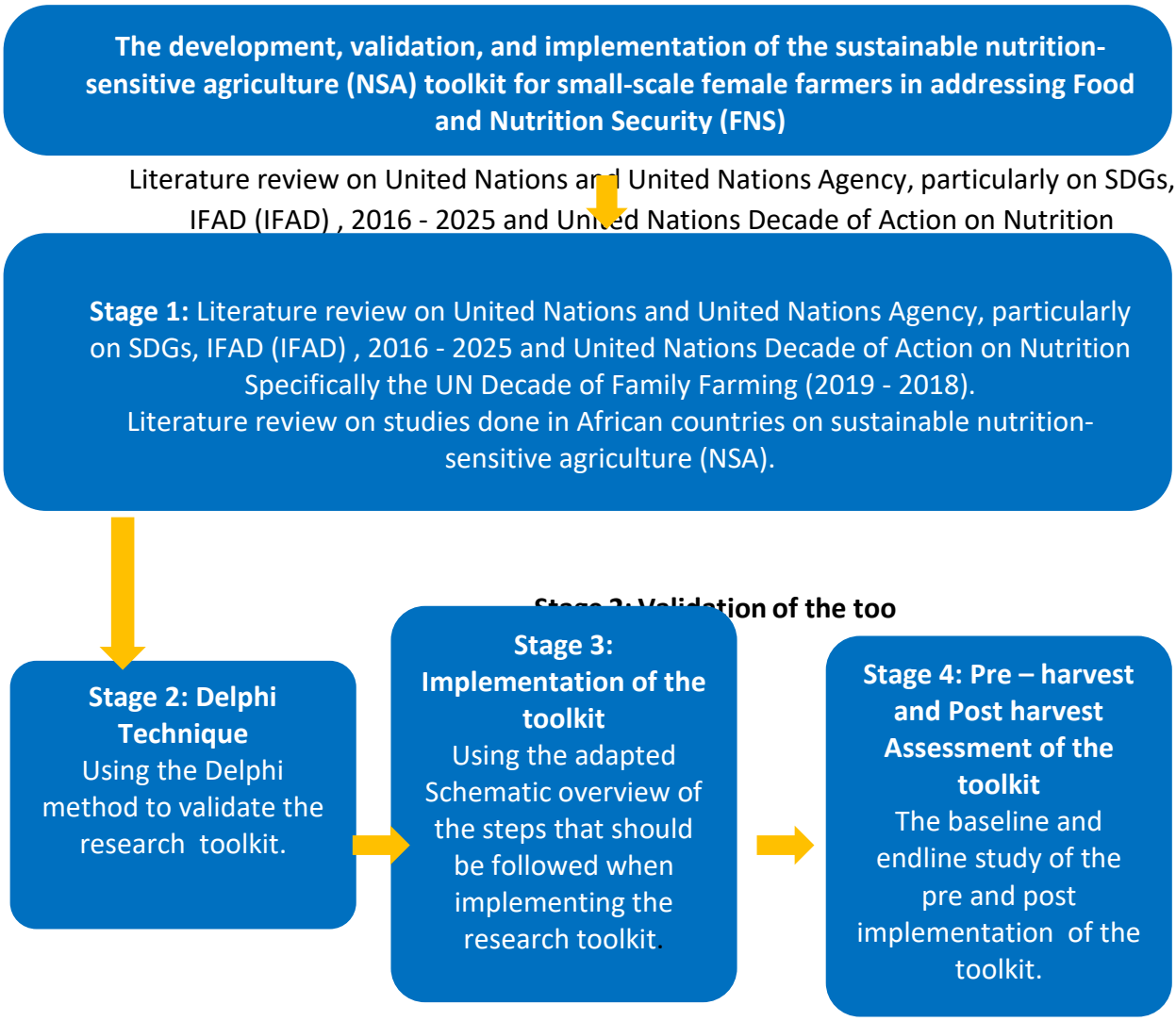
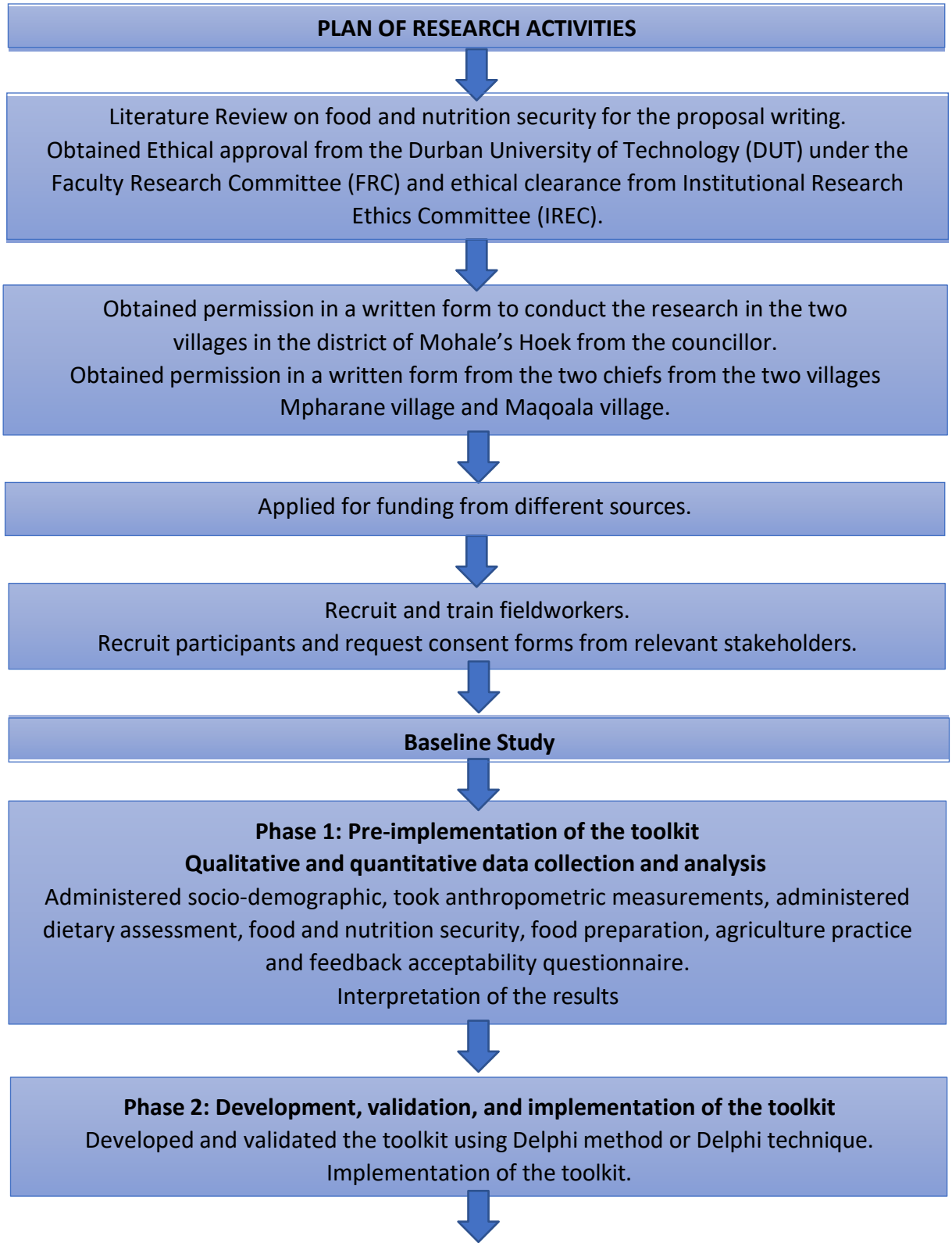


Figure 1: Conceptual framework of the intervention methodology

Stage 4: Assessment of the toolkit

The baseline and **1.10 THE OUTLINE OF THE RESEARCH STUDY FLOW**

endline study of the pre and post implementation of the to



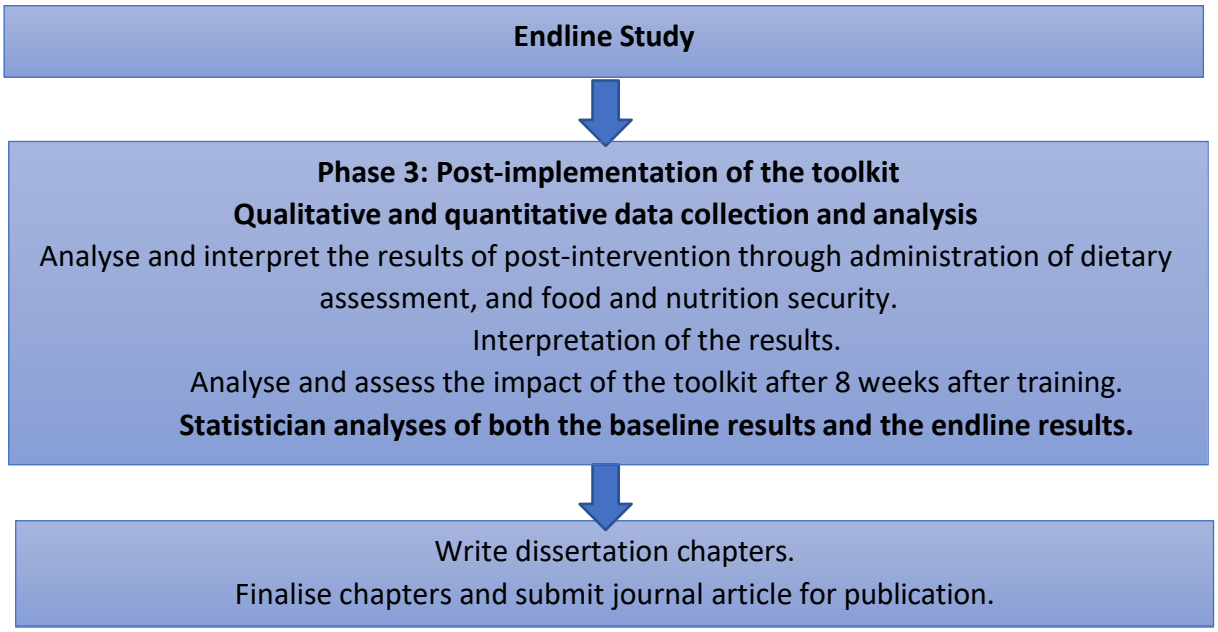


Figure 2: Illustrates the progression (flow) of the research project

1.11 STRUCTURE OF THE DISSERTATION

Chapter 1: General introduction to the dissertation

Chapter 1 gives an introductory background into this research, as discussed in the opening section of the chapter.

Chapter 2: Literature review

Chapter 2 analyses the accessible literature that applies to the study to provide a background to the trajectory of food and nutrition insecurity under the UNs and the UNA in relation to addressing poverty, hunger, and food and nutrition insecurity through food and nutrition security policies, strategic plans, programs, projects, and SDGs (SGD 2 Zero Hunger) in both developed and developing countries at international, national, regional, household, and individual level.

Chapter 3: Methodology

Chapter 3 outlines the research methodology for the research and the intervention. The section looks at the research design, data collection method and sampling, limitations of the study, reliability, validity, and method of data analysis.

Chapter 4: Results and Discussion

Chapter 4 reports on the results of the baseline study under the processed data, which have been tabularised, interpreted, and assessed. The study's results are presented, discussed, analysed and compared to the literature review in Chapter 2 and Chapter 3 relative to the objectives of this research.

Chapter 5: Conclusion and recommendations

Chapter 5 presents a summary of the main findings, the limitations, the conclusions, and the recommendations based on the analysis of the data.

1.12 CONCLUSION

In summary, this chapter has given an insight into the expectations of this dissertation. The aims and objectives have been highlighted, as well as the research questions, the significance of the study, and the problem statement. A brief discussion on food and nutrition insecurity in Lesotho and globally was also provided. This literature review is presented in the next chapter.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

Firstly, the literature review evaluates the chronological order in which the UNs and UNs Agencies in the last 50 years have attempted to address food and nutrition security from a global perspective through numerous policies, strategies, programs, and interventions. Secondly, this chapter reviews the available literature that applied to the study to provide a background to the topics in Figure 3 and Figure 5, which are aimed at addressing food and nutrition insecurity in the research study from the Unites Nations (UNs) and UNs Agencies concepts, theories, and conceptual frameworks. Thirdly, the literature review summarises some of the studies conducted in southern African countries on NSA as part of the study's intervention. Lastly, this chapter also substantiates the context of this research as a guide to the analysis in chapter 4. In the process of the review, relevant information regarding the topic are discussed.

2.2 THE TRAJECTORY OF FOOD AND NUTRITION SECURITY UNDER THE UNs AND THE UNs AGENCIES

Food and nutrition insecurity has been a persistent problem globally, although the world is now producing enough food to feed the global population. The WHO (2022a: para. 1 line 1), highlighted that in 2021 more people experienced hunger than the predicted 828 million people compared to 2019 when it was 150 million people. The number increased by 46 million people from 2020 to 2021. The hunger rate has remained unchanged since 2015, but a drastic change occurred in 2020, and it continued to 2021 and 2022 due to different challenges such as the COVID-19 pandemic, climate change, global conflict and political instability. As a result, approximately 2.3 billion (29.3%) of the population globally were either moderately or severely food insecure in 2021. There were 350 million more people affected compared to before the outbreak of the COVID-19 pandemic. According to the FAO (2022: para. 3 line 5) almost 924 million (11.7 %) people worldwide were exposed to food security at a severe level, a total increase of 201 million between 2020 and 2021.

To authenticate the results presented in the above paragraph and throughout the dissertation, the author of the research study will provide an overview of the role the UNs

and UNs Agencies in global food and nutrition security. After World War I, the League of Nations was developed. This was an international diplomatic group, and it was responsible for resolving disagreements between countries before open warfare was declared. From 1930 to 1945, the post-World War I period, the Health Division of the League of Nations dealt with world affairs, and after investigating Nutrition and Public Health, it was reported that there was a severe scarcity of food in deprived nations. This was the first indication of the magnitude of the food problem globally. The international politics forums, Health Division and nutrition specialists coordinated nutrition policies to address global hunger and malnutrition. This began the complex relationship between food and nutrition security (Shaw 2007b: 347; History 2020: para. 2 line 1).

After the establishment of the League of Nations post World War II, from 1945 to 1970, 51 countries came together to create another international organisation called the UNs (UN). The UN's mission was to preserve worldwide amity and safety, and cordial relationships among countries and promote social progress, better living standards and human rights. This review will specifically focus on the UN's efforts to address world hunger and food and nutrition security. Out of 193 UNs members, 54 of the members are from countries in Africa. The UNs Department of Economic and Social Affairs (DESA) functions directly with regimes and investors to assist nations around the globe in meeting their financial, societal, and ecological objectives. Within the UNs Secretariat, the DESA stimulates global collaboration for growth to improve the lives of individuals globally by engaging with the vital goals of deprivation elimination, lasting financial security and environmental development (UNs General Assembly 1976: para. 2 line 1).

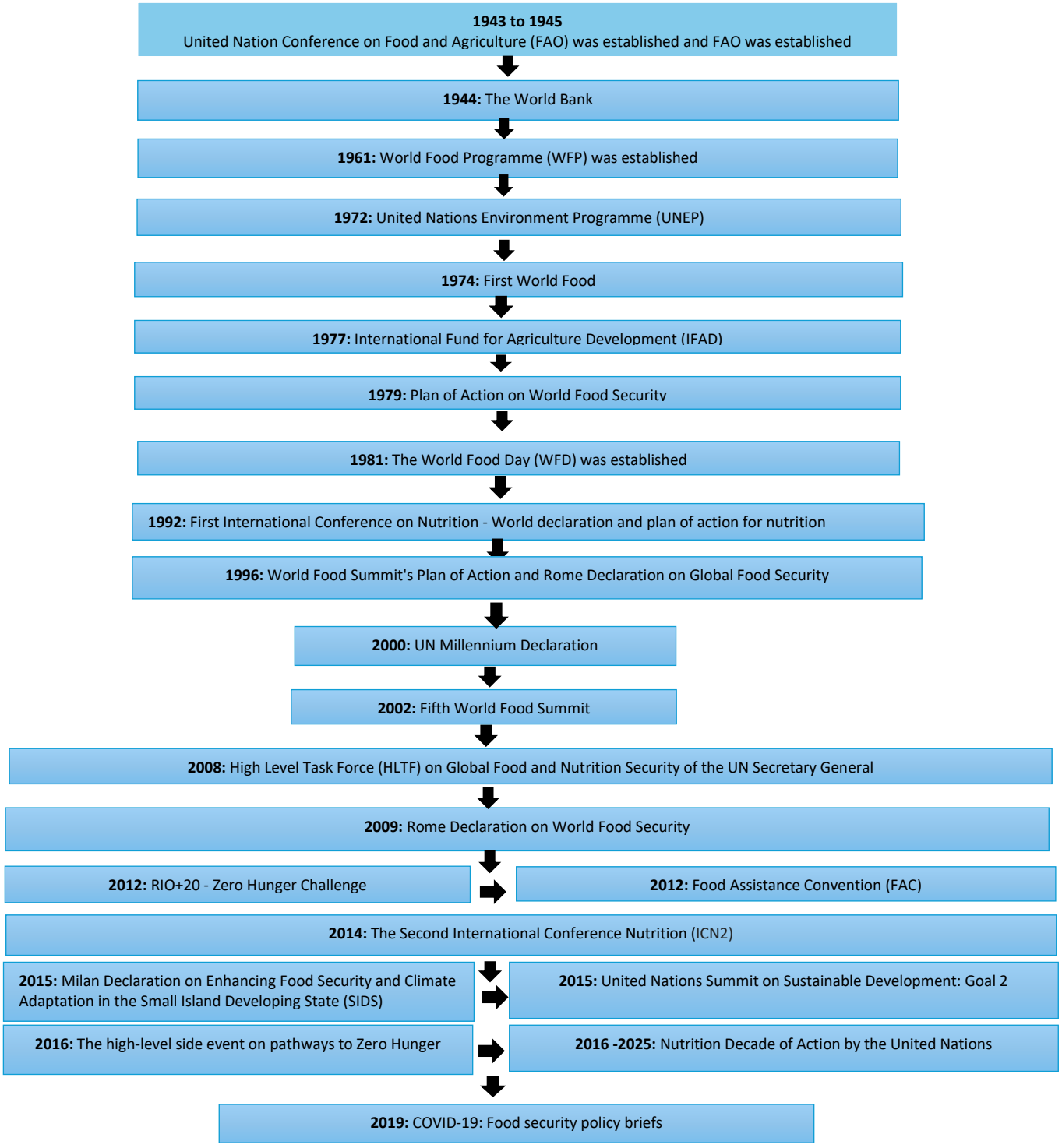


Figure 3: The summary of the trajectory (path) of food and nutrition security under the UNs and the UNs

2.2.1 1943 TO 1945: UNs CONFERENCE ON FOOD AND AGRICULTURE (FAO) WAS ESTABLISHED.

In 1943, the UNs held a conference with 44 governments where the FAO was initially introduced, and the aim of the conference was to end hunger by building a safe, sufficient, and appropriate food stream for everyone. The conference acknowledged that freeing everyone from starvation would involve a massive increase in food production. The organisation pointed out that there would be challenges in achieving the aim. Still, the organisation was optimistic that the methodological difficulties in achieving the needed production level would be overcome since such problems had occurred in previous years and were overcome through the methodological inventiveness of humankind. The conference also reflected on the tractable difficulties of social and governmental organisations since the world's independence from starvation ultimately depended on them (Strand and Pacif 1943: 283).

In 1945, FAO was officially made the UNs agency. The first session of the FAO conference was held to discuss the primary objectives that focused on raising awareness on improving nutrition, eliminating hunger, food insecurity, malnutrition, increasing agricultural outputs, raising the ordinary lives of rural people, and contributing to worldwide monetary development. Accomplishing food security was one of the major objectives of FAO, whose work was to ensure that individuals had continued access to sufficient good quality food to lead effective, healthy lifestyles.

Throughout the 1960s, the FAO focused on agendas on the growth of harvests of good strains of grain, the removal of protein deficiencies, rural employment, and increasing agricultural exportations. In 1969, the association issued an Indicative World Plan for Agricultural Development, which examined the core difficulties in the world of agriculture and recommended policies for resolving them. In the 1980s and 1990s, the FAO developed agendas for sustainable agriculture and rural growth with plans that highlighted economic achievability, which was ecologically sound, and technically suitable to the skill level of the host nation. Mingst (2006: para. 1 line 2) reported that the objective was to eradicate starvation and advance nutrition and living standards by growing agricultural productivity.

The FAO believed that synchronising governments' efforts and methodological activities in agendas, would initiate farming, fisheries, forestry products, land, and water properties. The FAO also believed its objectives could be achieved through improved and increased knowledge by conducting educational programs and sessions, establishing teaching centres, and maintaining data and support facilities, including maintaining figures on world manufacture, trade, and consumption of agricultural merchandise. Lastly, they published several periodicals, yearbooks, and research bulletins (FAO 1945: para. 1 line 2; World Food Summit 2002: para. 1 line 1)

Over the years, the FAO has focused its strengths on attempting to accomplish its objectives and worldwide aims: to reduce starvation, food insecurity and malnourishment. The FAO disputed the notion that there was adequate capability in the world to harvest sufficient food to supply every person adequately; however, despite the improvements over the last two decades, in 2020, 870 million individuals still suffered from persistent starvation. Children below the age of five (171 million) were constantly undernourished (stunted), almost 104 million were malnourished, and about 55 million were severely malnourished (wasted). By 2050, the worldwide populace is projected to rise to 9 billion. Several countries with the highest levels of population increase have high-level rates of food insecurity. These nations rely on the agriculture sector for harvests, livestock, forestry, and fisheries. This prediction has increased demand for the agriculture sector to improve the sustainability and production of food (FAO 2020b: para. 1 line 1).

Many of the world's poor people stay in rural regions. Hunger and food insecurity are expressions of rural poverty. Growth in the agriculture sector is one of the most effective means of reducing poverty and achieving food security. Decreasing rural poverty is crucial to FAO's mission, and numerous individuals living in rural areas have been moved out of poverty in recent years. In 1990, 54% of those residing in rural districts in emerging nations lived on less than $1.25 a day and were regarded as exceptionally poor. By 2010, the percentage had declined to 35%. Rural poverty continues to spread, especially in South Asia and Africa. These areas have also witnessed the least development in increasing rural livelihoods. Ensuring comprehensive and practical agriculture together with food systems can enhance rural

livelihoods (FAO 2014b: 28).

According to FAO, IFAD, UNICEF, WFP and WHO (2022b: 150), the FAO assists in raising levels of nutrition and living standards and ensuring humanity's freedom from hunger by promoting sustainable agricultural development and alleviating poverty. The organisation offers direct development assistance and policy and planning advice to governments for improving the efficiency of the production, distribution and consumption of food and agricultural products, collects, analyses, and disseminates information, and acts as an international forum for debate on food, nutrition, and agriculture issues. The focus is on the distinctive relationship between agriculture, food, and nutrition. The FAO works actively to protect, promote and improve established food-based systems as a sustainable solution to ensure food and nutrition security, combat micronutrient deficiencies, improve diets and raise levels of nutrition, and by doing so, achieve the nutrition-related SDG 2.

In 2023, after more than eighty years, the FAO is continuing to work towards ending hunger and achieving food security for every individual by creating admission to sufficient high-quality food to enable people to live an active and healthy life. Currently, the FAO is working with 194 countries, the European Union (EU), and over 130 countries worldwide to achieve the goal set in 1943 (FAO 2023: para. 3 line 4).

2.2.2 1944: The World Bank (WB)

The Bretton Woods Conference (1944) organised by the World Bank (WB) in 1944, has been aggressively engaged in supporting food schemes and courses. The WB has exceptional global partnerships with 189 members from different nations, staff from more than 170 nations and headquarters in over 130 venues. The goal of the WB Group is to bring sustainable solutions based on knowledge and expertise for different sectors of development, especially in developing countries that are faced with the hardest global and local development challenges such as reducing poverty, adapting to climate change, improving food security, and fighting corruption. In short, the WB offers a wide selection of monetary support and practical support and supports nations to share and apply ground-breaking information and resolutions to the nations' challenges (WB 2023: para. 3 line 4).

2.2.3 1961: The World Food Program (WFP) was established

The UN established the WFP agency in 1961 as a multifaceted food relief program that would respond to food emergencies and programs to combat hunger worldwide. The WFP is a charitable association that changes and saves lives. It delivers food aid in times of disasters and works with societies to advance nutrition and build resilience to disease. As a global organisation, WFP's mission is to eradicate poverty and hunger, achieve food security and improve the nutritional status of everyone globally by 2030. It is predicted that the majority of people still consume inadequate food. WFP assists countries that are experiencing natural and human disasters and helps people in reconstructing their disrupted lives. Moreover, WFP assists in reinforcing the resilience of individuals and societies affected by or exposed to prolonged disasters through humanitarian response systems (WFP 2007: para. 1 line 3).

The WFP development schemes emphasise nutrition, particularly for mothers and children experiencing starvation from the initial phases through programs aimed at the first 1,000 days from conception to a child's second birthday and later through school meals. The WFP is the major charitable association that has executed school feeding projects internationally for over 50 years when children are frequently placed in the most challenging situations. In 2019, WFP delivered food to schools, and 17.3 million children in 50 nations were provided with meals. In 2019, WFP delivered 4,2 million metric tonnes of food and donated US$ 2.1 billion in money and vouchers. The WFP transports food to 280 locations worldwide. The WFP raised a record-breaking USD8 billion in 2019; in the same year, it aided 97 million individuals, the biggest quantity since 2012. The WFP has 5,600 trucks, 30 ships and 100 aircraft transporting food and any other form of aid needed. Every year, WFP issues over US$15 billion worth of foods at a projected average cost per ration of US$ 0.61 (Medium 2019: para. 2 line 2).

The UNs (2023c: para. 1 line 1) reported that it was awarded the Nobel Peace Prize in 2020 for its efforts in combating hunger, its influence in founding the requirements for amity in conflict-ridden countries, for leading the initiative to stop the use of starvation as a weapon of war and conflict, and for its efforts in safeguarding satisfactory food supplies throughout

the continuing pandemic.

The WFP is also involved in extended plans that aim to improve food security for children and create self-help groups. The goal is to accomplish the second of the UN 17 sustainability goals: to end hunger by 2030. From the early 2000s until 2014, starvation levels dropped internationally, but this curve has since been reversed. In 2019, roughly 690 million individuals were hungry, the equivalent of 9% of the world's population, meaning that one in every ten people was confronted with food insecurity, and forty-seven million children were starving. The year 2021 was predicted to be the worst year because of the COVID-19 crisis, which caused a sudden shift in the WFP goals because the WFP's entire donations were used to fund the crisis. In 2021, the organisation sought to assist 138 million people, 41 million more than in 2019. For that to happen, the agency needed an additional USD 4.9 billion. The executive director of the WFP, David Beasley, has acknowledged that food might be the greatest vaccine against chaos and the long-term effects of a severe food crisis (UNs 2020b: para. 1 line 1).

2.2.4 1972: United Nations Environment Program (UNEP)

The UNs Environment Program (UNEP) was founded in 1972 as a global support program to offer advice and authority on ecological problems. The UNEP is the voice for the natural environment among the UNs Organisation, and its responsibility is to act as a facilitator, supporter, educationalist, and organiser to support sustainable growth globally. The UNEP's work involves measuring international, provincial, and state environmental situations and developments. It also creates global and nationwide ecological tools and improves the ecosystem. UNEP has a long history of contributing to the progress and employment of conservational law through international forums (UNEP 2022: para. 1 line 3).

The Fourth Montevideo Program for the Development and Periodic Review of Environmental Law was approved by the Member States in 2009. This produced a comprehensive scheme for the global legitimate society, and UNEP was able to create the events in the field of environmental law for the decade until 2020. The first UNEP World Congress on Justice, Governance and Law for Environmental Sustainability was conducted in 2012. Representatives of several nations asked UNEP to establish the UNs System and assist the state authorities in developing and applying conservation regulations. The Division of

Environmental Law and Conventions directed this request. UNEP was also involved in creating and improving ecological guidelines for the application of the law, which involved the advanced development of environmental law, defending human rights and the environment, tackling ecological corruption, improving admission to justice in environmental matters, and overall capacity building for appropriate stakeholders. One topic UNEP focuses on presently is food security (UNEP 2021: para. 5 line 3).

2.2.5 1974: First World Food

The first global food symposium was conducted in Rome on 5-16 November 1974, and the conference adopted the following declaration: "Universal declaration on the eradication of hunger and malnutrition". At the conference, governments investigated international food manufacturing and utilisation challenges. It announced that every adult male and female child has the right to be free from starvation and undernourishment because they need to strengthen their physical and mental abilities. Furthermore, it was agreed that it was of great importance for authorities to work collectively to produce and distribute adequate amount of food among nations (UNs General Assembly 1976: paragraph 2 line 1).

Governments were expected to initiate a more extensive collaboration on the persisting malnutrition and deficiency disorders amongst the defenceless groups and lower-income classes. In addition, the governments were to guarantee sufficient food for all and create suitable food and nutrition programs combined with socio-economic and agricultural development plans on acceptable knowledge of food resources. Food problems were to be handled during the planning and execution of national plans and programs for economic and social development, with importance placed on humanitarian characteristics. This conference was conducted during food shortages in the southern Sahara. The conference encouraged the FAO to endorse global food security plans, which involved assisting small farmers to implement low-cost projects to increase production (UNs General Assembly 1976: paragraph 1 line 3).

The updated concept of "food security" was agreed on in 1974 at the World Food Summit, and it was defined as "the availability at all times of adequate world supplies of basic

foods to sustain a steady expansion of food consumption and to offset fluctuations in production and prices". In 1983, the FAO extended the concept of "food security" by adding, "…ensuring that all people at all times have both physical and economic access to the basic food that they need". In 1986, the WB added more depth by saying, "…access of all people at all times to enough food for an active, healthy life". The 1996 World Food Summit adopted a still more complex definition that read as follows, "Food security, at the individual, household, national, regional and global levels is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". In 2001, the concept was refined further, and it read as follows, "Food security is a situation that exists when all people, at all times, 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." In 2012 the UNs' CFS, after in-depth discussion, finally agreed with the above definition and stated that "Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their food preference and dietary needs for an active and healthy life" (Benton 2017: 19).

In summary, food security is a multifaceted concept affecting both developed and developing countries concerning human rights problems at the international, national, community, household, and individual levels in relation to a global food crisis. This includes the availability of adequate volumes of food and the stability of food supplies and prices. Most importantly, securing access to food for vulnerable individuals exposed to extreme poverty and low income caused by natural disasters, economic collapse, or conflict was seen as paramount. The food consumed should be safe, and nutritious to provide an active and healthy life (Sen 1981b: 144, Sen 1981a: 433; FAO 2002: para. 2 line 1).

2.2.6 1977: International Fund for Agriculture Development (IFAD)

The International Fund for Agricultural Development (IFAD) was founded in 1977 by the UNs agency as a food and agriculture hub, and it is based in Rome. Since 1978, IFAD has delivered US$22.4 billion in donations and low-interest loans to developments that have impacted 512 million individuals. IFAD's primary efforts are focused on reducing rural poverty, assisting

underprivileged rural populations and nations to eradicate poverty, starvation, and malnourishment. The IFAD's aim is to support rural economies to assist people to be free from poverty and starvation. The purpose is to change rural economies and food systems by making them more comprehensive, industrious, robust, and sustainable. Substantial monetary investments have focused on entities at risk of being left behind: underprivileged communities, minor-scale food producers, females, young people, and other vulnerable groups residing in rural areas. The IFAD is an international development organisation that focuses on changing agriculture, rural economies and food systems worldwide (IFAD 2020a: para. 1 line 1).

The IFAD target was to reach out to communities in the remotest areas and help millions of rural people increase their productivity, access markets, jobs and experience economic growth; increase incomes, move out of poverty and improve food and nutrition security; build resilience in the face of climate change and manage natural resources based on sustainability; and improve coping mechanisms in fragile and conflicting environments (IFAD 2020b: para. 2 line 1).

The IFAD works with public and private investors in reinforcing economic policies and endorsing innovations to provide sustainable assistance to poor nations and help them accomplish permanent systemic change. IFAD works with administrations, civil society and other development agencies to help communities locate and use resources through the use of different tools, apparatus and information in order to respond to the challenges facing countries with the most critical needs (IFAD 2020a: para. 3 line 1).

Globally the majority of poorest individuals live in the rural areas of emerging nations. A significant number of these people rely on agriculture to survive. Due to weather change, an increasing global population, and volatile food and energy prices, there is a great possibility of millions of vulnerable people being impoverished and starving by 2030. In summary, the IFAD's main interest is to finance rural people and empower them to grow their food security, advance their nutrition and increase their earnings. The IFAD aids them to build resilience, enlarge their companies and manage their own development (IFAD 2016-2025: para. 2 line

1).

2.2.7 1979: Plan of Action on World Food Security

According to the UNs Dag Hammarskjöld Library (2016: para. 5 line 1), the FAO CFS approved the Plan of Action on World Food Security at its 4th meeting in Rome in 1979 "UN Milestones - Food Security and Nutrition - UNs". The Plan of Action contained a sequence of actions essential to create the International Undertaking on World Food Security. The actions were intended for the administrations of all the countries involved in exploring solutions to problems such as inadequate stock, increasing prices and food assistance for emerging nations affected by the world food security system. All administrations that had pledged to be part of the International Undertaking on World Food Security agreed with the institutional and constitutional guidelines in changing and applying the nationwide grain stock policies and aims or purposes in agreement with the Undertaking. The Undertaking understood the problems of emerging nations when it came to maintaining stocks at desirable levels, and this challenge added more accountability in guaranteeing world food security in the rest of the international community.

2.2.8 1981: World Food Day (WFD) established

The members of the different countries of the FAO created WFD in November 1979 at the organisation's 20th General Symposium. WFD was made official on 16 October 1981. The UN General Assembly approved the decision on 5 December 1980. An appeal was made to local, national, and global associations to participate in celebrating the WFD. Since 1981 WFD has been celebrated every year. These associations assembled globally on October 16 to support and reinforce the movement to end hunger. The WFD presents opportunities to strengthen both national and global unity in the fight against starvation, malnutrition, and poverty. The WFP also draws attention to food security and agricultural development achievements (Anthem 2020: para. 2 line 1).

2.2.9 1992: First International Conference on Nutrition - World Declaration and Plan of Action for Nutrition

In December 1992, the FAO and the WHO organised the first International Conference on Nutrition in Rome, Italy, and 159 states participated. The European Economic Community

declared its determination to eliminate hunger and reduce all forms of malnutrition at the International Conference on Nutrition. Starvation and malnutrition were the two aspects that were discussed and were unacceptable globally. The participating countries stated that access to nutritionally adequate and safe food was the right of every individual. The countries also realised that, internationally, there was sufficient food for everyone; the problem was unfair distribution of food. Furthermore, the right to an adequate standard of living, including access to sufficient food, is part of the Universal Declaration of Human Rights (Shaw 2007a: 304).

The nations pledged to act in unity to guarantee that freedom from starvation became a reality. The nations also pledged to support the obligation to join forces to guarantee sustained nutritional well-being for everyone in a non-violent and ecologically harmless world. The countries dedicated themselves to ensuring that the development of programs and policies resulted in a sustainable improvement in the welfare of human beings and the environment because it was evident that improved nutrition and well-being for both the present and future generations relied on those aspects (Shaw 2007: 309).

In the mid-1990s, food security incorporated nutrition security. In 1995, the ability to access or get enough nourishing food to maintain well-being and general health was described as "adequate nutritional status in terms of protein, energy, vitamins, and minerals for all household members at all times." This term was extracted from UNICEF's conceptual framework. In 2006, through WB and Mundial (2005: para. 2 line 3), there was more elaboration on the explanation as follows: "Nutrition security exists when food security is combined with a sanitary environment, adequate health services, and proper care and feeding practices to ensure a healthy life for all household members". Fanzo (2015: 17) highlighted that "nutrition security is achieved when secure access to an appropriately nutritious diet is coupled with a sanitary environment, and adequate health services and care, to ensure a healthy and active life for all household members". In 2012, the FAO defined nutrition security as "Nutrition security exists when all people at all times consume food of sufficient quantity and quality in terms of variety, diversity, nutrient content and safety to meet their dietary needs and food preferences for an active and healthy life, coupled with a sanitary environment, adequate health, education and care" (FAO 2011: para. 2 line 1;

Nicholson 2012: para. 2-line 2).

The purpose of nutrition security is to provide for food ingestion by individuals at the household level and the utilisation of food by the body. Nutrition security can only be accomplished when a person has access to sufficient food containing nutritional requirements that assist an individual in digesting and absorbing food and using the nutrients to promote the development and maintenance of the body to carry out daily activities needed to stay alive. In the light of continuing hunger and poverty, nutrition security has not yet been achieved over the years (CFS 2012: 6).

At the conference, the multifaceted roles of agriculture, particularly regarding the issues of food security, nutrition, sustainable farming, and the preservation of natural resources, were discussed. For both rural and urban communities to achieve and maintain population balance and equitable access to resources, countries are required to implement comprehensive farming, education, population, fisheries, food, animal, nutrition, social policies, and initiate environmental and economic programs at household, national, and international levels (FAO and WHO 1992: para. 3 line 1).

2.2.10 1996: World Food Summit Plan of Action and Rome Declaration on Global Food Security

In November 1996, world leaders gathered in Rome for the World Food Summit, which included attendees from 185 nations and the European Community. The FAO organised the summit, and its goal was to reaffirm political commitment at the highest level worldwide to eradicate hunger and malnutrition and ensure sustainable food access and availability for everyone. The world leaders' goal was to affirm their commitment to eliminating hunger in the new millennium. Participants from intergovernmental organisations (IGOs) and NGOs, among others, actively participated in the meeting. This collaboration helped to shape public opinion and provided a framework for enforcing significant changes in the policies and programs required to achieve Food for All (FAO 1996: para. 2 line 1)

The summit aimed to increase awareness among governmental and commercial sector decision-makers and the general public. Additionally, it established the conceptual, political,

and technological framework for a continuous campaign to end hunger in all nations, aiming to halve the number of undernourished people by no later than 2015. The problem with the follow-up was constantly having to ensure that the activities outlined in the Summit's Plan of Action were put into practice, such that a total number of 800 women, men, and children that were starving and undernourished were decreased by, or ideally sooner than, the Summit's target (FAO 1996: para. 1 line 1).

The Plan of Action outlined the goals and measures necessary to effectively fulfil the seven pledges outlined in the Rome Declaration, which serve as the cornerstone for attaining sustainable food security for everyone. Pledge number seven emphasised that national governments bear the primary duty of incorporating all stakeholders in establishing the political and economic framework necessary for action to be taken to ensure adequate food access and food availability in their populations (FAO 1996: para. 2 line 1).

2.2.11 2000: UN Millennium Declaration

Members of the UN endorsed the eight MDGs in September 2000. The UN Millennium Declaration established a new international alliance to end extreme hunger and poverty once and for all among all women, men, and children. Goal One aimed to reduce the number of individuals who experienced hunger by half by the year 2015. While many factors needed to be taken into account, some of the most significant accomplishments between 2000 and 2015 included the halving of extreme poverty due to a reduction in the number of people who were undernourished, a more than 50% drop in the child mortality rate, and a notable increase in the availability of clean and safe water for drinking (UN 2017: para. 2 line 2).

An increase in resource availability, wealth, and economic growth were envisaged to achieve these gains, mostly occurring in the world's poorest regions. Although eliminating the lack of access to and availability of food require growth of the economy, other elements, including inequality, climate change, and unequal distribution of food, all have an impact on food and nutrition security. There are still loopholes in the fight against severe hunger, and FAO said that since 2014, the number of people who were not well-nourished worldwide increased, reaching more than 821 million in 2017. Climate change, population expansion, conflict, and

socio-political changes contributed to the surge (FAO *et al*. 2018: para. 1 line 1).

2.2.12 2002: Fifth World Food Summit

The fifth World Food Summit (WFS) was held on 10 to 13 June 2002. Reviewing the lack of advancement in the fight against hunger and the quest for adequate food access and availability since 1996 was the goal of this summit. The Rome Declaration on World Food Security was reiterated by the member states, stating that "it is the right of everyone to have access to safe and nutritious food, consistent with the right to adequate food and the fundamental right of everyone to be free of hunger". The problem with the statement was that a couple of years later, 800 million people still had limited or no access to food, and 24,000 people were thought to die from starvation every day. The question was: why were so many people starving in a society with an adequate food supply able to give everyone a decent diet? The answer was that hunger had not decreased or stopped but had instead increased (World Food Summit 2002: paragraph 4 line 3).

2.2.13 2008: High-Level Task Force (HLTF) on Global Food and Nutrition Security of the UN Secretary General

In 2008, UN Secretary-General Ban Ki-moon formed the High-Level Task Force on Global Food and Nutrition Security (HLTF). The UN Secretary-General and FAO Director-General served as the Task Force's co-chairs. The goal of the FAO was to increase the distribution of food to people, raise their living standards, and increase output from their farming activities. Additionally, to foster global economic expansion, guarantee humanity's independence from hunger, and enhance rural communities' well-being. These objectives were to be accomplished by advocating and endorsing conservation, education, research, and adopting suitable farming policies at both the national and international levels (UNs 2015: para. 3 line 1).

The term "Food and Nutrition Security (FNS)" needed to be defined, so UNICEF and the FAO (2009) worked together to establish an interpretation of the phrase. They stated that FNS is achieved when sufficient food (in terms of safety, quantity, sociocultural acceptability, and quality) is available and easily accessible to and always satisfactorily utilised by all individuals

to live a healthy and active lifestyle. In addition, the UNICEF (2008: 5) further stated that “Food and nutrition security exists when all people at all times have physical, social and economic access to food of sufficient quantity and quality in terms of variety, diversity, nutrient content and safety to meet their dietary needs and food preferences for an active and healthy life, together with a sanitary environment, adequate healthcare, and education.”

The CFS (2012b: 7) defined and elaborated that “food and nutrition security exist when all people at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. Food insecurity exists when people do not have adequate physical, social or economic access to food as defined above." Food security, therefore, covers availability, access, utilisation, and stability issues, and – because of its focus on the attributes of individuals – also embraces their energy, protein and nutrient needs for life, activity, pregnancy, growth and long-term capabilities” (CFS 2012b: 7).

Sangeetha *et al.* (2013: 621) and Capone *et al.* (2014: 13) highlighted that FNS is an additional method for combining nutrition and food security aspects. The embedding of “nutrition” between “food” and “security” emphasises that raising levels of nutrition is the goal. Additionally, the combination of nutrition with food security is important because it aids in the creation of programs and policies which are vital to address and eradicate extreme poverty and hunger in the world to achieve Zero Hunger 2030. These links between adequate access and availability to food and nutrition security are crucial conceptually and linguistically, particularly at the household and individual levels.

2.2.14 2009: Rome Declaration on World Food Security

During the World Summit on Food Security in Rome in 2009, world leaders, including representatives of the European Community, unanimously endorsed a statement reaffirming their commitment to eradicating hunger in the world. The nations vowed to take all steps necessary at local, regional, and international levels, as well as by all states and governments, to stop the spread of undernourishment, lack of access to adequate food and its availability, and hunger as soon as possible. The countries pledged to intensify their efforts to achieve the

2015 MGD 1 and the goals of the World Food Summit on Food Security (WSFS) (FAO 2009: 1). The CFS (2009: para. 2 line 3) stated that nations had agreed to act as soon as was feasible to eradicate hunger. Over one billion people were estimated to be living in poverty and starvation, a shameful tarnish on the lives, livelihoods, and dignity of one-sixth of the world's population. Among other things, the impacts of long-term underinvestment in farming, food security, and development in rural communities had been worsened by the ongoing financial, food, and economic crises. Even though progress had been achieved, the MDGs and World Food Summit goal had not yet been fully realised. The nations sought to reverse the trend swiftly. They put the globe on a course towards increasingly realizing the right of people to an acceptable standard of living within the framework of national food security. Reinforcing international coordination and stewardship for food security through the Global Partnership for Agriculture, Food Security, and Nutrition, of which the CFS was a key component, had been sparked by a heightened sense of urgency and a dedication to addressing the global food crisis. Improving global stewardship, capitalising on current institutions, and promoting productive collaborations were crucial. It was seen as essential that global action be taken to reduce the number of people who suffered from hunger and malnutrition by half by 2015 through MDG 1 and the 1996 World Food Summit goal.

The Global Partnership for Agriculture, Food Security and Nutrition pooled its resources to improve cooperation and governance and overall coordination at the regional, national, and international levels and ensure that regional and national aspirations were properly articulated and considered. A commitment was made to fully execute the CFS reform, which comprised mainly, among other things, of a global platform for cooperation amongst committed partners. One of the keyways to develop the global partnership for agriculture, food security, and nutrition was through cooperating as a team (FAO 2021: para. 3 line 4).

There had to be a shift in domestic and international funding for agriculture, food security and rural development in developing countries. The challenges ranged from climate change to food security, including the need for adaptation, increase in agriculture and increased resilience on the part of the agricultural producers, with particular attention to small agricultural producers and vulnerable populations. The promotion of new investment could

have increased sustainability in agricultural manufacturing and effectiveness, reduced poverty, and contributed to the goal of ensuring adequate access to and availability of food for everyone (WB 2023: para. 1 line 2).

2.2.15 2012: RIO+20 - Zero Hunger Challenge

The RIO+20 – Zero Challenge was launched on 22 June 2012 at the UN Conference on Sustainable Development in Rio de Janeiro, Brazil (UNs 2012: para. 2 line 2). The UN Secretary-General launched the Zero Hunger Challenge, backed by the IFAD, UNICEF, WB, FAO, Biodiversity International, and WFP. Rio+20 was attended by more than 40,000 individuals, including governments and heads of state, mayors, influential members of industry, lawmakers, UN representatives, and civil society. To mobilise political commitment, the Zero Hunger Challenge first had to end hunger. It aimed to develop new laws and regulations to fight poverty, improve social justice, and save the environment. The five main goals of the Zero Hunger Challenge are to end all hunger, boost the efficiency and income of smallholders, especially women, eliminate malnutrition in early childhood and pregnancy, ensure that everyone has access to enough food throughout the year, eliminate food waste, and make all food systems sustainable (UNs 2012: para. 3 line 3; FAO 2012: para. 2 line 3).

To achieve adequate access to and availability of food, promote sustainable farming, and end hunger by 2030, the Zero Hunger initiative was designed to address the importance of food security and nutrition within the broader development agenda. The “Zero Hunger” target emphasis seeks to “eradicate all kinds of malnutrition” (SDG Target 2.2), in addition to “ensuring access by all people to safe, nutritious, and adequate food all year round” (SDG Target 2.1) (FAO, IFAD and UNICEF 2019: para. 2 line 1). Ki-moon (2002) added to the objective by stating that the Zero Hunger challenges focused on ensuring every person has access to sufficient nourishment. No one should be hungry in a world of abundance. A world without hunger would lessen poverty, build reliable food systems, protect the environment, and foster economic development. It would promote peace and stability.

2.2.16 2012: Food Assistance Convention (FAC)

An international agreement called the Food Assistance Convention was approved on April 25, 2012, in London. The convention sought to meet the dietary requirements of the most vulnerable groups. The 1999 Food Aid Convention, the only international agreement mandating parties to give a minimum level of food aid, was to be replaced by this agreement. It meant, symbolically, a donor commitment to fight hunger worldwide. The FAC was drafted in a conclave in December by officials responsible for food aid from Australia, the US, Switzerland, Japan, Argentina, and the EU and was presided over by Canada. This was after numerous renegotiations during the heated debate on food aid in the Doha Development Round (DDR). Instead of assuming the agreement to be a done deal, it was hoped that a more thorough and open discussion would occur.

The 1999 Food Aid Convention's provision to make adequate quantities of food aid readily accessible was the first concern. The second concern was tackling the dietary and nutritional requirements of the most vulnerable populations by agreeing to offer food aid that increased access to, utilisation of, and availability of safe, appropriate, and nutritious food. The third concern was that the monetary amount of the pledges should increase rather than decrease when world prices rose for the food aid provided under the new FAC to impact the lives of those most in need. Food assistance donations from FAC donors plunged to a 50-year low during the 2007-2008 food price surge, forcing organisations to hustle to keep emergency rations and school feeding programs intact. Minimum obligations, whether in kind or money, under the Convention were to be decided upon and disclosed afterwards rather than included in the agreement as was the case beforehand. The fourth concern was a divergence from the proposed DDR standards of the World Trade Organization in the specific language of the agreement, which prevented food aid from affecting local markets or trade (Clay 2012: para. 2 line 1); UN 2012, UNs 2012: para. 1 line 1; The MDGs Report 2012 Page number).

2.2.17 2014: The Second International Conference on Nutrition (ICN2)

The ICN2, convened jointly by the WHO and FAO, took place from November 19 to November 21, 2014, at the FAO headquarters in Rome, Italy "The ICN2: Implications for ...". ICN2 was a high-level international gathering focusing on addressing malnutrition in all its manifestations worldwide, including micronutrient deficiencies, undernutrition, overweight, and obesity. It

did this because it recognised that global issues demand global solutions. In particular, the ICN2 was organised to tackle the ongoing and intolerably high levels of malnutrition. To tackle the complicated problem of malnutrition through a multi-sectoral strategy, the ICN2 gathered national policymakers from farming, social protection, education, food, health, and other relevant sectors. Despite significant advancements in the fight against hunger, over two billion people still suffer from different micronutrient deficiencies, 795 million people worldwide still lack adequate nutrition, and an estimated 161 million children under the age of five continue to be wasted, stunted, and below normal weight. Additionally, more than 600 million individuals are obese (FAO 2017: vii).

The Framework for Action (FFA) and the Rome Declaration on Nutrition are the two documents that were created because of ICN2. With a political declaration of ten promises for more coordinated action and efficiency to enhance nutrition, participating states and committed world leaders adopted it at the conference. The goal of the first document was to create national policies that would work to abolish all types of malnutrition and restructure the food system so that everyone could have access to a healthy diet. The second document was the FFA, a voluntary technical manual that contained 60 suggestions for carrying out the political pledges.

2.2.18 2015: Milan Declaration on Enhancing Food Security and Climate Adaptation in the Small Island Developing States (SIDS)

On October 14 to 17, 2015, the Ministers, and representatives of the SIDS gathered in Milan, Italy. The gathering included stakeholders from non-SIDS countries, civil society, the UN system, the commercial sector, regional organisations, and other important partners, all contributing insightful observations. Increasing Food Security and Climate Adaptation in SIDS was the topic for the ministerial gathering. “Feeding the Planet Energy for Life” was the theme of the Expo. The meeting covered food security and nutrition from various perspectives, including the significance of supporting sustainable agricultural and farming practices and combating catastrophe and climate resilience. The advantages were enhancing smallholders' and family farmers’ rural livelihoods, particularly those of young people and women; the relationship between issues about adequate access to food and its availability; nutrition and

health emphasising non-communicable illnesses; and the necessity of ensuring food availability and the reliance on global trade. Collaborations play a vital role in advancing adequate access and availability of food and nutrition. To achieve the objective of total well-being for SIDS people and communities, advancements in SIDS nutrition, adequate food access and availability, and health are required (FAO 2017b: para. 3 line 2).

The UN Standing Committee on Nutrition (UNSCN) was a new strategic plan, which served as a dedicated forum for candid, in-depth, and helpful discussion on nutrition issues within UN agencies, and assisted SIDS as well. The SIDS Accelerated Modalities of Action (SAMOA) Pathway set out the goals that SIDS had agreed upon for the 2030 Agenda. The SAMOA Pathway recognised the efforts being made to carry out international commitments for the sustainable development of SIDS while highlighting the need for a more comprehensive strategy, as exemplified by the 2030 Agenda for Sustainable Development. To confront the ongoing development problems faced by SIDS and to fulfil globally agreed-upon objectives, it called for enhanced international collaboration and partnerships, with appropriate provision and mobilisation of all means of execution. This included assisting SIDS in their efforts to eradicate hunger in all its manifestations, particularly by ensuring year-round access to nutritious, adequate, reasonably priced, secure, and variety-rich food. Establishing a 10- year timeframe with aims and initiatives for the period of 2015 to 2025 would stop the spread and severity of non-communicable diseases (NCDs); encouraging the continued use of sustainable forestry, aquaculture, farming, fisheries, and other related practices to increase food and nutrition accessibility and availability. While guaranteeing the sustainable management of the necessary water resources; fostering effective, competitive, open local and international markets to boost the economy and improve nutrition and food security. Mover, enhancing global collaboration could retain access to food markets, especially during increased commodities market volatility, promoting rural employment and income with an emphasis on young people's and women's empowerment among smallholders and small-scale food producers and strengthening fisheries' and farming's resistance to adverse effects of climate change, natural calamities, and ocean acidification. This could be achieved by using worldwide technical collaboration, preserving the ecosystem functions that underpin sustainable agricultural practices. The 2030 Agenda for Sustainable Development was meant to be

implemented in an integrated manner, and it was designed to provide a tangible and meaningful contribution to that process (Acbano and Mascaretti 2016: 4).

2.2.19 2015: UNs Summit on Sustainable Development: Goal 2

From September 25 to 27, 2015, a high-level General Assembly plenary gathering took place at the UN to establish the post-2015 development agenda. The introduction of an additional 17 universal comprehensive and interconnected goals known as the SDGs followed the MDGs. The second of the seventeen defined goals were to eliminate malnutrition, poverty and hunger from the globe by 2030 and to create a solid social inclusivity. The Zero Hunger initiative was decided upon to aid in enhancing nutrition, advancing sustainable farming, eradicating hunger, and achieving adequate access to food and food availability by the year 2023. The accomplishment of many of the targets and indicators for the other 16 goals depends on fulfilling this goal (SDG Target 2.2) (FAO, IFAD and UNICEF 2019: para. 3 line 2).

SDG 2, which calls for establishing food security, advancing sustainable farming, eradicating hunger, and enhancing nutrition by 2023, recognises nutrition and food security as a top goal for the 2023 Agenda. Since food security and nutrition are important for the coordinated implementation of the 2030 Agenda, most of the SDGs include objectives that are either directly or indirectly related to these issues. The UN General Assembly Committee Member of States pledged to observe a Decade of Action on Nutrition in April 2016 after recognising the need to speed up global progress toward SDG2 and the importance of nutrition and adequate access to food and its availability for attaining the 2030 Agenda for Sustainable Development (2016-2025). All this had to be within the confines of the Rome Declaration on Nutrition and FFA 2 and were endorsed as components of the 2030 Agenda and presented at the ICN2 in November 2014. The Decade of Action on Nutrition is an international movement to eradicate malnutrition in all its aspects (UNs 2016c: para. 2 line 1).

After decades of a steady drop in the number of people who experienced hunger, as defined by the prevalence of undernutrition, the numbers of hungry and undernourished people began to increase again in 2015. Nearly 690 million people, which is 8.9% of the world's population, were projected to be undernourished and starving in 2016. In one year, the

number was projected to rise to 10 million, and in five years, to approximately 60 million. The goal of eradicating hunger worldwide by 2030 is not being met. It is predicted that by 2030, 840 million people will suffer from hunger, if current trends continue (IFPRI 2016: 100).

According to the UNs' World Food Program (2020: para. 2 line 1), economic downturns, climate change, and wars caused by humans were the main causes of acute hunger for 135 million people. The COVID-19 pandemic was predicted to double the figure, placing 130 million more people at risk of experiencing acute hunger by the end of 2020. Swift action was required to deliver food and humanitarian aid to the most vulnerable areas since more than a quarter of a billion people were on the verge of hunger. To feed the additional two billion people who would inhabit the planet by 2050, in addition to the more than 690 million people who were already undernourished, a significant transformation in the world's food and agricultural systems was also required. Increasing agricultural output and implementing sustainable food production was seen as essential to lessen the dangers of hunger.

Most African nations did not set the proper priorities while working to achieve SDG 2. According to the Sustainable Development Solutions Network (SDSN) (2019), African countries are still far from experiencing no hunger. The FAO *et al*. (2019) report, which evaluated the Prevalence of Undernourishment (POU) in the population, the prevalence of wasting in under-five-year- olds, and the prevalence of stunting in under-five-year-olds, served as the foundation for the statement. The results below indicated that the number of severely food-insecure people (in millions) in Africa from 2014 to 2018 were 210.7, 226.7, 268.2, 287.5, and 277.0, respectively. Furthermore, from 2014 to 2018, the number of Africans who experienced moderate or severe food insecurity were 554.1, 577.1, 644.1, and 682.0, respectively. Over the years, the number of people with moderate or severe food insecurity has increased steadily, negatively impacting the Zero Hunger goal (Otekunrin *et al.* 2019: 10). According to Johnsen, Buckner, and Ray (2020: 1), achieving this crucial Sustainable Development Goal (SDG) would require audacious actions, significant political commitment, and necessary investments.

2.2.20 2016: The high-level side event on pathways to Zero Hunger

The high-level side event on pathways to Zero Hunger was held on 22 September 2016. The

high-level side event occurred in the UNs Economic and Social Council (EcoSoc). The importance of achieving all the SDGs, especially Zero Hunger by 2030, were one of the most vital topics of discussion at the 71st UNs General Assembly (UNGA). Foreign ministers, Heads of States, and many other significant personalities gathered at the event to address inequality, poverty, and climate change (SDG Target 2.2), and SDGs, which were endorsed by well-known leaders in 2015 (FAO *et al.* 2019: para. 2 line 1).

UNs Secretary-General Ban Ki-moon summed up the SDGs and Zero Hunger agendas by stating that "with the 2030 agenda, we have the opportunity to silence once and for all, the cry of hunger and malnutrition". The Secretary-General later asked world leaders and agricultural organisations to take up the challenge and work together until Zero Hunger became a reality. Following the Secretary-General's speech, Ambassador Peter Thomson, President of the 71st UNGA, Mr. President John Dramani Mahama of Ghana, and President Faure Gnassingbe of Togo also made remarks regarding the SDGs and asked for more resources and leadership initiatives to achieve the Zero-Hunger goal by 2030.

Another topic discussed at the high-level UNGA side event was "Leaving No One Behind", which advocated for the fifth SDG: Gender Equality. Achieving gender equality and the empowerment of women and young girls is one element that every panellist advocated strongly for and there was strong support to end issues like child marriage and violence against women and young girls, as well as social, political, and economic inequalities.

2.2.21 2016 -2025: Nutrition Decade of Action by the UNs

A UNs General Assembly decision established the 2016-2025 Nutrition Decade of Action. In coordination with the WFP, the FAO (2016: para. 4 line 1) highlighted that the IFAD, and the UNICEF's calls were made for the WHO and FAO to take the lead in implementing the UNs Decade of Action on Nutrition (2016-2025). The different agencies identified and formulated a work program based on the Rome Declaration and its FFA (IFPRI 2016: 80). The UNs Member States agreed to implement programs, policies, and increased funding over ten years to eradicate malnutrition in all its forms worldwide, leaving no one behind. This commitment is known as the "Decade of Action on Nutrition (2016-2025)" or more simply the "Nutrition

Decade" (IFPRI 2016: 108).

The 2019-2028 UN Decade of Family Farming seeks to redefine what it means to be a family farmer in a changing world. This initiative emphasises the crucial part small-scale farmers play in determining the direction of agriculture and alleviating hunger. Due to their knowledge and concern for the environment, family farming has the unique prospect of providing adequate food access and availability while preserving the environment, enhancing livelihoods, achieving sustainable development, and better managing natural resources, particularly in rural regions. Family farmers are the change-makers needed to accomplish SDG 2: Zero Hunger, and a more stable and resilient environment (Brady and Pierri 2020: 127).

2.2.22 2019: COVID-19: Food security policy briefs

According to Reid (2022: para. 2 line 1), the COVID-19 family of viruses, including the coronavirus, could cause various illnesses, including severe acute respiratory syndrome and the common cold. The respiratory symptoms of COVID-19, which range from moderate to severe, include shortness of breath, fever, and coughing. It is mostly spread by direct contact between individuals via respiratory droplets released into the air when an infected person talks, coughs, or sneezes. COVID-19 infected more than 117 million individuals worldwide between 2019 and 2021 and claimed the lives of more than 2.6 million people.

On the one hand, the world was struggling with an epidemic of obesity, but on the other hand, many were struggling with insufficient food to consume to meet the required dietary intake because of climate change, strife, and war, and, most recently, also the financial and health-related ramifications of a pandemic. The Global Hunger Index (GHI) (2020: paragraph 2 line 1) predicted that hunger would increase because of the COVID-19 pandemic, the economic downturn, and the massive outbreak of desert locusts that decimated crops in the Horn of Africa. All these aspects aggravated food and nutrition insecurity for millions of people. COVID-19 has negatively affected food systems, which makes it almost impossible to achieve Zero Hunger by 2030.

The COVID-19 epidemic has put a generation of children's futures in danger and has the

potential to overturn decades of progress made in the fight against wealth inequality and poverty. World Vision strived to assist at least 72 million people, half of whom were children and was actively working in all programs and development sectors to protect all children from illness. World Vision has assisted more than 26.3 million children and roughly 59.5 million individuals. Around the world, the distribution of COVID-19 vaccinations sparked optimism for a turnaround. The potential of these vaccinations to save lives globally and allow the world to resume its normal practices gave hope to millions. Safe vaccines were formulated and distributed worldwide to safeguard the world's most helpless citizens and to restore hope and normality to life (Reid 2022: para. 2 line 1).

The COVID-19 pandemic's consequences affected human welfare, food security, and nutrition for millions of people worldwide. Before the virus struck, hundreds of millions of people were already malnourished and starving. Without widespread coordinated action, the long-term repercussions of COVID-19, and the impending global recession could undermine the effective operation of food systems. Such a disturbance may have a far-reaching effect on nutrition and health that has not been witnessed in more than 50 years.

The projection was at odds with SDG Hub for Goal 2: enhance food security, support sustainable agriculture, end hunger, and boost nutrition, which is part of the Zero Hunger 2030 initiative. The WFP (2020: para. 2 line 1), Anthem (2020: para. 3 line 4), and the UNs Academic Impact (UNAI) (2019) all supported the claims. All parties agreed that there was a dire need to transform the world's food and agricultural systems to feed the 800 million starving people, as an additional 2 billion by 2030 was anticipated. Acute hunger is a problem for around 135 million people, and with the COVID-19 pandemic crise the figure will double. Acute hunger is currently a problem in 55 nations. The numbers give a stunning look into the virus's capacity for destruction. The virus threatens lives and livelihoods as well as the trading network that people depend on for existence, causing the greatest concern in Africa and the Middle East.

According to Mark *et al*. (2020), public health gained more prominence in 2020 than at any other time in recent memory, yet even before COVID-19, the world was already experiencing

a far more subdued pandemic: hunger. Malnutrition affects an astonishing number of individuals. Forty-five percent of all child fatalities had undernutrition as a direct or contributing factor, with an estimated 149 million children suffering from chronic undernutrition and 50 million suffering from acute undernutrition worldwide. Ironically, 678 million people worldwide are classed as obese (Black *et al*. 2013; Micha *et al*. 2020 Page number.). Poverty is one of the root causes of malnutrition, according to Cullinan (2020: para. 2 line 2). However, while poverty does not cause malnutrition, it significantly impacts the groups that are most at risk of lacking access to enough nourishing food.

It was estimated that the COVID-19 pandemic resulted in an additional 88 million to 115 million people experiencing extreme poverty in 2020 and in 2021, and the total might rise to 150 million depending on the severity of the economic contraction (WB 2020: para. 2 line 1). The above situation might be categorised as "chronic hunger" by Tumushabe (2018: 853). Chronic hunger, according to Tumushabe (2018: 853), is when a person does not obtain enough energy from meals to sustain an active and regular lifestyle over an extended length of time. It is often quantified in children as height for age and in adults as insufficient kilojoule intake. It is typically associated with poverty in the most vulnerable and underprivileged communities. More than 300 million people in Africa experience chronic hunger, with roughly 235 million of those people living in Sub-Saharan Africa (SSA).

By emphasising that the continuing COVID-19 pandemic was expected to drastically lower SSA's GDP per capita growth in 2020 by five percentage points compared to pre-pandemic projections, Montes *et al*. (2020) reinforces these statistics. These results represent an examination of an extensive database of surveys from 45 of the 48 SSA nations that looked at how the project's retarded growth affected poverty in the area. SSA might have up to 58 million people living in extreme poverty, which is determined by the international poverty level of $1.90 per day in 2011 PPP. The region's effort to reduce poverty will be delayed by five years as the poverty rate in SSA is anticipated to rise by more than two percentage points (The WB 2020b: para. 2 line 1).

Johnsen, Buckner and Ray (2020: 1) used the Global Nutrition Report (GNR) 2020 to relate the

importance of nutrition in the health and well-being of people, especially in light of the recent world pandemic COVID-19 which tested food and health systems, and the agricultural and food supply chains which were affected by the required controls to stop the disease's spread. Suppose politicians, nations, governments, and other stakeholders did not take immediate remedial action. In that case, the long-term effects of nutrition and food security, and the livelihoods of fishermen, farmers, and other food supply chain workers will be incalculable. Additionally, the impact will be felt more keenly in nations grappling with multiple crises, "hotspots" of food insecurity, including conflict-affected and disadvantaged areas, those experiencing considerable currency depreciation, and vulnerable and marginalised populations (Micha *et al*. 2020; The WB 2020b: para. 2 line 1).

As suggested above, the WFP (2020: paragraph 1 line 1) predicted that 265 million people, an increase from the anticipated figure of 135 million individuals before the pandemic, could experience a lack of access to food and its availability by the end of 2020. Although the COVID-19 pandemic presented significant obstacles to short-term adequate food access and food availability, it offered a rare opportunity to modify the farming industry in the long term in order to create stable food processes that can withstand other challenges such as climate change in the future (Anthem 2020: para. 2 line 3).

The worldwide COVID-19 pandemic has compounded the inadequacies and vulnerabilities of global food systems. As a result, according to projections, there would be 262 million people suffering from severe food insecurity by 2020, up from 135 million in 2019. In the four years before the pandemic, severe lack of access to food and its unavailability rose to 70%. Now the economic repercussions of pandemic-related job losses in cities, and in low- and middle-income countries (LMICs), and a decrease in the amount of money sent home by relatives working in wealthier countries have exacerbated an already dire situation. In Central and West Africa, food insecurity has increased by 90%. The COVID-19 pandemic has also shown a regional and systematic disparity in access to essential services for individuals residing in nations where systems were already compromised by climatic disasters, conflicts, and persistent poverty (Bridget and Kuehn 2020: 1489; World Food Program of the UNs 2020: para. 2 line 3).

According to Heady (2013: paragraph 3 line 1), Mark *et al*. (2020), and Webb *et al*. (2018: 361), if nothing is done, an additional 140 million people would be living in severe poverty due to COVID-19. It was predicted that by the end of 2020, that total number of people residing in LMICs who experience severe food insecurity would have doubled to 265 million. Obesity is more common among the impoverished population in many high- and middle-income nations, in part due to the accessibility and affordability of low-quality food in vulnerable areas. Inequalities were highlighted and exacerbated by the disproportionate burden of COVID-19 infections, hospital admissions, and deaths experienced by low-income people from ethnic minorities (Marmot and Bell 2019; Ali, Asaria and Stranges 2020). Interventions were seen as being crucial to helping those affected by food problems, especially during the COVID-19 epidemic, and the focus should be on children and mothers who are still fertile (Fore *et al*. 2020).

Ørstavik (2020: para. 2 line 3) validated that the world is aware of the challenging dynamics of the global food crisis, especially from 2020 on because of the COVID-19 pandemic that resulted in the protectionism, financial catastrophe, and lockdowns. Furthermore, it was estimated that another six to seven million children could experience malnutrition as a direct result of the pandemic, meaning that Zero Hunger by 2030 may not be realised. Making matters worse, the pandemic triggered an emergency that consumed funds that would have otherwise been allocated to long-term initiatives focused on education, nutrition, and health (Mark *et al*. 2020). From 2019 when the pandemic started to 2020, the COVID-19 caused the world's hunger status to reach the "acute hunger" stage, affecting a total estimated number of 270 million people worldwide, an increase of 82% in less than two years (Bridget and Kuehn 2020: 1489; The FAO 2020a: 31).

2.3 THE BACKGROUND TO FOOD AND NUTRITION INSECURITY IN RELATION TO POVERTY, HUNGER AND STARVATION

Although food security is essential to ensure adequate nutrition and prevent hunger, the concepts of food security, optimal nutrition, and lack of hunger and undernutrition are interlinked but not synonymous. Figure 4 illustrates the distinctions and overlaps between

hunger, food insecurity, nutrition insecurity and undernutrition. The literature discussed below further explains the relationship between the long-lasting coexisting relationship between the different demission of food and nutrition insecurity.

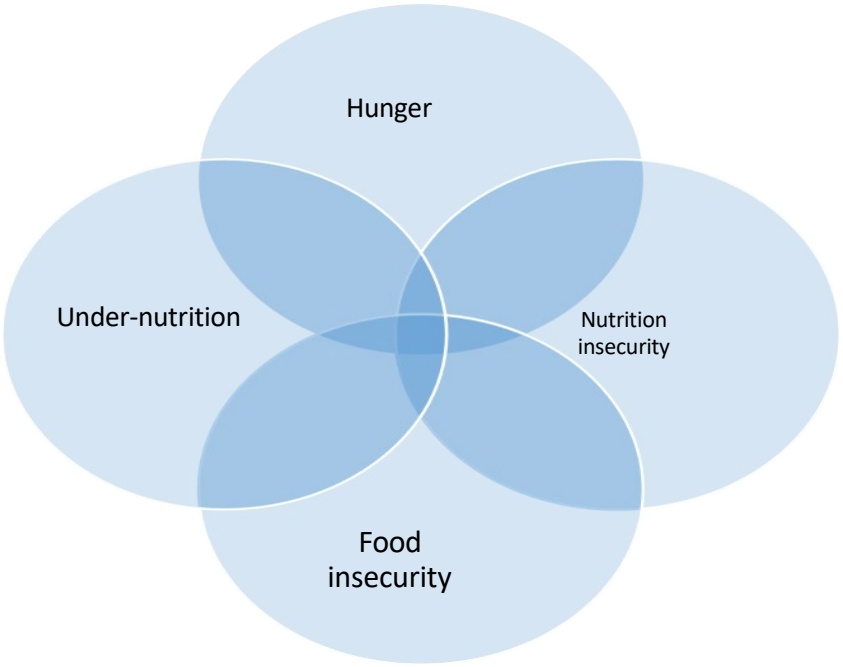


Figure 4: Distinctions and overlaps between hunger, food insecurity, nutrition insecurity and undernutrition Source: (Benson 2004: 13). Reproduced with permission from the IFPRI

Poverty is the primary reason for starvation. Poverty is linked to inadequate national monetary performance, an inadequate revenue delivery and poor governmental structures that render poor individuals powerless in either a democratic system or dictatorship. Restrictive economic systems increase food volatility and food prices, making the cost of food a constant concern for poor people in developing nations because the majority of them spend over 50% of their income on food. Other contributing factors to hunger led by poverty are family food insecurity, unsuitable maintenance of practices, hazardous settings that have little admission to clean water, hygiene, and sanitation, and insufficient admission or accessibility to health amenities and education (IMF 2008: 8; Cohen and Reeves 1995: para. 2 line 3; UN 2023d: para. 1 line 2).

In support of the above explanation, Concern Worldwide (2020: para. 2 line 1) stated that the major reasons for global poverty are: discrimination and demotion, conflict, malnutrition,

starvation and poor healthcare schemes (particularly for females and children), limited access to clean water, lack of sanitation, exposure to climate change, lack of education, poor municipal performance, lack of employment opportunities, absence of government support and lack of capital. Heady (2013: para. 2 line 1), Barrett and Lentz (2016: 602), Smith and Haddad (2015: 180), Otekunrin *et al.* (2019: 2) further support the above explanation by indicating that the main reasons for starvation in Africa are poverty, severe pre- and post-harvest losses triggered by pests and disease, population growth, unemployment, dangerous climate circumstances, exaltation, conflict and insurrections. Earlier research has also indicated links between exploitation, extreme poverty, slow progress, and struggles with starvation and malnutrition (Otekunrin *et al.* 2020: 98).

Peer (2020: para. 1 line 2) and the WB (2020a: para. 2 line 3) estimated that in 2020 global poverty was at 9.2%, meaning 689 million individuals lived in poverty on $1.90 or less a day. In the US, 11.8% of the populace, meaning 38.1 million people, lived in poverty with a salary of $33.26 per day or less. Four out of five people lived below the poverty line in rural regions in 2018. Almost one-third of the population in emerging nations were poor, with 70 to 80% from SSA. Nearly half of underprivileged people in SSA are found in five countries: Nigeria, the Democratic Republic of Congo, Tanzania, Ethiopia, and Madagascar.

Anderson (1990: 1559) defined hunger as “the uneasy or painful sensation caused by a lack of food; the recurrent and involuntary lack of food.” WFP (2013: para. 2 line 3) and Cullinan (2020: para. 2 line 2) elaborated further by explaining that hunger is the word used to describe times when people are going through extreme food insecurity, which indicates that people spend a whole day not eating because of the absence of money, and absence of access to food. World hunger means hunger that has advanced to the universal stage. Global hunger is caused by the following challenges: poverty, climate change, failing economy, poor public policies, war and conflict, forced migration, poor nutrition, food shortage and food waste (Concern Worldwide 2023: para. 3 line 1). Cohen and Reeves (1995: para. 2 line 1) clarified hunger as a complex social problem that negatively affects societies. Furthermore, the FAO *et al*. (2019: 26) explained hunger as not consuming enough nutritious foods to maintain a healthy and active life.

Kent (2019: 5) believed that nations have yet to do much more deliberation about the core causes of hunger and have yet to implement mechanisms to end hunger in the world. Individuals with the expertise to resolve starvation difficulties are not distressed from starvation, so they cannot recognise the three fundamental origins of continuing and rising world hunger: one "Disjunction" of starvation and poverty; two "Compassion" for the helpless, feeble and most defenceless people from the people who have the power to support them; three "Material interests" is when the poor work hard to feed the rich because they are helpless and at the mercy of the people in power.

The author of the current research concurs with the above declaration by indicating a global gap between the rich and the poor. The disparity cannot be separated from the causes of the accumulating high levels of starvation globally, particularly in Africa (Kent 2016: para. 3 line 1; Roser 2016: para. 1 line 1; Kent 2019: 7; Luhby 2019: para. 2 line 1; Matthews 2019: para. 2 line 3). This statement is based on the following results, as in the total number of undernourished people in Africa from 2005 to 2019 was 192.6, 196.1, 216.9, 224.9, 231.7, 236.8, and 250.3 people, respectively. The results indicate that there has yet to be a reduction in or progress on ending hunger in Africa. The World Vision (2023: para. 1 line 1) further highlighted the above statement by emphasising that 50 million people in 45 countries have been confronted by hunger and starvation because of local disputes, increasing cost of living, extreme climate change and the COVID-19 pandemic.

Otekunrin *et al.* (2020: 88) pointed out that malnutrition deficiency were considered as the main reasons for hunger. Starvation might be seen in terms of three categories common to the African continent, and these were severe, lasting, and concealed starvation. Behera, Rout and Behera (2019: 1) defined acute hunger as the most extreme form of hunger. Countries that were faced with political instability suffered from a declining economy, which in turn reduced the worth of the nation's money. As a result, there were inflated food costs and less nourishing foods available to buy. To make matters worse, unemployment also contributed to the deteriorating economy, impacting society's capacity to have enough money to buy food. Nations such as the Democratic Republic of Congo, South Sudan, Yemen and Venezuela

are examples of nations where governmental uncertainty has disturbed food security (FAO, WFP and EU 2018: para. 1 line 4).

The FAO *et al*. (2020: 10) explained that starvation was prevalent in the majority of sub-regions of Africa, with "POU" measured as the portion of the population whose caloric intake is insufficient. POU is the key pointer for observing growth in eliminating starvation in the world. The FAO *et al*. (2020: 10) further highlighted that the POU in Africa increased from 192.6 million in 2005 to 250.3 million in 2019 and is expected to increase to 433.2 million by 2030. East and West Africa have experienced burgeoning numbers of starving people, increasing from 95 million to 117.9 million and 36.9 million to 117.9 million in 2005 and 2019 respectively.

Behera, Rout and Behera (2019: para. 4 line 1), Food Security Information Network (FSIN) (2020: para. 2 line 1) and Global Report on Food Crises (GRFC) (2020: para. 1 line 3) explained that in Africa, five nations were experiencing severe starvation which included DRC, Ethiopia, Nigeria (northern region), South Sudan and Sudan. Other countries apart from Africa were Haiti, the Syrian Arab Republic, Venezuela, Afghanistan, and Yemen. Severe starvation might be activated by famine, conflicts and tragedies.

Oyekanmi (2021: para. 6 line 1) listed the most recent top ten "hungriest" countries. Oyekanmi (2021: para. 6 line 2) highlighted that at number ten, in Nigeria, the hunger crisis was brought about by inequality and recent violence in the country. At number nine was Afghanistan, which experienced the El Niño drought in 2019. Hunger was predicted to increase in Afghanistan because of climate change and the ongoing conflict. At number eight was Lesotho with EL Nino droughts in 2019, which left over 30% of the nation's populace confronted with severe stages of food insecurity that were predicted to distress people until March 2020. This situation was a continuation of centuries of harvest disappointments, together with an increase in poor climate that left 41% of rural Basotho people spending more than half of their salary on food. The influence of COVID- 19, which reached the nation in May 2020, was projected to have a severe effect on monetary constancy and food security. Lastly, the longstanding effects of climate change will probably continue to affect an additional 70%

of the nation’s people, who rely on subsistence farming for their food and income.

At number seven was Sierra Leone, with 26% of the nation's population still facing long- lasting starvation and trying to recover from the economic and personal losses of the 2014 to 2016 Ebola epidemic, with added trials from school and commercial closure to restraint of the blowout of COVID-19. At number six was Liberia, a country that had faced hunger from 2019; nonetheless, its food insecurity goes back to its 1989-2003 civil war when approximately 16% of Liberian people were left food insecure. The nation was not affected as harshly by the COVID-19 pandemic as by the 2014 to 2016 Ebola epidemic. However, the problem of border posts being closed due to the Covid-19 lockdown affected the economy significantly and threatened to increase hunger in many more families (Oyekanmi 2021: para. 11 line 2).

The top five were: Mozambique at number five with increased stages of food insecurity; this was a concern since, in 2015, the nation reached its MDG of decreasing the quantity of food-insecure Mozambicans by half, but now there were 32.6% of undernourished individuals, indicating that nearly one-third of Mozambicans were experiencing long-lasting starvation. Haiti was at number four, with the biggest stage of starvation in the western part. The island population was affected by a mixture of governmental uncertainty and natural tragedies, including the continuing effects of the nation’s 2010 earthquake and Hurricane Matthew in 2016. In 2019, 2.6 million Haitians were food insecure. A year later, this increased to 3.7 million, including 1 million in a single state categorised as being in an emergency situation since the nation’s disaster. At number three was Madagascar, which has been described as experiencing a stage of severe food insecurity, with one of the repercussions being a disturbing uptick in malnutrition levels, from 30% in 2009-11 to approximately 42% in 2017-19. The political uncertainty and severe climate change have left almost half of the nation's regions categorised as being at the disaster-stage of food insecurity (Oyekanmi 2021: para. 14 line 2).

At number two was Timor-Leste, with one-third, meaning 1.2 million of its population, suffering from chronic food insecurity. Many reasons have caused the persistent food insecurity in this nation: decreased agricultural productivity, the nation's utilisation of staple

food was also insufficient in both value and quantity, and many individuals have relied on single low-value livelihoods. Moreover, other contributing factors were inadequate infrastructure for water supply, hygiene, and sanitation, which caused a high percentage of waterborne illnesses that could inhibit individuals (particularly children) from absorbing nutrients. At number one was Chad, with ongoing climate change affecting the nation that has increased prevalent food insecurity, and which has been intensified by an influx of immigrants from conflict-torn countries such as Nigeria, Sudan, and the Central African Republic, all of whom required emergency food support (Oyekanmi 2021: para. 16 line 2).

On the one hand, in 2019, 8.9% of the global populace experienced starvation, and nearly two billion did not have access to reliable, adequate, healthy food. Furthermore, 1 billion individuals lived in Asia, 675 million resided in Africa, and 205 million lived in Latin America (FAO, IFAD and UNICEF 2019: para. 2 line 1). On the other hand, in 2020, more than six billion individuals were not starving compared to two billion 50 years previously. In spite of these accomplishments, more than 820 million individuals globally are still starving, and a minimum of two billion lack adequate nutrients (FAO 2017a: para. 1 line 2; Fanzo *et al.* 2018: para. 2 line 1); Haddad *et al.* 2015: 663).

Hunger was believed to have increased throughout the world due to food deficiencies triggered by an increase in the population explosion expansion (Kent 2019: 7). Venkatramanan, Shah and Prasad (2020: para. 2 line 1) disagreed with this statement by stating that irrespective of issues such as population increase, urbanisation, land shortage and related costs, global food crop production and manufacturing has been tripled in the past 50 years, respectively. According to Evenson and Rosegrant (2003: 473), the GR has been one of the contributors to the world being able to produce enough food. The GR created an increase in global food supplies and a decrease in food costs, and without the GR, world food prices would have been 35 to 65% higher in 2020 (Evenson and Rosegrant 2003: 473).

Even though the world manufacturers adequate food to feed all its 7.5 billion inhabitants, one in nine people still goes hungry every day. Cohen and Reeves (1995: para. 1 line 2) have stated that the persistence of hunger in a world of abundance was the most philosophical moral

contradiction of today's world. Since the mid-1970s, the world has produced sufficient food to provide a minimally adequate diet for everyone. Cullinan (2020: para. 1 line 3) agreed with these sentiments by emphasising that the world was indeed manufacturing sufficient food to supply the worldwide population; however, more than 690 million individuals were starving in 2020. From 2018 to 2019, the sum of malnourished individuals rose by 10 million and there were approximately 60 million more malnourished individuals than in 2014. Almost 800 million individuals came from developing countries, which accounted for 20% of the global population of chronically malnourished people.

This research has established that world hunger is an escalating problem even after more than 75 years of the UN's efforts to end hunger. The world has struggled to eradicate global hunger because there has been an increase of 82% of hungry people globally from 2019 to 2020. World hunger escalated to "acute hunger" because an estimated 270 million people globally were affected by hunger on a daily basis (Bridget and Kuehn 2020: 1489; WFP of the UN 2020: para. 1 line 3).

Hasnain, Ingram and Zurek (2020: 12) supported the efforts put into place by the UN, by highlighting that the greatest human accomplishments in the past half-century worldwide were improving food manufacturing and mainly keeping pace with the global demand (Otekunrin *et al*. 2020: 87). Cullinan (2020: para. 4 line 1) pointed out that providing food for more than 7 billion people worldwide took a lot of work.

Hunger is interconnected with poverty, and both exist in a vicious cycle. Over 1 billion people go hungry every day because of a lack of buying power and access to resources. Reid (2022: para. 3 line 2) revealed that the number of hungry people in Africa continued to increase dramatically, and in 2020 one in five people in Africa faced hunger due to conflict, climate change, and economic downturn because of the COVID-19 pandemic. One-third of the continent's people were undernourished, meaning that 282 million people in Africa were faced with hunger which was double the percentage of people in other regions in the world. Moreover, in East Africa, 7.2 million people were at risk of hunger, 26.5 million were battling acute food insecurity, and 12.8 million children were suffering from acute malnutrition.

2.4 SUSTAINABLE NUTRITION- SENSITIVE AGRICULTURE (NSA) FRAMEWORK IN ADDRESSING FOOD AND NUTRITION INSECURITY

Nutrition has captured global attention and has remained a featured agenda item for most development partners. Several international initiatives, multi-stakeholder processes and commitments have added fuel to the fire, including Scaling Up Nutrition (SUN) Movement (2009), the Global Nutrition for Growth Compact (2013), the UNs Secretary-General's Zero Hunger Challenge (2012: para. 1 line 1), the WHO (2014: para. 2 line 2), Lartey (2015: para. 1 line 1) and UN (2015: para. 4 line 1). Balz, Heil and Jordan (2015: 5) highlighted that the ICN2 (WHO 2014: para.2 line 2) in November 2014 was conducted to review the progress made regarding nutrition since the 1992 ICN1, and the results were that there was still a significant problem relating to nutrition insecurity. Furthermore, there were also new emerging challenges and opportunities for improving nutrition, such as that the majority of half of the global population was not adequately nourished. Hunger, micronutrient deficiencies, overweight and obesity often exist in parallel in the same country (FAO 2014a: 7). The following flow diagram represents the adapted sustainable NSA toolkit conceptual for the current study. The framework was from the Schematic overview of the food-based approach to address vitamin A deficiency development in SA (Faber and Laurie 2011: 178; High Level Panel of Experts (HLPE) 2017: 26; IPC 2021: 1).

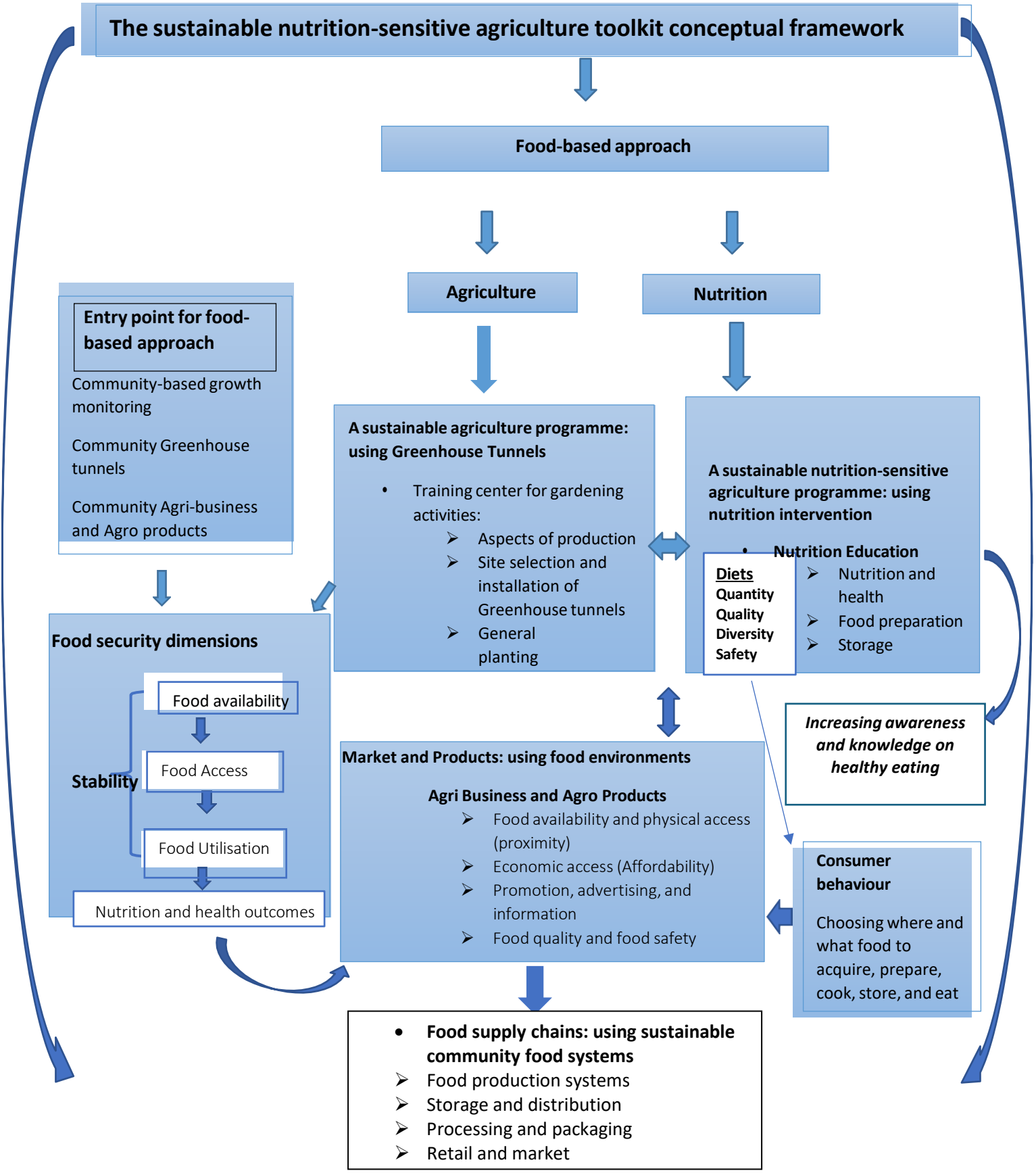


Figure 5: The flow diagram of the adapted sustainable NSA toolkit conceptual Faber and Laurie 2011: 178; High Level Panel of Experts (HLPE) 2017: 26; IPC 2021: 1;)

The ICN2 generated two primary outcome documents: firstly, the high-level political 'Rome Declaration on Nutrition' and secondly, a global policy 'FFA'. This set of policy options and strategies were for governments, acting in cooperation with other stakeholders, to incorporate, as appropriate, into their national nutrition, health, agriculture, development, and investment plans, and negotiate international agreements to achieve better nutrition for all. After the UN evaluated the progress made since the ICN2, new strategies were developed on undernutrition, in 2015, the UN under the SDGs Goal 2 Zero Hunger: to end hunger, achieve food security and improved nutrition and promote sustainable agriculture by 2030. The UN and SDGs introduced the concept NSA as an intervention to reinforce and improve the underlying primary causes of malnutrition presented in the UNICEF conceptual framework (Swan and Wijeratna 2014: para. 2 line 1; UNs 2020: para. 2 line 1). Ballard (2016) supported the above statements by stating that the NSA interventions had the potential to address all underlying causes of undernutrition identified in the framework of UNICEF: household food insecurity, inadequate care practices, lack of access to health services, and unhealthy household environments (UNICEF 1999).

The adapted Figure 5 above and the supporting literature below explain and elaborates on the measures of achieving the aims of NSA. Keding, Schneider and Jordan (2013: 1) emphasised that it was necessary to comprehend the complexity of the factors that influence NSA. NSA requires a trans-disciplinary approach, which includes the three sectors: nutrition and health at research extension, and agriculture. Ensuring that farmers are knowledgeable about production systems that sustainably provide adequate amounts of nutritious food while conserving the environment is essential to NSA. At the same time, for the benefit of NSA to be realised, educated individuals, household members and consumers are required who understand what constitutes a healthy and sustainable diet.

Thompson and Amoroso (2011: 4), FAO (2014b: 28) defined NSA as a food-based approach to agricultural development that focuses on nutritionally rich foods, dietary diversity, and food fortification to address malnutrition and micronutrient deficiencies. This approach stressed the multiple benefits derived from enjoying a variety of foods, recognising the nutritional value of food for good nutrition, and the importance and social significance of the food and

agricultural sector in supporting rural livelihoods. The overall objective of NSA is to make the global food system better equipped to produce good nutrition outcomes. Nordhagen, Thiam and Sow (2019: 1) highlighted that the sustainability of NSA focuses on training and education on nutrition and hygiene for better nutritional status.

Abdulhameed, Food Security Cluster, WFP, FOA and Food basket design and NSA training (2018) further elaborated on the above definitions by explaining NSA as an approach that increases the focus of agriculture activities towards healthy nutrition to address food and nutrition insecurity and all forms of malnutrition by concentrating on sustainably producing food that is highly rich in nutrients, diversified, and fortified through well-structured global food systems. Figure 6 illustrates how NSA can be achieved through agriculture, food, and information about healthy nutrition.

Figure 6: NSA (FAO and Abdulhameed 2018)

NSA can achieve food security and good nutrition by expanding and integrating the Figure 6 concept into Figure 7, as illustrated below. Turner *et al*. (2013: 370) and Jaenicke and Virchow (2013: 679) clarified that NSA was a concept that aims to narrow the gap between the availability and accessibility of food and the food needed for a healthy and balanced diet for all people. Figure 7 explicitly incorporates nutrition into agriculture and addresses the utilisation of the food and nutrition security dimension by including health, education, economic, environmental, and social aspects.

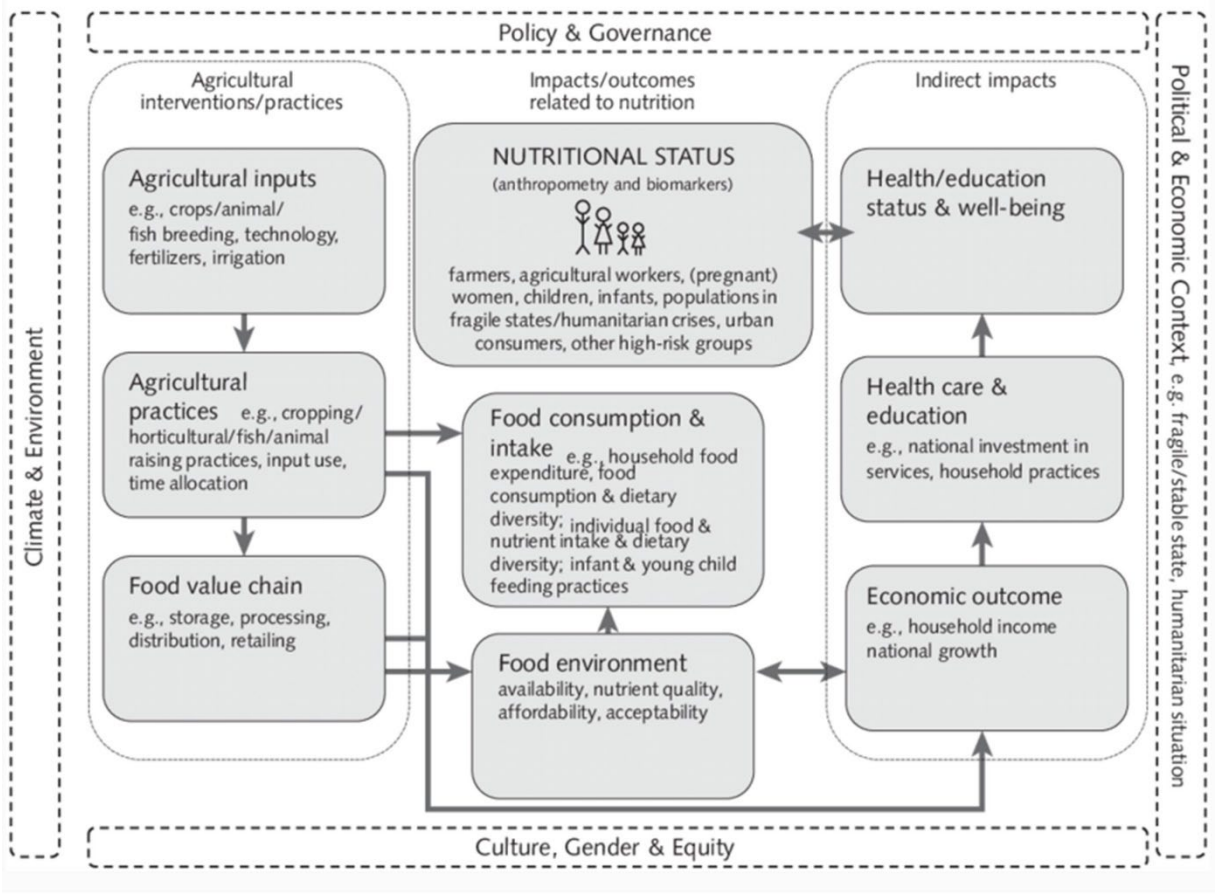


Figure 7: Conceptual framework for research on agriculture for improved nutrition (Turner et al. 2013: 369)

Strengthening Partnership, Results, Innovations and Nutrition Globally (SPRING) (2021) stressed that agriculture is nutrition-sensitive when it addresses the underlying causes of malnutrition through food insecurity, adequate caregiving resources and access to health services and a hygienic environment. Ruel, Quisumbing, and Balagamwala (2018: 129) further explained nutrition-sensitive interventions or programs as those that address the underlying determinants of foetal and child nutrition and the development of food security, adequate caregiving resources at the maternal, household and community levels, and access to health services and a safe and hygienic environment which incorporates specific nutrition goals and actions (Ruel, Alderman and the Maternal and Child Nutrition Study Group 2013: 536).

Moreover, the nature and causes of malnutrition are more complex now, with additional challenges such as the changing demand for agricultural products, climate change and natural resource degradation. In the future, different targets should be defined that include ending

hunger, reducing the multiple burdens of malnutrition, and sustainable agriculture (FAO 2014a: 7; Albrecht 2013: 2). Lartey (2015: para. 1 line 1) and UNs (2015: para. 2 line 1) agree with the above statement by further elaborating on SDG 2: Zero Hunger as creating new paths for nutrition, agriculture, and food systems.

Keding, Schneider and Jordan (2013: 825) explained that some forms of malnutrition are partly due to agriculture not having nutrient outputs as an explicit goal. A better understanding of what is required from agricultural production and food processing for healthy and sustainable diets is needed. Besides nutritional quality or nutrient output, other important factors are water, soil, health hazards, agrobiodiversity, and seasonality. Therefore, possible interactions among constituents of the food chain, human health, the environment, and knowledge and education should be considered from a systemic perspective.

Globally, the need for agriculture to support better nutrition and health has been recognised and this was reflected in the discussions leading up to the UNs' 2030 Agenda for Sustainable Development (UNs 2017: para. 2 line 1). It is reflected in the growing number of initiatives to support countries in integrating nutrition interventions into their agricultural investment plans, as illustrated by the Comprehensive Africa Agriculture Development Program investment plans (Rampa and van Seters 2013). Ruel, Quisumbing, Balagamwala (2018: 128) indicated that countries like Nigeria and Ethiopia, for example, have recently developed nutrition-sensitive agricultural plans, a clear manifestation of the greater political priority given to improving the nutritional impact of investments in the agricultural sector. However, making agriculture more nutrition-sensitive requires a new way of thinking, planning, implementing, and partnering, as well as the active engagement of various stakeholders from multiple sectors. It also requires identifying critical entry points where nutrition goals can be incorporated into agro-food systems.

Ruel, Quisumbing and Balagamwala (2018: 128) elaborated that there was a broad realisation that agricultural interventions would have to become nutrition-sensitive to improve food access and attain global nutrition targets. NSA interventions go beyond the conventional idea of increasing food production by incorporating specific nutrition objectives and actions in the design and implementation of agriculture interventions. One major aspect of NSA

interventions is sustainable agriculture. Dumanski *et al*. (1998: 1) and Purvis, Mao and Robinson (2019: 681) stated that truly sustainable agriculture will not be business as usual. It will be a type of agriculture that will provide environmental, economic, and social opportunities for the benefit of present and future generations, while maintaining and enhancing the quality of the resources that support agricultural production. Figure 8 below illustrates the three dimensions of sustainable output: environmental, economic, and social under sustainable agriculture (SA). sustainable agriculture is at the heart of the 2030 Agenda and the first fundamental step to securing zero hunger. While many of the SDGs address issues related to agriculture, SDG indicator 2.4.1 is fully dedicated to sustainable agriculture (FAO 2023: para. 1 line 1).

Figure 8: Typical representation of sustainable agriculture as three intersecting circles (Mead 2021)

Carlsson (2006: 7) and Mead (2021) explained that in the early 1980s, the Alliance for Sustainability (originally the International Alliance for Sustainable Agriculture (IASA)) started the movement of Sustainable Agriculture. The movement was initiated by the organic farmer Nicanor Perlas from the Philippines together with his colleagues Minnesota environmental management, co-operative business consultant Nancy K, Herzberg technology expert, Thomas Fricke Stuart Hill of McGill University, and Ecological Agriculture Products in Canada, and Minneapolis-based ecologist and agricultural economist Terry Gips. This group of people created the International Sustainable Agriculture Project (ISAP), and in 1983 they coined the

term Sustainable Agriculture. In 1989, MacRae *et al*. (1989: 173) defined Sustainable Agriculture as managing a network of procedures that work with natural processes to conserve all resources by minimising waste and environmental impact, preventing problems and promoting agroecosystem resilience and in addition, practising self-regulation, evolution, and sustainability in production for the nourishment and fulfilment of the environment and people.

Bill (1990) elaborated further by explaining that sustainable agriculture is regarded as a combination of a system of plant and animal production practices with specific applications that will, over the long term: satisfy human food and fibre needs; enhance environmental quality; and make efficient use of non-renewable resources and on-farm resources. Furthermore, they will integrate appropriate natural biological cycles and controls, sustaining farm operations' economic viability. Lastly, they will enhance the quality of life for farmers and society (Velten, Leventon, Jager and Newig 2015: 7834).

Brodt *et al*. (2011: 1) highlighted both the positive and negative impacts of the growing sustainable agriculture movement that has been around for the past four decades since the end of World War II. The positive impacts of sustainable agriculture are that it offers innovative alternatives in the agriculture sector, which is one reason it has gathered increasing support and acceptance within the food production systems. Sustainable agriculture food and fibre productivity has increased due to new technologies, mechanisation, increased chemical use, specialisation and government policies favouring maximising production and reducing food prices and these developments have had many positive effects, reduced many risks in farming, and allowed farmers to produce more food and fibre at lower prices. The same developments have also come with significantly high costs. The most prominent negative impacts among these high costs are topsoil depletion, groundwater contamination, air pollution, greenhouse gas emissions, the decline of family farms, and neglect of farm labourers' living and working conditions. In addition, new threats to human health and safety are due to the spread of new pathogens, economic concentration on food and agricultural industries, and the disintegration of rural communities. The UNs Development Program (UNDP) (2021) pointed out that one of the problems was climate change because it continued to put a strain on ever-depleting natural resources. As a result, there is an increase in the vulnerability of the highly

resource-dependent agricultural sector. To rectify this problem, sustainable global food production should develop innovations that are much more climate resilient.

The Union of Concerned Scientists (UCS) (2012: 1) further highlighted the negative impacts by explaining that when it came to farming practices, federal policies decreased agricultural operations that used millions of tons of toxic chemicals, which in return continued to damage the soil, water, and air along with the people's health. The worst part was that taxpayers' money also funded research that maintained and expanded these harmful industrial systems. UCS suggested that instead of subsidising processed food and pollution, there should be support for implementing healthy food and farms with forward-thinking farm and food policies. There should be strict implementation of legislation that offers subsidies for various crops and farming practices, low-income food programs, incentives for farmers to protect and conserve the soil and water, investments in agricultural research, and many others. This implementation would offer a unique opportunity to change what the nation's farmers grow and how the farmers grow it for years to come.

Kesavan and Swaminathan (2018: 1876) continued to highlight the negative impact on the environment regarding the implementation of biodiversity through the GR of the 1960s. Over the last five decades, increasing production through intensive agriculture, crop and livestock improvements, and agrochemicals has resulted in irreparable damage to biodiversity and the natural environment. Global biodiversity is declining, with substantial ongoing losses of populations, species, and habitats (Nuttall 2012: para. 2 line 1). Moreover, increasing land clearance for crop cultivation has been leading to habitat loss and may ultimately result in the loss of plant varieties. Policy needs to strengthen the public perception of humanity and nature as interdependent and interacting. This requires revisiting our policies and behaviours and developing adaptive management approaches that acknowledge the systemic and dynamic nature of current global changes. In addition, agriculture and food systems need to be at the centre of debates around sustainability, while the global food system is subjected to the conflicting pressures of delivering the food demanded by an expanding and increasingly affluent population. Bottom-line environmental sustainability needs to be achieved (Godfray *et al.* 2010: 812; Tilman and Clark 2014: 518).

Many recent reports support this conflict by highlighting the need for a holistic approach and the radical transformation of agriculture and food systems to tackle the multiple burdens of malnutrition and contribute to the achievement of the 2030 Agenda High-Level (Haddad *et al.* 2015: 663; Whitmee *et al.* 2015: 1973; Global Panel on Agriculture and Food Systems for Nutrition 2016: para. 1 line 1; International Panel of Experts on Sustainable Food Systems (IPES-Foods) 2016; HLPE 2017: para. 1 line 1). The FAO *et al.* (2017b: para. 2 line 5) reported that the future of food and agriculture clearly outlines the stark trends and challenges that will influence food and agriculture in the coming decades. Food systems and agriculture need transformative changes worldwide because there is still a growing demand for diverse types of food from increasing and wealthier populations. Although global agriculture provides sufficient calories overall for today's human population, more than 800 million nevertheless remain undernourished (FAO; WFP and EU 2018: para. 1 line 3). According to FAO, there is a need to double food production by 2050 to meet the demands of over nine billion people (FAO 2009b: para. 2 line 1). Therefore, there is a need to take stock of the current situation and measure all the costs and benefits of agriculture and food systems so that they can be transformed to meet the growing food demand as well as protect planetary and human health through appropriate policy responses (Zhang *et al.* 2018: para. 2 line 1).

To correct these negative impacts, sustainable agriculture has focused on integrating three main goals: environmental health, economic profitability, and social equity. Weil (1990: 126) explains the three broad areas of sustainable agriculture as, firstly, economic concerns (over economic justice), meaning the survival of the owners of the operated farms and the long-term profitability of agriculture. Secondly, environmental concerns over adverse impacts of agriculture on land, water, and wildlife resources. Thirdly, public welfare concerns over food quality and human exposure to toxic chemicals.

Sustainable agriculture is more than a collection of practices. It is also a process of negotiations: a push and pull between sometimes-competing interests of an individual farmer or people in a community as they work together to solve the complex problems about how they grow their food and fibre. When conducting the research (the intervention), the researcher will consider these dynamics because the UNs Development Program (UNDP) (2021) has indicated that in 2050 the world will need to sustain some nine billion people with

food, which will require an increase of 70% in food production. It is vital for everyone to get involved in sustainable agriculture and work together because most of the global production of food relies on smallholder farmers. When it comes to sustainable agriculture, major stakeholders need to focus on and address the challenges smallholder farmers are faced with, such as lack of access to adequate and affordable production technology, timely and accurate information that helps them manage their farm, insurance products that mitigate risk, as well as sources of finance to invest in the smallholder farmer's business. Naizi and Rahmen (2021) focused on sustainable agriculture as an effective management of capital for agricultural businesses with the purpose of helping human needs to change, thus preserving or increasing the standard of the climate and conserving nature.

Sustainable Agriculture Research and Education Programme (2021) supported the above statements and the goal of sustainable agriculture which is to meet society's food and textile needs in the present time without compromising the ability of future generations to meet their own needs by integrating the three main objectives of sustainable agriculture (healthy environment, economic profitability, and social and economic equity). One of the focus areas is ensuring a sustainable agricultural system through sustainable food system growers in relation to food processors, distributors, retailers, consumers, and waste managers. Growers should be encouraged to use methods to promote soil health, minimise water use, and lower pollution levels on the farm to ensure both sustainable agriculture and sustainable food systems. These good practices that concern sustainability can even be devolved to the consumers and retailers by advising them to look for "values-based" foods that are grown using methods promoting farmworkers' wellbeing, that are environmentally friendly, and that strengthen the local economy. Moreover, researchers participating in sustainable agriculture should be encouraged to increase cross-disciplinary lines with their work by combining biology, economics, engineering, chemistry, community development, and many others.

According to Timmermans *et al.* (2014: para. 2 line 4) and HLPE (2017: para. 5 line 3) the primary challenge for agriculture and food systems is to meet the increasing and evolving dietary needs of a growing population in a sustainable way, in the context of climate change and increased pressure on natural resources, paying specific attention to the rights and needs

of the more vulnerable groups. Piecemeal action will not suffice: the world's food systems require a comprehensive overhaul. Kickbusch and Buckett (2010: para. 3 line 4) simplify food systems as a system that governs what we eat and discourages the use of the term 'food chain' (from farm to fork) because it can be misleading since it neglects simultaneously interacting processes, complex causes and effects of relationships, and feedback loops. HLPE (2017: para. 2 line 4) agreed with the above discouragement regarding the food chain by explaining that food systems encompass all activities that move food from production to consumption, including production, storage, distribution, processing, packaging, retailing and marketing. The decisions made by the many actors at any stage of this chain have implications for the other stages. They influence the types of food available and accessible, as well as how they are produced and consumed.

Van Berkum, Dengerink and Ruben (2018: 2) explained that food systems is a useful interdisciplinary conceptual framework for research and policy aimed at sustainable solutions for a sufficient healthy food supply. Timmermans *et al.* (2014: para. 2 line 3) defined a food system as a combination of all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outputs of these activities, including socio- economic and environmental outcomes. The FAO (2017b: para. 1 line 3) explained further by stating that food systems have diverse activities in sustainable agricultural production, which includes growing, harvesting, processing, packaging, distribution, marketing, consumption and disposal of food products that originate from agriculture, forestry or fisheries, and all these are parts of the broader economic, societal and natural environments in which they are embedded. HLPE (2017: para. 3 line 2) clarified the food environmental factors in the food systems by referring to the physical, economic, political and socio-cultural context in which consumers engage with the food system to acquire, prepare and consume food. The food environment consists of: "food entry points", for example, the physical spaces where food is obtained; the built environment that allows consumers to access these spaces; personal determinants of food choices (including income, education, values, skills, etc.); and the political, social, and cultural norms that underlie these interactions. The critical elements of the food environment that influence food choices, food acceptability and diets are physical and economic access to food (proximity and affordability),

food promotion, advertising and information, food quality and safety.

In summary, Ingram and Brklacich (2006: 222), Van Berkum, Dengerink and Ruben (2018: 2), Timmermans *et al.* (2014: para. 2 line 3), UNs Environment Program (UNEP) (2016: para. 3 line 4), Global Panel on Agriculture and Food Systems for Nutrition (2016: para. 2 line 1), HLPE (2017: para. 3 line 2) and concurred with each other by elaborating that food systems comprises all the processes associated with food production and food utilisation: growing, harvesting, packing, processing, transporting, marketing, consuming and disposing of food remains (including fish). All these activities require inputs and result in products and services, income and access to food, and environmental impacts. A food system operates in and is influenced by social, political, cultural, technological, economic, and natural environments. A food system includes activities related to the production, processing, distribution, preparation, and consumption of food; these activities' outcomes contribute to food security, availability, food access and food utilisation.

HLPE (2020) emphasised that food systems must be transformed if the global community is to achieve the SDGs (SDG) by 2030, especially SDG 2 to end hunger and malnutrition in all its forms and promote sustainable agriculture by 2030. The particular call to action of the SDGs is central to the 2030 Agenda, which states “leave no one behind.” This call emphasises equity at the same time as it underlines the importance of sustainability. The UNs General Assembly supported the above statement in relation to the implementation of sustainable food systems by acknowledging the importance of sustainable food systems in 2015 regarding the 2030 Agenda for Sustainable Development by adopting SDG target 2.4 which strives “to ensure sustainable food production systems by implementing resilient agricultural practices, which help maintain ecosystems and strengthen capacity.” Thus, the UN General Assembly and all its Member States recognise the need for sustainable food systems; the SDGs emphasise sustainable food systems but lack policy options and comprehensive and concrete plans for action to reach the 2030 goal for sustainable food production systems successfully. Fortunately, many countries are starting to use the UN Decade of Action on Nutrition to take action and ensure sustainable food systems (UNs 2016a: para. 3 line 2). Figure 9 below depicts the holistic approach to NSA through food systems which solidifies the above statements and highlights sustainable agricultural systems and sustainable food systems under the umbrella of

NSA.

Moreover, food systems were explained by (Hoddinott 2016: para. 3 line 1; FAO and WFP (WFP) 2016: para. 1 line 2; UNEP 2016: para. 3 line 1; HLPE 2017: para. 3 line 4) as a holistic approach on aspects under the food chain (production, processing, distribution and consumption), the socio-economic and environmental outcomes of food production and consumption (such as food security and soil depletion). Van Berkum, Dengerink and Ruben (2018: 5) pointed out that food systems are increasingly being used internationally as a useful analytical framework for the integrated consideration of interests relating to food and for introducing a policy focus on public health, ecological sustainability, and robustness of food production and consumption.

Furthermore, Von Braun *et al.* (2020: 7) explained that the food system includes the related resources, the inputs, production, transport, processing and manufacturing industries, retailing, and consumption of food as well as its impacts on the environment, health, and society. There is an accelerating momentum worldwide to adopt the food systems approach to bring consumption and production patterns together. Furthermore, food systems should support the global and national collective efforts to bring about positive change in food systems, accelerating progress on meeting the 2030 Agenda and the SDGs. Moreover, food systems should be sufficiently precise to define the domains for policy and programmatic priorities. Food systems should also serve data gathering, modelling, and analysis concepts to assist in effective policy action. Simultaneously, food systems should be sufficiently general to include all aspects of the economic, social, and environmental dimensions of the sustainability (HLPE 2020: para. 3 line 1). It has been clearly stated that food systems contribute to a range of other socioeconomic (income, employment), environmental (greenhouse gas emissions, biodiversity, climate) and food security (nutrition) issues.

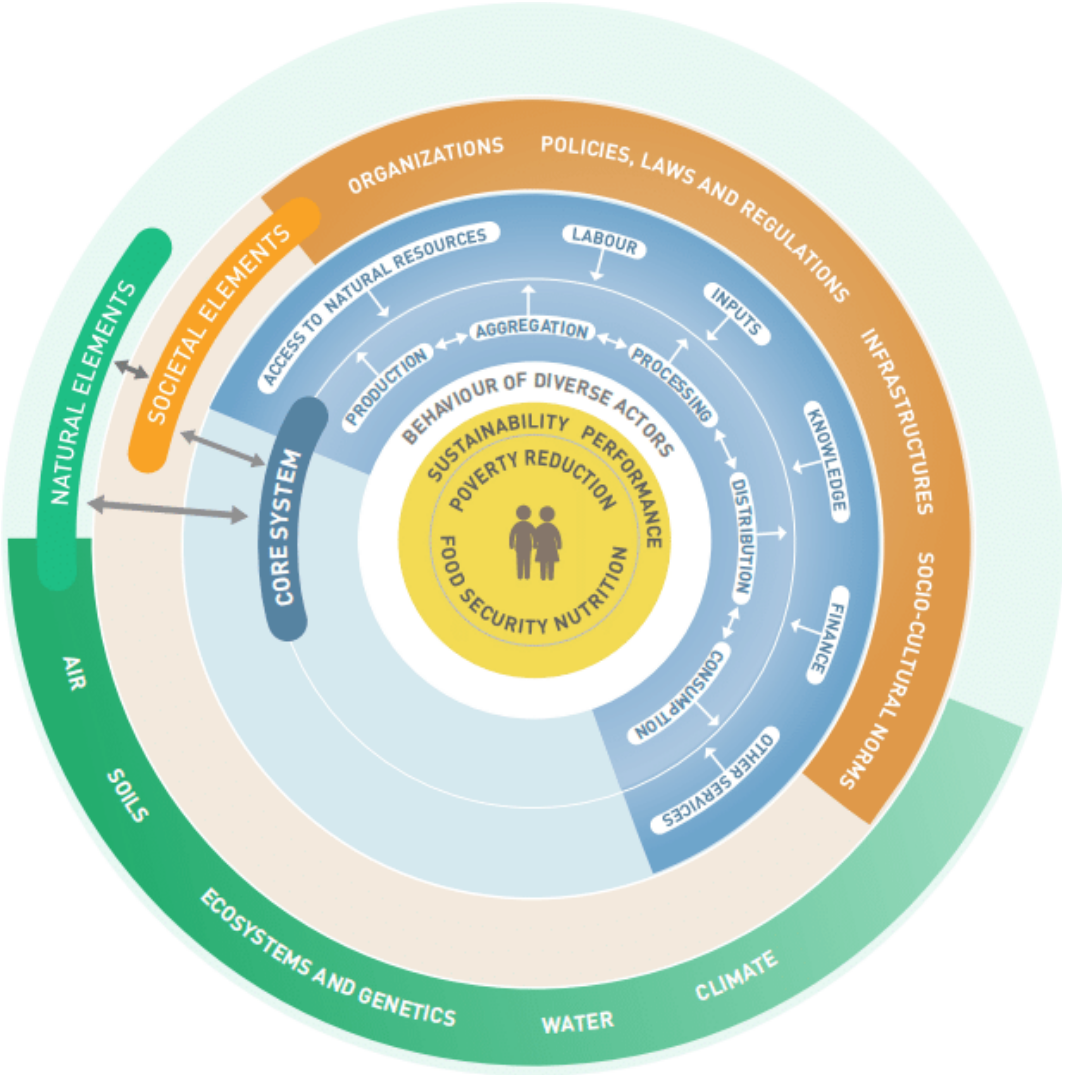


Figure 9: Food System Wheel Framework (FAO 2018: 3)

The Food System Wheel Framework is centred around FAO's primary goals: poverty reduction, food security and nutrition. These are embedded in the broader performance of the system, referring to the three dimensions of sustainability: economic, social, and environmental (elaborated in the above paraphs). Such performance is determined by the behaviour of diverse actors, or the conduct of stakeholders in the food system (people-centric). This takes place in the system's structure, which consists of a core system, societal elements, and natural elements. The core system includes a layer of activities through which

food products flow (production, aggregation, processing, distribution, and consumption, including waste disposal), with a layer of services supporting the flow. These activities are embedded in a societal context and a natural environment. The former includes all related

policies, laws and regulations, socio-cultural norms, infrastructures, and organisations; the latter provides water, soils, air, climate, ecosystems, and genetics (FAO 2018: 5).

Sustainability has become a guiding principle and a primary goal for human development. Environmental degradation, social distress, and economic fluctuation are worldwide concerns challenging conventional views on development and forcing a reconsideration of our everyday behaviours. Rapid climate change has been occurring for several decades and is predicted to continue and possibly accelerate (Field *et al.* 2012: para. 3 line 3). Pothukuchi and Kaufman (1999: 213) explained a sustainable food system (SFS) as a collaborative network that integrates several components to enhance a community's environmental, economic and social well-being. It is built on principles that further the ecological, social, and economic values of a community and region. Kickbusch and Buckett (2010: para. 3 line 4) emphasise that a sustainable food system provides healthy food to meet current food needs while maintaining healthy ecosystems that can provide food for generations to come with minimal negative impact on the environment. sustainable food system also encourages local production and distribution infrastructures and makes nutritious food available, accessible, and affordable to all. Further, it is humane and just, protecting farmers and other workers, consumers, and communities (American Public Health Association (APHA) 2007: para. 4 line 3).

The FAO and WHO now recognise sustainable food system as being paramount to population health with its "Ambition and Action in Nutrition 2016-2025". WHO's core goal for sustainable food system is to "Define healthy sustainable diets and guide the identification and use of effective nutrition interventions." With this goal, WHO is responsible for defining healthy sustainable diets that not only ensure the prevention of all forms of malnutrition and diet-related NCDs throughout the life course but are also compatible with planetary health. This ambitious goal requires developing national policies that incorporate both international and local contexts to ensure effective interventions that do not unintentionally harm local populations and cultures. Additionally, as global guidelines for sustainable diets are not yet defined, the WHO will be challenged to clearly articulate and measure their goals in a relatively new field in nutrition (WHO 2017: para. 3 line 3).

The FAO (2017b: para. 3 line 4) highlighted that a sustainable food system is a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised; meaning that it is profitable throughout (economic sustainability), it has broad-based benefits for society (social sustainability) and it has a positive or neutral impact on the natural environment (environmental sustainability). A sustainable food system lies at the heart of the UNs SDGs. Adopted in 2015, the SDGs call for significant transformations in agriculture and food systems to end hunger, achieve food security and improve nutrition by 2030. To realise the SDGs, the global food system needs to be reshaped to be more productive, more inclusive of poor and marginalised populations, environmentally sustainable and resilient, and able to deliver healthy and nutritious diets to all. These complex and systemic challenges require the combination of interconnected actions at the local, national, regional and global levels (UNEP 2016: para. 2 line 5).

Sustainable food systems are paramount in the fight to ensure planetary health and end malnutrition in all its forms. Tilman and Clark (2014: 519) prove this connection between sustainability and population health by stating that global diets should link environmental sustainability and human health. The reason is that creating sustainable agricultural and aquaculture practices will simultaneously secure stocks of nutrient-rich foods to fight the double burden of malnutrition and mitigate the harmful climate impacts that current agricultural practices have on planetary health. Sustainable food systems, therefore, creates a "win-win" situation by securing population and planetary health. Neglecting to develop sustainable food system will contribute to an 80% increase in global agricultural greenhouse gas emissions by 2050. Healthy global diets could reduce greenhouse gases from food by 29-70 % and have economic benefits of up to $31 trillion by 2050 (Springmann *et al*. 2016: 4146). Figure 10 below depicts the nutrition food systems for diets and nutrition, which solidifies the above statements and highlights a sustainable agricultural system, and a sustainable food system under the umbrella of NSA.

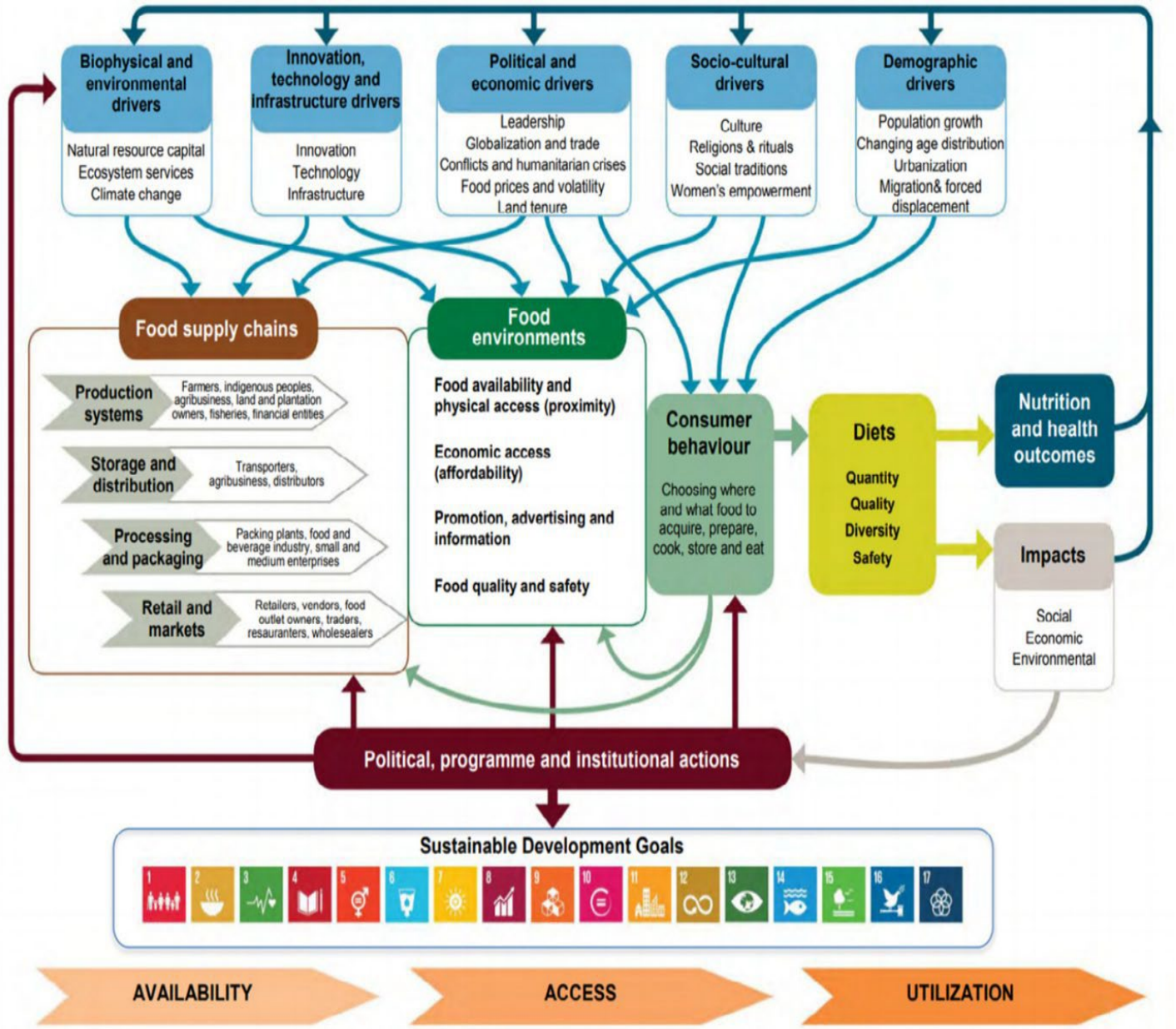


Figure 10: Conceptual framework of food systems for diets and nutrition (HLPE 2017: 26)

Figure 10 illustrates the conceptual framework of food systems for diets and nutrition and shows the interlinkage between nutrition and the food system functions such as food production, food processing and storage, food trade and marketing, consumer demand, food preparation and preferences. Also, the conceptual framework helps to assess the food system from the point of view of consumer's nutritional needs. Food system have both linear and non-linear processes, which help broaden the perspective when seeking solutions for the root causes of problems such as poverty, malnutrition, and climate change. The food system ramework offers at least three benefits. Firstly, it provides a checklist of topics that should, at

the very least, be addressed when it comes to improving food security, certainly in relation to other policy objectives. Secondly, food system helps to map the impact of environmental and climate changes on food security by pointing to the various vulnerabilities of the food system. In that sense, the approach can contribute to the search for possibilities for strengthening the system's resilience to climate change. Thirdly, it helps to determine the most limiting factors for achieving food security and hence identifies effective interventions to improve food security (HLPE 2020: para. 3 line 1).

In relation to Figure 10, in 2015, the CFS requested the HLPE to prepare a report on Nutrition and Food Systems. As a result of the report, in 2017 the HLPE developed a conceptual framework of food system for diets and nutrition. The conceptual framework of food systems for diets and nutrition covers the three main components of food system: food supply chain, food environment, and consumer behaviour. This interlink highlights the effective interaction between the global population, politics, policies, and programs. This is to holistically advance agriculture, the food industry, trade, environment, energy, health, water and sanitation, education, social protection, gender equality, and women's empowerment.

Furthermore, the conceptual framework of food systems for diets and nutrition identifies five main drivers of food system changes: biophysical and environmental, innovation, technology and infrastructure, political and economic, socio-cultural and demographic drivers (Ingram, Monika and Hasnain 2020). Biophysical and environmental drivers include natural resource and ecosystem services, and climate change. Political and economic drivers include leadership, globalisation, foreign investment and trade, food policies, land tenure, food prices and volatility, conflicts, and humanitarian crises. Socio-cultural drivers include culture, religion, rituals, social traditions, and women's empowerment. Finally, demographic drivers include population growth, changing age distribution, urbanisation, migration and forced displacement (Nesheim, Oria and Yih 2015: para. 3 line 3).

The framework has been adapted from previous reports (Sobal, Khan and Bisogni 1998: 853; Pinstrup-Andersen and Watson II 2011: 7; Haddad *et al*. 2015: 663; Global Panel on Agriculture and Food Systems for Nutrition 2016: 27; Hasnain, Ingram and Zurek 2020: 4). The framework can be summarised by identifying the three significant additions it offers. Firstly,

it highlights the central role of the food environment in facilitating nutritious, healthy, and sustainable consumer food choices. Secondly, it emphasises the role of diets as a core link between food systems and their nutrition and health outcomes. Lastly, it considers the impacts of agriculture and food systems on sustainability in its three dimensions (economic, social, and environmental). The framework also focuses on nutrition and diets, and these two aspects are vital in several international global goal-setting agendas, including the UNs Zero Hunger Challenge, the UNs Decades of Action on Nutrition and SDGs. In summary, the conceptual framework is reorienting food systems to support nutrition better to achieve SDGs, goal 2 (zero hunger) and goal 3 (good health and well-being).

In support of the Conceptual Framework of food systems for diets and nutrition by HLPE, the UN Decade of Action on Nutrition provides a holistic platform that serves as an umbrella space for nutrition-related work along six cross-cutting integrative areas for impact on sustainable food system. The six areas of the Nutrition Decade include the following three relevant to sustainable food system: sustainable, resilient food systems for healthy diets, social protection and nutrition education, and safe and supportive environments for nutrition at all ages. Consequently, the UN Decade of Action on Nutrition catalyses change and provides a robust platform for Member State action to attain SDG2 and ensure sustainable food system (Branca, Phelps and Mahy 2017: para. 1 line 2).

Keding, Schneider and Jordan (2013: 825) summarised that NSA needed to consider and understand the role of biodiversity in improving dietary quality, dietary diversity, and seasonality in the food supply. Besides improving agricultural systems to close the nutrition gap, efficient storage, and food processing technologies to prolong shelf-life are required. If processing is poor, high food losses can cause food insecurity or increase the risk of producing unsafe and unhealthy food. Food storage and processing technologies, particularly at the household level, are challenging and often not applicable to traditional crops. Agriculture and Food system contribute to nutrition through the quantity, quality and diversity of food produced, prices and purchasing power of producers, as well as food preferences and consumption choices**.** Figure 11 Nutrition-sensitive food system depicts the above information and summarises a sustainable NSA framework in addressing food and nutrition

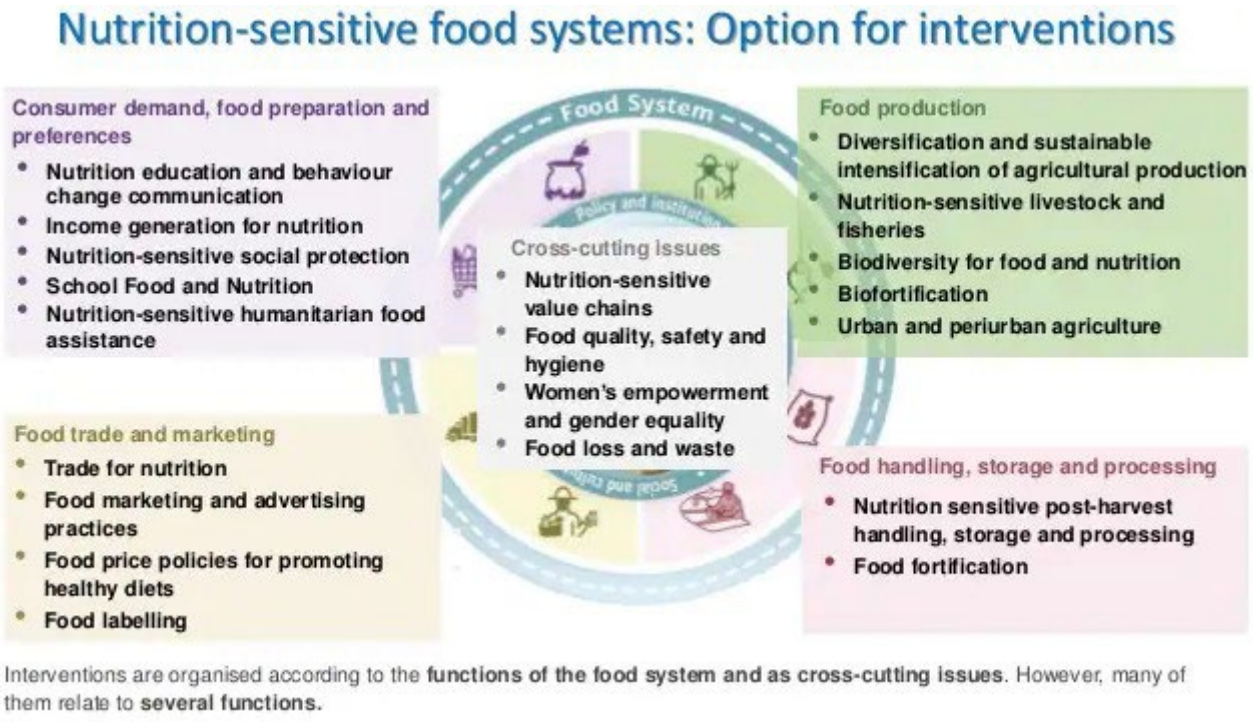


Figure 11: Nutrition-sensitive food systems (Abdulhameed, Food Security Cluster, WFP, FAO and Food basket design and NSA training 2018)

The Global Panel on Agriculture and Food Systems for Nutrition (2016: 82) and HLPE (2017: 9) supported the above statements by emphasising the role of the consumer; it is consumers who determine what the system produces. The food culture (values, convictions, and social norms regarding food) plays a crucial role in what people eat. Incomes and other socio-economic characteristics in society also determine to a significant degree the choice of food, for example, knowledge of the relationship between nutrition and health. In addition to sufficient quantities of food, food systems should produce healthy food ('healthy diets').

HLPE (2017: 11) simplified consumer behaviour as choices made by consumers, at household or individual levels, on what food to acquire, store, prepare and eat, and on the allocation of food within the household (including gender bearing age and feeding of children). Consumer behaviour is influenced by personal preferences determined by taste, convenience, culture and other factors. However, consumer behaviour is also shaped by the existing food environment. Collective changes in consumer behaviour can open pathways to more sustainable food systems that enhance FSN and health. These three components of food systems impact consumers' capacity to adopt sustainable diets which are: protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair

and affordable, and nutritionally adequate, safe and healthy, while optimising natural and human resources.

Asirvatham, Demi and Ezezika (2023: 5) highlighted that implementing NSA interventions required nations to amend and create new policies prioritising NSA as a key driver in overcoming malnutrition. This decision was concluded after the authors' case study on the past and current thirty national policies and strategies relevant to agriculture and nutrition from Ethiopia, Ghana, Malawi, Nigeria, and SA. The policies and strategies were reviewed against FAO's Key Recommendations for Improving Nutrition through Agriculture and Food Systems Guidelines. Through the review of thirty policy documents, it was discovered that the link between agriculture and nutrition remains weak, particularly in agriculture policies. The review of the policies highlighted insufficient attention to nutrition and the production of micronutrient-rich foods, a lack of strategies to increase farmer market access, and weak multi-sectoral collaboration and capacity building.

Baral *et al*. (2021: 1) agreed with the above recommendation when it comes to promoting nutrition-sensitive farming practices among smallholder farmers since it was suggested by potential pathway to address food and nutrition insecurity through agriculture interventions. Some of the initial steps undertaken to bring the multi-sectoral collaboration and capacity building together include designing and agreeing on conceptual frameworks that identify the multiple pathways by which agriculture can impact nutrition. This topic has been the participants of an extensive body of work, including the development of several conceptual frameworks that highlight the dynamic and multifaceted linkages between agriculture, health, and nutrition (Headey *et al*. 2012; Herforth and Harris 2014: 1; IFPRI 2011; Jaenicke and Virchow 2013: 679; Kadiyala *et al*. 2014: 52; Pinstrup-Andersen 2012; WB 2007).

2.5 CONCLUSION

In conclusion, this chapter has given an insight into the UN and UN agencies' multiple attempts to address food and nutrition insecurity globally. The literature review exposed the complex relationship between poverty and hunger in relation to food and nutrition insecurity. The literature review further elaborated on NSA as an approach to make food more available,

accessible, diverse and nutritious through sustainable production. To strengthen the above statements, Thompson and Amoroso (2011: 3), FAO (2014: para. 2 line 1) and Balz, Heil and Jordan (2015: 5) explained that nutrition-sensitive food and agriculture-based approaches are needed to overcome malnutrition and improve nutrition. These approaches are generally recognised by the FAO and WHO, specialised UN agencies. The FAO assists in raising nutrition and living standards and ensuring humanity's freedom from hunger by promoting sustainable agricultural development and alleviating poverty. Through policy and planning, governments can improve the efficient production, distribution and consumption of food and agricultural products. The focus is on the distinctive relationship between agriculture, food and nutrition. Protecting, promoting and improving food-based systems as a sustainable solution can ensure food and nutrition security, combat micronutrient deficiencies, improve diets and raise levels of nutrition, and achieve the nutrition-related SDG 2 (FAO, IFAD, UNICEF, WFP and WHO 2022a: para. 2 line 3). This literature review leads to the next chapter, Research methodology.

CHAPTER THREE: METHODOLOGY AND INTERVENTION

3.1 INTRODUCTION

This chapter describes the research design and methodology used in this study. A description of the participants and sampling procedure and an overview of the intervention implementation are provided. The research process, data collection methods used for both the baseline and endline and the study's data analysis are explained. This research study will present quantitative and qualitative findings conducted with Basotho female farmers residing in Mpharane village and Maqoala village in the Mohale's Hoek, Lesotho district. The study aimed to introduce and educate rural female farmers about agri-business and agro-products (agro-food industry) using Greenhouse tunnels and a NSA toolkit developed specifically for this study. The toolkit will be used to address and reduce food and nutrition insecurity in the community.

3.2 ETHICAL CONSIDERATIONS

Ethical approval was obtained from the Durban University of Technology (DUT) under the Faculty Research Committee (FRC) and ethical clearance from the IREC 029\19 (Appendix A). The second ethical approval was obtained from Lesotho through the Lesotho Research Coordinating Unit (ethics committee), the Ministry of Agriculture and Food Security, and the Ministry of Health and Social Welfare (Appendix B).

A meeting with the councillor of the district of Mohale's Hoek was arranged to obtain permission in a written form to conduct the research in the two villages of the district. Once consent was obtained from the district councillor, a meeting was arranged with the chiefs from the two villages. Information letters regarding the research were given to the chiefs from Mpharane village and Maqoala village (Appendix C). A meeting was conducted to discuss the research project and to gain permission in a written form to conduct the study in the villages. Once permission in a written form in a written form was granted by the chiefs of the Mpharane and Maqoala villages, the chiefs assisted in creating a community forum made-up of five local women from each village to explain and inform all parties about the study to be conducted in their villages. The ten women assisted the researcher in understanding the dynamics and interests of the women residing in the two villages. The community forums

also helped adapt the research questionnaires to tailor to the community's needs. The community forums also helped with adapting the research toolkit. After the adaptation of the

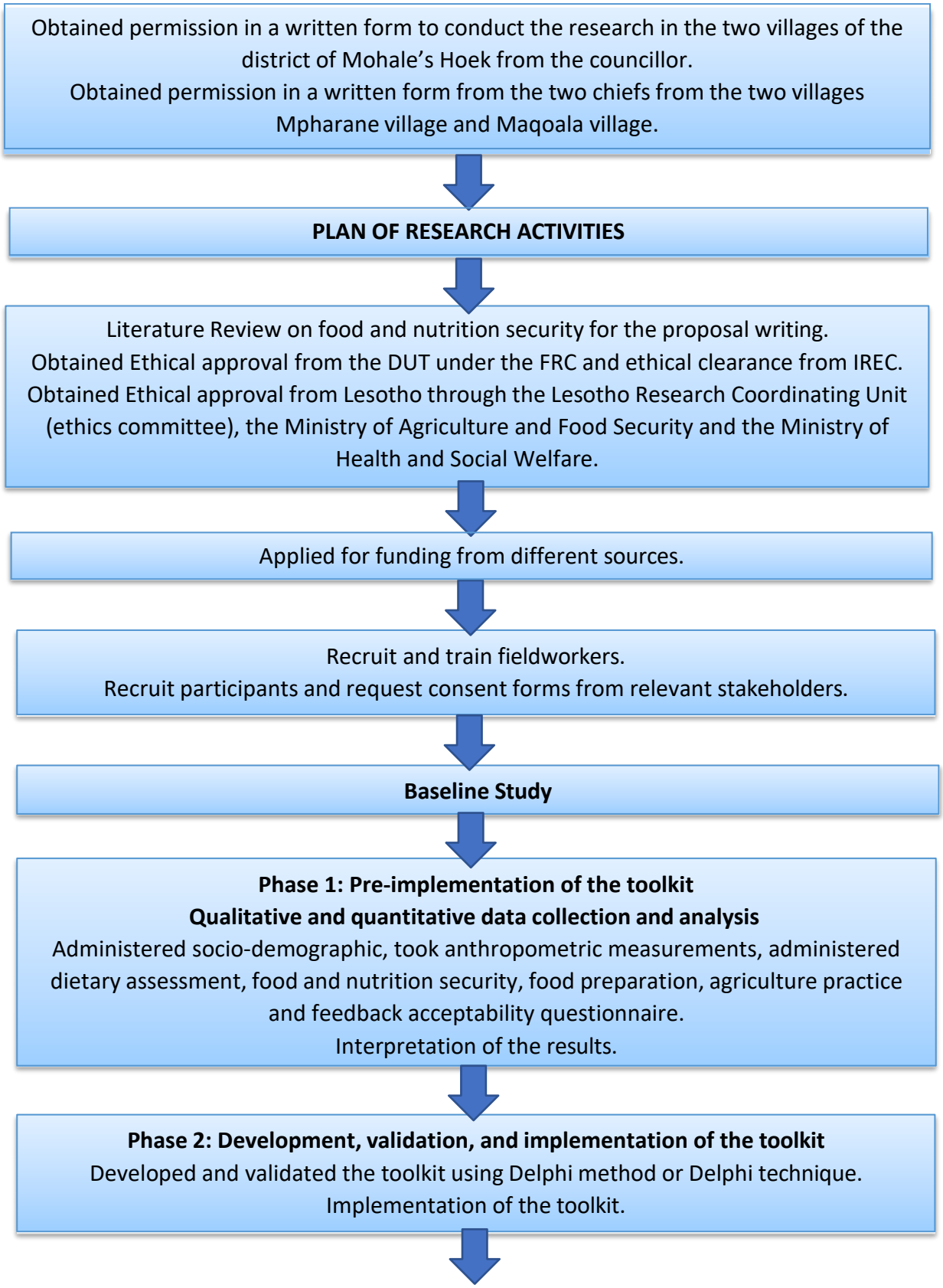
research questionnaires and the toolkit, a pilot study was conducted with ten female members from each village to assist with validating and making a reliability assessment of the adapted questionnaires and toolkit. These twenty females from the two villages were excluded from the main research study.

Once all the questionnaires were adapted, a randomised controlled trial (RCT) design (true-experimental) was used to obtain the sample population and sample size. The female participants from each village were given an information letter outlining the study's purpose, aims and objectives. The letter was translated into Sesotho (Appendix D) to allow all the participants to access the information and to enable them to ask questions and raise any concerns. For the participants who could not read, the letter was read to them in Sesotho and explained to them in detail by the researcher. Once the participants had a clear understanding of the study, they were requested to sign a consent form (Appendix E and F) and the participants who could not write were requested to make a thumbprint or draw an X.

The participants were made aware that participation in this study was voluntary and they could withdraw from the research study at any given time. It was communicated to the participants that there was no financial gain for participation in the study. Participants would also incur no costs for being part of the study. Participants were made aware that all information gathered was considered confidential, that the participants would be given a number, and that no names or personal information would be used during the study. All data would be stored in the Department of Food and Nutrition for five years, after which it would be shredded, and electronic data deleted. Electronic data was password protected.

3.3 PLANNING AND ADMINISTRATION

The outline of the research study flow:



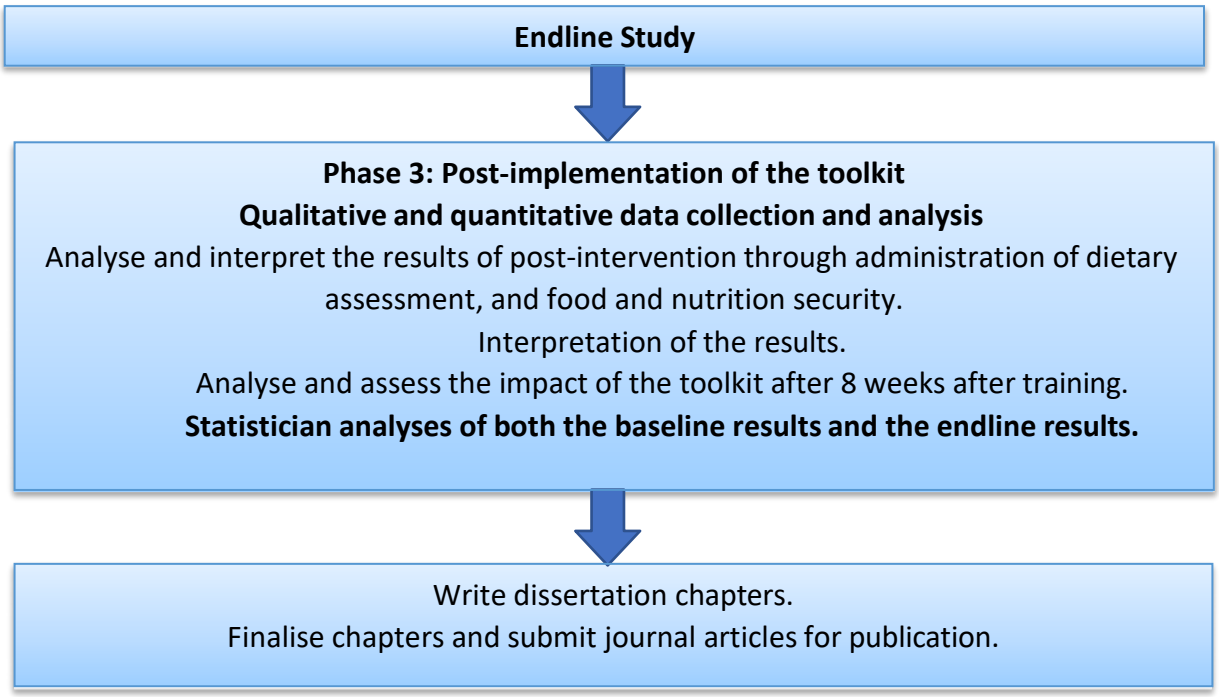


Figure 12: Provides the progression (flow) of the research project

3.4 GEOGRAPHIC SETTING OF THE STUDY

Basotho-land was renamed the Kingdom of Lesotho after its independence from the United Kingdom (UK) in 1966. Lesotho is a small mountainous country with total land boundaries of 909 km and is surrounded by SA. Lesotho's total land area is 30 355 sq/km, and it is slightly smaller than Maryland, United States of America (USA) Lesotho has ten districts, and the capital and largest city is Maseru. The WB classifies Lesotho as the world's least developed, lower middle-income food deficit country. Lesotho is ruled by a king as Head of State, and the Prime Minister as Head of Government, governed by a 33-member Senate and 120-member National Assembly. Lesotho falls under the Southern African Development Community (SADC) (FAO 2005: 7; Cross-border Road Transport Agency 2017: 21; WB 2020b: para. 1 line 1).

Lesotho has a population estimated at 2,007,201 with 982,133 males and 118,213 females (UNs 2019: 1). Lesotho has a population density of 68 people per square kilometre (162/sq.mi) and is 138th worldwide for this statistic. Population density is lowest in the highlands. This research was conducted in one of the ten districts of Lesotho called Mohale's Hoek. Mohale's Hoek has a population size of approximately 165,590, with 81,299 males and 84,291 females. Mohale's Hoek has an area of 3,530 square kilometres with 186 villages. Mpharane and Maqoala villages fall under the Councils (cluster) of Thaba-Mokhele with 136 villages, 4526

households, 9210 males, 9176 females and a total population of 18386. In Mpharane village, there are 101 households with 131 males, and 151 females and a total population size of 282. In Maqoala, there are 50 households with 90 males, 91 females and a total population size of 181 (Lesotho National Development Corporation (LNDC) 2022). In 2006, the female population of Mohale's Hoek was 90,290 persons. The female population of Mohale's Hoek increased from 57,473 persons in 1966 to 90,290 persons in 2006, growing at an average annual rate of 12.7%.

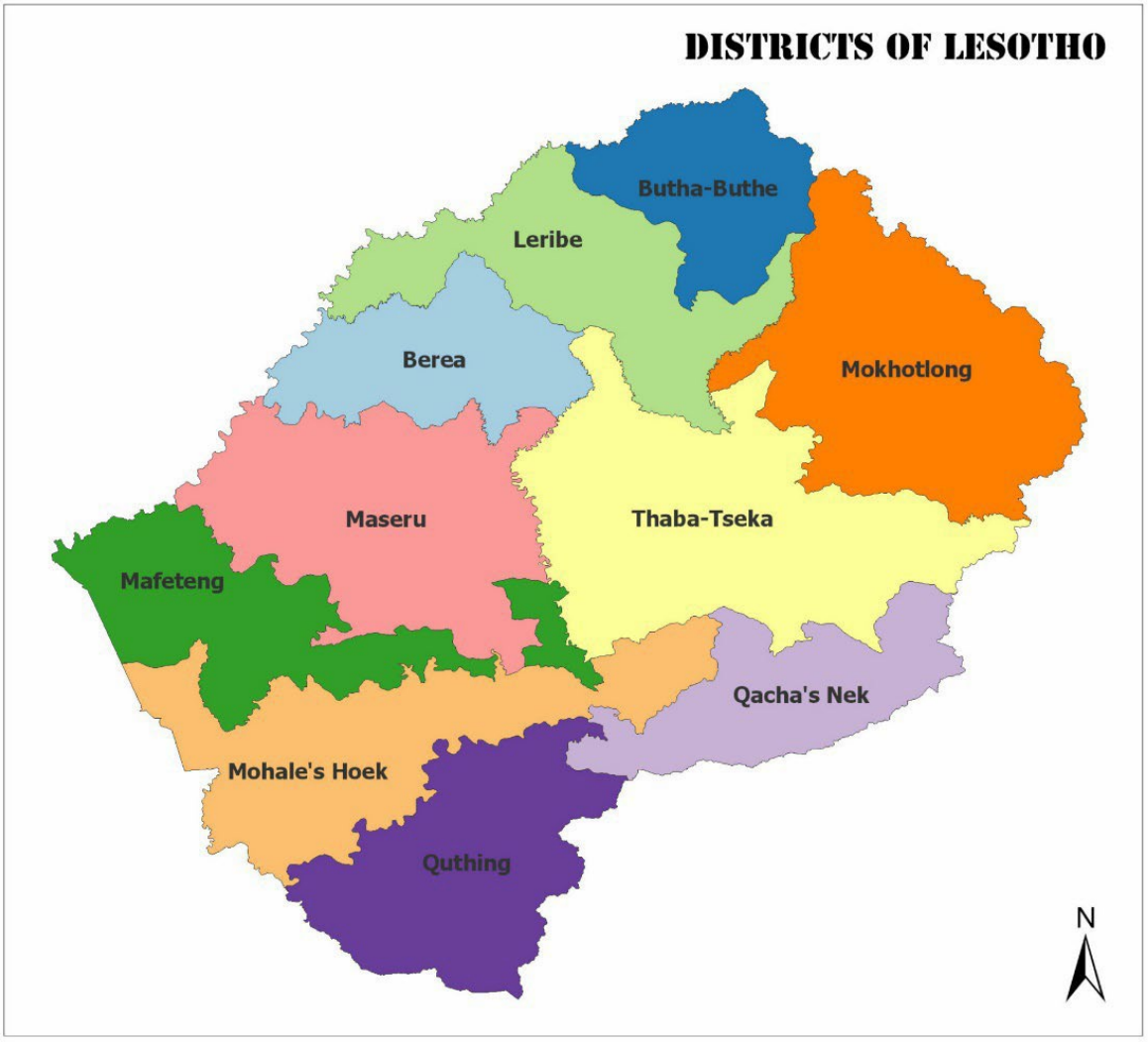


Figure 13: Map of Lesotho with the ten districts (Mappr 2021: para. 2 line 1)

3.5 RESEARCH DESIGN

The research involved field research in Mohale's Hoek because it took place in the natural real world of the setting of Mohale's Hoek district in Mpharane (intervention group) and Maqoala (control group). The two villages were selected based on geographic location as they are rural communities with low-income households, and they have similar profiling (McCombes 2023a: para. 2 line 1). The Maqoala (control group) village is situated approximately 37.6 km, which is approximately 1h 6 min by car, away from Mpharane (intervention group). This distance indicates that there was minimal interaction and crossover of information between the participants. The researcher notified the control group not to engage in any of the sessions conducted in the farming area. Participants were also asked not to discuss any knowledge gained during the study.

A fixed research design was used since the subjects, timescale and location were set before data collection began. The study design was also experimental or intervention research because variables were manipulated and controlled to determine causes and effects (Bhide, Shah and Acharya 2018: 380; Bevans 2021). The type of experimental research design used was a RCT design (true-experimental) since there was a control group which was not participants to changes, and an intervention group, which did experience the changed variables (Sibbald and Roland 1998: 201; White, Sabarwal and de Hoop 2014: 1; McCombes 2023a: para. 2 line 1). The research study had a component of community participation; this was to activate the participation of both the community people themselves and their representatives in the conceptualisation of the research idea, decision making and implementation of the research programs.

The type of research used is also applied research because the research's purpose was to develop techniques, products, and procedures by expanding the scientific understanding and solving practical problems of food and nutrition insecurity that female farmers are challenged with. The research explored the well-defined problems of food and nutrition insecurity by explaining the causes and consequences in both Mpharane and Maqoala villages. The type of research data is primary data because the researcher collected data directly through interviews and interventions. The research used two methods of data

collection: qualitative research, which focused on words and meanings and observational research under naturalistic and controlled observation since the experimental or intervention research variables were manipulated and controlled to determine causes and effects. Quantitative research, focused on numbers and statistics (Streefkerk 2022: para. 1 line 1; McCombes 2023a: para. 1 line 1).

3.5.1 Sampling procedures

Probability sampling was used since this procedure means that every member of the sample size has a chance of being selected. Since the research is experimental the longitudinal data collection at several points in time were required because there could be tracking of changes such as behaviour, attitude and understanding of participants over time after the toolkit was implemented. Simple random sampling of individuals was used for the sample size because every member of the sample size then has an equal chance of being selected. Simple random sampling of individuals under the sampling unit allows everyone in the population group an equal chance of being chosen for the simple size. To choose a simple random sample of female farmers in both villages a list was created of willing female farmers that matched the inclusion criteria. Each female farmer was given a number from the list (number 1 to 63 in each village). Figure 14 and Table 1 illustrate further (Gravetter and Forzano 2011: 658; Saunders, Lewis and Thornhill 2012: 128; Thomas 2020: para. 2 line1).

Mpharane village was the intervention group, and Maqoala village was the control group. In each village, the sample size included young female adults aged from 20 years up to older female adults aged 60 years and above. Simple random sampling was conducted in the two villages. Simple random sampling Each female participant was screened for eligibility, and all the eligible participants were randomised into an intervention and a control group. Each group was followed up through time, and the incidence of the outcome in each of the groups was compared. Participants for the research study were female farmers randomly selected from the Mpharane and Maqoala villages in the Mohale's Hoek district under the councils (Cluster) of Thaba-Mokhele. There are 136 villages in Thaba-Mokhele, with 4,526 households and a total number of 9,176 females. In Mpharane and Maqoala, there are 101,50 households with a total number of 151,91 females. The number of eligible female participants were

between Mpharane and Maqoala was 242. The sample size was calculated using Qualtrics calculation with a 95% (Z Score = 1.645) confidence level, and a 6% margin of error. The ideal sample size was 127 participants. The sample size of 127 was divided by two. In summary, there were 63 female participants from Mpharane and 63 from Maqoala village. (Thomas 2021, Qualtrics 2022 and Smith 2017).

$$\text{Necessary Sample size} = \frac{(Z - \text{Score})^2 \times \text{StdDev} \times (1-\text{StdDev})}{(\text{Margin of Error})^2}$$

- Population Size (242 females)
- Margin of Error (Confidence Interval) (6%)
- Confidence Level (95% – Z Score = 1.645)
- Standard of Deviation (.5)

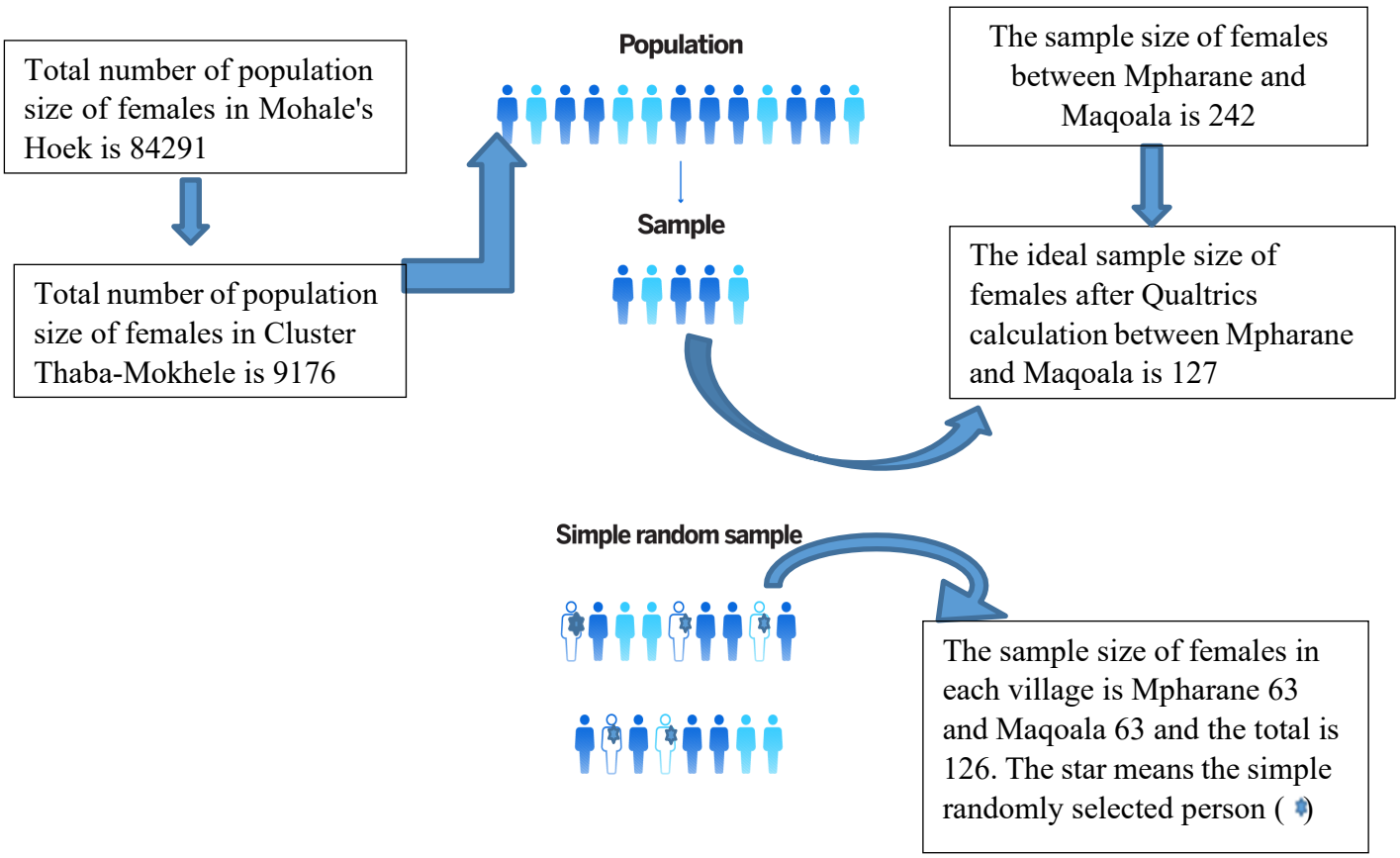


Figure 14: Simple random sampling (White, Sabarwal and de Hoop 2014; UNICEF 2018; Bhide, Shah and Acharya 2018: 380; McCombes 2023b: para. 1 line 2)

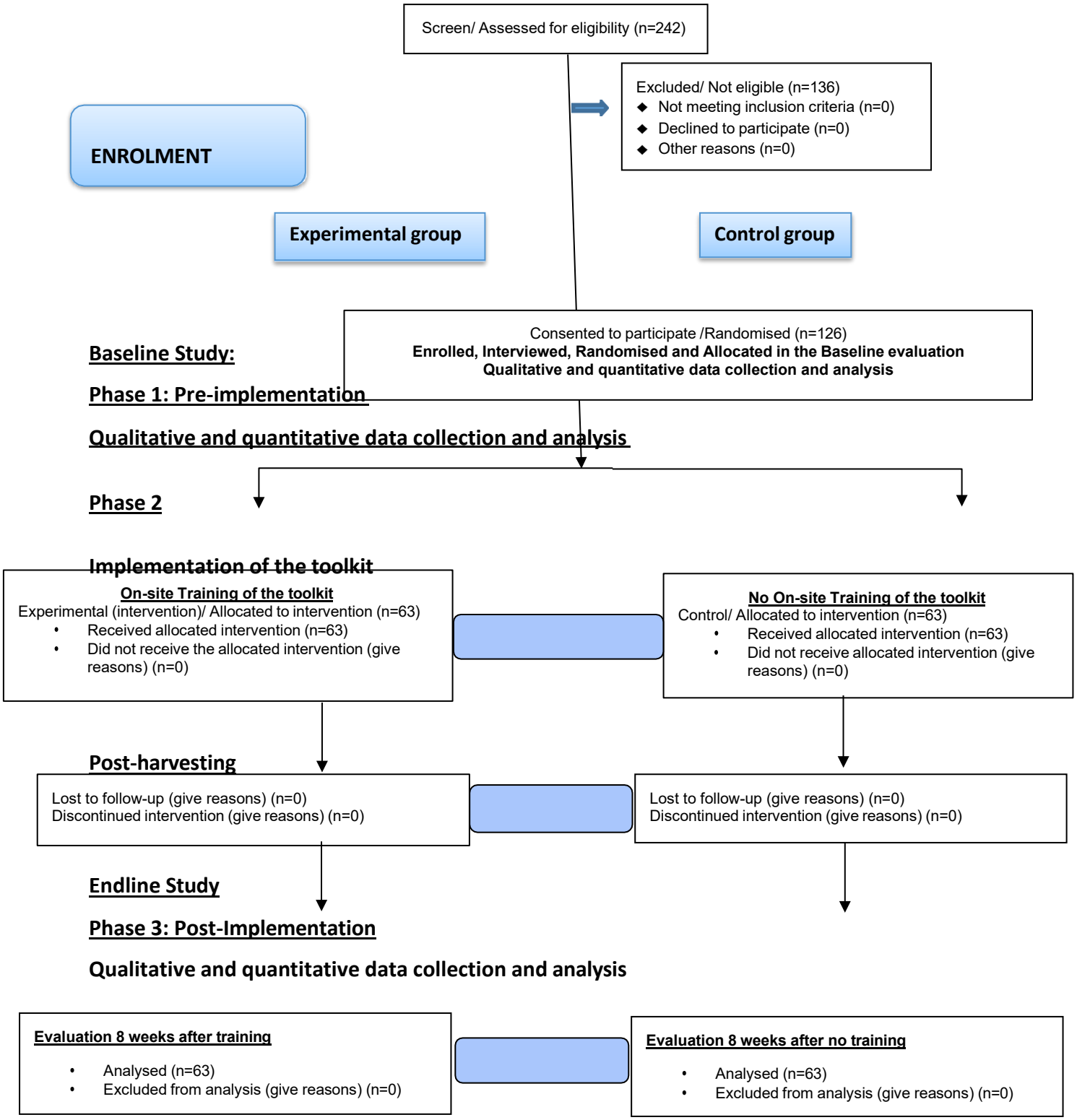


Figure 15: The Adapted CONSORT flow diagram of the progress through the phases of a parallel RCT of two groups (that is, enrolment, intervention allocation, follow-up, and data analysis) (Moher, Schulz and Altman 2001: 1193; Orlando et al. 2017: 3308; Bhide, Shah)

A RCT (true-experimental) was used for data collection. The purpose of the RCT was to see if the incidence of the outcome differed from the randomised experimental (interventions) and the randomised control group (Hariton and Locascio 2018: 1716). The control group received the standard treatment by getting similar resources to the intervention group, except for the formal training of the toolkit that the researcher provided for the experimental group at the start of the project. The control group continued with their normal lifestyle pattern and agricultural activity. The results of the RCT will be assessed by comparing the occurrence of the outcome of interests between the intervention group and control group, and in this study, the researcher will compare dietary diversity and food and nutrition security between the control and intervention groups.

The intervention group received a comprehensive toolkit (Appendix U page)397 comprised of educational programs that included skills development, application, demonstration methods and assessments. Group discussions were included as well to broaden the knowledge and understanding of nutrition knowledge and agriculture knowledge on both theory and practical under pre- harvesting, post-harvesting, preparation, and preservation practices on food. As an incentive for participating in the research study, the control group was provided with a compact summarised training of the toolkit after the intervention to improve their food and nutrition security.

Table 1: Sample random sampling (Inclusion criteria and Exclusion criteria)

Criteria	**126 Participants from Mpharane (63) and Maqoala (63)**
Inclusion criteria	• Women aged 20 to 60 years and above • Women farmers who are heading the households • Women who are caregivers • Women who are currently engaged in farming activity, either as individuals, as part of a co-operative, or in a community project • Women who can read and write basic Sesotho • Women who have been able to cultivate from 2019-2021 • Women who have *not* been able to cultivate from 2019-2021 • Women who own land for cultivating

Criteria	126 Participants from Mpharane (63) and Maqoala (63)
	• Women farmers who are active in any farming activity • Woman that are single parents • Women who are unemployed
Exclusion criteria	• Women younger than 20 years of age • Women farmers not heading the households • Male farmers • Women farmers who are not active in any farming activity • Women farmers who are not part of the study village/area • Members within co-operatives who only perform administrative duties • Women farmers who are employed • Women who do not own land for cultivating

3.6 ASSUMPTIONS

Assumptions made in this study are that:

- The RCT was used for the sample size was acceptable.
- All instruments used were valid for measuring each variable.
- Participants were honest in their responses.
- Farmers are not necessarily aware of the nutritional benefits of certain food crops.
- The knowledge of farmers could be improved.
- The farmers are food insecure.
- There is a double burden of malnutrition due to the poor nutrition status among farmers and household members.
- Policies are created but not implemented at all or not to their full capacity in communities.
- There are limited interactions between government policy makers and communities.
- There are limited policies that address gender inequality in farming in Lesotho, especially in the agriculture sector.
- There are limited resources, technology, and knowledge to create a sustainable

agriculture system to address food and nutrition security in rural communities.

3.7 FIELDWORKER TRAINING

The fieldworkers were allocated by the Nutrition Department of Lesotho. The allocated fieldworkers included a retired teacher and a nurse. All fieldworkers (n=15) were fluent in both Sesotho and English. The fieldworkers had to be trained in administering the questionnaires to the participants to assist the researcher with data collection. The training session for the fieldworkers was done both in English and Sesotho, and the fieldworker training manual guidelines were printed in English (Appendix G). The fieldworkers' training included aspects such as, how to approach the participants: with respect, friendliness, and patience (most important factors when dealing with elderly people), and a code of conduct, which included punctuality, reliability, and consistency because that is key to successful fieldwork since participation depended on the times that the participants were available.

The fieldworkers were trained on how to administer the questionnaires: socio-demographic, HHS and HFIAS, nutrition knowledge and anthropometry measurements on nutritional assessment, food frequency, 24-hour food recall, agricultural and knowledge practices both pre-harvesting and post-harvesting, preparation, and preservation practices. A demonstration was given on how to obtain correct anthropometric measurements and the use of food models to demonstrate correct portion sizes and to assist the participants in identifying unfamiliar foods. An assortment of participatory facilitating methods, such as case studies, role-playing, and communication skills were used to allow the fieldworkers to capture the correct data as well as to make them feel confident when collecting data. The fieldworker training was done over a period of five days from 09:00 am till 15:00 pm and their skills and understanding was measured by the researcher through roleplaying so to demonstrate their understanding.

3.8 ADMINISTRATION OF MEASURING INSTRUMENTS

Table 2: Measuring instruments and data analysis for the Baseline study and Endline study.

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
1. Baseline Study and Endline study			
Phase 1: Pre-implementation and Phase 3: Post-implementation **Qualitative and quantitative data collection and analysis**			
Fieldworkers were trained with an adapted training manual from the department of Consumer Science Food and Nutrition to assist the participants to complete all questionnaires in both self-administration and interview setting. Data collection was done on socio-demographic, HHS and HFIAS, nutrition knowledge and anthropometry measurements on nutritional assessment, food frequency, 24-hour food recall, agricultural and knowledge practices both pre-harvesting and post-harvesting and preparation and preservation practices questionnaires. All the questionnaires in the research had quantifiable factors because they could be measured and described using statistics which included frequencies and percentages to determine the results. The measurements that were used to collect information on the participants' variables such as: gender, age, level of education, nutritional status, levels of food and nutrition insecurity, agricultural knowledge and income were measured using both instruments (scale), questionnaires and standardised tools (training manuals) to educate the farmers to meet the research objectives. The outcomes of intervention would have more than one outcome, namely: the provision of information which focuses on trying to change the knowledge, attitude and norms of the participants. Data analysis was sorted and checked for completeness and accuracy by the researcher. The data was captured on Microsoft Excel® Spreadsheet by the researcher. SPSS version 29 was used to analyse the data. The following tests were used on different data for statistical analyses. • **Descriptive statistics**: which included means and standard deviations, (where applicable) and frequencies were represented in tables or graphs. • **Binomial test:** Tested whether a significant proportion of respondents select one of a possible two responses. • **Paired samples t-test**: Test that compared the means of two variables for a single group. • **McNemar:** Test that determine significant change pre to post for a categorical response variable.			
Instrument one: Socio-Demographic Questionnaire - Used to collect social and demographic data on the population, housing censuses, administrative records, and	A sociodemographic variable questionnaire includes age, education, gender, language, religion, employment, marital status, income levels, migration	To determine the combination of social and demographic factors for both Mpharane and Maqoala village women practising small-scale family	All the data completed on the socio-demographic questionnaires was sorted and checked for completeness

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
household samples (Banda 2003: 1-4; Statistics Bureau 2018). Before the intervention a valid and reliable socio-demographic questionnaire was used to determine the socio-demographic profile of the households. The socio-demographic questionnaire developed by (Napier 2006; Oldewage-Theron and Kruger 2008) was adapted for this specific community by the researcher and the focus group through a pilot study. A socio-demographics questionnaire assists the researcher to understand the target audience so to create products and services the participants need to solve their problem (Appendix G).	background, race, location, and ethnicity. Accommodation status, for example, access to water supply, toilet facilities, environmental sanitation, and problems with pets. Family composition, for example, number of people per household. Work and economic status, for example, employment status, household individual contribution to income for purchase of food, money to purchase food, frequency of food purchases, meals consumed per day, where most meals are consumed and cooking activities; education, for example, the highest education level achieved and household assets. The questionnaire will not be administered again after the intervention. It was administrated in a structured interview by the fieldworkers.	farming to clearly understand the participants' background and verify that the research data is collected from the right population.	and accuracy by the researcher. The data was captured on an Excel Spreadsheet by the researcher and then analysed by utilising the SPSS version 29 for Windows program with the assistance of the statistician. Descriptive statistics including frequencies, and percentages were determined. The results are presented in means and standard deviation in graphs and tables. The data was presented in tables and figures, terms of frequencies and percentages for various categories with summarised interpretations.

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
Instrument two: Anthropometric Measurements - Anthropometry is the study of the measurement of the human body regarding the dimensions of bone, muscle, and adipose (fat) tissue. Malnutrition is assessed by the reduction in body size which can be caused by dietary intake. The basic anthropometric measurements are simple, user-friendly, effective, not complicated, inexpensive, and safe (Appendix H).	The anthropometry measurements include a variety of human body measurements such as weight, stature (standing height), recumbent length, skinfold thickness, circumferences (head, waist, limb, etc.), limb lengths, and breadths (shoulder, wrist). **Weight** Weight is determined to the nearest kilogram (0.1 kg) on a good quality, electronic standardized collaborate medical scale (CCPS - physical scale, scales 2000). Each participant is dressed in minimum or light clothing and shoes, and the socks are removed prior to being weighed. The scale is placed on a flat, hard, smooth and uncarpeted floor. The scale is switched on and the researcher waits until the zero indication (0, 0) appears. The participants stand upright on the platform, facing the fieldworker and looking straight ahead. Feet are to be flat and slightly apart, and the participants stand still until the measurements are recorded in the space provided on the form. The participants then step down from the scale and the fieldworker waits for the zero recording to appear on the digital dial and weighs the	To determine the nutritional status of both the Mpharane and Maquala village women by assessing the BMI which includes body mass (body weight) and measurement of height (stature) (Truswell 2007: 429). BMI is used to estimate and predict the prevalence of underweight, overweight and obese within the population and the risk associated with it. The waist circumference measures can indicate an increased risk if it is ≥88 cm in women. Changes in waist circumference indicate changes in risk factors for cardiovascular diseases. The measurements of blood pressure are taken to determine the prevalence of hypertension.	The weight, height and waist circumference of all the participants were captured on a Microsoft Excel® Spreadsheet and descriptive statistics including frequencies, and percentages were used to classify and determine the BMI, waist-to-height ratio (WHtR) and blood pressure. The BMI was calculated by dividing weight in kilograms (kg) by height in m^2. BMI (or Quetelet's index) = Weight (in kilograms) / [Height (in metres)] ^{2} The results were presented in the following categories: underweight (BMI >18.5), normal weight (BMI 18.5-24.99) overweight (BMI 25.00-29.99)

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
	participant for the second time. The next participant is weighed when the scale's reading is zero. All measurements are taken twice and the average of the two measures is recorded (WHO 1995). **Height** The portable stadiometer (scales 2000) with a sliding head plate, a base plate and three contacting rods marked with a measuring scale is used. The stadiometer stands vertically on a hard flat surface, with no molding, for example skirting board, with the base at floor level. The floor surface is either made out of tiles or cement and not carpeted or covered with other soft materials. Height is measured according to the following procedures: The participant removes his or her shoes. The participant is positioned facing the fieldworker. The participant is requested to stand with shoulders relaxed, with shoulders, buttocks and heels touching each other against the wall. The participant's arms are relaxed at the sides and legs are straight,		and the three obese categories ranged from (BMI 30.00-≥40). The waist to height ratio was measured by dividing waist by height. If the WHtR was ≥0.5, there was a risk of cardiovascular diseases (WHO 2005). The blood pressure measurement data was captured on an Excel spreadsheet to determine the prevalence of hypertension according to the WHO cut-off points (Normal blood pressure) BP systolic BP/Diastolic BP <120 mmHg/<80mmHg, Pre-hypertension SBP/DBP 120-139 mmHg /80-89mmHg, Stage 1 SBP/DBP 140-159 mmHg /90-99mmHg and Stage 2 SBP/DBP ≥160mmgH

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
	knees together, feet flat, heels touching. The participant looks straight ahead before the headpiece is placed on top of the head. The fieldworker then records the participant's height in millimetres (mm) in the space provided on the form. The procedure is repeated twice for each participant. The two readings should not vary by more than 5mm and these measurements are taken to the nearest 0.5cm by using a stadiometer (Lee 2010). **Body mass index (BMI)** The WHO (2016) explains that BMI is a simple index of weight-for-height that is normally used to categorize underweight, overweight and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in metres (kg/m^2). The desirable range for BMI is given as 20 to 25 by the WHO, with values above 30 being associated with obesity. Similarly, values below 18 are indicative of under-nutrition (Barasi 2003: 12). The desirable range for BMI is given as 20 to 25 by the WHO, with values above 30 being associated with obesity. Similarly, values		/≥100mmHg) (WHO/ISH 2003).

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
	below 18 are indicative of under-nutrition (Barasi 2003: 12). Data was collected through the use of a stadiometer, electric scale and recorded on an anthropometric data form (Appendix H). The measurements were then compared and evaluated against reference standards to assess underweight, overweight and obesity. **Waist circumference** The waist circumference is measured with a non-stretchable metric steel tape measure. The circumference is measured at the level midway between the lower rib margin and iliac crest with the tape held all around the body in a horizontal position. It is recommended that measurements of the circumference of the waist be taken while participants are semi-clothed. The participant removes heavy outer garments, for example, jacket or coat, before being measured. Measurements of the circumference of the waist of the participants is taken with all the tight clothing, including the belt,		

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
	loosened and with the pockets emptied. The fieldworker stands at the side of the participant in order to have a clear view of the measurements. The participant stands up straight with the feet together. The participant is requested to relax, especially the abdominal muscles by breathing normally so that the abdominal muscles do not contract and give inaccurate measurements; the reading of the measurements is taken at the end of the gentle exhaling. The tape is held firmly, and its horizontal position should be ensured. The tape should be loose enough to allow the fieldworker to insert one finger between the tape and the participant's body. This procedure is conducted twice, and both measurements are recorded. The average of the two measures is recorded (Barasi 2003: 12). The waist circumference measurements for an increased risk of heart disease are ≥88 cm in women and ≥102 cm in men. Changes in waist circumference		

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
	indicate changes in risk factors for cardiovascular diseases. **Blood Pressure** A digital sphygmomanometer device (Omron) is used for blood pressure measurements on all the participants. The blood pressure is measured with the participant in a seated position and the left arm is used. The participant is asked to remove any clothing on the arm so that there can be direct contact between the sphygmomanometers and the pulse. This procedure is conducted twice and both measurements are recorded. The average of the two measures is recorded.		
DIETARY ASSESSMENT			
Instrument three: The Food Frequency Questionnaire (FFQ) - uses the nine food groups recommended by FAO (2009a: para. 2 line 1) which are different types of meat/animal protein, legumes, starch, vegetables, dairy foods, fruits, sugars and oils. FFQ can give more information if the food items on the questionnaire are two hundred or more (Rankin *et al* 2011:	FFQ is selected as the dietary variety assessment tool for the study to determine the Food Group Diversity Score (FGDS) and Food Variety Score (FVS) of the population. The FFQ instrument also validates the 24-Hour Food Recall. The FFQ that is used does not specify serving sizes (Oldewage-Theron *et al*. 2008). The different Dietary Diversity measures that are referred to as FVS and FGDS are	The FFQ determines the most frequently consumed foods over a period of a week. The FFQ was captured on an Excel spreadsheet and analysed for descriptive statistics using the SPSS version 29 computer software program and presented in terms of means and standard deviation in graphs and tables.	All the data completed in the food frequency questionnaires is sorted and checked for completeness and accuracy by the researcher. The data was captured on an Excel spreadsheet by the researcher and then analysed by utilising the SPSS

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
68). The researcher will adapt the FFQ developed by Oldewage-Theron *et al*. (2008) for this specific community and the focus groups through the pilot study (Appendix I).	calculated as follows: (1) overall variety score (sample count of food items), (2) variety score between all nine food groups and (3) a variety score within every food group (Hatløy, Torheim and Oshaugh 1998: 891). These scores are calculated for a reference period of seven days for this study and were used together to reflect Dietary Diversity in different ways. The FVS consisted of a simple count of single foods and food groups, similar to previous studies in developing countries. The nine nutritious food groups (meat group, eggs group, dairy group, cereal group, legume group, vitamin A group, fruit group, vegetables group and fats group) recommended by the FAO were used for the classification of broad food intakes. A low variety was indicated when less than 30 food types were consumed in a period of 7 days, compared to a medium variety with 30 to 60 foods or high variety with more than 60 foods consumed in the same period (Matla and Hope 2008: 18). All the dietary diversity scores (FVS and FGDS) were calculated from the seven-day FFQ (n=63) period. Tables were drawn up with percentages of different variables		version 29 for Windows program with the assistance of the statistician. The ANCOVA of co-variance is used for statistical analyses. Descriptive statistics including frequencies and percentages are determined. The results were presented as means and standard deviation in graphs and tables. The data was presented in tables and figures, terms of frequencies and percentages for various categories with summarised interpretations.

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
	included in the questionnaire. Data were presented in terms of frequencies, percentages and standard deviation for the various categories. The FGDS and the Nutrient Adequacy Ratio (NARs) were correlated to determine if nutrient adequacy improved as the food group variety increased.		
Instrument four: 24-Hour Food Recall Questionnaire - developed by Wiehl in 1942. The 24-Hour Food Recall is more applicable to different ethnicities and it is a very simple, quick, non-invasive dietary tool (Rankin *et al.* 2011: 69) (Appendix J).	Three 24-Hour Food Recall questionnaires were administered which looked at food quantities and consumption patterns.	To measure and determine the actual nutrient intake of the participants. To determine the top 20 foods consumed by the participants. The nutrient intake was compared to the Estimated Average Requirements (EAR) for women aged 31-50 years old and 51-70 years old (Appendix M).	The results were captured and analysed using the Food Finder computer software version 3 which was developed by the Medical Research Council (MRC) of SA Food Finder Version 3.0 software, based on the SA Food Composition Table of SA (Langenhoven, Kruger, Gouws and Faber 1991; Food Finder 3, 2002). This program was developed to analyse the nutrient content of food items consumed. The nutrient intake and top 20 food items most commonly consumed by the

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
			participants for two weekdays and one weekend day were recommended. Statistical analysis was performed by the researcher, correlations were drawn with certain variables and tables were used to illustrate the results by means and standard deviation for interpretation of the prevalence of the nutrient intake and nutritional status was compared to 100 percent of the DRIs (IoM 2003) for people with different age groups. EARs were used as the reference measure and if not available, Adequate Intake (AI) as Recommended Daily Allowances (RDAs) is indicated for use in individuals and not groups of people (NICUS 2003).
FOOD SECURITY ASSESSMENT			

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
Instrument five: Household Food Security and HHS Questionnaire - HFIAS and HHS questionnaires were used to evaluate the food security status in each of the women famer's households (FAO 2007; Mkhize 2014) (Appendix K).	The questionnaires will include an assessment of food safety and (food) behavioural patterns prevalent within the households of these farmers.	This information was used to classify the households within the community through food security status levels and food practices.	All the data completed on the HFIAS and HHS questionnaires was sorted and checked for completeness and accuracy by the researcher. The data was captured on an Excel spreadsheet by the researcher and then analysed by utilising the SPSS version 29 for Windows program with the assistance of the statistician. Descriptive statistics including frequencies, and percentages were determined. The results were presented in means and standard deviation in graphs and tables. The data was presented in tables and figures, terms of frequencies and percentages for various categories with summarised interpretations.

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
KNOWLEDGE ASSESSMENT			
Instrument six: Nutrition Knowledge and Nutritional Assessment Questionnaire – The Nutritional knowledge survey instrument is used to make valid and reliable measurements on nutritional knowledge, diet knowledge, and food knowledge (Macías and Glasauer 2014; Steyn *et al.* 2005). Existing tested nutrition knowledge questionnaires were adapted and used to test the knowledge of the participants on their overall knowledge on nutrition based on the food dietary guidelines (Whati *et al*. 2005: 83) (Appendix L).	The Nutritional knowledge survey assesses the nutritional knowledge, attitude, and feeding behaviour of the participants. Nutritional knowledge survey also assesses the diet of the participants in terms of energy intake, dietary intake, diet, eating, nutrient intake, food intake, food consumption.	The Nutritional knowledge survey assesses and determines the impact of nutrition policies and the NSA education program initiatives that are designed to help promote the healthy nutritional status of the participants in the study.	All the data completed on the nutrition knowledge and nutritional assessment questionnaires was sorted and checked for completeness and accuracy by the researcher. The data was captured on an Excel spreadsheet by the researcher and then analysed by utilising the SPSS version 29 for Windows program with the assistance of the statistician. Descriptive statistics including frequencies, and percentages were determined. The results were presented in means and standard deviation in graphs and tables. The data was presented in tables and figures in terms of frequencies and percentages for various categories

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
			with summarised interpretations.
Instrument seven: Agricultural and Knowledge Practices Questionnaire - An agricultural survey questionnaire was used to assess knowledge systems and agricultural practices performed by women farmers. (Appendix M): **Farmers' knowledge, attitude and practice** The purpose of this questionnaire was to measure the accessibility of resources to practise all methods of agriculture in order to produce food and to evaluate the knowledge of the farmer.	The agricultural survey questionnaire assessed accessibility of resources such as water for both human consumption and agricultural practices, land, agricultural production of crops, and livestock; farm income and farm assets were also assessed. The agricultural survey questionnaire assessed the knowledge of the participants when it comes to practising effective and sufficient methods in pre- and post-harvesting.	It also determines the knowledge of the participants on pre-harvesting and post-harvesting.	All the data completed on the agricultural and knowledge practices questionnaires was sorted and checked for completeness and accuracy by the researcher. The data was captured on an Excel spreadsheet by the researcher and then analysed by utilising the SPSS version 29 for Windows program with the assistance of the statistician. Descriptive statistics including frequencies, and percentages were determined. The results are presented in means and standard deviation in graphs and tables. The data was presented in tables and figures in terms of frequencies and

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
			percentages for various categories with summarised interpretations.
Instrument eight: Food preparation and Food Preservation Practices Questionnaire - The purpose of this questionnaire was to evaluate the preference of farmers on their food preservation methods and their understanding on preservation methods (Appendix N).	The food preservation and preparation questionnaire were to assess the knowledge and preference of the participants when it comes to the type of food they want to prepare, and they want to preserve and the technique and skills that they have when it comes to health and safety in food preparation and preservation	**Instrument eight: Food preparation and Food Preservation Practices Questionnaire -** It was to determine the knowledge and preference of the participants are skills methods when it comes to food preparation and food preservation under health and safety of food preparation.	All the data completed on the food preparation and food preservation practices questionnaire was sorted and checked for completeness and accuracy by the researcher. The data was captured on an Excel spreadsheet by the researcher and then analysed by utilising the SPSS version 29 for Windows program with the assistance of the statistician. Descriptive statistics including frequencies, and percentages were determined. The results are presented in means and standard deviation in graphs and tables. The data was presented in tables

MEASURING INSTRUMENTS	VARIABLES	OBJECTIVES	DATA ANALYSIS AND STATISTICS
			and figures in terms of frequencies and percentages for various categories with summarised interpretations.

3.9 THE DEVELOPMENT, VALIDATION, AND IMPLEMENTATION OF A SUSTAINABLE, NSA TOOLKIT TO ADDRESS FOOD AND NUTRITION INSECURITY IN LESOTHO

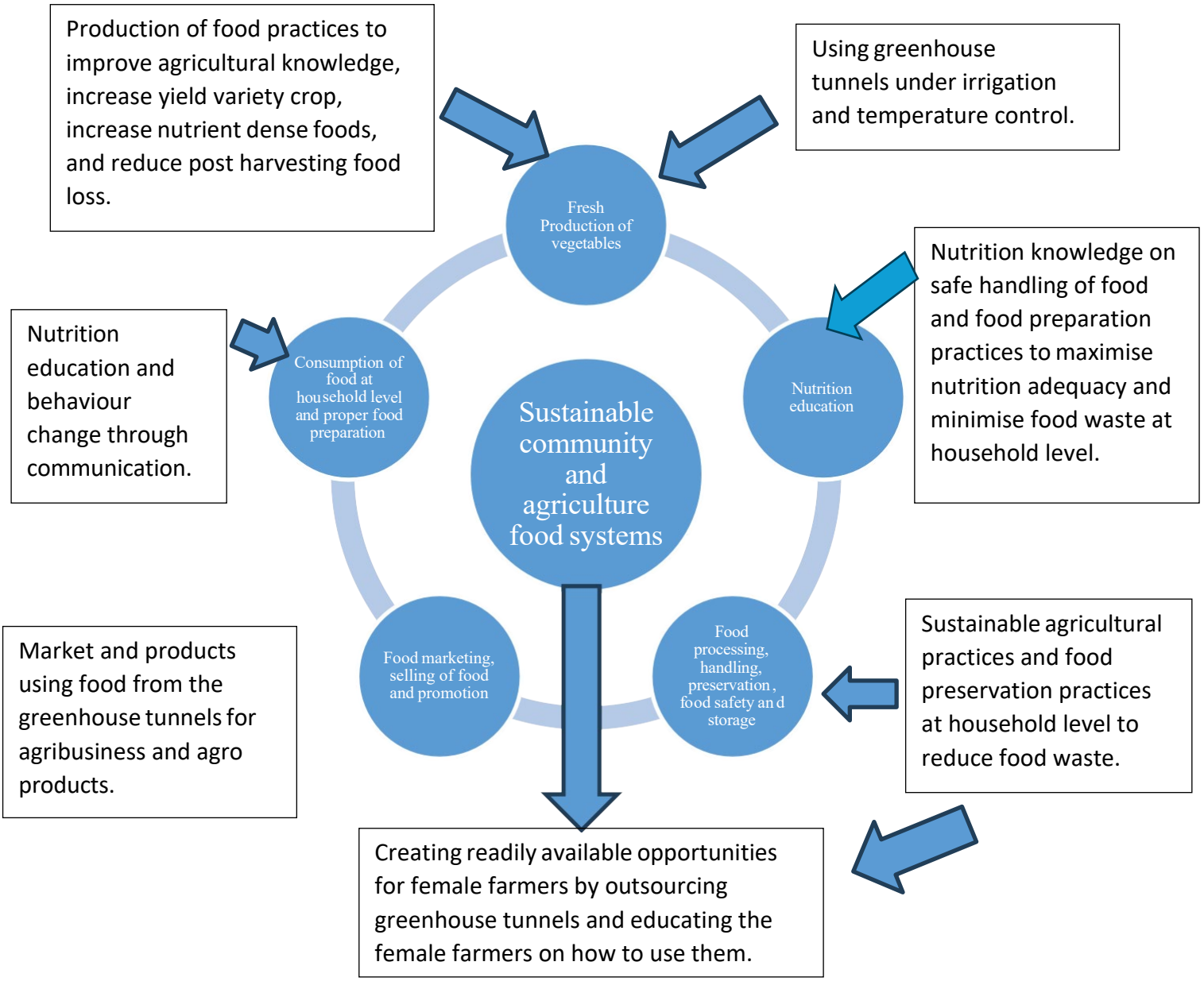


Figure 16: The summary of a sustainable NSA toolkit

3.10 APPENDIX T: THE SUSTAINABLE NUTRITION-SENSITIVE AGRICULTURE (NSA) TOOLKIT IN THE FORM OF A TRAINING MANUAL.

Appendix T contains the training manuals for both the trainers' and participants' intervention (toolkit). The NSA toolkit has two programs which are: the sustainable agriculture program and the NSA program. Further details of the development, validation, and implementation of a sustainable NSA toolkit to address food and nutrition insecurity have been provided in this chapter and chapter 4.

Based on the literature review in chapter 2, both developing and developed countries are still faced with the challenge of food and nutrition insecurity. The UN and the UNA's policies were used to develop a sustainable NSA toolkit to help female farmers in addressing food and nutrition insecurity in their community. The author of the research found it fitting to apply the IFAD and 2016-2025 UNs Decade of Action on Nutrition, specifically the UN Decade of Family Farming (2019-2028) concepts and use them as the supporting bodies for the development of the research toolkit since the major focus of the two bodies is based on the development of the lives of the people living in rural areas in developing countries and practising agriculture. IFAD aims to invest in rural people by empowering them with the hope of increasing food security, improving nutrition and increasing incomes for both individuals and their families by assisting the people to build resilience, expand businesses and take charge of their development.

The UN Decade of Family Farming (2019-2028) aims to create awareness and work with family farmers as it believes that family farmers are the key agents in the development of strategies for food and nutrition security. Globally there are over 500 million family farms, most of which are small-scale with limited opportunities to improve their livelihood and the well-being of their communities. These farms produce over 80% of the world's food, although the farmers often have minimal access to energy, clean water, sanitation, and decent jobs, and have higher rates of poverty. Despite these constraints, family farmers have huge potential in helping to ensure that food systems contribute to healthier diets, ensuring the environmental, social, and economic sustainability of our food systems. Supporting family farmers also mean managing land rights and developing enabling policies and investment plans.

In this study, it is understood that food and nutrition insecurity is a complex topic that needs a holistic approach when addressing food and nutrition insecurity. Figures 3, 6, 7, 8, 9, 10 and 11 in chapter 2 were used as the foundation for the holistic approach when developing the current research conceptual framework of the toolkit in Figure 5 in chapter 2. The figures illustrate the distinctions and overlaps between hunger, food insecurity, nutrition insecurity, undernutrition, sustainable agriculture, health, food, education, research, and sustainable food systems.

The researcher understands that NSA should be considered and used in food and nutrition interventions as there is a possibility of achieving food security and good nutrition. The researcher is in agreement with the UN under the SDGs 2015, where NSA was embedded and introduced as an intervention to reinforce and improve the underlying and basic causes of malnutrition presented in the UNICEF conceptual framework as discussed in detail in chapter 2. The researcher promotes the NSA and encourages the programs to focus on improving access and consumption of high-quality diets for all household members. Moreover, the researcher understands that contextual, cultural, economic, and food environment factors (including markets) need to be taken into account when designing and implementing NSA because there are still important knowledge gaps to be filled, including questions of sustainability, scale-up and cost-effectiveness of NSA.

The researcher's major focus when developing the toolkit was to concentrate on and improve four major aspects of NAS:

- Sustainable community and agricultural food systems in producing food practices to improve agricultural knowledge, increase the yield of a variety crops, increase nutrient-dense foods, and reduce post-harvesting food loss.
- Nutrition knowledge in understanding the safe handling of food and food preparation practices to maximise nutrition adequacy and minimise food waste at the household level.
- Creating readily available opportunities for female farmers by outsourcing greenhouse tunnels and educating the female farmers on how to use them.

- Sustainable agricultural practices and food preservation practices at the household level to reduce food waste.

All these significant aspects have been depicted in the conceptual framework (figure 5) and elaborated in the training manual.

The toolkit has two programs:

- The sustainable agriculture program which focuses on agriculture practices and the use of greenhouse tunnels for fresh produce production.
- The sustainable NSA program which focuses on nutrition education.

In support of the above information, the toolkit was developed with two programs to cover the holistic approach. One of the many ways to improve small-scale farming is by adapting new agricultural practices and emboldening them with traditional agricultural practices. As a result of encouraging the old and new practices, there is hope to improve and increase crop yield production. Furthermore, improving agriculture can lead to the production of more diverse crops and vegetation, which can lead to food diversity. As a result, this could provide better food choices in diets when combined with sound nutrition information, education, and behaviour change through communication, training, and practices.

The sustainable NSA program, and sustainable agriculture program under food preservation and preparation practices, are aimed at promoting healthy eating behaviour changes and increasing the participants' knowledge, or changing attitudes and beliefs, when it comes to food consumption.

Since the toolkit has both the agri-business and agro-products, the innovation introduces a business sector that offers business activity, product and service which encompasses farming and farming-related commercial activities such as marketing and selling of fresh produce (vegetables) and processed foods in the form of preserved products using bottling to prolong the shelf life and create a variety of products. In short, the toolkit will educate the participating female farmers about production, processing, and distribution.

See Appendix (T) for the sustainable NSA toolkit in the form of a training manual:

- A sustainable NSA toolkit for the facilitator; a crop-based approach to address food and nutrition insecurity using greenhouse tunnels in rural communities.
- A sustainable greenhouse vegetable planning participants' handout booklet derived from the sustainable NSA toolkit, a crop-based approach to address food and nutrition insecurity using greenhouse tunnels in rural communities.

3.10.1 Conceptual framework

The study follows the conceptual framework outlined in Figure 17 which Depicts the intervention and objectives of the study.

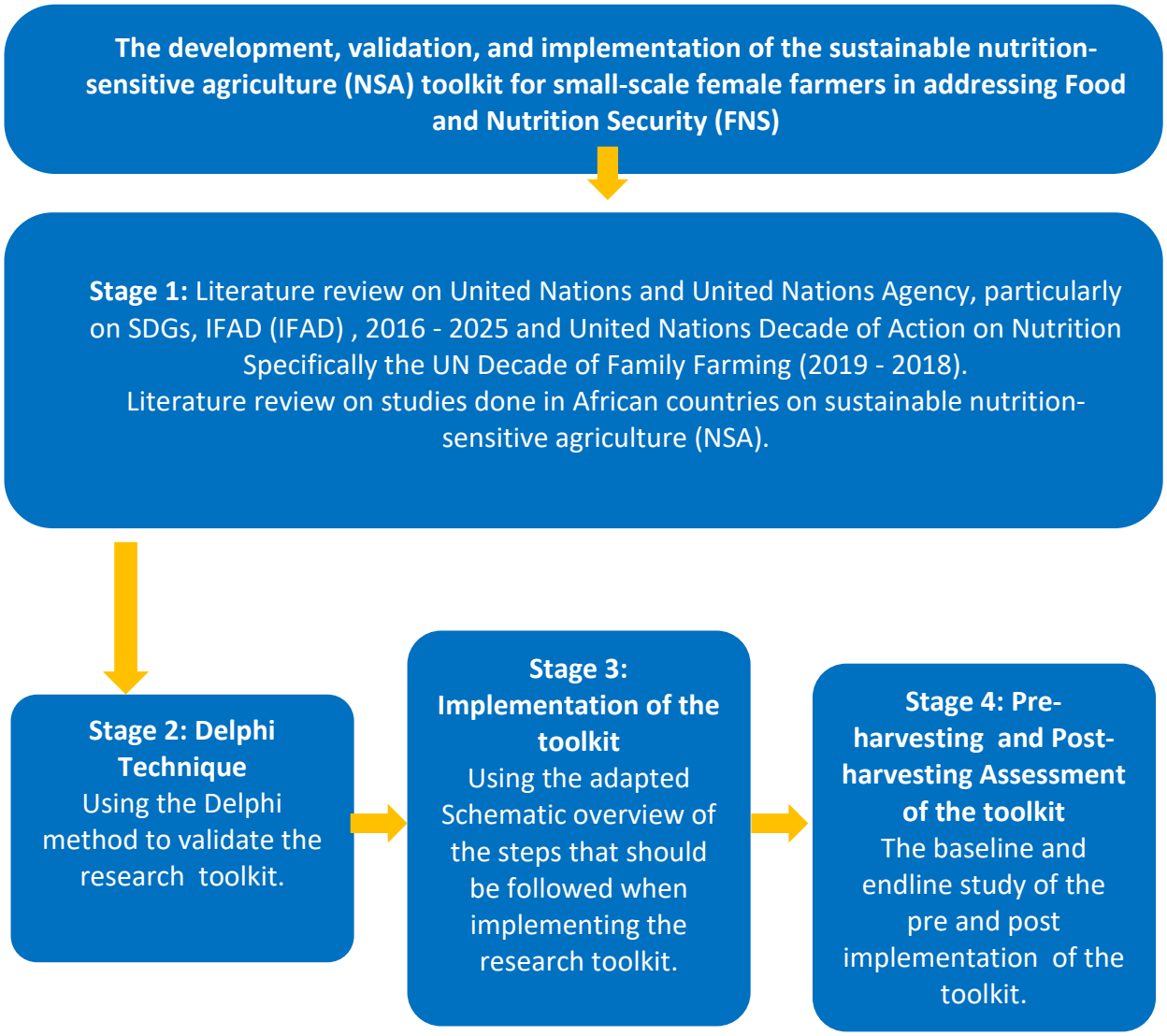


Figure 17: Conceptual framework of the intervention methodology

3.10.2 The development stage of the toolkit in the form of a training manual

Figure 17 above depicts the summary of the conceptual framework of the stages of the development, validation, implementation, and assessment of the toolkit. The development stage has embedded some of the components of the National Food for Work Programs (NFWP) 2004, which focused on the significant number of rural farmers producing food to feed their families for part of the year (van Esch *et al*. 1997: 6). The second program the researcher has used is the Income-transfer program which focuses on cash or assistance such as food stamps, subsidised rations, and other targeted measures for poor households. This was to increase food-purchasing power and improve dietary intake (Barrientos 2009: 165; Floate, Marks and Durham 2019: para. 2 line 2). The researcher has introduced the infrastructure of the greenhouse tunnels with irrigation and temperature control systems. The researcher has incorporated agri-business and agro-products for both household consumption and small-scale commerce for the female farmers from the products they produce from the greenhouse tunnels to highlight the sustainable community and agriculture food systems.

Step 1: Planning the development of the toolkit using the sustainable NSA toolkit conceptual framework

- Incorporate agriculture, nutrition objectives, actions, and indicators in the toolkit's design.
- Assess the local context to understand how best to address nutrition problems.
- Identify and mitigate potential harm to nutrition of agricultural investments using greenhouse tunnels.
- Increase equity by ensuring participation and access to resources.

Step 2: Taking action

- Empower women and ensure equal access to resources, technologies, services, and information for farming and other agricultural businesses.
- Incorporate nutrition promotion, education and behaviour change communications in project activities.
- Maintain or improve natural resources.
- Facilitate diversification of production and livelihoods to improve availability

and resilience e.g., increase production of nutrient-dense crops.

- Increase incomes through the production and development of value chains for various nutritious foods.
- Improve processing, storage, and preservation to retain nutritional value, address food safety and reduce post-harvest losses (with positive effects for income and prices).
- Expand markets and market access for nutritious foods.

Step 3: Creating a supportive environment

- Ensure program coherence to support nutrition throughout the supply chain.
- Improve control of undernutrition and agriculture by drawing up an action plan by allocating adequate budgetary resources.
- Implementing nutritional and agriculture surveillance activities and supporting multisectoral activities.
- Develop information systems to support analysis, monitoring, management and evaluation of consumption, production, processing and marketing aspects of NSA and local food systems.
- Advocate for improving nutrition through agriculture at a local level.

3.10.3 The validation stage

The researcher has used the Delphi technique to validate the toolkit. Grime and Wright (2016: 1) and Dalkey, Brown and Cochran (1969: 1) defined the Delphi technique as a method that facilitates a structured group of expert opinions to gather a consensus (a general agreement) on complex problems, expensive endeavours, and uncertain outcomes through the distribution of a series of questionnaires. The principles of the method are that more minds are better than a single mind, and when used as a forecasting tool, structured group efforts lead to more accurate forecasts than unstructured ones. Three experts from different organisations were approached and asked to participate in the validation of the toolkit using the Delphi technique namely: the National University of Lesotho (the Department of Agriculture), the DUT (the Department of Consumer Science: Food and Nutrition) and the Mangosuthu University of Technology (Department of Community Extension). The Delphi technique was used in the research study since each expert contributes their knowledge

which then solidifies the different concepts of the study because having more experts makes it easier to produce concrete results. See appendix (s) for the questionnaire used in the Delphi technique validation and report created after the questionnaire was conducted. Below is Figure 18 of the Delphi technique procedures used in the validation of the sustainable NSA toolkit for the research study.

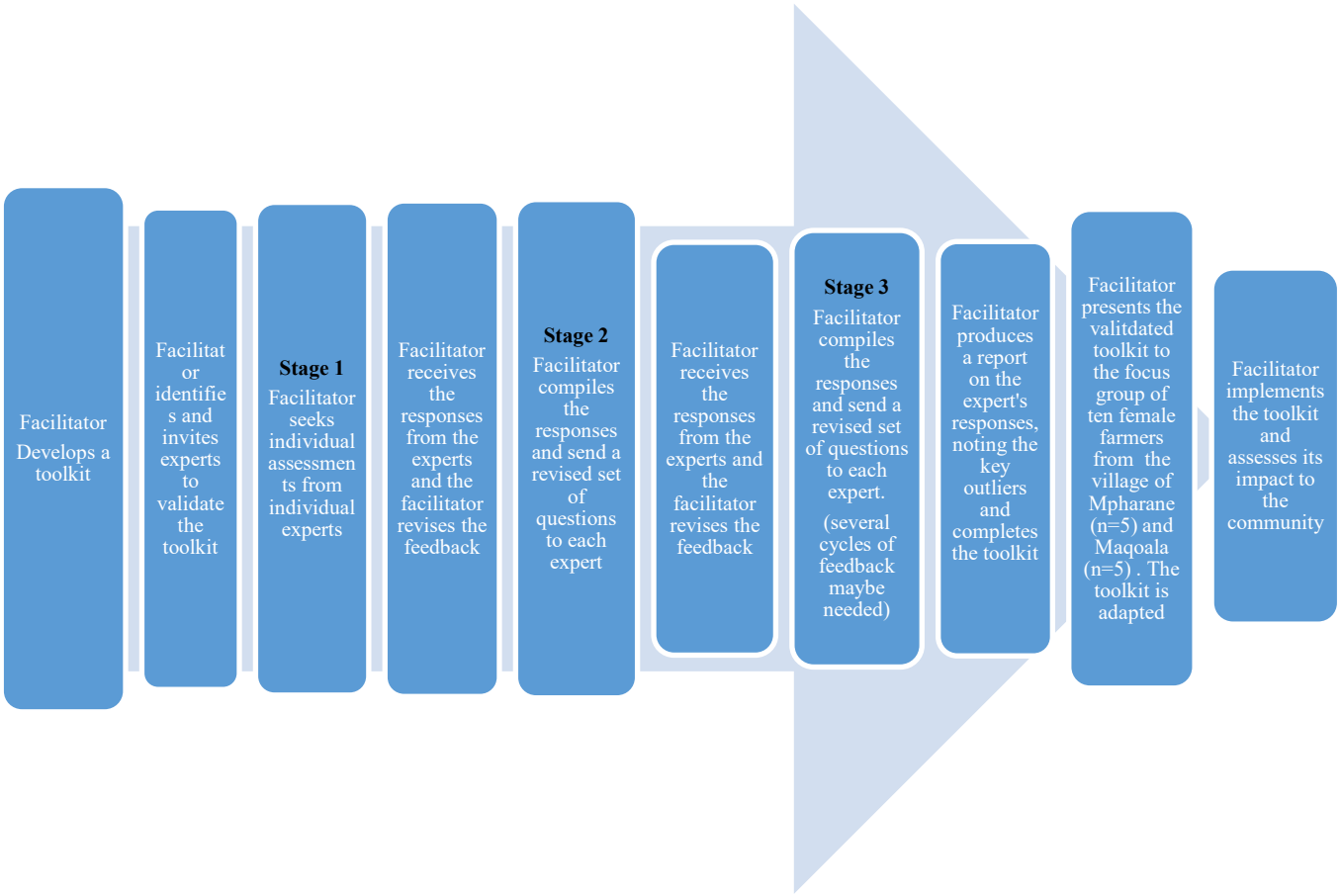


Figure 18: The Delphi method used in validating the sustainable NSA toolkit for the research study **(Grime and Wright 2016: 1 and Dalkey, Brown and Cochran 1969: 1)**

3.10.4 The Implementation Stage

Step 1: The Baseline Study

- **Phase 1: Pre-implementation**

  Enrolled, Interviewed, Randomised and Allocated in the Baseline evaluation.

  Qualitative and quantitative data collection and analysis.

The Process of implementation of a sustainable NSA toolkit

- **Community meeting with groups or individuals who can potentially provide the information (learning about the community)**

- As indicated in 3.2 of this chapter of the dissertation under Ethical Consideration a meeting with the councillor of the district of Mohale's Hoek was arranged to obtain permission in a written form to conduct the research in the two villages of the district and a letter was given to him explaining the research study.
- A meeting was arranged to meet with the chiefs from the two villages, and information letters regarding the research study were given to the chiefs from Mpharane village and Maqoala village. The meeting was conducted to discuss the research project and gain permission in a written form to conduct the study in the villages.
- The chiefs would assist in creating a community forum made up of five local women from each village to explain and inform all parties about the study that would take place in the villages. The ten women would help the researcher understand the dynamics and interests of the women residing in the two villages. The community forums would also help with the adaptation of the research questionnaires so that the questionnaires could be tailored to the community's needs. The community forums would also help with adapting the training manuals.

- **Situation assessment**

- After the adaptation of the research questionnaires and training manuals, a pilot study was conducted with ten community members (female) from each village for them to assist with validating and reliability assessment of the adapted questionnaires and training manual. The twenty women from the two villages were excluded from the main research study.

- **Feedback**

- The results of the situation assessment were reported to and discussed with the community. The results were presented in a language and format and at a level that was understood in the community. The findings were presented in a manner that did not affect any individual unfavourably.

- **Enrolment (screened/assessed for eligibility)**

- Once all the questionnaires had been adapted, probability sampling was used to obtain the sample population and sample size. After the probability sampling, simple random sampling was used to obtain the desired sample size of 126 female participants as indicated in Figure 16 simple random sampling in this chapter of the dissertation.
- The 63 female participants from each village were provided with an information letter outlining the purpose, aims and objectives of the study. The letter was translated into Sesotho to allow all the participants to have access to the information and to give them the opportunity to ask questions and raise any concerns as indicated in Figure 15 the adapted CONSORT flow diagram in this chapter of the dissertation.
- For the participants who were unable to read, the letter was read to them in Sesotho and explained to them in detail by the researcher. Once the participants had a clear understanding of the study, they were requested to sign a consent form, and the participants that could not write were requested to use a thumbprint or draw an X.
- Once the sample size was concluded, the researcher and the chief from Mpharane and Maqoala village decided on the land that would be used for the Greenhouse Tunnels. Once the land was selected, there was an allocated of six Greenhouse Tunnels. Each Greenhouse Tunnels' quality was a 10m wide x 30m long x 4m structure with 200 microplastics net for covering the complete tunnel (sawed 7 installed), strapping, hoist for flaps, gates, and extra support anchors (to stabilise the tunnels against strong wind). Further details are discussed in the following pages and in the training manual. As discussed in previous pages the intervention study had two clusters: the experimental, or intervention group, and the control group with similar socio-demographic profiles.

- **The administration of the programs to the control group**

The control group was notified to refrain from engaging in any sessions conducted in the farming area (Mpharane) and not to discuss any knowledge gained during the study. The control group received the standard training by being exposed to similar resources as the experimental group, except for the formal training and monitoring during the intervention that the researcher provided to the experimental group. The control group continued with their routine lifestyle patterns and agricultural activities. The results of the RCT are assessed

by comparing the occurrence of the outcome of degrees of interest between the experimental group and the control group. The nutrition knowledge, agricultural practices, food preparation and food preservation practices of the control group are compared to those of the experimental group using the same criteria. As a reward for participating in the research study, the control group was exposed to a compact summarised training session on the toolkit after the intervention to improve their food and nutrition security with the presumption that the toolkit would have a positive impact on the food and nutrition security status of both the Mpharane and Maqoala village participants.

- **The administration of the programs to the experimental group**

The experimental group was exposed to comprehensive educational programs that included skills development and application, demonstration methods and assessments during the group discussions to broaden their knowledge base and understanding of nutrition, agriculture practices, food preservation and food preparation. The experimental group was expected to gain knowledge from these practices. The study aimed to help participants to gain knowledge to improve and promote healthy eating behaviour changes. This knowledge would be able to change attitudes and beliefs when it comes to food consumption, unhealthy diets, and agricultural practices.

The toolkit contains theoretical and practical training components and pre-intervention and post-intervention questionnaires. Before the implementation of the toolkit, the questionnaires were administered to assess the knowledge of the participants regarding agriculture and agricultural practices, basic human nutrition knowledge, nutrients, food safety, food preparation, diet, and food preservation practices. After the implementation of the toolkit, the second administration of questionnaires was conducted to assess the dietary intake (as mentioned above) gained by the participants to achieve food and nutrition security.

Both theoretical and practical training sessions were implemented at the beginning of the programs. This was in the form of formative assessment, and no summative activities were conducted. All written educational material was provided through visual and written communication, which the participants took home with them. This was done so that the female farmers could use the materials to remind themselves of what was communicated

verbally during the educational sessions. Other studies have emphasised the benefit of using print media in the form of booklets and leaflets to clarify and reinforce messages consistently. The limitation of this, however, is that these materials do not guarantee readability and understanding (Billek-Sawhney *et al*. 2000; Horner *et al*. 2000). To improve their knowledge of the reading material and the discussions, recorded audio sessions were provided to reinforce the nutrition, agriculture and food preservation and preparation practice education messages. Pre-and post-evaluations were used to measure the effectiveness of the intervention programs (Oshaug 2006; Healthy People 2010). Nutrition, agriculture and food preservation and preparation practice education topics were used to develop interventions through lesson planning.

Qualified chief training officers (n=2) administrated all training. The chief officers were specialists in nutrition, agriculture, horticulture and food and food science. Trained fieldworkers assisted the researcher and the chief officers in carrying out the research interventions. For example, in crop planting, the demonstration was done by an agricultural extensionist and horticulturalists. The chief officers were postgraduate students with master's qualifications, and they supervised the progress of the toolkit every week. To ensure compliance and the quality of the work during the intervention phases, there was supervision in the farming areas. The fieldworkers were trained in advance on conducting a survey, and the researcher supervised fieldworkers on the correct procedures in the training manual. This supervision was done to ensure consistency throughout the target group. Supervising entailed observing and recording each intervention phase by the researcher, chief officers, field workers, and participants.

The researcher visited the farming area once a month to engage in program roll-out and to monitor the progress of implementing the new techniques. This enabled the researcher to note and measure any limitations that may have caused the farmers not to fully understand the programs. In addition, any barriers that may have caused the farmers to withhold valuable information were able to be identified. This information was used to report on the challenges encountered during the intervention.

The crops grown were identified by the Lesotho government, the female farmers, agricultural

extensionists and horticulturalists together with the researcher in terms of being socially and culturally acceptable. The crops were grown and harvested within the normal growing season of each crop. The type of crops selected as being socially and culturally acceptable influenced the nature of the planting process. Winter crops and summer crops are grown and harvested in different phases. This can take as much as six months, taking the training soil quality assessment, planting, watering and caring, fertilising and harvesting seasons. With the use of greenhouse tunnels all the mentioned obstacles were put to test since the greenhouse tunnels had irrigation systems and temperature control.

Step 2: On-site training of the toolkit for the experimental group

- **Phase 2: Implementation (Training)**
  Recruiting and training of fieldworkers
  Implementation of the toolkit through on-site training of the toolkit

Part 1: Aspects of production

The aspects of production regarding this research are elaborated in Appendix N where a diagrammatic representation is made of the phases of decision-making, production planning, securing finance, buying inputs, growing produce, and harvesting, selling, or marketing your product, paying your debts, and saving some money for the future.

Part 2: Site selection and installation of greenhouse tunnels

The site selection and installation of the greenhouse tunnel in this research is elaborated in Appendix O where a diagrammatic representation is made of the phases of selecting the fields**,** identifying the fields for planting, and installing the six greenhouse tunnels, ensuring that the site gets at least six full hours of sunlight daily (for vegetables), considering the availability of water, and considering past uses of the land.

In addition, training was provided on preparing and developing the fields, cleaning the fields, developing, and designing the plantation on the fields, gathering the required resources such as tools, seeds, and greenhouse tunnels, deciding on the field sizes, marking the fields clearly

with field names, including plans for a storage area for tools and other equipment, as well as a compost area, and arranging for land preparation. Lastly, the installation of greenhouse tunnels 10m wide x 30m long x 4m high made of treated mild steel tunnel with irrigation and temperature control systems was completed. Training and demonstration of the use of greenhouse tunnels were given to the researcher, fieldworkers, and participants.

Part 3: General planting techniques

The general planting techniques in this research are elaborated in Appendix O, where a diagrammatic representation is made of the phases of providing training on planting vegetables in greenhouse tunnels, timing of operations, and season extension.

Part 4: Developing the market and product (Agri-business and Agro-products)

The developing of the market and product (Agri-business and Agro-products) for this research is elaborated in Appendix O where a diagrammatic representation is made of the phases of nutrition education focusing on healthy eating of the planted vegetables**,** teaching the farmers how to prepare and preserve foods, and reduce food wastage, and loss of vegetables, and basic supplies for setting up a farmers' market stand (Community Supported Agriculture (CSA)).

Step 3: The endline study

- **Phase 3: Post-implementation (post-training)**

  Qualitative and quantitative data collection and analysis

Monitoring and evaluation

The assessment of the impact stage

Part 5: Post-harvesting and post-training

The post-harvesting and post-training regarding this research are elaborated in Appendix O where a diagrammatic representation is made of the phases of seedling production, making compost, production records**,** financial records**,** monitoring, evaluation after training, and repeat evaluation eight weeks after training.

3.11 CONCLUSION

In conclusion, this chapter has presented an outline of the research methodology approach for data collection and data analysis methods used at the baseline and endline of the pre-training and post-training phases of the research study. Food and nutrition security programs can play a vital role in preventing and reducing malnutrition, hunger, and poverty and improving people's livelihoods, provided that the programs are developed, implemented, and validated successfully. For any developed food and nutrition security programs to be successfully implemented, fundamentals such as food and nutrition security policies, legislation, investors, stakeholders, governments, program developers and researchers are required to work together under related topics such as sustainable agriculture, sustainable food systems, sustainable agri-business, and agro-products. The next chapter will provide the results, findings, interpretation, and discussion of the study.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter presents results, findings, and discussions of the study's quantitative and qualitative data with Baseline (BL) and Endline (EL). A fixed research design was used since the subjects, timescale and location were set before data collection commenced.

The qualitative data collection used was an observational research method under naturalistic and controlled observation because experimental or intervention research variables were manipulated and controlled to determine causes and effects. The type of experimental research design used was a randomised controlled trial (RCT) design because there was a control group and an intervention group.

The quantitative data determined the interaction between the socio-economic conditions, dietary diversity, nutritional adequacy, food consumption patterns, food security status, and agricultural practices in relation to food insecurity in households headed by small-scale rural female farmers for household consumption and local small-scale commerce. The results have been tabulated and interpreted.

The sampling techniques resulted in n=126 participants residing in rural households in the district of Mohale's Hoek, Lesotho. The experimental group was from Mpharane n=63 participants, and the control group was from Maqoala n=63 participants, each with BL and EL data. The results are presented in percentages (%) unless otherwise stated.

4.2 RESULTS OF THE INTERVENTION

4.2.1SOCIO-DEMOGRAPHIC RESULTS

The socio-demographic results present the study population categorised in percentages and numbers according to the sample size, accommodation, family composition, work status, income, education, and assets.

4.2.1.1 Personal Information

Table 3: The role of the participants in the family and language spoken

VARIABLE	**NUMBER (%) (N=126)**
The language spoken in the house	
Sesotho	100 (126)
The role in the family	
Mother	100 (126)
	Mean age years (SD)
The whole group	40.40±12.64 (126)
Mpharane	41.00±13.19 (63)
Maqoala	40.67±12.12 (63)

The information in Table 3 indicates that all the participants (100%) spoke Sesotho, and all the participants were mothers from both villages, with the mean age for the participants at 40.40 years and a SD± of 12.64.

4.2.1.2 Accommodation and Family Composition

Table 4: The living conditions of the households

VARIABLE	**NUMBER (%) (N=126)**
The living situation at the moment	
Own house/flat	100 (126)
Do other people live in the house with you	
Yes	100 (126)
Total	100 (126)

Table 4: The living conditions of the households

How many people are permanent residents living in the house?	
1	9.5 (12)
2	21.4 (27)
3	16.5 (21)
4	18.3 (23)
5	14.3 (18)
6	7.9 (10)
7	5.6 (7)
8	1.6 (2)
9	1.6 (2)
10	1.6 (2)
10+	1.6 (2)
The number of rooms per household	
1 room	61.9 (78)
2 rooms	16.7 (21)
3 rooms	11.9 (15)
4 rooms	9.5 (12)
Total	**100 (126)**
Other houses/ shacks within the yard	
Yes	50.8 (64)
No	49.2 (62)
Total	**100 (126)**

The results in Table 4 show that all the participants had full ownership of the housing unit, and all the participants resided with other people; the majority 21.4% people resided with two people. A large number of 61.9% of the houses had one room, and 16.7% of the houses had two rooms, while 11.9% of houses consisted of three rooms. Half of the participants, 50.8% had other houses or shacks within the yard.

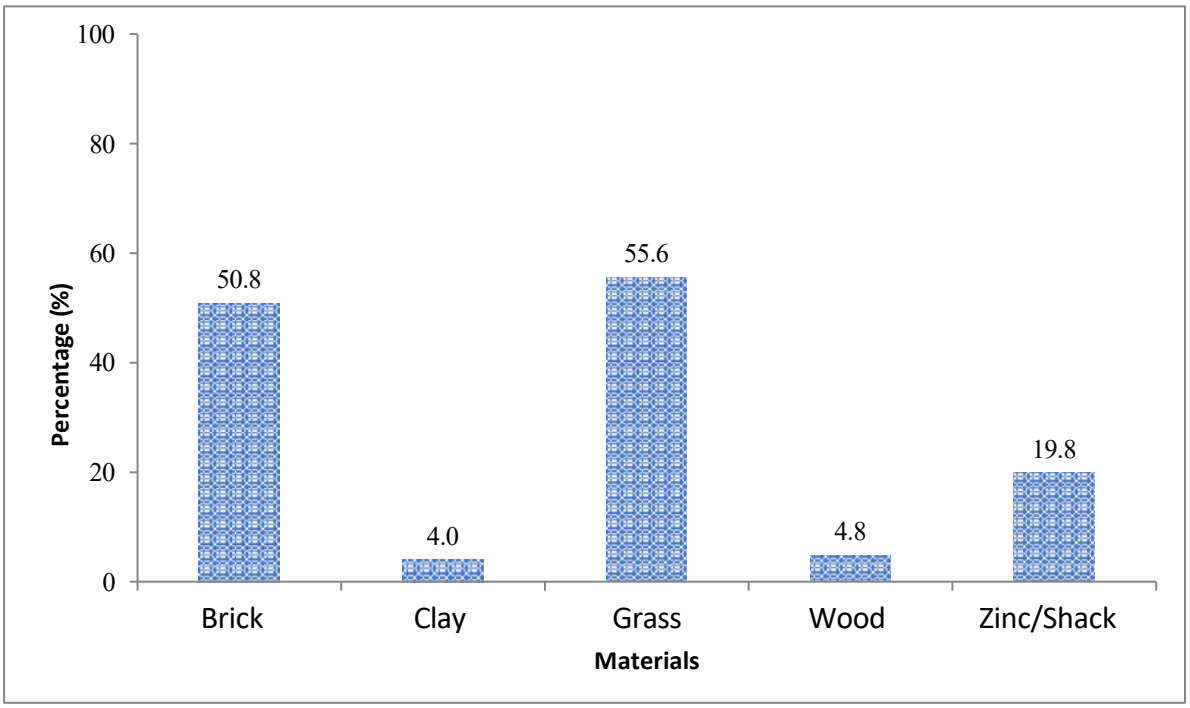


Figure 19: Type of material used to construct the houses in Mpharane and Maqoala villages

Figure 19 displays the type of material used to construct the participants' houses (n=126). The majority of participants, 55.6%, resided in houses made of grass, 50.8% resided in houses made of bricks, and 4.0% of the houses were made of clay.

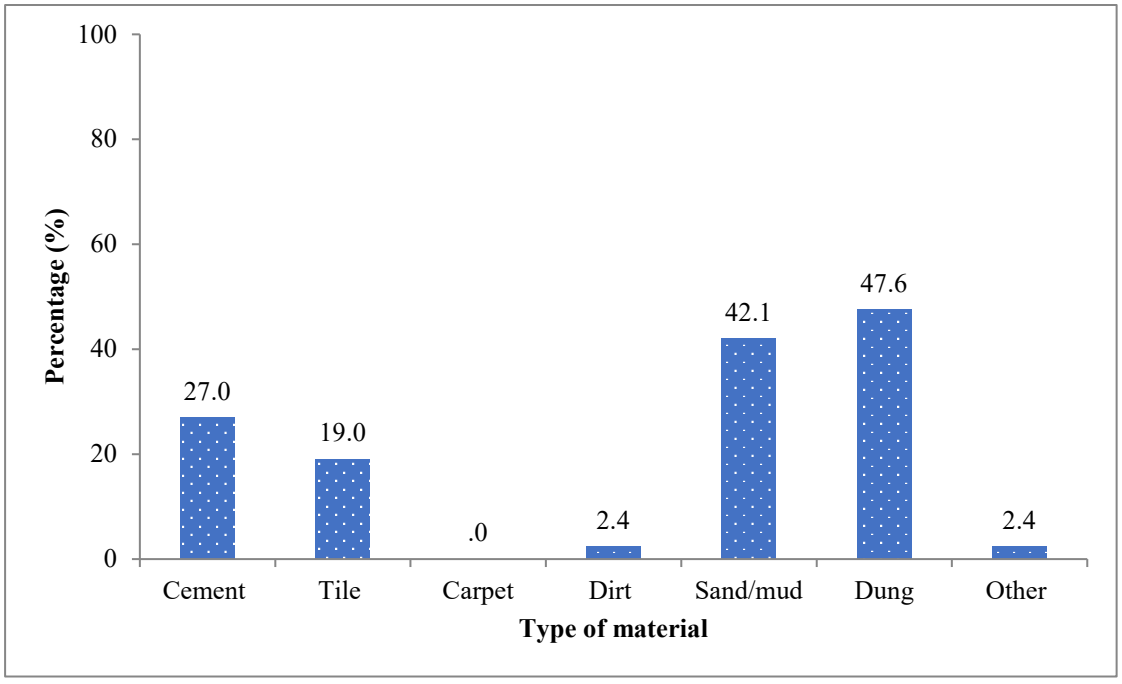


Figure 20: Type of material used for the floor for Mpharane and Maqoala villages

As depicted in Figure 20, 47.6% of the population reported having flooring made from dung in their houses, followed by 42.1% who resided in houses with sand or mud flooring. Only 2.4% of the population reported using materials for flooring other than cement, tiles, carpet, dirt, sand or mud, and dung.

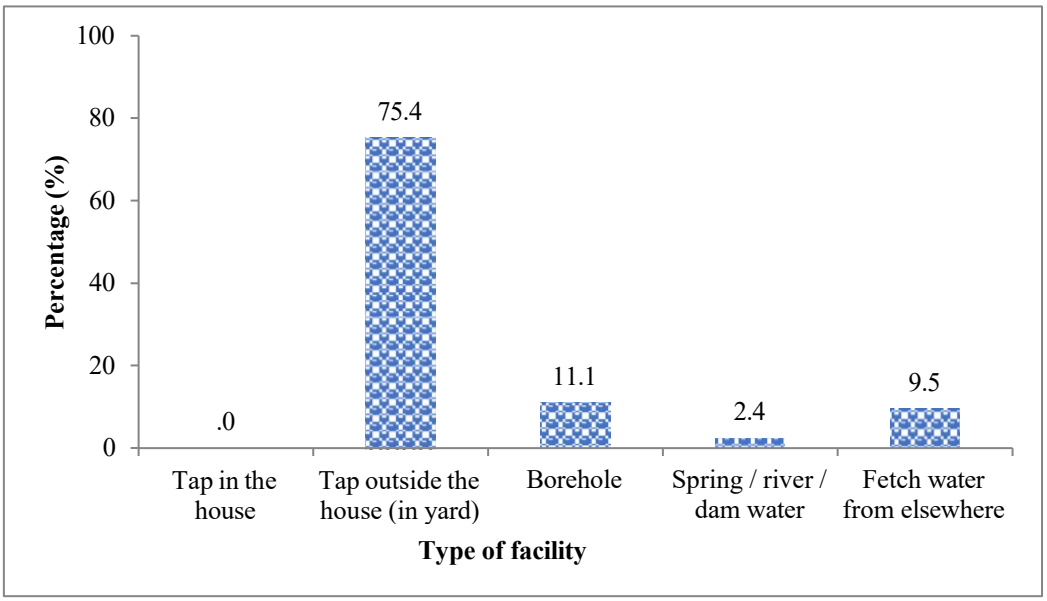


Figure 21: Access to water for Mpharane and Maqoala villages

Figure 21 depicts that 75.4% of the participants had taps in their yards, with 11.1% and 2.4% of the participants having access to water from the borehole and spring or river or dam, respectively. None of the participants had taps inside their houses.

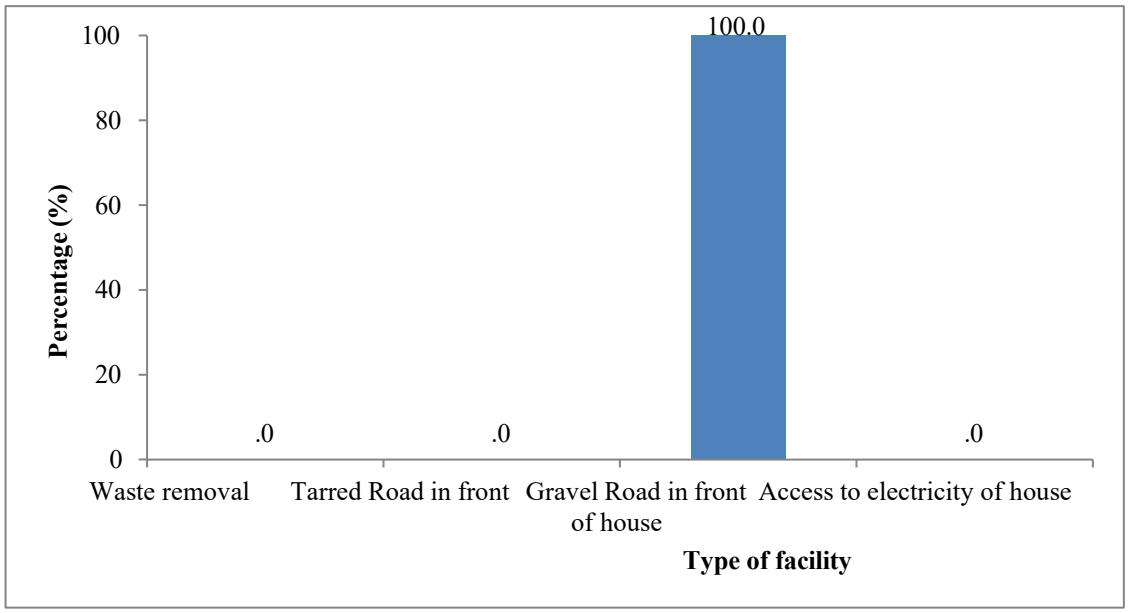


Figure 22: The type of road infrastructure for Mpharane and Maqoala villages

As illustrated in Figure 22, all participants (n=126) indicated that they had gravel roads in front of their houses, and all the participants had no access to waste removal and electricity.

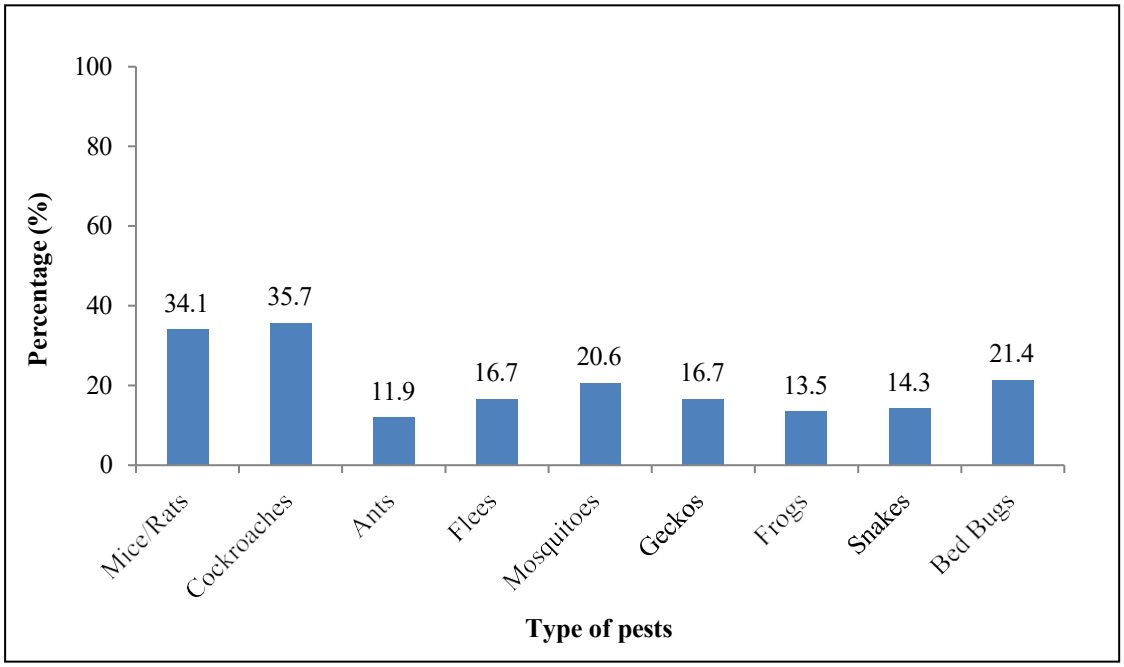


Figure 23: Pest infestation for Mpharane and Maqoala villages

The majority of the participants reported having multiple pests' infestations in their homes. Figure 23 reveals that 35.7% of the participants had their homes infested by cockroaches. According to 34.1% of the participants, rats were identified as the second most prevalent pest in their homes and 13.5% reported on frogs.

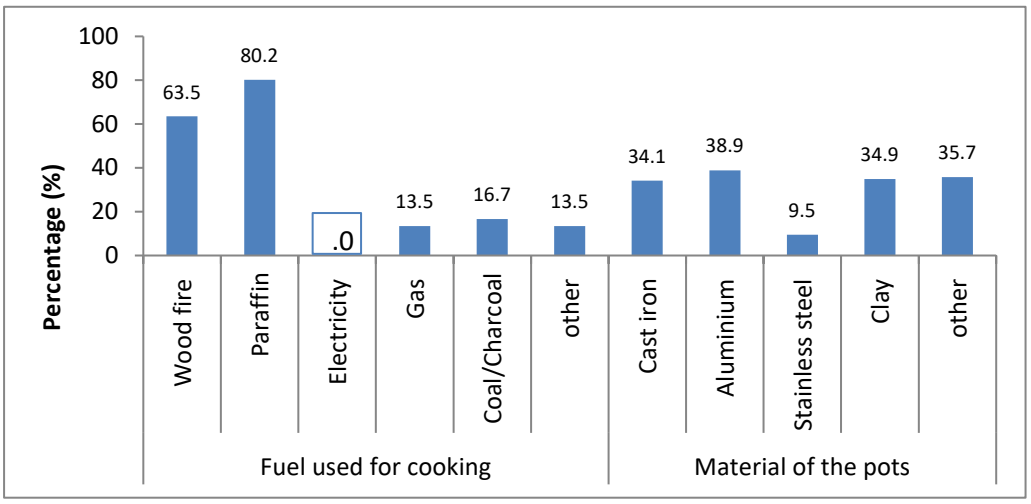


Figure 24: Fuel and cookware preferences for food preparation for Mpharane and Maqoala village

Figure 24 reveals that 63.5% of the participants used wood fire for cooking, 80.2% of the participants used paraffin for cooking, 13.5% of the participants used gas for cooking, and none used electricity. Most participants, 38.9%, used pots made from aluminium, and 34.9% of the participants used clay pots

Table 5: Children in the household

VARIABLE	NUMBER (%) (N=126)
How many children have birth certificate	
None	44.4 (56)
1	6.4 (8)
2	11.1 (14)
3	5.6 (7)
4	4.8 (6)
5	4.0 (5)
6	3.2 (4)
7	4.0 (5)
8	1.6 (2)
All	7.9 (10)
How many children have completed their immunisation schedule	
None	31.7 (40)
1	3.2 (4)
2	5.6 (7)
3	2.4 (3)
4	1.6 (2)
5	1.6 (2)
6	0.8 (1)
7	1.6 (2)
8	0 (0.0)
All	44.4 (56)
Have any children in the household died	
Yes	5.6 (7)
No	94.4 (119)

Table 5 provides descriptive data of children residing in the household, 44.4% did not have birth certificates and 31.7% did not complete their immunisation in both Mpharane and Maqoala villages. Ninety-four-point-four percent of the participants reported no mortality of children in their households, with 5.6% having reported death of children in their households.

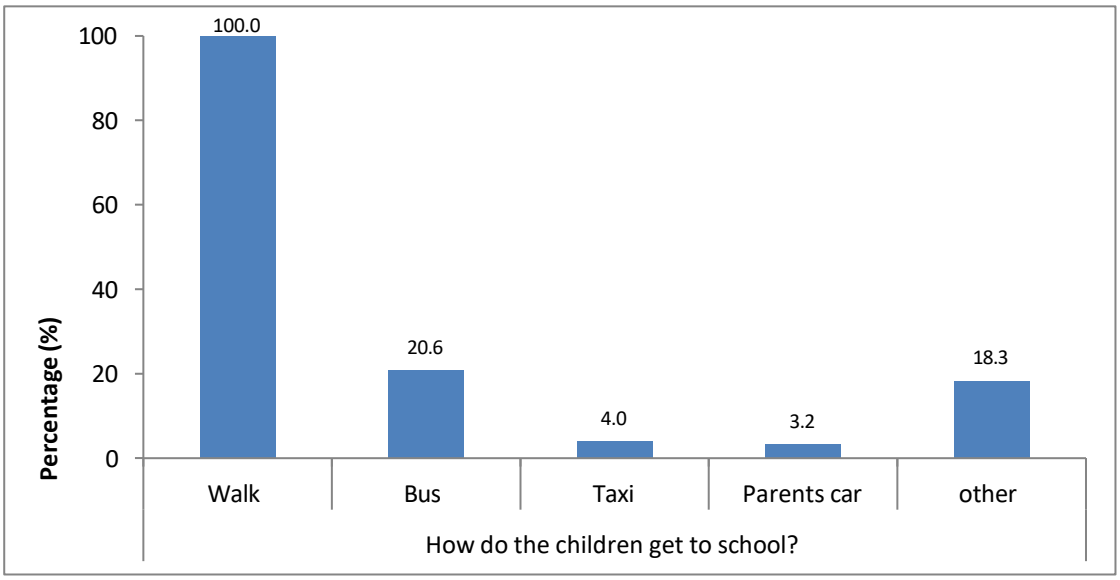


Figure 25: Type of transport the children used to go to school for Mpharane and Maqoala villages

As depicted in Figure 25, all participants indicated that all their children primarily walked to school. In addition, 24.6% of the participant's children also used public transport to get to school, 20.6% used a bus, and 4.0% used a taxi. Only 3.2% of the participant's children commuted to school by a private transport.

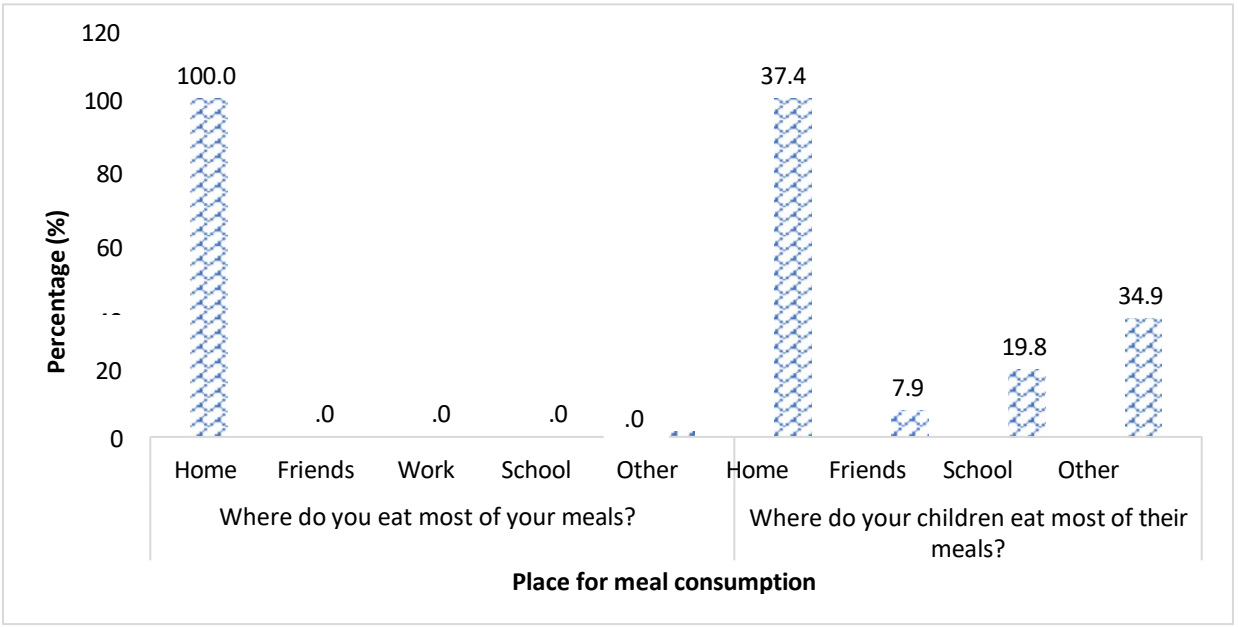


Figure 26: Place meal consumption for Mpharane and Maqoala villages

As shown in Figure 26, all participants and their children consumed most of their meals at home. Figure 26 further reveals that, at times, children also consumed some of their meals at their friends' homes, schools, and in other locations (relatives).

4.2.1.3 Anthropometric Results

Table 6: The mean anthropometry and blood pressure for the whole group (n=126)

VARIABLE	MEAN HEIGHT (CM) (SD)	MEAN WEIGHT (KG) (SD)	MEAN BMI (SD) KG/M^2	MEAN WC CM (SD)	WHR (SD)	SYSTOLIC BP MMHG (SD)	DIASTOLIC BP MMHG (SD)
Whole group (n=126)	152.00 ±7.56	65.70 ±12.32	27.62 ±5.42	84.00 ±13.69	54.00 ±0.08	123.00 ±23.96	78.00 ±15.28
Mpharane (n=63)	150.70±8.00	65.21±12.39	28.75±5.28	84.89±12.87	0.56±0.08	121.27±23.68	75.57±13.74
Maqoala (n=63)	152.80±7.09	63.92±12.38	27.47±5.55	82.50±14.94	0.54±0.09	126.84±23.33	80.30±16.09

Table 6 indicates the mean and standard deviation for weight of the whole group at 65.70kg (±12.32), and the mean and standard deviation for height was 152.00cm (±7.56). The mean BMI for the whole group was 27.62 kg/m^2 (±5.42). The mean systolic BP reported was 123.00 mmHg (±23.96), and the mean diastolic BP was 78.00 mmHg (±15.28). The hip-to-ratio mean was 54.00 (±0.08). Mpharane women had a mean BMI of 28.75 kg/m^2 (±5.28), while Maqoala women had a mean BMI of 27.47kg/m^2 (±5.55). Mpharane had mean height of 150.70 cm (±8.00) and Maqoala had mean height of 152.00 cm (±7.09).

Table 7: The summary of Body Mass Index (BMI)

PARAMETER	CLASSIFICATION	% MPHARANE (N=63)	% MAQOALA (N=63)
Body Mass Index-BMI classifications WHO (1995)	Underweight (<18.5)	3.17	4.76
	Normal weight (18.5- 24.99)	22.22	26.98
	Overweight (25.00- 29.99)	34.92	33.33
	Obese I (30.00- 34.99)	30.16	28.57
	Obese II (35.00- 39.99)	7.94	4.76
	Obese III (≥40)	1.59	1.59
	TOTAL	**100.00**	**99.99**

Table 7 presents the results of participants weight and height by BMI classification. Table 7 shows that 4.76% of the participants in Maqoala were underweight compared to 3.17% of the participants who were underweight in Mpharane. Both Maqoala and Mpharane had similar percentages of participants that were overweight and obese.

4.2.1.4 Food Security Status Results

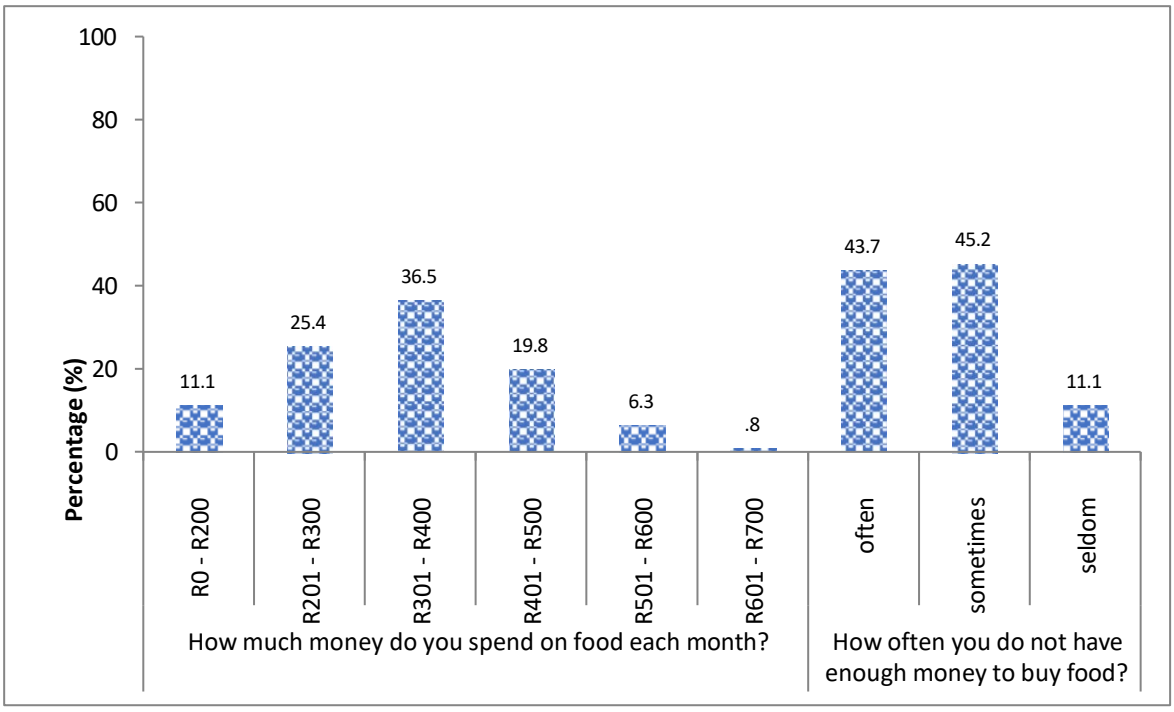


Figure 27: Frequency and sources of food purchases for Mpharane and Maqoala villa

Figure 27 reveals that 11.1% of the participants spent between R0 to R200.00, 25.4% of the participants spent between R201.00 to R300.00, and 36.5% of the participants spend between R301.00 to R400.00 on food each month. Furthermore, 45.2% of the participants sometimes do not have enough money to buy food, and 43.7% of the participants often did not have enough money to buy food.

Table 8: Food intake changes in the last 12 months

VARIABLE	NUMBER (%) (N=126)
In the last 12 month has your food intake changed?	
Yes, it has changed	100 (126)

Table 8 exhibits the results of food intake change in the last 12 months and according to Table 8 all participants (n=126) reported a change in their food intake because of food accessibility.

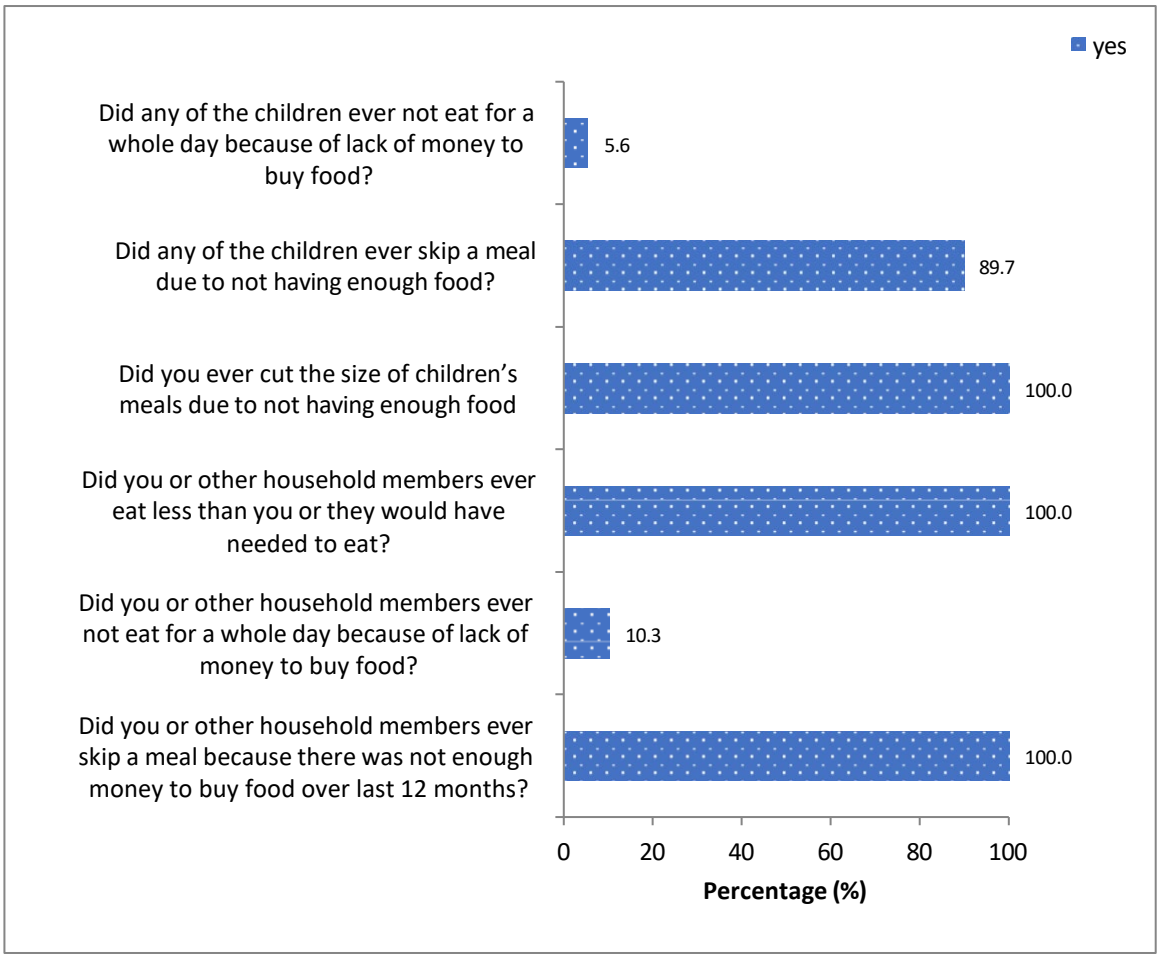


Figure 28: Household food insecurity experiences in the last 12 months

All participants (n= 126), as indicated in Figure 28, had skipped meals before because of inadequate access to funds to buy food. Additionally, all participants (n=126) reported having to reduce the size of their children's meals because of insufficient food. Five-point six percent of the participants reported that they had a situation where their children went an entire day without eating because they did not have money to buy food.

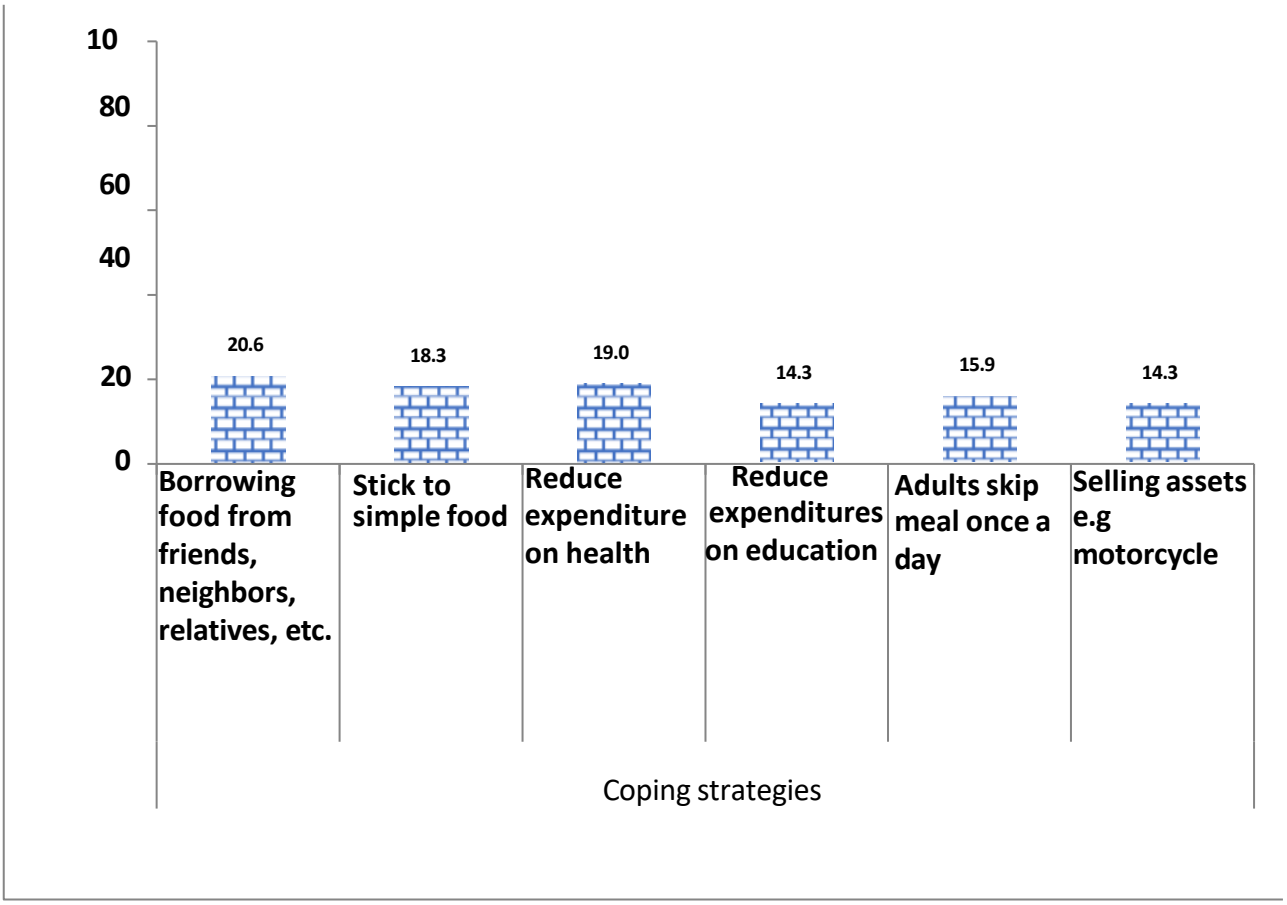


Figure 29: Household coping strategies because of food insecurity

Figure 29 shows a diagrammatic representation of the study participants' coping strategies. The figure revealed that 20.6% of the participants borrowed food from their friends, neighbours, relatives, and others. Among the participants, only 18.3% reported that they stuck to simple foods that were cost-effective. Fourteen-point-three percent reported selling assets they owned to have money to buy food for their households.

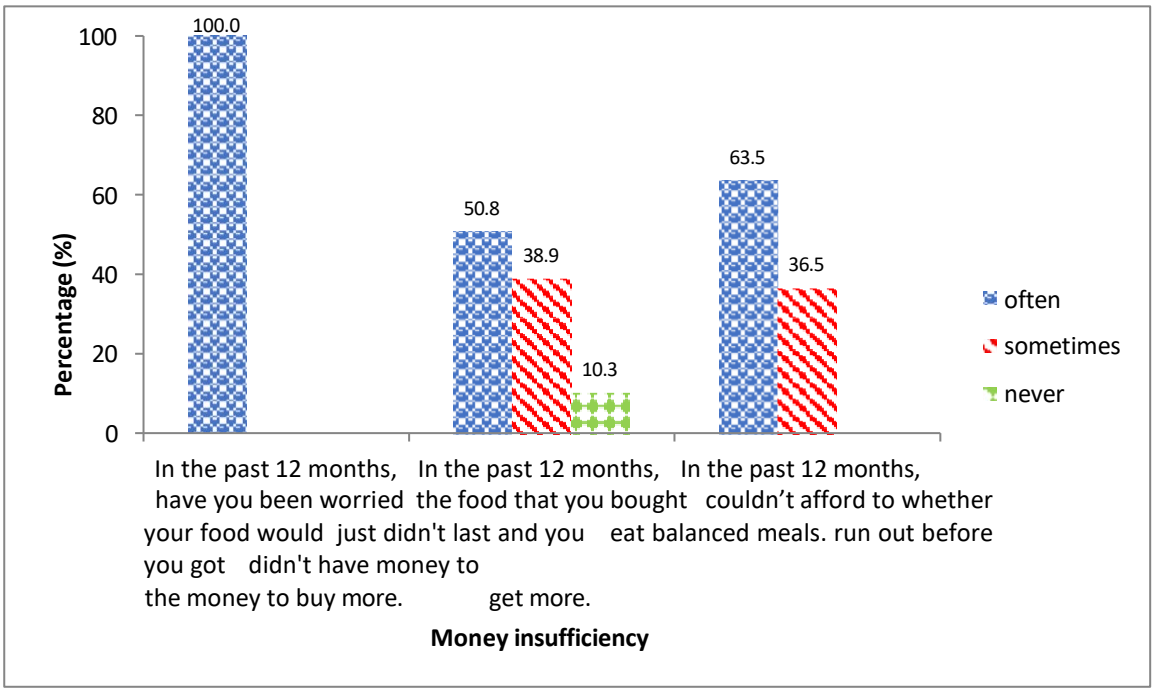


Figure 30: Food affordability and food adequacy in the past 12 months

Regarding food affordability and food frequency, Figure 31 revealed that all (n= 126) participants experienced anxiety about running out of food before having money to buy more. Furthermore, 50.8% of the participants reported that they bought food that did not last, and 63.5% occasionally could not afford to eat balanced meals.

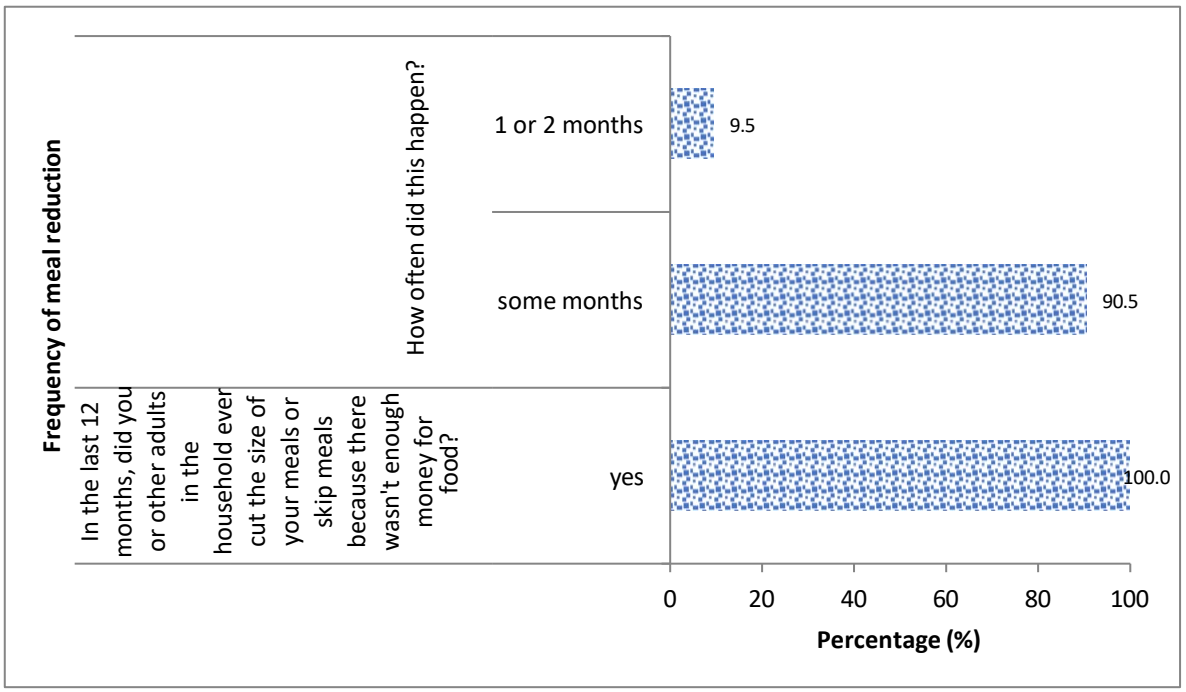


Figure 31: Meal reduction and frequency due to financial constraints in the past 12 months

Figure 32 reveals that all participants (n=126) or other adults in the household had reduced the size of the meals or skipped meals before because there was not enough money to buy food. Ninety-point-five percent of the participants have reduced the size of their meals or skipped meals in some months, while 9.5% have done this in one or two months.

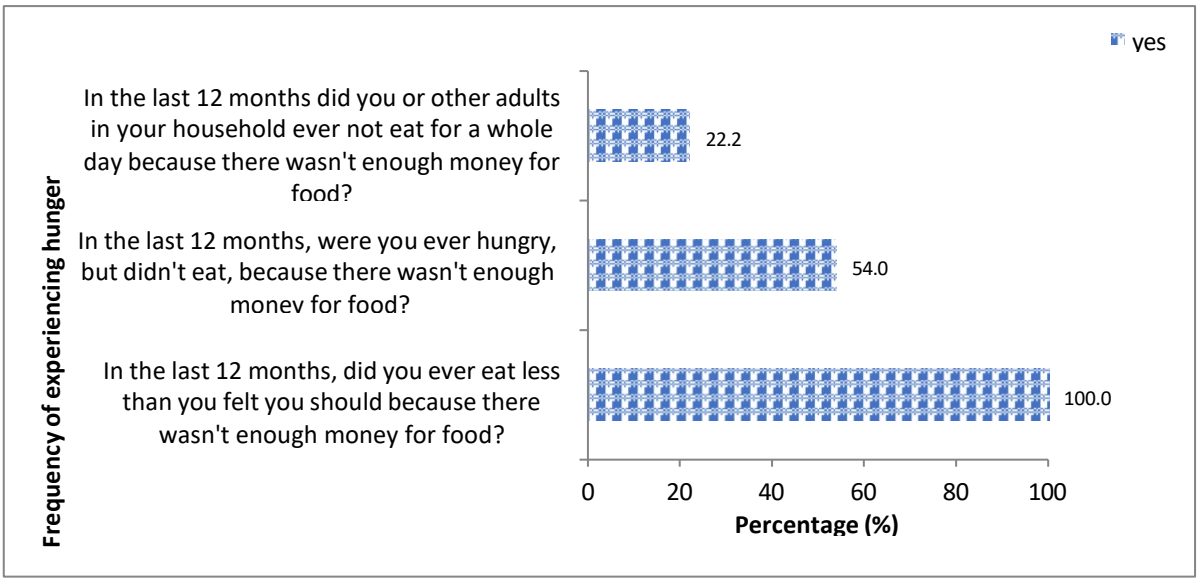


Figure 32: Experiences of hunger and reduced food consumption due to financial constraints in the last 12 months

In terms of the frequency of experiencing hunger, Figure 33 illustrates that all participants (n= 126) had previously eaten less than they thought they should have because they could not afford to buy food. More than half, 54.0% of the participants reported that they were always hungry because there was insufficient food. Among the participants, 22.2% reported that they had gone without food for an entire day due to financial difficulties.

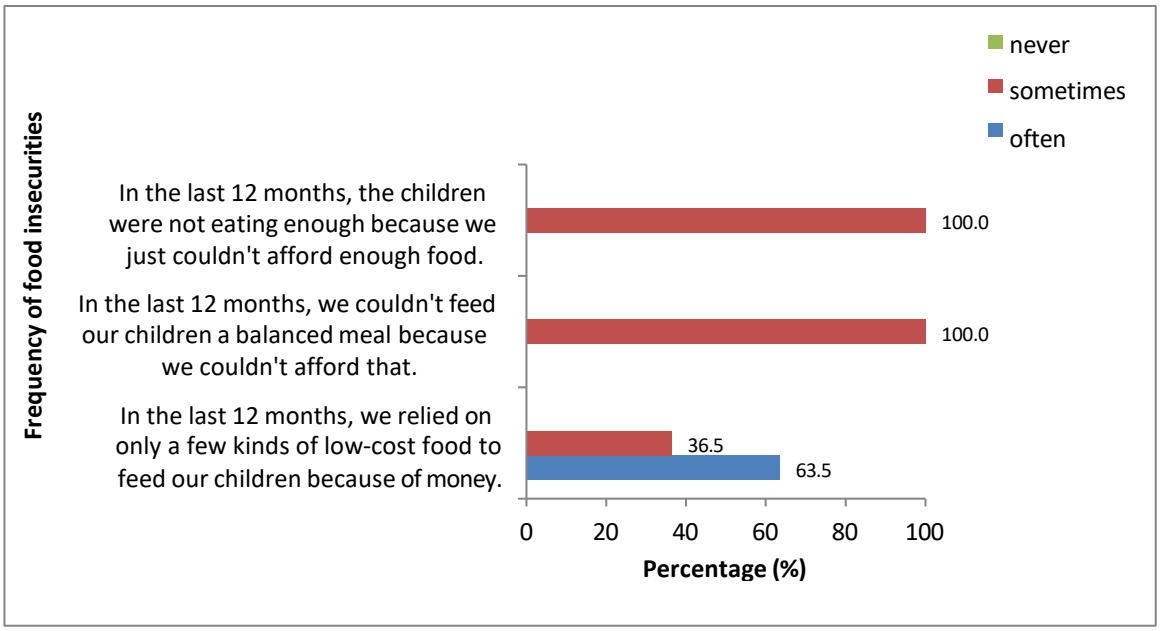


Figure 33: Child nutrition and food affordability due to financial constraints in the past 12 months

Figure 34 elucidates that the children of all participants (n=126) were sometimes not eating enough because the participants could not afford to buy enough food. Moreover, all the participants sometimes were unable to provide a balanced meal for their children due to financial constraints. More than half, 63.5% of the participants relied on low-cost food to feed their children because they ran out of money to buy food.

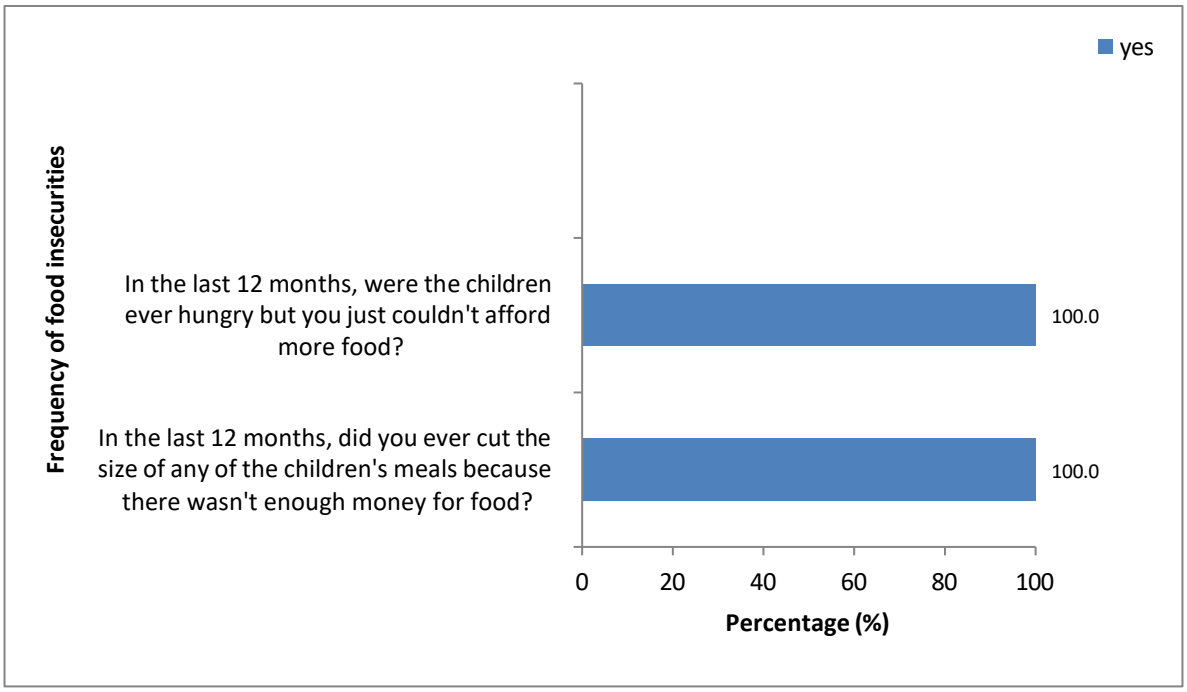


Figure 34: Childhood hunger and food accessibility in the last 12 months

According to Figure 35, all participants (n=126) had experienced a situation where their children were hungry because they could not afford more food. All participants (n=126) had to cut the size of their children's meals because there was not enough money to buy food.

4.2.1.5 Nutrition Knowledge Results

A nutrition knowledge questionnaire was used to assess the knowledge of the participants on their overall understanding of nutrition.

Table 9: Nutrition knowledge for Mpharane (n=63) and Maqoala (n=63)

Item	Frequency (%) (n=)		n	p-value
	Correct	**Incorrect**		
1. Which type of dairy do experts say people should drink?	3 (4)	97 (1220)	126	p < 0.001
2. How many times per week do experts recommend that people eat oily fish?	7 (96)	24 (30)	126	p < 0.001
3. How many times per week do experts recommend that people eat breakfast?	100 (126)	-	126	p < 0.001
4. According to the SA dietary guidelines, how much of a person's diet should be made up of starchy foods?	21 (26)	79 (100)	126	p < 0.001
5. Which of these diseases is related to a low intake of fibre?	82 (103)	18 (23)	126	p < 0.001
6. Which of these diseases is related to how much sugar people eat?	100 (126)	-	126	p < 0.001
7. Which of these diseases is related to how much salt (or sodium) people eat?	100 (126)	-	126	p < 0.001
8. Which of these options do experts recommend to prevent diabetes?	87 (109)	13 (17)	126	p < 0.001
9. To maintain a healthy weight people should cut fat out completely?	6 (8)	94 (118)	126	p < 0.001
10. To maintain a healthy weight people should eat a high protein diet	2 (2)	98 (124)	126	p < 0.001
11. Eating bread always causes weight gain	100(126)	-	126	p < 0.001
12. If someone has a Body Mass Index (BMI) of 23kg/m², what would their weight status be?	-	100 (126)	126	p < 0.001
13. If someone has a Body Mass Index (BMI) of 31kg/m², what would their weight status be?	-	100 (126)	126	p < 0.001

related to a high intake of fibre, sugar, and salt correctly, p<0.001. A hundred percent answered the BMI classification question incorrectly, p<0.001.

Table 9 illustrates the average knowledge as 52.08%, which ranged from 38% to 69% in both Mpharane and Maqoala. Significantly, more than 97% incorrectly answered the question on what type of dairy they should consume, p<0.001. A minority, 7% of the participants answered the question of how many times in a week one should eat oily fish correctly, and 24% incorrectly. All the participants answered the question of how many times an individual should have breakfast correctly. A significant 79% of the participants answered the question

incorrectly on how much of a person's diet should be made up of starchy foods, p<0.001, and 21% of participants answered correctly. significant number of participants answered the question of which of the diseases were

Table 10: Nutrition knowledge for Mpharane (n=63)

Item	Frequency (%) (n=)		n	p-value
	Correct	Incorrect		
1. Which type of dairy do experts say people should drink?	76 (48)	24 (15)	63	p <0.001
2. How many times per week do experts recommend that people eat oily fish?	5 (3)	95 (60)	63	p <0.001
3. How many times per week do experts recommend that people eat breakfast?	79 (50)	21 (13)	63	p <0.001
4. According to the SA dietary guidelines, how much of a person's diet should be made up of starchy foods?	100 (63)	-	63	p <0.001
5. Which of these diseases is related to a low intake of fibre?	21 (13)	79 (50)	63	p <0.001
6. Which of these diseases is related to how much sugar people eat?	100 (63)	-	63	p <0.001
7. Which of these diseases is related to how much salt (or sodium) people eat?	100 (63)	-	63	p <0.001
8. Which of these options do experts recommend to prevent diabetes?	89 (56)	11 (7)	63	p <0.001
9. To maintain a healthy weight people should cut fat out completely?	6 (4)	94 (59)	63	p <0.001
10. To maintain a healthy people should eat a high protein diet	3 (2)	97 (61)	63	p <0.001
11. Eating bread always causes weight gain	100 (63)	-	63	p <0.001
12. If someone has a Body Mass Index (BMI) of 23kg/m², what would their weight status be?	-	100 (63)	63	p <0.001
13. If someone has a Body Mass Index (BMI) of 31kg/m², what would their weight status be?	-	100 (63)	63	p <0.001

Table 10 illustrates that 76% of the participants were aware of the appropriate type of dairy they should consume p<0.001. A minority, 5% of the participants, answered the question of

how many times in a week one should eat oily fish correctly, and 95% answered incorrectly, p<0.001. Twenty-one percent of the participants correctly answered the question of how many times an individual should have breakfast. All the participants correctly answered the question of how much of a person's diet should be made up of starchy foods, p<0.001. All the participants answered the question of which of the diseases were related to a low intake of fibre, high sugar intake, and high salt intake correctly, p<0.001.

Table 11: Nutrition knowledge for Maqoala (n=63)

Item	Frequency (%) (n=)		n	p-value
	Correct	Incorrect		
1. Which type of dairy do experts say people should drink?	87 (55)	13 (8)	63	p <0.001
2. How many times per week do experts recommend that people eat oily fish?	2 (1)	98 (62)	63	p <0.001
3. How many times per week do experts recommend that people eat breakfast?	73 (46)	27 (17)	63	p <0.001
4. According to the SA dietary guidelines, how much of a person's diet should be made up of starchy foods?	100 (63)	-	63	p <0.001
5. Which of these diseases is related to a low intake of fibre?	21 (13)	79 (50)	63	p <0.001
6. Which of these diseases is related to how much sugar people eat?	100 (63)	-	63	p <0.001
7. Which of these diseases is related to how much salt (or sodium) people eat?	100 (63)	-	63	p <0.001
8. Which of these options do experts recommend to prevent diabetes?	84 (53)	16 (10)	63	p <0.001
9. To maintain a healthy weight people should cut fat out completely?	6 (4)	94 (59)	63	p <0.001
10. To maintain a healthy people should eat a high protein diet	-	100 (63)	63	p <0.001
11. Eating bread always causes weight gain	100 (63)	-	63	p <0.001
12. If someone has a Body Mass Index (BMI) of 23kg/m², what would their weight status be?	-	100 (63)	63	p <0.001
13. If someone has a Body Mass Index (BMI) of 31kg/m², what would their weight status be?	-	100 (63)	63	p <0.001

Table 11 illustrates that 13% of the participants answered the question of what type of dairy

they should consume incorrectly. A minority, 2% of the participants, answered the question of how many times in a week one should eat oily fish correctly, and 98% answered incorrectly, p<0.001. Seventy-three percent of the participants answered the question of how many times an individual should have breakfast correctly. All the participants answered the question of how much of a person's diet should be made up of starchy foods correctly, p<0.001. All the participants answered the question of which of the diseases were related to a low intake of fibre, high sugar intake, and high salt intake correctly, p<0.001.

4.2.1.6 Dietary Results

Nutrient Adequacy, Food Variety Score, and Dietary Diversity Score

Dietary assessment was conducted at the BL and EL using three 24-hour Food Recall questionnaires, including two weekdays and one weekend day. A Food Frequency questionnaire indicating variety over seven days period was also used. Extrapolated is the nutrient intake, the top 20 foods consumed, food variety, and food group diversity.

Table 12: The Dietary Nutrients Intake Analysis, Nutrient Adequacy Ratio (NARs) and % of the participants DRIs are measured using the average of three 24-hour Food Recalls for the experimental group and control group

Variables	Category	MPHARANE (Experiment)				MAQOALA (Control)				
		Mean (SD)	NARs mean % of the DRIs	% women <100% of DRIs	p-value	MEAN (SD)	NARs mean % of the DRIs	% women <100% of DRIs	p-value	DRIS ♀
Energy (KJ)	BL	4892.90 (1872.02)	48.48	97.02	0.536	4516.07 (1724.73)	44.74	95.86	0.642	8465
	EL	5093.89 (2090.72)	39.55	94.25		4362.55 (1903.33)	41.15	95.21		
Protein (g)	BL	33.77 (13.76)	73.42	80.33	0.589	33.31 (15.67)	72.41	80.00	0.249	46 RDA
	EL	35.11 (14.67)	62.47	79.00		30.16 (13.63)	63.29	79.45		
Total Fat (g)	BL	15.52 (6.94)			0.117	15.83 (10.46)			0.402	
	EL	18.16 (9.82)				14.43 (7.54)				
Carbohydrate (g)	BL	203.90 (78.19)	203.90	10.41	0.791	179.05 (81.65)	179.05 (81.65)	8.00	0.795	100 EAR
	EL	207.72 (94.95)	206.51	11.04		183.08 (86.96)	183.08	8.66		
Total Diet Fibre (g)	BL	18.10 (9.20)	86.15	78.50	0.636	14.24 (8.26)	56.97	50.00	0.360	25 AL

Variables	Category	MPHARANE (Experiment) Mean (SD)	NARs mean % of the DRIs	% women <100% of DRIs	p-value	MAQOALA (Control) MEAN (SD)	NARs mean % of the DRIs	% women <100% of DRIs	p-value	DRIS ♀
	EL	17.40 (8.83)	57.94	51.67		15.51 (7.28)	68.77	57.67		
Calcium (Ca) (mg)	BL	213.47 (179.38)	17.79	96.94	0.380	168.31 (145.49)	14.03	93.44	0.592	800 AL
	EL	185.80 (138.26)	15.41	94.89		181.50 (119.00)	15.12	94.83		
Iron (Fe) (mg)	BL	13.22 (5.31)	264.44	6.89	0.728	11.11 (5.26)	222.11	6.51	0.331	8.1EAR
	EL	13.54 (6.08)	225.37	6.59		12.04 (5.61)	231.13	6.65		
Magnesium (Mg) (mg)	BL	234.26 (111.48)	88.40	60.72	0.187	222.31 (118.86)	83.89	56.87	0.393	265 EAR
	EL	209.25 (101.92)	60.01	89.11		204.37 (104.43)	73.01	95.09		
Phosphorus (P) (mg)	BL	675.70 (281.60)	116.50	56.81	0.720	636.22 (266.53)	109.69	52.00	0.333	580 EAR
	EL	692.77 (295.37)	119.08	57.94		588.83 (269.30)	101.52	51.59		
Potassium (K) (mg)	BL	1024.54 (538.64)			0.142	994.51 (436.63)			0.061	
	EL	911.49 (398.35)				846.57 (383.79)				
Sodium (Na) (mg)	BL	1864.48 (2935.00)			0.546	1422.88 (670.58)			0.267	
	EL	1623.37 (688.10)				1572.05 (794.73)				
Zinc (Zn) (mg)	BL	6.71 (2.61)	98.74	51.00	0.468	6.20 (3.12)	91.24	47.08	0.688	6.8 EAR
	EL	7.06 (3.15)	74.89	80.36		5.98 (2.89)	82.52	75.66		
Selenium (Se) (µg)	BL	5.62 (7.15)	12.49	93.38	0.251	7.39 (8.04)	16.42	97.96	0.155	45 EAR
	EL	7.38 (8.55)	16.15	98.47		5.58 (6.81)	12.39	93.72		
Iodine (I) (µg)	BL	136.33 (229.45)	143.51	46.00	0.430	97.24 (48.92)	102.36	29.34	0.170	95 EAR
	EL	111.91 (48.42)	117.45	33.82		109.89 (56.02)	115.67	31.71		
Vitamin A (µg)	BL	424.14 (307.39)	84.83	77.32	0.219	307.38 (271.93)	61.48	74.62	0.002	500 EAR
	EL	536.83 (673.82)	85.09	82.34		473.06 (336.88)	89.51	79.58		
Thiamin (mg)	BL	1.16 (.48)	128.92	46.81	0.558	1.02 (0.50)	112.95	44.97	0.834	0.9 EAR
	EL	1.21 (0.60)	120.97	44.94		1.04 (0.53)	112.41	44.73		
Riboflavin (mg)	BL	0.61 (0.27)	68.17	95.63	0.175	0.64 (0.31)	71.21	97.89	0.124	0.9 EAR
	EL	0.69 (0.34)	61.99	93.87		0.56 (0.27)	60.15	93.46		
Niacin (mg)	BL	11.52 (5.06)	104.73	48.97	0.293	10.64 (5.83)	96.68	47.49	0.910	11 EAR
	EL	12.57 (6.33)	104.27	50.94		10.52 (5.23)	93.96	47.41		

Variables	Category	MPHARANE (Experiment) Mean (SD)	NARs mean % of the DRIs	% women <100% of DRIs	p-value	MAQOALA (Control) MEAN (SD)	NARs mean % of the DRIs	% women <100% of DRIs	p-value	DRIS ♀
Vitamin B6 (mg)	BL	0.83 (0.41)	63.79	93.27	0.226	0.67 (0.40)	51.26	85.52	0.115	1.1 EAR
	EL	0.93 (0.52)	65.65	97.10		0.78 (0.38)	58.75	83.68		
Folate (µg)	BL	388.38 (198.34)	121.37	45.81	0.536	311.95 (193.70)	97.48	42.99	0.278	320 EAR
	EL	409.64 (217.17)	127.27	53.70		348.08 (168.43)	108.77	43.05		
Vitamin B12 (µg)	BL	0.85 (2.94	42.54	78.66	0.308	0.80 (1.62)	39.83	74.70	0.609	2.0 EAR
	EL	1.50 (3.82)	73.89	82.75		0.61 (2.23)	30.62	68.43		
Pantothenate (mg)	BL	1.78 (1.69)	35.56	92.16	0.358	1.86 (1.96)	37.23	93.75	0.498	5.0 AL
	EL	2.07 (1.61)	40.88	98.47		1.65 (1.33)	33.09	90.54		
Biotin (µg)	BL	13.52 (6.65)	45.06	84.33	0.051	13.49 (11.88)	44.98	83.95	0.665	30 AL
	EL	20.57 (27.89)	67.71	93.38		14.37 (10.42)	47.91	84.87		
Vitamin C (mg)	BL	9.90 (10.32)	16.51	91.74	0.149	9.65 (9.83)	16.08	91.28	0.577	60 EAR
	EL	14.74 (25.21)	19.41	98.56		10.59 (8.81)	16.77	91.93		
Vitamin D (µg)	BL	0.81 (2.21)	8.12	97.88	0.815	0.79 (1.33)	7.90	97.03	0.470	10 AL
	EL	0.91 (2.53)	6.00	97.23		0.60 (1.62)	5.84	95.37		
Vitamin E (mg)	BL	4.75 (3.21)	39.60	87.13	0.373	3.71 (3.00)	30.93	81.59	0.060	12 EAR
	EL	5.38 (4.24)	44.62	92.83		4.73 (3.02)	39.44	87.00		
Vitamin K (µg)	BL	409.14 (443.33)	454.60	32.13	0.745	242.21 (326.81)	269.13	22.75	0.001	90 AL
	EL	385.27 (336.62)	319.92	26.59		527.93 (561.27)	536.04	35.23		

♀ Women

EER: Estimated Energy Requirements (Institutes of Medicine, 2005)

AI: (Adequate Intake) used where EAR (Estimated Average Requirement) is not available

EAR: estimated average requirements

RDA (Recommended Dietary Allowance)

Table 12 indicates the energy intake (kJ) in the two groups, with an EER 8465kJ for each female participant group. Mpharane BL was 4892.90kJ, and the EL was 5093.89KJ. Maqoala BL was 4516.07kJ, and EL was 4362.55KJ. The carbohydrate intake was high for both the Mpharane (BL 203.90g; ±78.19, EL 207.72; ±94.95) and Maqoala (BL 179.05g; ±81.65, EL 183.8; ±86.96) participants, of 100g. The protein intake was lower than the DRI of 46g at BL 33.77g (±13.76), EL 35.11g (±14.67) in Mpharane and BL for Maqoala was 33.31g (±15.67), and EL was 30.16g (±13.63). The Mpharane consumed a mean total dietary fibre of 18.10g BL and 17.40g EL, and Maqoala consumed 14.24g BL and 15.51g EL compared to the AI of 25g. The dietary analysis indicated a mineral deficiency intake of calcium as seen in Mpharane with BL at 213.47mg (±179.38), EL at 185.80mg (±138.26) and in Maqoala BL at 168.31mg (±145.49), EL 181.50mg (±119.00) compared to the recommended DRI of, 800mg. The Mpharane and Maqoala participants consumed 17.79% BL, 15.41% EL, and 14.03% BL, 15.12% EL, respectively, of the Al required for calcium. The phosphorus intake for Mpharane and Maqoala was high at BL 675.70mg; ±281.60, EL 692.77mg ±295.37 and BL 636.22mg; ±266.53 respectively, but Maqoala' s EL was slightly low with 588.83mg; ±269.30. The DRI for phosphorus for the participants was recommended at 580mg. The NARs for Mpharane 116.50% BL and 119.08% EL and Maqoala 109.69% BL and 101.52% EL in phosphorus were more than 100%. Iron intake for Mpharane was 13.22mg (±5.31) BL, 13.54mg (±6.08) EL and for Maqoala was 11.11mg (±5.26) BL and 12.04mg (±5.61) EL. The recommended DRIs for iron in these groups was 8.1mg for females. Intake of selenium in Mpharane was noted at 5.62µg (±7.15) BL, 7.38 µg (±8.55) EL and in Maqoala was reported at 7.39µg (±8.04) BL, 5.58µg (±6.81) EL compared to the recommended DRIs 45µg. Iodine intake for Mpharane was noted at 136.33µg (±229.45) BL, 111.9µg (±48.42) EL and for Maqoala was noted at 97.24µg (±48.92) BL, 109.89µg (±56.02) EL. The DRI for iodine in these groups was 95µg for females. The intake of folate for Mpharane was 388.38µg (±198.34) BL, 409.64µg (±217.17) EL and in Maqoala was 311.95µg (±193.70) BL, 348.08µg (±168.43) EL. The recommended DRI for folate for females was 320µg. Vitamin C intake for Mpharane was 9.90mg (±10.32) BL, 14.74mg (±25.21) EL and 9.65mg (±9.83) BL and 10.59mg (±8.81) EL for Maqoala, which was lower than the recommended DRI of 60mg for females. The vitamin D intake of 0.81µg was (±2.21) at BL, 0.91µg was (±2.53) EL for Mpharane and 0.79µg (±1.33) BL, 0.60µg was (±1.62) EL for Maqoala was low compared to the recommended DRI at 10µg for female. Both Mpharane and Maqoala had adequate zinc NARs mean percentage of the DRIs. In Mpharane at the EL the vitamin A was above the NARs mean percentage of the DRIs compared to Maqoala which had slightly less at 473.06(±336.88). Both Mpharane and Maqoala did not have adequate Vitamin B12.

Table 13: Baseline and Endline of Food variety within the Food Groups for the whole group

Variable	Category	Number of pairs (n)	Mean (SD)	Paired difference test			
				Mean difference (SD)	t	df	p-value
Group 1: Flesh foods (Meat Poultry, Fish)	BL	126	11.20 (7.09)	-1.058 (12.52)	-.948	125	.345
	EL		12.26 (9.72)				
Group 2: Eggs	BL	126	40.48 (49.28)	-6.349 (72.38)	-.985	125	.327
	EL		46.83 (50.09)				
Group 3: Dairy products	BL	126	10.58 (16.68)	-8.201 (30.01)	-3.067	125	.003*
	EL		18.78 (22.89)				
Group 4: Cereals	BL	126	26.70 (8.53)	8.163 (10.40)	8.804	125	<.001*
	EL		18.54 (6.33)				
Group 5: Legumes and nuts	BL	126	20.00 (12.13)	7.143 (17.42)	4.600	125	<.001*
	EL		12.86 (12.51)				
Group 6: Fruits and vegetables	BL	126	19.18 (8.62)	1.631 (11.41)	1.604	125	.111
	EL		17.55 (8.32)				
Group 7: Oils and fats	BL	126	22.22 (9.60)	3.770 (19.25)	2.1198	125	.030*
	EL		18.45 (17.37)				

A summary of the food group variety is presented in Table 13. Mean ±SD was observed for all the food consumed from all the food groups over a period of seven days for both BL and EL in Mpharane and Maqoala (n=126). The mean ±SD for group 1 at BL was 11.20 (±7.09) and 12.26 (±9.720) at the EL. Group 2 was 40.48 (±49.28) at BL and 46.83 (±50.09) at the EL. Group 3 was 10.58 (± 16.68) at BL and 18.78 (±22.89) at the EL with a mean difference (SD**)** of -8.201 (±30.01), *p*=00.3. Group 4 was 26.70 (±8.53) at BL and 18.54 (±6.33) at the EL with a mean difference (SD**)** of 8.163 (±10.40), p<.001. Group 5 was 20.00 (±12.13) at BL and 12.86 (±12.51) at EL, p<.001. Group 6 was 19.18 (±8.632) at BL and 17.55 (±8.32) at EL. Lastly, group 7 was 22.22g (±9.60) at BL and 18.45 g (±17.37) at EL with a mean difference (SD**)** of 3.770 (±19.37), *p*=.030.

Table 14: Comparison of food groups at endline for Mpharane (n=63) and for Maqoala (n=63)

Variable	Endline Mpharane Mean (SD)	p-value	Maqoala Mean (SD)	p-value
Group 1: Flesh foods (Meat Poultry, Fish)	10.57 (1.21)	.051	13.94 (1.21)	.051
Group 2: Eggs	44.49 (6.34)	.604	49.16 (6.34)	.604
Group 3: Dairy products	19.39 (2.88)	.766	18.17 (2.88)	.766
Group 4: Cereals	19.17 (.84)	.322	17.91 (.84)	.322
Group 5: Legumes and nuts	13.02 (1.58)	.888	12.71 (1.58)	.888
Group 6: Fruits and vegetables	17.38 (1.05)	.825	17.71 (1.05)	.825
Group 7: Oils and fats	17.06 (2.19)	.372	19.84 (2.19)	.372

Table 14 illustrates the comparison for Mean ±SD of the EL for Mpharane and EL Maqoala of all the food consumed from all the food groups over a period of seven days. Mean ±SD 10.57 (±1.21) for group 1 under EL for Mpharane (n=63) compared to EL for Maqoala (n=63) was the Mean ±SD 13.94 (±1.21) with a p-value of <.051. Group 2 EL for Mpharane was 44.49 (±6.34) compared to Maqoala with 49.16 (±6.34) with a p-value of <.604. The dairy products for Mpharane EL were 19.39 (±2.88) compared to Maqoala, which was 18.17(±2.88) with a p-value of <.766.

Table 15: Top 20 food variety score in Mpharane (n=63) at baseline and endline

MPHARANE						
	Baseline			Endline		
No	**Food Item**	**The number of times a food item has been consumed**	**Frequency (%)**	**Food Item**	**The number of times a food item has been consumed**	**Frequency (%)**
1	Cereal Sorghum	63	100	Cereal Maize	57	90.5
2	Cereal Maize	62	98.4	Wild leafy vegetables (fresh and dried)	43	68.3

	MPHARANE					
	Baseline			Endline		
No	Food Item	The number of times a food item has been consumed	Frequency (%)	Food Item	The number of times a food item has been consumed	Frequency (%)
3	Wild leafy vegetables (fresh and dried)	54	85.7	Cereal Sorghum	42	66.7
4	Sunflower oil	53	84.1	Onions	32	50.8
5	All beans (dried)	44	71.0	All milk	28	44.4
6	Cereals (wheat)	41	65.1	Eggs	28	44.4
7	Onions	41	65.1	Cereal dumpling	25	39.7
8	Cabbage	39	61.9	Cereal wheat	23	36.5
9	Cereals bread (all)	33	52.4	Sunflower oil	16	25.4
10	Cereals mageu	27	42.9	Pumpkin	15	23.8
11	Chicken meat	27	42.9	All beans (dried)	14	22.2
12	Eggs	26	41.3	Apple	14	22.2
13	Cereal potatoes	21	33.3	Tomatoes	14	22.2
14	Processed meat	19	30.2	Lard	14	22.2
15	Orange	17	27.0	Soya	13	20.6
16	Dried peas	15	23.8	Carrots	12	19.0
17	All milk	13	20.6	Green beans	12	19.0
18	Apple	12	19.0	Cabbage	12	19.0
19	Tomatoes	11	17.5	Spinach	11	17.5
20	Cereals dumpling	11	17.5	Banana	11	17.5

Table 15 indicates that the participants consumed a large amount of sorghum (100.0%), maize (98.4%), wild leafy vegetables (85.7%), and sunflower oil (84.1%) at the BL. At the EL, the most consumed food was maize (90.5%), wild leafy vegetables (68.3%), sorghum (66.7%), onion (50.8%), and all milk (44.4%). The least consumed food was processed meat (30.2%), oranges (27.0%), dried peas (23.8%), all milk (20.6%), apples (19.0%), tomatoes (17.5%), and dumplings

(17.5%) at BL. At the EL, the least consumed food was lard (22.2%), soya (20.6%), carrots (19.0%), green beans (19.0%), cabbage (19.0%), spinach (17.5%), and banana (17.5%).

Table 16: Top 20 food variety score in Maqoala (n=63) at baseline and endline

MAQOALA						
	Baseline			**Endline**		
No	**Food Item**	**The number of times a food item has been consumed**	**Frequency (%)**	**Food Item**	**The number of times a food item has been consumed**	**Frequency (%)**
1	Cereals Maize	62	98.4	Cereals Maize	56	88.9
2	Cereals Sorghum	56	88.9	Wild leafy vegetables (fresh and dried)	50	79.4
3	Wild leafy vegetables (fresh and dried)	53	84.1	Cereals Sorghum	37	58.7
4	Onion	43	68.3	Onions	35	55.6
5	Sunflower oil	42	66.7	Eggs	31	49.2
6	All beans (dried)	41	65.1	All tribe/Offals/Runners and Heads	23	36.5
7	Cereals (wheat)	34	54.0	All milk	22	34.9
8	Cabbage	29	46.0	Cereal Dumpling	22	34.9
9	Eggs	25	39.7	Banana	21	33.3
10	Cereal bread (all)	22	34.9	Sunflower oil	21	33.3
11	Chicken meat	22	34.9	All beans (dried)	21	33.3
12	Tomatoes	21	33.3	Lard	21	33.3
13	All milk	20	31.7	Cereals Wheat	20	31.7
14	Processed meat	16	25.4	Cereals Potatoes	17	27.0
15	Cereals Potatoes	14	22.2	Processed Meat	16	25.4
16	Flesh tinned fish	12	19.0	Cabbage	16	25.4
17	Dried peas	11	17.5	Tomatoes	13	20.6
18	Apple	11	17.5	Maas/Inkomazi	12	19.0
19	Banana	11	17.5	Chicken Meat	11	17.5
20	Lard	11	17.5	Apple	11	17.5

Table 16 indicates that the participants consumed a large amount of maize (98.4%), sorghum (88.9%), wild leafy vegetables (84.1%), onions (68.3%), and sunflower oil (66.7%) in the BL. At the EL, the most consumed foods were maize (88.9%), wild leafy vegetables (79,4%), sorghum (58.7%), onion (55.6%), and eggs (49.2%). The least consumed foods were processed meat (25.4%), potatoes (22.2%), tinned fish (19.0%), dried peas (17.5%), apples (17.5%), bananas (17.5%), and lard (17.5%) in the BL. At the endline, the least consumed foods were potatoes (27.0%), processed meat (25.5%), cabbage (20.6%), tomatoes (19.0%), maas (17.5%), chicken meat (17.5%) and apple (17.5%).

Table 17: Household food access measured by food variety within the food consumed over a period of seven days in Mpharane (n=63)

Meat Group (n=	**ggs Group (n=**	**airy Group (n=**	**ereal Gr n=10)**	**egume Gr n=4)**	**ruit Grou n=5)**	**egetable Gr n=9)**	**ats Grou n=2)**
=27 =6 =1 =6 =4 =19	=26 =37	=13 =50	=5 =62 =63 =41 =3 =33 =11 =2 =27 =21	=44 =15 =1 =2	=12 =10 =17 =13 =11	=6 =5 =54 =9 =41 =39 =7 =2 =2	=53 =10

Low = 0-3 food groups or <30 individual foods, **Medium =** 4-5 food groups or 30-60 individual foods, **High =** 6-9 food groups or >60 individual foods.

Table 17 indicates that participants n=27 did not consume any meat group foods, participants n=6 consumed one type of the meat group, and participants n=19 consumed five different types of meat group. In the egg group, participants n=26 did not consume the eggs. The participants n= 50 consumed one type of dairy. Out of 10 different types of cereal in the cereal group, participants n=62 consumed one type of cereal, participants n=63 consumed two types of cereal, participants n=33 consumed five different types of cereal, participants n=21 consumed nine different types of cereal, and only participants n=5 consumed did not consume cereal. A large

number of participants, n=44, did not consume any of the four different legumes, and only participants, n=15, consumed one type of legume. The fruit group had five different types of fruits, and participants n=12 did not consume any fruits, participants n=17 consumed two types of fruits and participants n=11 consumed four different types of fruits. Under the vegetable group with nine different types, participants n=6 did not consume any vegetables, participants n=5 consumed one type of vegetable, n=54 of the participants consumed two types of vegetables, participants n=39 consumed five different types of vegetables, and only n=2 participants consumed eight different types of vegetables. The majority of the participants, n=53, did not consume the two types of fats.

Table 18: Household food access as measured by food variety within the food consumed over a period of seven days in Maqoala (n=63)

Meat Group (n=	**Eggs Group (n=**	**Dairy Group (n=**	**Cereal Gro n=10)**	**Legume Gro n=5)**	**Fruit Grou n=4)**	**Vegetable Gro n=11)**	**Fats Grou n=4)**
=22	=25	=20	=2	=41	=11	=8	=42
=4	=38	=43	=62	=11	=20	=4	=11
=2			=56	=3	=11	=53	=1
=1			=34	=1	=21	=11	=2
=1			=1	=8		=1	
=6			=22			=43	
=12			=8			=29	
=16			=2			=4	
			=1			=4	
			=14			=6	
						0=3	

Low = 0-3 food groups or <30 individual foods, **Medium =** 4-5 food groups or 30-60 individual foods, **High =** 6-9 food groups or >60 individual foods.

Table 18 indicates that participants n=22 did not consume any meat group foods, participants n=4 consumed one type of the meat group, and participants n=6 consumed five different types of meat group. In the egg group, participants n=25 did not consume the eggs. The participants n=43 consumed one type of dairy. Out of 10 different types of cereal in the cereal group, participants n=62 consumed one type of cereal, participants n=56 consumed two types of cereal, participants n=22 consumed five different types of cereal, participants n=14 consumed nine different types of cereal, and only participants n=2 consumed did not consume cereal.

large number of participants, n=41, did not consume any of the four different legumes, and only participants, n=11, consumed one type of legume. The fruit group had five different kinds of fruits, and participants n=11 did not consume any fruits, participants n=20 consumed two types of fruits and participants n=21 consumed three different types of fruits. Under the vegetable group with nine different types, participants n=8 did not consume any vegetables, n=4 of the participants consumed one type of vegetable, n=53 of the participants consumed two types of vegetables, participants n=43 consumed five different types of vegetables, and only n=4 of participants consumed eight different types of vegetables. Most of the participants, n=42, did not consume any of the fats group.

Table 19: Summary of Food variety within the Food Groups (n=126)

Variable	Location	Mean	p
Group 1: Flesh foods (Meat Poultry, Fish)	Mpharane	10.571	.051
	Maqoala	13.944	
Group 2: Eggs	Mpharane	44.493	.604
	Maqoala	49.158	
Group 3: Dairy products	Mpharane	19.392	.766
	Maqoala	18.174	
Group 4: Cereals	Mpharane	19.166	.322
	Maqoala	17.908	
Group 5: Legumes and nuts	Mpharane	13.016	.888
	Maqoala	12.698	
Group 6: Fruits and vegetables	Mpharane	17.384	.825
	Maqoala	17.713	
Group 7: Oils and fats	Mpharane	17.063	.372
	Maqoala	19.841	

Table 19 summarises the food variety consumed in Mpharane and Maqoala. There were no statistically significant differences (p=.051) between the food variety consumed in group 1 for Mpharane (mean intake of 10.57) and Maqoala (mean intake of 13.94).

4.2.1.7 AGRICULTURAL PRACTICES RESULTS

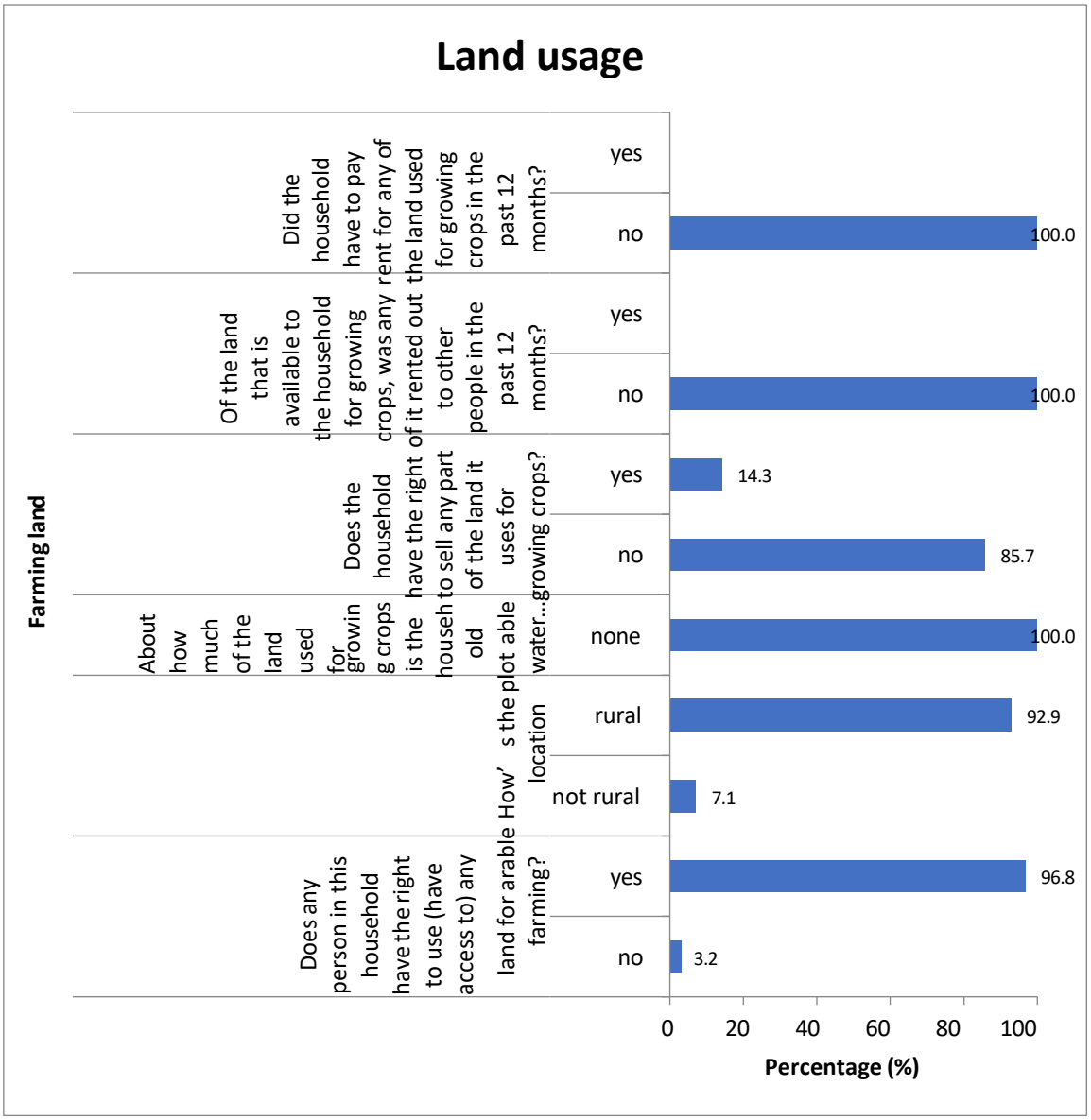


Figure 35: Land rights, usage, and tenure for arable farming

The findings for the farming land are depicted in Figure 36, where 96.8% indicated that the participants had access and the right to utilise any land for arable farming, both in Mpharane and Maqoala. Merely, 7.1% of the participants stated that the land was in an area that was not rural. Figure 36 further demonstrates that 100.0% of the participants emphasised that they were never obliged to pay rentals for the land they used, nor was the land suitable for agricultural growth rented out.

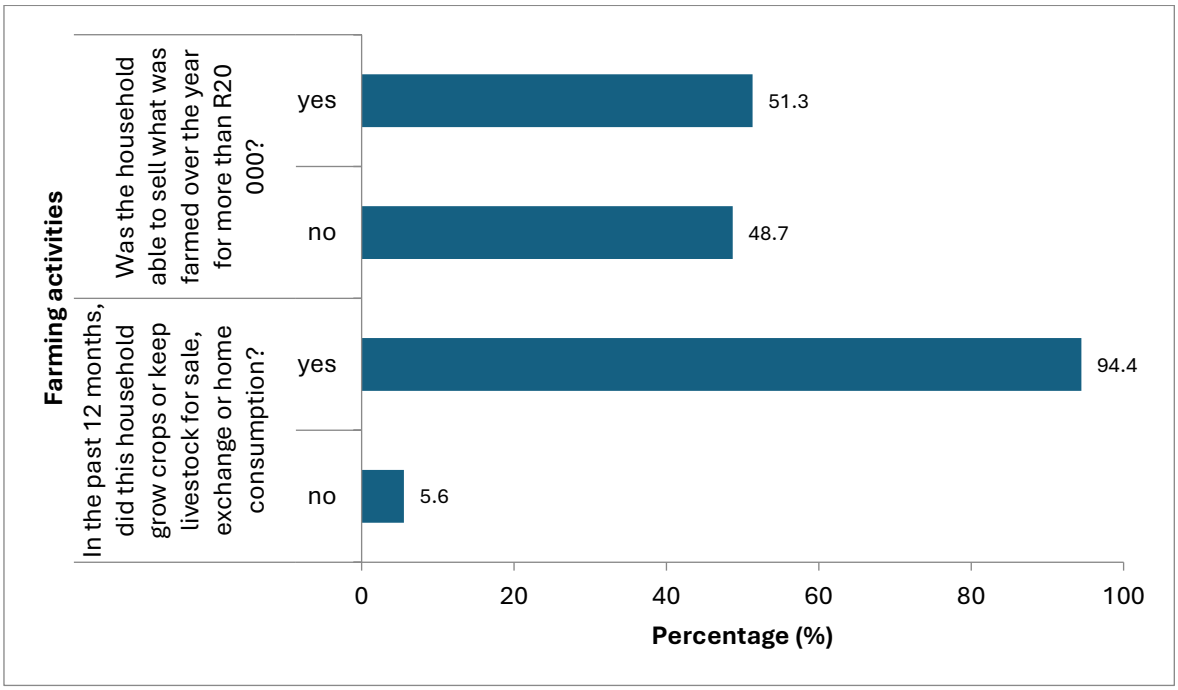


Figure 36: Agricultural activities and earnings from farming in the last 12 months

According to Figure 37, 94.4% of the participants stated that they grew crops, and kept livestock for sale, exchange or for home consumption. Furthermore, 51.3% of the participants were able to sell what was farmed over the year for more than R20 000, and 48.7% did not do so.

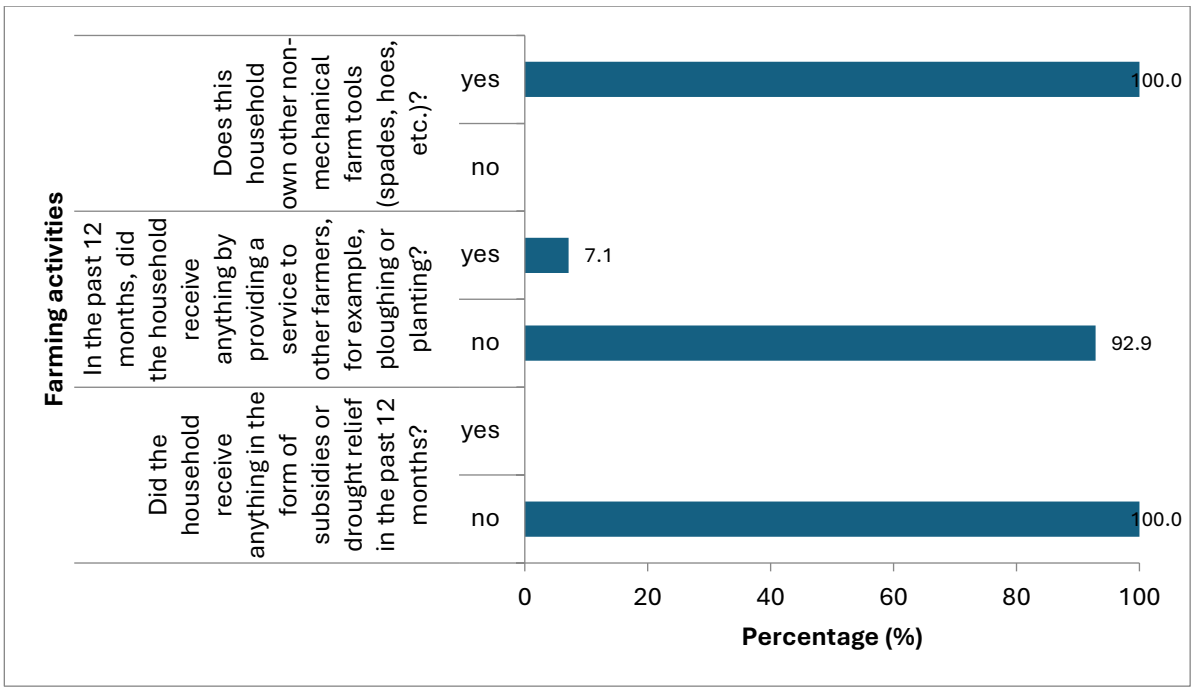


Figure 37: Household subsidies, services, and farming equipment ownership in the last 12 months As shown in Figure 38, not a single household of the participants, n=126, received any kind of subsidy or drought relief. Furthermore, only 7.1% of the study population obtained

compensation for their services rendered to other farmers. All participants (n=126) indicated that their households owned various non-mechanical farm tools such as spades, hoes, etc.

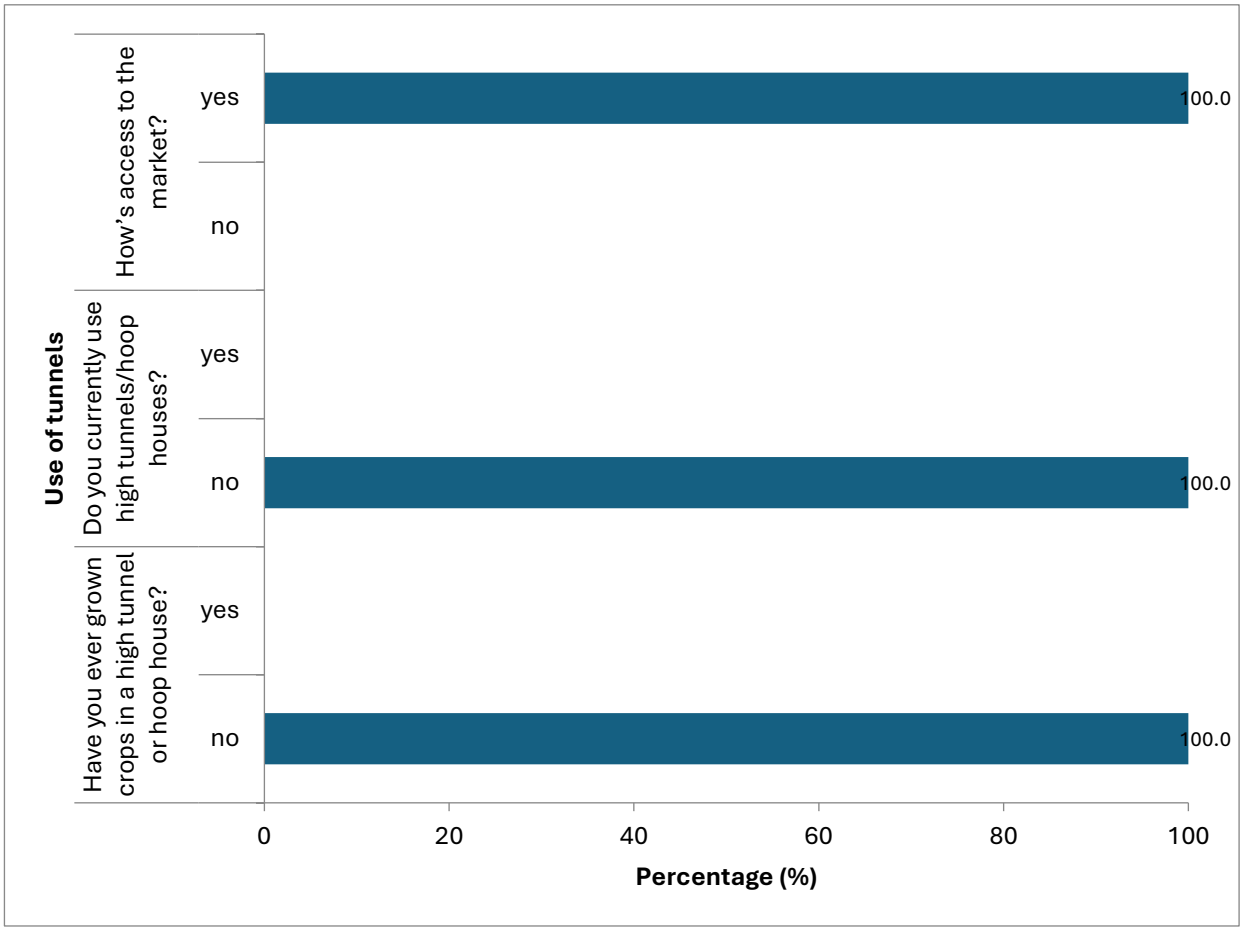


Figure 38: High tunnel and market access usage

Figure 39 provides a diagrammatical illustration of the participants utilisation of tunnels and market access. The diagram shows that all participants (n=126) had never grown crops in a high tunnel or hoop house. Furthermore, all participants (n=126) did not use high tunnels/hoop houses. In terms of access to the market, all participants indicated that they could access the market.

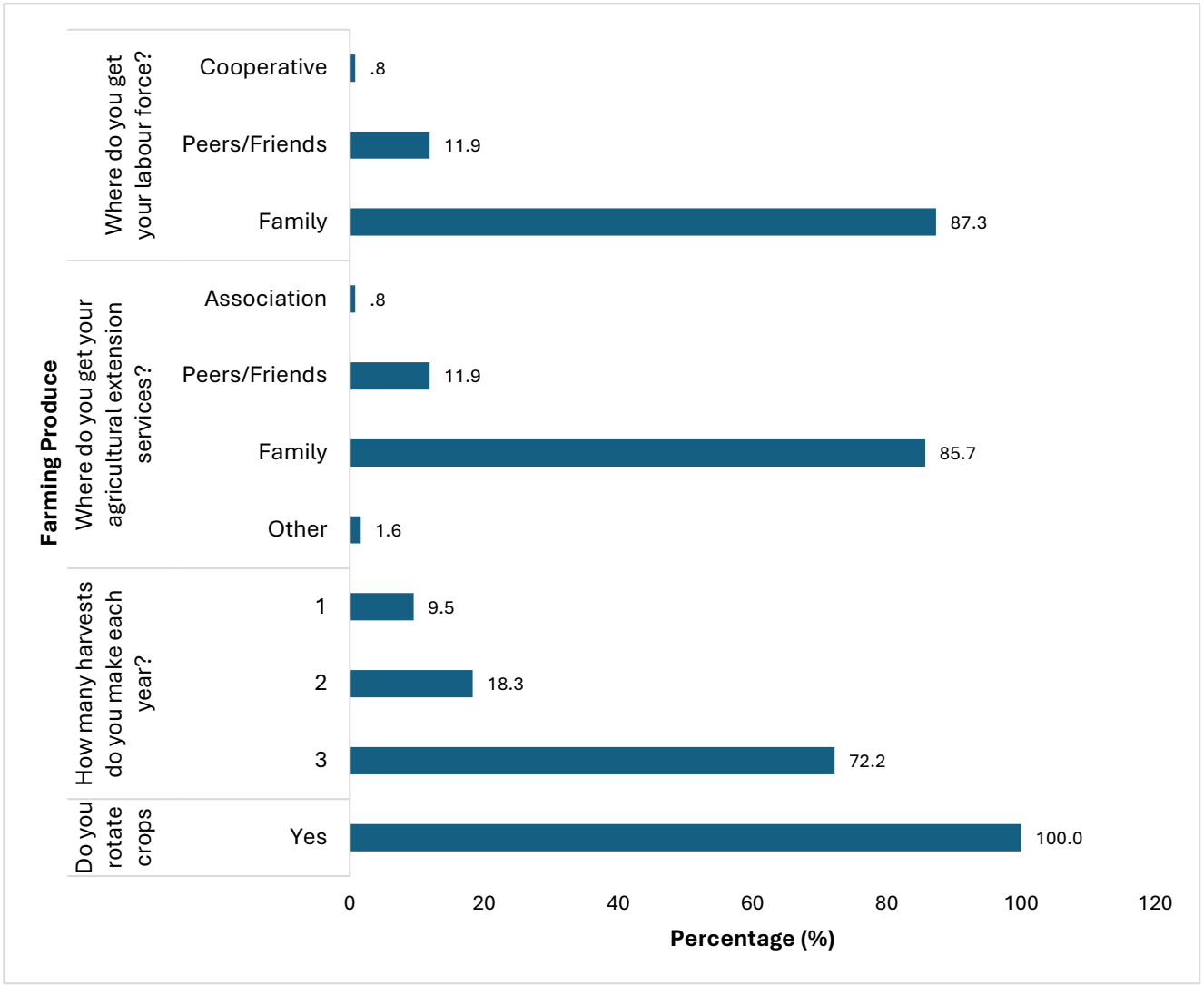


Figure 39: Agricultural practices, harvest frequency, extension services, and labour sourcing

According to Figure 40, all participants (n=126) rotated their crops, in addition, 72.2% of the participants harvested three times in a year compared to the 9.5% of the participants who harvested only once in a year. Eighty-five-point-seven percent of the participants indicated that they got agricultural extension services from their families compared to 87.3% of the participants that got labour force from their families and 0.8% received the labour force from an association.

4.2.1.8 Food Preparation/Preservation

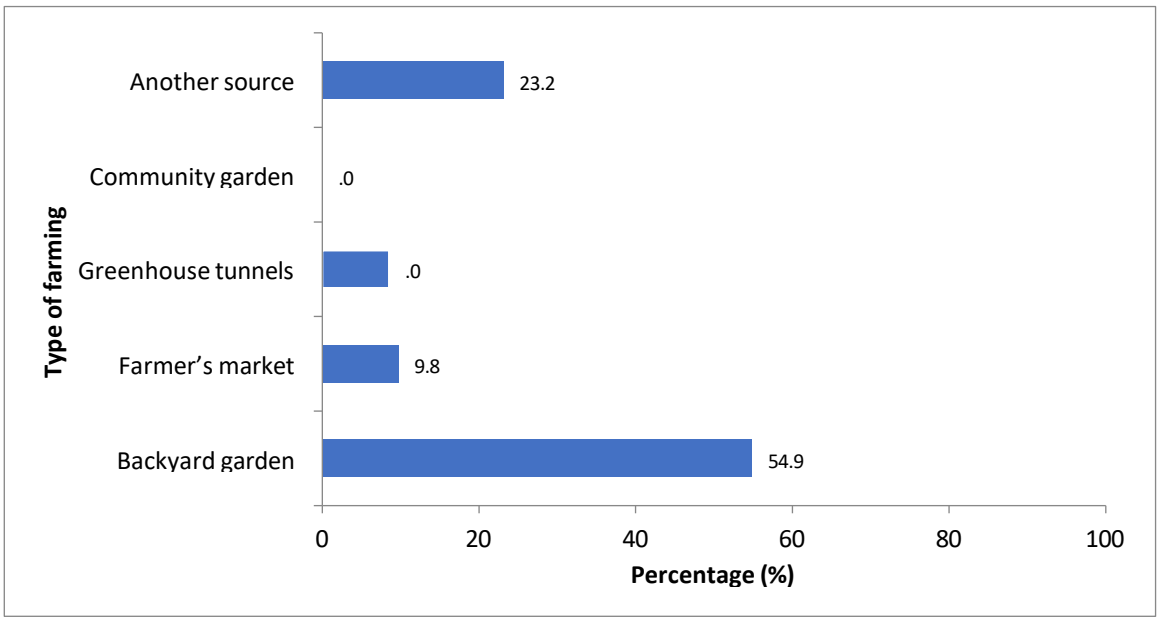


Figure 40: Source of produce for bottling

The results for the source of produce for bottling are depicted in Figure 41, where 54.9% of the participants obtained the produce from the backyard garden and 8.5% from the greenhouse tunnel.

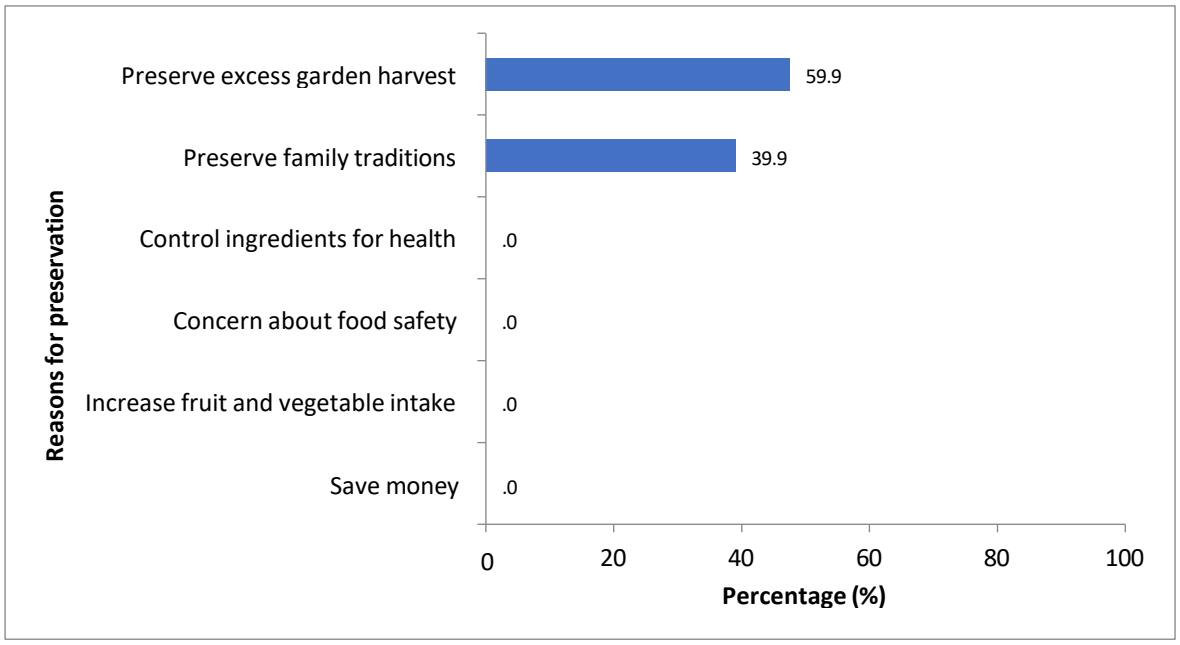


Figure 41: Reasons for food preservation

Figure 42 shows the results of the participants' reasons for preserving food. Only 39.9% of the participants stated that they use traditional ways of preserving food, whereas 59.9% of the participants preserved excess garden harvest.

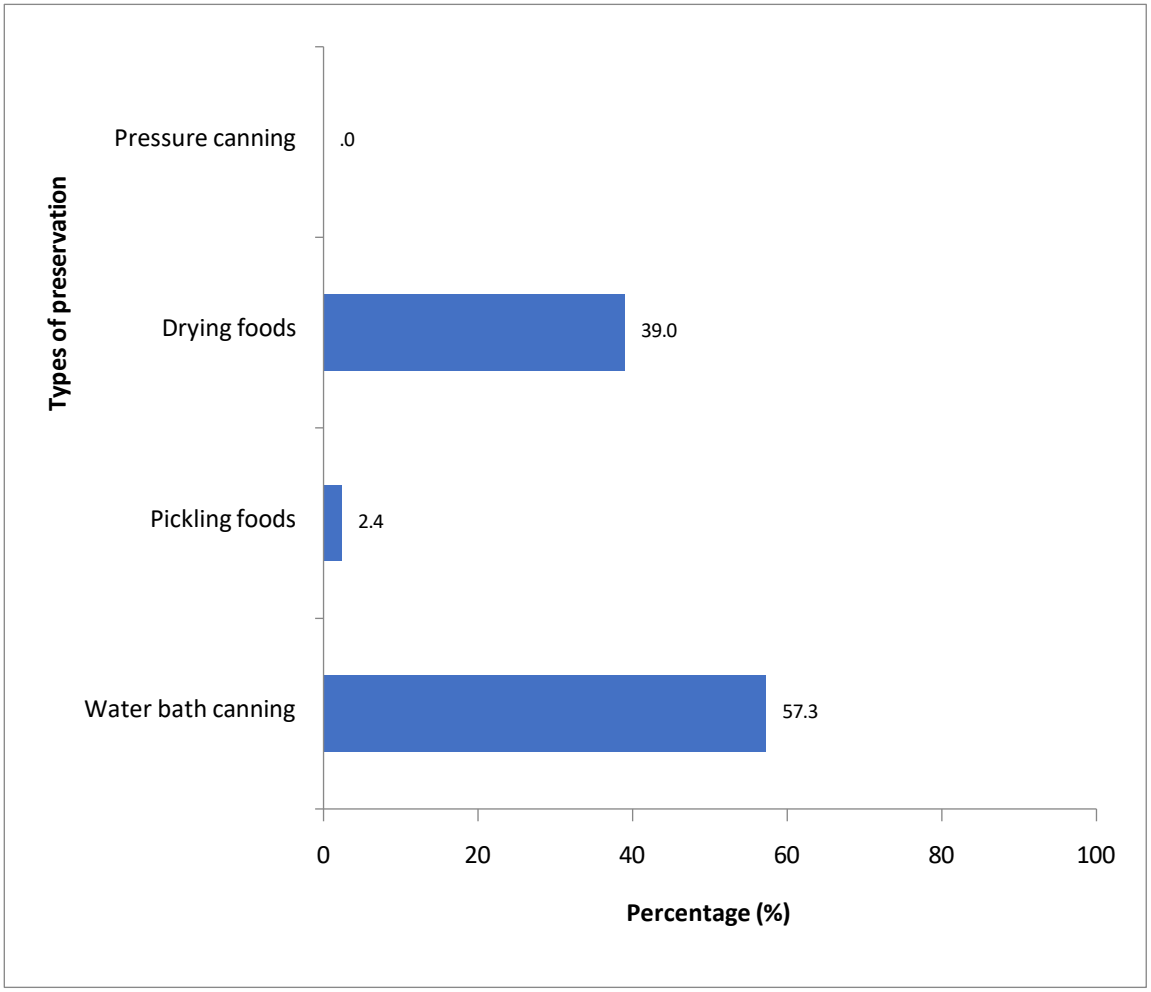


Figure 42: Methods of food preservation

Figure 43 elucidates a diagrammatical representation of methods of food preservation preferred by the population. According to Figure 43, 57.3% of the study population used the water bathing canning method. Drying food was the second most used method by 39.0% of the participants. None of the participants used pressure canning as a method for preservation.

4.2.1 Feedback Acceptability Results

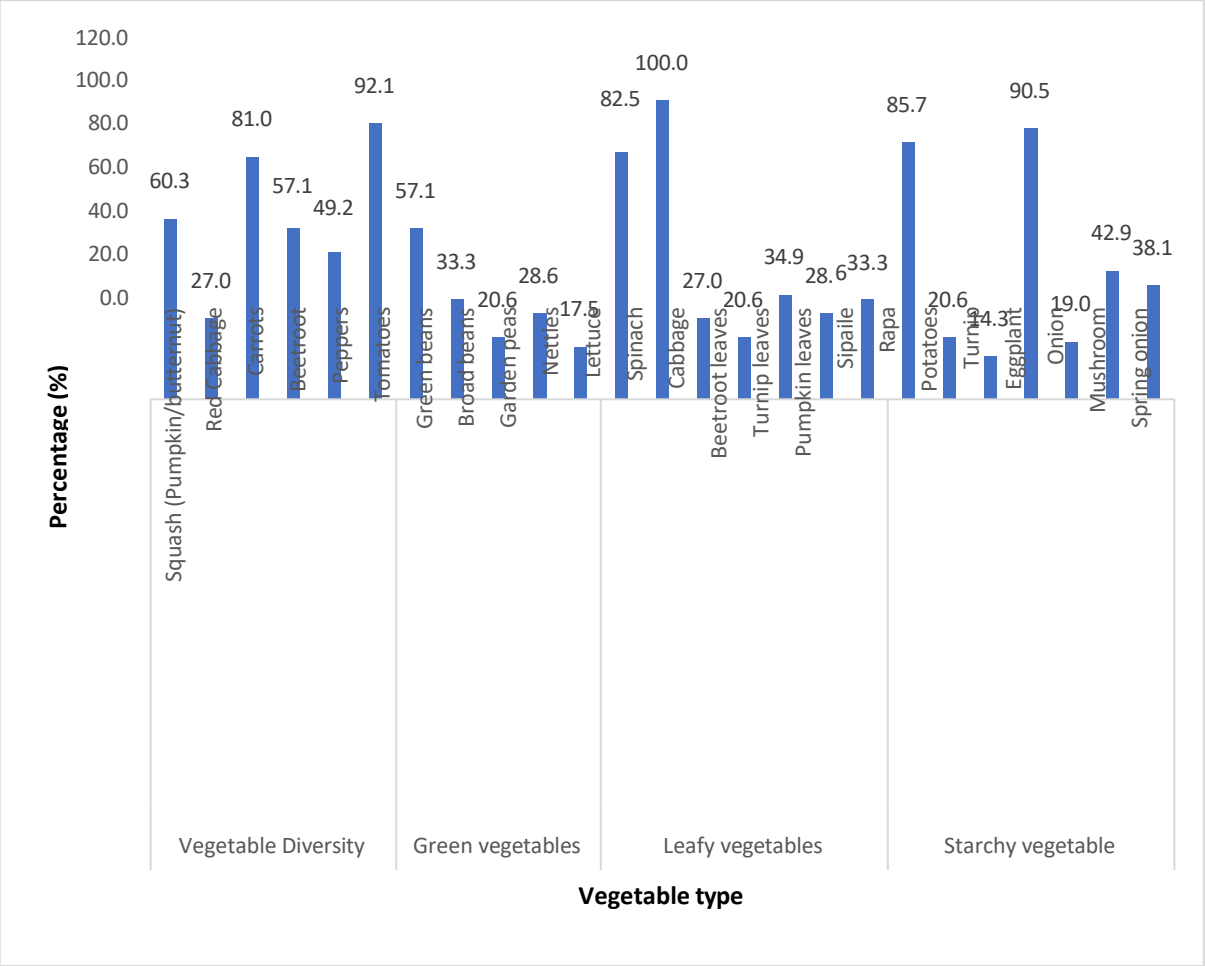


Figure 43: Preferred vegetables for cultivation and consumption for Mpharane (n=63)

Figure 44 annotates a diagrammatical representation of the vegetables preferred by the participants of Mpharane. The majority of the participants, 92.1% (n=58), selected tomatoes as their preferred vegetable. Additionally, of the participants, lettuce was the least preferred green vegetable by 17.5%. Cabbage was preferred by all participants (n=63) in the group of leafy vegetables, in contrast to turnip leaves, which were the least preferred by 20.6%. Ninety-point-five percent of the participants preferred onion, while 85.7% preferred potatoes.

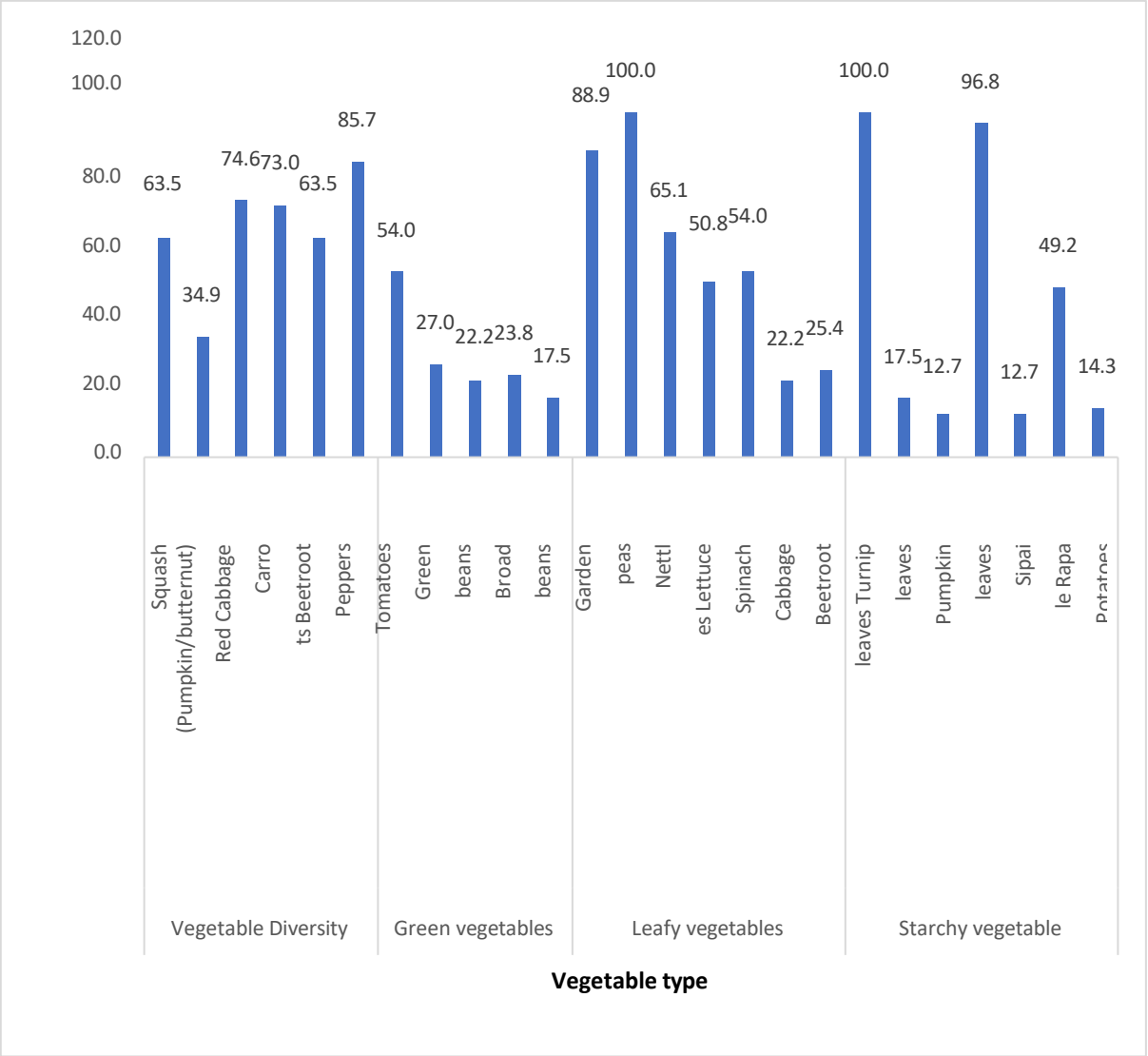


Figure 44: Preferred vegetables for cultivation and consumption for Maqoala (n=63)

Figure 45 shows a diagrammatical representation of the vegetables preferred by the participants of Maqoala. Less than half of the participants, 34.9% (n=22), selected red cabbage as their least preferred vegetable under diverse vegetables. Furthermore, of the participants, green beans were the most preferred green vegetable by 54.0%. Cabbage was preferred by all participants (n=63) in the group of leafy vegetables, in contrast to Sipaile, which was the least preferred by 22.2%. All the participants (n=63) preferred potatoes, followed by onions, which were preferred by 96.8% of the participants.

4.2.2 The results of the sustainable nutrition-sensitive agriculture toolkit on both baseline and endline

Table 20: Allocation of inputs (materials) for both the experimental group and control group

Experimental group from Mpharane n=63	Control group from Maqoala n=63
A sustainable agriculture program: using Greenhouse Tunnels	
Allocation and installation of Greenhouses Tunnels (establishing the storage facility and food preparation)	**Allocation and installation of Greenhouses Tunnels** (establishing the storage facility and food preparation)
Allocation of inputs	**Allocation of inputs**
A sustainable nutrition-sensitive agriculture program: using nutrition intervention	
Allocation of training manual	**Allocation of training manual**
Starting the training with Mpharane village participants on the toolkit	**No training is provided for the Maqoala village**

Table 20 provides information on the allocation of the Greenhouse Tunnels to the experimental group and control group. Each group was allocated three Greenhouse Tunnels. Each Greenhouse Tunnel was a 10m wide x 30m long x 4m structure, with 200 microplastics, a net for covering the complete tunnel, strapping, a hoist for flaps, gates, and extra support anchors (to stabilise the tunnels against the wind). Each Greenhouse Tunnel had an irrigation system. The irrigation system comprised of 500m x 16mm x 40cm spry dripper pipe, irrigation pipes and fittings (set), pump station junior automatic two-valve, security cage housing, computerised pump, 4 station controllers with relays, solenoid valves, 5000L tanks. Each Greenhouse Tunnel had a cooling system and heater. The cooling system and heater comprised of an 8.6m complete wet wall system, 8.6m water gutter system, 8.6m x 1.2m x 100mm pads, heavy duty fans 380, 0,75kw, pipe works, pumps 5000L wet wall tank, steel pipe support, temperature controller with thermostat, cooling system, and 5kw fan electric heater. The allocation of inputs was seeds that were certified by the government of Lesotho: round cabbage, spinach (Swiss hard), green beans (snap beans), red beetroot, carrots (Nantes), red bell pepper, tomato (stupice), butternut squash, potato (Vivaldi), brown onion. Each group was given two training manuals: the first training manual was the facilitator manual, and the second training manual was the participant's

handout booklet. Maqoala village was not provided with any training. The Greenhouse Tunnels and seeds were sponsored by the Ministry of Agriculture and Food Security together with the Lesotho National Development Corporation.

Figure 45: The structure of the Greenhouse tunnels in Mpharane village

Figure 46: The structure of the Greenhouse tunnels in Maqoala village

Figure 47: Greenhouse tunnels in Mpharane village

Figure 48: Greenhouse tunnels in Maqoala village

Figure 49: Training Day at Mpharane

Mpharane village was provided with in-depth training using both manuals. Each participant (n=63) was given the second training manual, named: participant handout booklet. The handout booklet comprised of three parts: part one, agriculture practices and general planting techniques, with lesson one on agriculture practices. Part two, Nutrition education, with lesson two on nutrition knowledge. Part three was on developing markets and products with lesson three, on food preparation and preservation. Mpharane female participants were divided into six groups to enable teamwork and support.

Table 21: The summary of the guidelines when planting in the Greenhouse tunnel (Department of Agriculture, Forestry and Fisheries South Africa 2010)

Planting in a Greenhouse Tunnel										
Vegetables	**Cabbage**	**Spinach**	**Green beans**	**Carrots**	**Peppers**	**Onion**	**Tomatoes**	**Butternut**	**Potatoes**	**Beetroot**
Production season	All year round	All year round	All year round	All year round	All year round	All year round	All year round	All year round	All year round	All year round
Area to plant	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)
Seeds required	5g – 10g	50g	800g – 1000g	20g – 40g	30g – 50g	25g – 35g	1.5g – 5g	20g – 40g	25g	20g – 40g
Planting spacing in row	30cm – 50cm	15cm	30cm – 50cm	5cm – 8cm	40cm – 45cm	5cm – 8cm	30cm – 50cm	50cm – 70cm	150cm – 260cm	20cm – 2cm
Spacing Between rows	60cm – 90cm	45cm	60cm – 90cm	30 cm – 50cm	75cm – 90cm	30cm – 45cm	75cm – 150cm	120cm – 150cm	20cm – 30cm	5cm – 10cm
Spacing between rows	60cm – 90cm	45cm	60cm – 90cm	30 cm – 50cm	75cm – 90cm	30cm – 45cm	75cm – 150cm	120cm – 150cm	20cm – 30cm	5cm – 10cm
Compound fertilizer kg/ha	42648	42589	6	1.2 – 2.0	6 – 10	42651	10 – 15	4 – 6	1300 – 2100	1.2 – 2.0
AN top-dressing kg/ha	1 – 2.5	1	Not necessary	1.0kg	1 – 2.5	1 – 2.5	0.8 – 1	2	1	1.0kg
Manure kg/ha	250	250 – 500	250 – 500	100 – 200	250	50	250 – 500	100 – 250	250	100 – 200
Days to harvest	70 – 160 days (depending on the season and variety)	120 – 160 days depending on the season and variety	60 – 90 days depending on the season and variety	70 – 120 days depending on the season and variety	120 – 220 days depending on the season and variety	120 – 220 days depending on the season and variety	80 – 120 days depending on the variety	60 – 120 days depending on the variety	120 – 150 days depending on the variety	60 – 90 days depending on the season and variety
Harvest duration	15 – 40 days	60 – 150 days	14 – 30 days after flowering	20 days	30 – 60 days	Done when 50% of the tops have wilted or collapsed	60 days	30 days	30 days (start to harvest 2 – 3 weeks after leaves and stems have died)	30 days
Post harvesting handling	Heads are cut and harvested individually	Tie 10 leaves into bundles. Store in the shade and keep cool and moist	Pods are picked when seeds are well developed but still sweet, soft, and juicy. Store in a cool place	Roots are lifted by hand, or a garden fork is used to harvest when they are about 2cm in diameter	Fruits are cut and harvested individually	Bulbs dry of satisfactorily when thinly laid out in rows in an open shed/ field for a week	Ripe fruits are picked when dull red to full red colour but still firm	Heads are cut and harvested individually	Use a fork or single furrow plough to lift potatoes. (do not leave potatoes lying in the sun)	Roots are lifted by hand, or a garden fork is used to harvest when they are about 2cm in diameter
Normal packaging	Heads	Bundles	Pockets	Pockets	Fruits	Sacks	Box	Heads/pockets	Pockets	Bundles/ pockets
Estimated production	200 – 750	1500	80 – 150	250 – 500	70 – 100	300 – 700	200 – 600	200 – 300	7kg – 10kg pockets	250 – 500

Table 22: Quantity produced, sold, and preserved in Phase 1, Phase 2 and Phase 3 after planting in the Greenhouse Tunnels with the experimental group

Agribusiness						Agro-processing						
			Phase 1 planting	Phase 2 planting	Phase 3 planting	Produce pricing 2022	Phase 1 planting	Phase 2 planting	Phase 3 planting	Phase 1 plantin g	Phase 2 plantin g	Phase 3 plantin g
Vegetables	Normal packaging	Estimated production	Produced vegetables	Produced vegetables	Produced vegetables	Industry Pricing	Sold Vegetables	Sold vegetables	Sold Vegetables	Preserved vegetables and household consumption	Preserved vegetables and household consumption	Preserved vegetables and household consumption
Cabbage	Heads	200 - 750	1each x 468	1 each x 612	1 each x 675	R14.95/each	1 each x 278	1 each x 422	1each x 485	1each x 1 89	1each x 189	1each x 189
Spinach	Bundles	1500	1bunch x 519	1bunch x 834	1bunch x 1238	R12.95/bunch	1bunch x 329	1bunch x 644	1bunch x 1048	1bunch x 189	1bunc h x 189	1 bunch x 189
Green beans	Pockets	80 - 150	1kg x 55	1kg x 130	1kg x 110	R29.95/kg	-	-	-	1kg x 55	1kg x 130	1kg x 110
Carrots	Pockets	250 - 500	1kg x 184	1kg x 347	1kg x 425	R9.99/kg	-	1kg x 157	1kg x 235	1kg x 184	1kg x 189	1kg x 189
Peppers	Fruit	70 - 100	1 each x 62	1 each x 96	1each x 82	R9.47/each	-	-	-	1 each x 62	1 each x 96	1each x 82
Onions	Sacks	300 - 700	1kg x 181	1kg x 373	1kg x 519	R14.99/kg	-	1kg x 183	1kg x 329	-	1kg x 189	1kg x 189
Tomatoes	Box	200 - 600	1kg x 123	1kg x 316	1kg x 524	R23.95/kg	-	1kg x 126	1kg x 334	1kg x 123	1kg x 189	1kg x 189
Butternut	Heads/ pockets	200 - 300	1each x 95	1each x 120	1eac h x 174	R14.95/each	-	-	-	1each x 95	1each x 120	1each x 174
Potatoes	Pockets	7kg – 10kg	1kg x 20	1kg x 33	1kg x 44	R11.99/kg	-	-	-	1kg x 20	1kg x 33	1kg x 44
Beetroot	Bundles/ pockets	250 - 500	1kg x 130	1kg x 141	1kg x 215	R12.95/kg	-	-	-	1kg x 130	1kg x 141	1kg x 215

Cabbage (size of the head: small 1-2kg, medium 3-4kg and large over 5kg) Spinach (1 bunch is equivalent to 500g) Pepper (size of a pepper: small 74g, medium 119g, large 165g) Butternut

(average weight 1.5kg)

Table 22 indicates that the experimental group in phase 1 harvested 468 cabbage heads, sold Two hundred seventy-eight heads and preserved 189 heads for household consumption. In phase 2, the number of cabbages increased to 612 heads; the participants sold 422 heads and preserved 189 heads for household consumption. In phase 3, 675 cabbage heads were harvested, 485 heads were sold, and 189 were preserved for household consumption. The participants harvested 519 bundles of spinach in Phase 1, and in Phase 2, 834 bundles were harvested, 329 bundles in Phase 1 and 644 bundles in Phase 2 were sold, and 189 bundles were preserved for household consumption. The participants harvested 1238 bundles of spinach in phase 3, and 1048 bundles were sold, whilst 189 were preserved for household consumption.

The harvested green bean pockets were 55kg in Phase 1 and 130kg in Phase 2, which the participants shared for preservation for household consumption. In phase 1 and phase 2, under the selling category, there was no selling since the participants harvested below the minimum harvest, which was 80kg. The harvested green bean pockets were 110kg in phase 3, and 130kg and 130kg were shared among n=63 participants for preservation for household consumption. Green beans were not sold. The 184kg carrots were harvested in phase 1, and they were all preserved for household consumption. In phase 2, 347kg of carrots were harvested, 157kg were sold, and 189kg were preserved for household consumption. The carrots were harvested at 425kg in phase 3, 235.9kg was sold, and 189kg was used for preservation for household consumption. Peppers were not sold in Phase 1 and Phase 2; both Phase 1 and Phase 2 produced 62 and 96 peppers, which were used for preservation for household consumption. Peppers were not sold in phase 3, and 82 each were used for preservation for household consumption. The participants harvested 123kg of tomatoes in phase 1. They did not sell any tomatoes, and all 123kg of tomatoes were preserved for household consumption. In phase 2, 326kg of tomatoes were harvested, 126kg were sold, and 189kg were for preservation for household consumption. The participants harvested 524kg of tomatoes in phase 3, sold 334kg of tomatoes, and used 189kg of tomatoes for preservation for household consumption. The participants managed to produce butternut, potatoes and beetroot in all phases but did not sell any of the produce, only used them for preservation for household consumption.

Table 23: Quantity produced, sold, and preserved in Phase 1, Phase 2 and Phase 3 after planting in the Greenhouse Tunnels with control group

Agribusiness						Agro-processing						
			Phase 1 planting	**Phase 2 planting**	**Phase 3 planting**	**Produce pricing 2022**	**Phase 1 planting**	**Phase 2 planting**	**Phase 3 planting**	**Phase 1 planting**	**Phase 2 planting**	**Phase 3 planting**
Vegetables	Normal packaging	Estimated production	Produced vegetables	Produced vegetables	Produced vegetables	Industry Pricing	Sold Vegetables	Sold vegetables	Sold Vegetables	Preserved vegetables and household consumption	Preserved vegetables and household consumption	Preserved vegetables and household consumption
Cabbage	Heads	200 - 750	1each x 567	1each x 627	1eac h x 414	R14.95/each	-	-	-	1 each x 567	1 each x 627	1each x 414
Spinach	Buddle's	1500	1bunch x 527	1bunch x 811	1bunch x 857	R12.95/bunch	-	-	-	1bunch x 527	1bunch x 811	1bunch x 857
Green beans	Pockets	80 -150	-	-	-	R29.95/kg	-	-	-	-	-	-
Carrots	Pockets	250 -500	1kg x 218	1kg x 375	1kg x 396	R9.99/kg	-	-	-	1kg x 218	1kg x 375	1kg x 396
Peppers	Fruit	70 -100	1each x 47	-	_	R9.47/each	-	-	-	1 each x 47		
Onions	Sacks	300 -700	1kg x 260	-	1kg x 317	R14.99/1kg	-	-	-	1kg x 260	-	1kg x 317
Tomatoes	Box	200 -600	1kg x 186	1kg x 434	1kg x 573	R23.95/1kg	-	-	-	1kg x 186	1kg x 434	1kg x 573
Butternut	Heads/ pockets	200 -300	-	-	-	R14.95/each	-	-	-	-	-	-
Potatoes	Pockets	7kg –10kg	1kg x 24	-	1kg x 37	R11.99/kg	-	-	-	1kg x 24	-	1kg x 37
Beetroot	Bundle/ pockets	250 - 500	1kg x 90	-	-	R12.95/kg	-	-	-	1kg x 90	-	-

Cabbage (size of the head: small, 1-2kg, medium, 3-4kg and large over 5kg). Spinach (1 bunch is

equivalent to 500g) Pepper (size of a pepper: small 74g, medium 119g, large 165g) Butternut (average weight 1.5kg)

Table 23 indicates that the control group did not sell any fresh produce they harvested. Instead, they shared the harvested fresh produce with each other. In phase 1, 567 cabbage heads were harvested, and 567 heads were shared among the n=63 participants for household consumption. In phase 2, the number of cabbages harvested increased to 627 heads and all 627 heads were shared among the participants for household consumption. In phase 3, 414 cabbage heads were harvested, and 414 heads were shared among the n=63 participants for household consumption. The participants harvested 857 bundles of spinach and used all 857 bundles were used for household consumption. The participants did not plant green beans. The participants planted and harvested 47kg of peppers in Phase 1 and shared the peppers and did not plant peppers in Phase 3. The participants did not plant peppers in phase 2. Potatoes and beetroot were also planted only in Phase 1 and not in Phase 2, respectively. The participants harvested 37kg of potatoes in phase 3 and shared them for household consumption.

Table 24: The summary and comparison of the quantity harvested, sold, and preserved in Phase 1, Phase 2 and Phase 3 after planting in the Greenhouse Tunnels between the experimental group and control group

	Mpharane Experimental Group (n=63)			Maqoala Control group (n=63)		
Cabbage	**Harvested**	**Sold**	**Preserved**	**Harvested**	**Sold**	**Preserved**
Phase 1	468	278	189	567	-	567
Phase 2	612	422	189	627	-	627
Phase 3	675	485	189	414	-	414
Total	**1755**	**1185**	**567**	**1608**	-	**2175**
Spinach (1bunch =500g)						
Phase 1	519	329	189	527	-	527
Phase 2	834	644	189	811	-	811
Phase 3	1238	1048	189	857	-	857
Total	**2591**	**2021**	**567**	**2196**	-	**2195**
Green beans						
Phase 1	55	Not sold	55	Not produced	Not sold	Not preserved
Phase 2	130	-	130	-	-	-
Phase 3	110	-	110	-	-	-
Total	**295**	-	**295**	-	-	-
Carrots						
Phase 1	184	Not sold	184	218	Not sold	218
Phase 2	347	157	189	375	-	375
Phase 3	425	235	189	396	-	396
Total	**956**	**392**	**562**	**989**	-	**989**
peppers						
Phase 1	62	Not sold	62	47	Not sold	47
Phase 2	96	-	92	-	-	-
Phase 3	82	-	82	-	-	-
Total	**240**	**-**	**236**	**47**	**-**	**47**

Table 24: The summary and comparison of the quantity harvested, sold, and preserved in Phase 1, Phase 2 and Phase 3 after planting in the Greenhouse Tunnels between the experimental group and control group

	Mpharane Experimental Group (n=63)			Maqoala Control group (n=63)		
Tomatoes	**Harvested**	**Sold**	**Preserved**	**Harvested**	**Sold**	**Preserved**
Phase 1	123	Not sold	123	Not produced	Not sold	Not preserved
Phase 2	326	126	189	-	-	-
Phase 3	524	334	189	-	-	-
Total	**973**	**460**	**501**	**-**	**-**	**-**
Butternut						
Phase 1	95	Not sold	95	Not produced	Not sold	Not preserved
Phase 2	120	-	120	-	-	-
Phase 3	174	-	174	-	-	-
Total	**389**	**-**	**389**	**-**	**-**	**-**
Potatoes						
Phase 1	20kg	Not sold	20kg	24kg	Not sold	24kg
Phase 2	33kg	-	33kg	-	-	-
Phase 3	44kg	-	44kg	37kg	-	37kg
Total	**97kg**	**-**	**97kg**	**61kg**	**-**	**61kg**
Beetroot						
Phase 1	130kg	Not sold	130kg	90kg	Not sold	90kg
Phase 2	141kg	-	141kg	-	-	-
Phase 3	215kg	-	215kg	-	-	-
Total	486kg	-	486kg	90kg	-	90kg

(- not produced, - not sold, - preserved)

This paragraph summarises the above findings from Table 24 that have been put together from Table 22 to Table 23 regarding the experimental and control groups' fresh produce production. The experimental group had an increase of 144 heads of cabbage from Phase 1, 468 heads of cabbage in Phase 2, and 612 heads of cabbage in Phase 3 (675 heads of cabbage). The increase was very

Low, with 63 heads of cabbage between phase 2 to phase 3. The control group had a total of 1608 heads of cabbage between phases 1, 2 and 3, and the experimental group had a total of 1755 heads of cabbage between phases 1, 2 and 3, with 147 heads of cabbage more than the control group. The experimental group had a vast increase in the bundle of spinach in phase 3, with 1238 bundles of spinach, compared to phase 1, with 468 bundles, and phase 2, with 612 bundles. The total of the bundles of spinach in the experimental group was 2591 bundles between phases 1, 2, and 3, and in the control group, the total of the bundles of spinach was 2196 bundles between phases 1, 2, and 3. The experimental group had 396 bundles more than the control group. There was almost a triple increase in phase 2, with 130kg of green beans, compared to 55kg in phase 1, but there was a decrease in phase 3 with 110kg. The control group did not produce any green beans in phases 1, 2, and 3 but produced a large number of carrots, 989kg between phases 1, 2, and 3, compared to the experimental group, with a total of 956kg between phase 1, 2, and 3. There was low production of peppers among the experimental group, 240 each between phases 1, 2, and 3 and the control group, with a total of 47 each in phase 1.

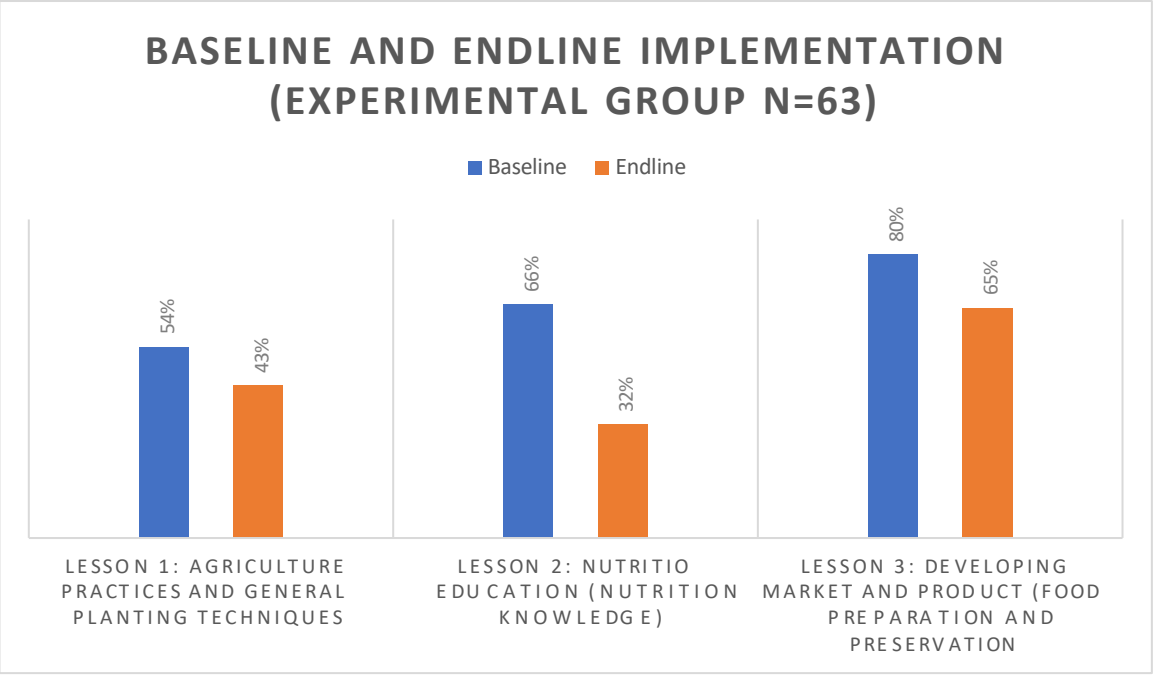


Figure 50: Baseline and endline implementation summarised scoring for three training lessons

The participants were taught agriculture practices, nutrition, and developing market products in the baseline, and immediately after the lesson, the participants were assessed. At the endline, the participants were not taught again but were expected to remember the previous lessons and practices that they had done during the intervention. Figure 51 indicates that the participants scored 54% out of 100% in lesson 1, 66% in lesson 2 and 80% in lesson 3. There was a decrease in the participant's scores in the endline. The participants scored 43% in lesson 1, 32% in lesson 2 and 65% in lesson 3.

4.3 DISCUSSION OF THE RESULTS

The intervention focused on the current food and nutrition insecurity in Lesotho in the district of Mohale's Hoek between the two villages, Mpharane (experimental group) and Maqoala (control group), among Basotho small-scale female farmers.

The results of the study indicated high levels of food insecurity in both Mpharane and Maqoala villages since all participants from both villages indicated that in the last 12 months, there has been a change in their food intake, Table 8. In addition, Figures 29, 32 and 33 highlight that all participants indicated that sometimes, in the household, some members would eat less food, cut the size of the meals, or skip meals. Moreover, 54% reported that there were times when they would be hungry but could not eat. In the extreme case, 22,2% of the participants reported that other adults in the household would go the whole day without eating. One of the contributing factors that the participants reported regarding the decreased access and availability of food in their households was that there was not enough money to buy food. This above financial constraint in acquiring food is highlighted in Figure 28, which indicates that 11.1% of the participants spent between R0 to R200.00, 25.4% spent between R201.00 to R300.00, and 36.5% spent between R301.00 to R400.00 on food each month. Furthermore, almost half of the participants 45.7% indicated that sometimes they did not have enough money to buy food, and 43.7% often did not have enough money to buy food.

This is a clear indication that Basotho people in Lesotho are currently experiencing food insecurity at different levels. According to the FAO (2023), there was a steady increase in the frequency of moderate or severe food insecurity in Lesotho in the last four years of the total population (percent) of Lesotho over a 3-year average from 2020 -2022. From 2017 to 2019, the prevalence was 49.7 percent; from 2018 to 2020, the prevalence increased to 52.0 percent; from 2019 to 2021, the prevalence increased to 54.4 percent; and from 2020 to 2021, it increased to 56.7 percent.

The food insecurity in the study is more alarming because the results indicated that the children are experiencing food insecurity in the participants' households. Figures 29, 34 and 35 reported that all the children in the last 12 months did not have enough food and a balanced meal. Some

of the contributing factors to the children's food and nutrition insecurity could be the fact that all the participants reported that they cut the size of their children's meal, 89.7% of the children skipped meals, and in the extreme case, 5.6% of the participants reported that the children went a whole day without eating. One of the contributing factors to the children facing food and nutrition insecurity it's because the mothers do not have money to buy food. The severity of having limited spending money for food has a significant negative impact on human life.

The Integrated Food Security Phase Classification (IPC) (2023) supported the study's reports regarding the increasing food insecurity in Mohale's Hoek by indicating that in Mohale's Hoek, 80 650%) of people were in phase 1, falling under minimal food insecurity, 48 039 (30 percent) were in phase 2, falling under stressed food insecurity; and 32026 (20 percent) were in phase 3, falling under crisis food insecurity. None of the people experienced phase 4, which was emergency food insecurity, and phase 5, which was famine food insecurity. However, phase 3 or above meant people were facing high food insecurity and needed urgent action.

Food insecurity affects both developed and developing countries, and Lesotho is no exception. According to the United Nations Population Fund (UNFPA) (2023), World Population Review (2023), and Reliefweb (2023), in 2023 the degree of acute food insecurity globally continued to increase due to food emergency and different challenges. In 48 nations, 238 million people were experiencing extreme rates of acute food insecurity; this was 10 percent more than in 2022. Lesotho, a country grappling with food insecurity, has a population of over 2 million, out of which 58 000 people were food insecure, and 24.1 percent of the population lived in extreme poverty (IPC 2023). From July to September 2022, 229 000 people (15 percent) of the populace in Lesotho residing in the rural areas fell under IPC Phase 3, indicating a food security crisis. In summary, six out of ten districts of the country were categorised as IPC Phase 2 (Stressed), four districts were classified as the IPC Phase 3 (Crisis). The population in Lesotho residing in rural areas under IPC Phase 3 (crisis) increased to 320,000 (22 percent) from October 2022 to March 2023. This means eight out of ten districts were classified as IPC Phase 3 (crisis). The first reason for the increase from 15 percent to 22 percent in IPC Phase 3 (crisis) from 2022 to 2023 was climate change in Lesotho (WFP 2023). At a national level, the seasonal rain occurred without delay.
Nonetheless, most of the regions experienced extreme volumes of rainfall, which demolished several produces and initiated waterlogging some parts of the nation. As a result, Lesotho

indicated decreased crop productivity compared to the former year, 2021 and the last five-year average. The second reason was the escalated prices; prices have stayed higher than the 5-year average and higher than the last year. The third reason was economic decline, which has resulted in increased inflation combined with decreased salary prospects from primary sources, and this has reduced the purchasing power (WFP 2023).

The World Bank Group (2023) confirmed these findings, which stated that poverty remains relatively high in lower-middle-income countries such as Lesotho. Thirty-three-point nine percent of the people was projected to live below $2.15/day, which was the global poverty line in 2023, whilst 56.2 percent of the populace was under the lower-middle-income country poverty line of $3.65/day. The International Monetary Fund (2008: 8), Cohen and Reeves (2020: paragraph 2 line 3), and the UN (2023a) explained that poverty was linked to inadequate national monetary performance, inadequate revenue delivery and poor governmental structures that render poor individuals powerless in either a democratic system or dictatorship. Restrictive economic systems increase food volatility and prices, making the cost of food a constant concern for poor people in developing nations because most people spend over 50 percent of their income on food. Furthermore, poverty has been an occurring problem globally. In 2020, global poverty was 9.2%, meaning 689 million individuals lived in poverty on $1.90 or less a day. In the United States, 11.8 % of the populace, meaning 38.1 million people, were living in poverty with a salary of $33.26 per day or less. Four out of five people globally lived below the poverty line in rural regions in 2018. Almost one-third of the population in emerging nations were poor, with 70 to 80 percent from Sub-Saharan Africa. Nearly half of underprivileged individuals in Sub-Saharan Africa were found in the following five nations: the Democratic Republic of Congo, Madagascar, Tanzania, Ethiopia, and Nigeria.

The Department of Statistics South Africa (Mbalo Brief) (2023) revealed that a large number of female-headed households in South Africa experienced inadequate access to food. As a result, 16.5% experienced moderately inadequate food access, and 7.7% experienced severely inadequate access to food, which was higher than the national average in both these categories of food access. The above finding was supported by The World Bank's (2023) findings as it estimated poverty at 62.6% in 2022 in South Africa based on the upper-middle-income country poverty line. South Africa does not have as high

occurrence of food insecurity as Lesotho. In South Africa, between 2017 and 2019, the prevalence was 17.4%, in 2018 to 2020, the prevalence was 18.2%, in 2019 to 2021, the prevalence was 19.0%and in 2020 to 2021, the prevalence was 20% (FAO 2023). However, South Africa shares similar food insecurity challenges and socio-demographic problems with Lesotho. World Economic Forum (2022), under the global gender gap report of 2022, together with Statistics South Africa (2023), stated that approximately 43 % of South African homes were female-headed households. The reasons for this include decades of colonisation and apartheid which resulted in men working far from their households and a higher proportion of females' birth as compared to men.

Evidence from the current study has highlighted that female-headed households in Lesotho just like in South Africa experience difficulties in accessing food. The participants expressed the anxiety over running out of food with 50.8% of the participants running out of food and not having money to buy more food in Figure 31. This contributed to the 63.5% of the participants in the past 12 months not being able to eat a balanced meal. Figure 30 and 34 indicated some of the coping strategies the participants used in order to have money to buy food or have access to food. The figures revealed that 20.6% of the participants borrowed food from their friends, neighbours, relatives, and others. Among the participants, only 18.3% reported that they stuck to simple foods that were cost-effective. Fourteen-point-three percent reported selling assets they owned to have money to buy food for their households.

The current study showed that in terms of the frequency of experiencing hunger, all participants had previously eaten less than they thought they should have because they could not afford to buy food. Among the participants, 22.2% reported that they had gone without food for an entire day due to financial difficulties. The Global Hunger Index (2023) specifically indicated that Lesotho has a hunger score of 34.5, which falls under the category of alarming (the scoring ranges from ≤9.9 low, 10.0 to 19.9 moderate, 20.0 to 34.9 serious, 35.0 to 49.9 alarming and ≥50.0 extremely alarming). Lesotho ranks 121 out of 125 countries that were evaluated and experienced hunger under the global hunger index. The disparity in income levels is one of the causes of the accumulating high levels of starvation globally, particularly in Africa (Kent 2016;

Roser 2016; Kent 2019: 7; Luhby 2019; Matthews 2019).

FAO, UNICEF, WFP, IFAD, and WHO (2023) reported that from 2019 to 2022, millions of people experienced hunger. Some of the contributing factors are the COVID-19 pandemic, climate change, global conflict, and political instability. Action Against Hunger (2023) explained that in 2022, 2.4 billion individuals, primarily women residing in rural areas, experience hunger and do not have consistent access to nutritious, safe, and sufficient food. In 2021, 22.3% (148.1 million) of children were stunted, 6.8 % (45 million) were wasted, and 5.6% (37 million) were overweight. These figures clearly indicated that child malnutrition was still high in the world. Figures 34 and 35 highlight some of the reasons for the increase in malnutrition in children in general. All participants explained that the children were sometimes not eating enough because the participants could not afford to buy enough food. Also, the participants were unable to provide a balanced meal for their children due to financial constraints. More than half, 63.5% of the participants, outlined that they frequently relied on a few kinds of low-cost food to feed their children because they were running out of money to buy food. The participants also experienced situations where their children were hungry and could not afford more food. 5.6% of the participants reported that their children ran out of food the entire day because there was not enough money to buy food.

Since the participants have reported experiencing inadequate access to food over a period of time, this experience could have negatively affected some of their nutrient adequacy, both macronutrients and micronutrients. Tables 12 to 19 reported on the nutrient adequacy, food variety, and dietary diversity of the participants on BL and EL of the experimental group and control group. The carbohydrate intake was high for both the experimental group (BL 203.90g; ±78.19, EL 207.72; ±94.95) and control group (BL 179.05g; ±81.65, EL 183.8; ±86.96) participants, of 100g. Tables 15 and 15 indicate that both the experimental group and control group consumed a large amount of sorghum and maize in the BL and EL. The amount of consumption of both cereals decreased in the EL for both groups. The protein intake was lower than the DRI of 46g at BL 33.77g (±13.76), EL 35.11g (±14.67) in the experimental group, and BL for the control group was 33.31g (±15.67), and EL was 30.16g (±13.63). In the top 20 most

consumed food, beans appeared at number 5 with 71.0% at BL and number 11 with 22.2% in the EL. Chicken meat appeared in number 11 with 42.9% at BL, and in the EL, chicken meat did not appear in the top 20. Eggs appeared at number 12 with 41.3% BL and number 6 in the EL with 44.4%, and lastly, milk appeared at number 17 with 20.6% BL and at number 5 with 44.4% EL with the experimental group. In the control group the top 20 most consumed foods when it comes to protein food indicated that beans appeared at number 6 with 65.1% BL and number 11 at EL with 33.3%. Chicken meat appeared at number 11 in BL with 34.9%, and it did not appear in the EL, but in the EL tribe, offal's, runners and heads appeared at number 6 with 36.5%. Eggs appeared at number 9 with 39.7% BL and number 5 at EL with 49.2%, and lastly, milk appeared at number 13 with 31.7% BL and number 7 EL with 34.9%. The above findings explain the reason protein intake was low; none of the complete proteins were in number 1 or 2 of the top 20 most consumed food, furthermore, Tables 17 and 18 indicated that out of n=6 meat group in the experimental group 0=20 did not eat any of the meat group, out of n=1 egg group 0=27 did not eat any eggs, out of n=2 dairy group 0=13 did not consume any dairy and out of n=4 legume group 0=44 did not consume any legumes. In the control group, out of n=8 meat group in the experimental group, 0=22 did not eat any of the meat group, out of n=1 egg group, 0=25 did not eat any eggs, out of n=2 dairy group, 0=20 did not consume any dairy and out of n=5 legume group 0=41 did not consume any legumes. Besides money being one of the main factors in accessing food, seasonal availability, nutrition knowledge, and dietary preference play major roles in consumption.

Moreover, the participants did not meet their recommended DRIs for vitamin A, D, and B12. However, micronutrients such as iron, iodine and zinc recommended DRIs were met. Tables 15 to 18 depict the top 20 foods consumed by the participants, which can explain the micronutrient variations. In relation to findings from the WHO (2023), vitamin B12, vitamin A, vitamin D, iron, iodine, and zinc are the highest common micronutrient deficiencies globally, with a greater frequency in iron, iodine, vitamin A, and zinc. The frequency rates are 30% of the globe's populace has inadequate iodine intake, and one out of three children below five years of age have vitamin A shortage from low and middle-income countries. Siddiqui, Lassi, and (2020) concur with the above

findings by highlighting that insufficient intake of micronutrients can lead to different types of malnourishments. Micronutrient deficiencies exist in all age groups and any socioeconomic rank. In low- and middle-income countries, iron, folate, vitamin A, iodine, and zinc are among the most common and widespread micronutrient deficiencies among women and children. Several of these micronutrient deficiencies co-exist.

This study showed that the nutrition knowledge of participants was 52% on average, which ranged from 38% to 69%. This clearly indicates that people need to be more educated on nutrition. According to Piscopo (2019), nutrition education has the broad goal of promoting individual, family, community and global well-being. Momo-Cabrera, Ortiz-Andrellucchi, and Serra-Majem (2019) explained that food and nutrition education plays a crucial part in aiding access to adequate quality and quantity of foods for families and populations.

As indicated in the previous chapter, all participants were female farmers aged 20 to 60 years and above. The female farmers were engaged in farming activities, either as individuals, as part of a cooperative, or in a community project and had cultivated their land from 2019-2021. These attributes were part of the criteria for the inclusion of participants. The fundamentals of the study and criteria were based on the SDG2 to "End hunger, achieve food security and improve nutrition and promote sustainable agriculture". SDG2 recognises the connection between encouraging sustainable agriculture, uplifting small-scale farmers, encouraging gender equality, ending rural poverty, safeguarding healthy lifestyles, undertaking climate change, and other topics addressed within the set of 17 SDGs in the Post-2015 Development Agenda (United Nations Sustainable Development Goals Knowledge Platform 2023).

In order to address the high levels of food and nutrition insecurity as indicated in the above results and findings, the research intervention toolkit tried to meet some of the elements in the SDG 2 by: (i) supporting sustainable agriculture through introduction of Greenhouse tunnels with temperature control and irrigation system, practicing both old and new agriculture practices and incorporating technology and research in the

intervention; (ii) empowering small-scale farmers by selecting active female farmers who own land for cultivating from the age of 20 years and above; (iii) promoting gender equality by selecting females heading households who are caregivers and unemployed; (iv) ending rural poverty by selecting two rural villages (Mpharane and Maqoala) in the district of Mohale's Hoek Lesotho; (v) ensuring healthy lifestyles by introducing and educating the female farmers on nutrition; (vi) tackling climate change by introducing Greenhouse tunnels with temperature control and irrigation system.

In agreement with the above statement, the United Nations Women (2021) stated that rural women and girls must ensure food security for their communities, build climate resilience and strengthen economies. United Nations Women (2021) further highlighted the underlying negative challenges that women and girls experience in the agriculture sector, such as gender discrimination, inequitable laws, and societal norms, combined with a fast-altering financial, technical, and ecological landscape which limits their full potential. All these challenges leave women and girls far behind men. Agriculture is still the most vital part for females in emerging countries and rural areas. Agriculture still falls among the informal economy with minimum or no social protection and rights and is thus affected by the inequality between men and women. Globally, less than 15% of the agricultural landholders are women. This study shows a different result, as the findings indicated that 96.8% of the participants had access to and the right to utilise any land for arable farming. Merely 7% of the participants stated that the land was in an area that was not rural. All participants emphasised that they were never obliged to pay rentals for the land they used, nor was the land suitable for agricultural growth rented out. In addition, not a single household of the participants received any kind of subsidy or drought relief from the government. Furthermore, only 7 percent of the participants obtained compensation for their services rendered to other farmers. All households own various non-mechanical farm tools such as spades, hoes, etc.

To tackle the above limitations, the current study utilised Prima, Wright, Sharma, Syurina, and Broerse (2022) and Ruel, Quisumbing, and Balagamwala (2018) to assist in improving nutritional outcomes by using information on nutrition-sensitive

agriculture (NSA). The UN AND SDGs introduced the concept of NSA as an intervention to reinforce and improve the underlying primary causes of malnutrition presented in the UNICEF conceptual framework (Wijeratna and Swan 2014: paragraph 2 line 1, and United Nations 2020: paragraph 2 line 1). Thompson and Amoroso (2011) and FAO (2014b: 28) explained nutrition-sensitive agriculture as a food-based method to agricultural growth that focuses on nutritionally rich foods, nutritional variety, and food fortification to address malnourishment and micronutrient deficiencies. This method emphasises the numerous benefits derived from enjoying a diversity of foods, acknowledging the dietary value of food for good nutrition, and the vital and social impact the food and agricultural sector has in supporting rural livelihoods. The general aim of nutrition-sensitive agriculture is to make the universal food system better equipped to produce good nutrition outcomes. Nordhagen, Thiam and Sow (2019) highlighted that the sustainability of nutrition-sensitive agriculture focuses on training and educating on nutrition and hygiene for better nutritional status.

According to United Nations Women (2022), in Senegal and Mali, over 7000 rural females were skilled in climate-resilient agriculture practices, renewable energy, and water-efficient technologies. In Nigeria**,** more than 2300 rural females in agroindustry and organisations have been encouraged to improve the production and cost-effectiveness of their organisations within the rice value group. The program was projected to reach over 12500 rural females across the country. In Uganda, rural females were educated on how to improve their talents and capacity in the blue economy. The latest evaluation of the Joint Program on Rural Women's Economic Empowerment, employed by FAO, IFAD, UN Women and WFP, reconfirmed that combined methods in supporting rural females lives by addressing prejudiced social norms, decrease and redistribute unpaid care and domestic work, alongside increased agricultural production, has led to improved food security and enhanced nutrition outcomes. The program has enhanced the disposable income for more than 80000 rural females among seven participating countries: Liberia, Nepal, Nigeria, Ethiopia, Guatemala, Kyrgyzstan, and Rwanda.

In the intervention, the experimental group was provided with in-depth training using

both manuals from the sustainable nutrition-sensitive toolkit. Each of the n=63 participants were given the second training manual, named: the participant handout booklet. The handout booklet comprised of three parts: part one - agriculture practices and general planting techniques, with lesson one on agriculture practices. Part two - nutrition education, with lesson two on nutrition knowledge; and part three - developing markets and products, with lesson three on food preparation and preservation. The control group village was only given the resources, and no training was provided as indicated in the previous chapters.

After engaging in training, the results are presented in Table 22. The experimental group in phase 1 harvested 468 cabbage heads, sold 278 heads, and preserved 189 heads for household consumption. In phase 2, the number of cabbages increased to 612 heads; the participants sold 422 heads and preserved 189 heads for household consumption. In phase 3, the number of cabbage heads increased to 675 heads; the participants sold 485 heads and preserved 189 for household consumption. In the control group in phase 1, 567 cabbage heads were harvested, and 567 heads were shared among the 63 participants for household consumption. In phase 2, the number of cabbages harvested increased to 627 heads and all 627 heads were shared among the participants for household consumption. In phase 3, 414 cabbage heads were harvested, and 414 heads were shared among the 63 participants for household consumption. The experimental group had an increase of 144 heads of cabbage from phase 1 468 heads of cabbage to phase 2 612 heads of cabbage, and in phase 3 (675 heads of cabbage), the increase was very low, with 63 heads of cabbage between phase 2 to phase 3. The control group had a total of 1608 heads of cabbage between phases 1, 2 and 3, and the experimental group had a total of 1755 heads of cabbage between phases 1, 2 and 3, with 147 heads of cabbage more than the control group.

The participants in the experimental group harvested 519 bunches of spinach in Phase 1; in Phase 2, 834 bundles were harvested; in Phase 3, 1238 bunches were harvested; 1048.9 bunches of spinach were sold in Phase 3 and 189 bunches were preserved for household consumption. The control group harvested 857 bundles of spinach and used all 857 bundles were used for household consumption. The experimental group had a

vast increase of the buddle of spinach in Phase 3, with 1238 bundles of spinach compared to Phase 1, 468 bundles and Phase 2, 612 bundles. The total bundles of spinach in the experimental group were 2591 bundles between Phases 1, 2, and 3. In the control group, the total number of spinach bundles was 2196 bundles between Phases 1, 2, and 3. The experimental group had 396 more bundles than the control group.

The experimental group harvested green bean pockets of 55kg in Phase 1, 130kg in Phase 2, and 110kg in Phase 3. In Phase 1, phase 2, and Phase 3, under the selling category, there was no selling since the participants harvested below the minimum harvest of 80kg. All the green beans that were harvested and preserved for household consumption. The control group did not plant green beans. The experimental group had a triple increase in phase 2, with 130kg of green beans compared to 55kg in phase 1, but there was a decrease in phase 3's 110kg.

In the experimental group in Phase 1, 184 kg of carrots were harvested; in Phase 2, 347 kg of carrots were harvested; 157 kg were sold in Phase 2, and 189kg were preserved for household consumption. In phase 3, 424kg of harvested carrots were sold, 235kg were sold, and 189kg were preserved for household consumption. The control group produced a large number of carrots, 989kg between phases 1, 2, and 3, compared to the experimental group, with a total of 956kg between phases 1, 2, and 3. There was low production of peppers among the experimental group, 240 each between Phases 1, 2, and 3 and the control group, with a total of 47 each in Phase 1.

The experimental group in all the phases managed to plant the vegetables, and, in each phase, there was a gradual increase in the number of vegetables harvested. Even though not all harvested vegetables could be sold, the households managed to have them for consumption. Unfortunately, the control group did not plant all the vegetables and never sold any of the vegetables. This is a clear indication that with every intervention there has to be formal training and continues training in order to obtain the best results.

The above findings concur with the UN General Assembly (2007) by emphasising the

essential part and impact of rural and indigenous females in improving agriculture and rural improvement, enhancing food security, and ending rural poverty. Rural females and young women contribute fundamental roles in food systems from production to processing, preparation, consumption, and distribution of food and securing home and rural community nutrition. Oliver (2016) advocated that additional agroecological methods and local approaches for crop diversity and enhanced soil, water and pest management should be increased to improve family's income and food security. UN Women (2021) encourages rural females and young women worldwide to participate in decision-making fully and equally at all levels, to promote gender-responsive policy programs, and to increase access to suitable tools, technologies, organisations, and establishments to improve resilience and better food security and nutrition.

4.4 CONCLUSION

The results analysed and discussed in this chapter indicate that food and nutrition insecurity is a chronic challenge in Lesotho. Such challenges are found globally and are progressively increasing because of multiple factors. As a result, countries face great difficulties in meeting Zero Hunger by 2030. Despite some economic growth, Lesotho must still address rural poverty and promote inclusive social development. Over a quarter of the populace faces elevated rates of acute food insecurity and needs humanitarian intervention to decrease food gaps, safeguard and rebuild livelihoods, and inhibit severe undernourishment (WFP 2023). The results indicate that food and nutrition insecurity can be reduced through NSA programs. Here, an NSA toolkit was developed and shown to benefit the rural female farmers who were exposed to it. There was a

CHAPTER FIVE: RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

This chapter provides the main findings of the study, the limitations, strengths, recommendations, and the conclusion based on the literature review in chapter two and the analysis of the data in chapter four.

5.2 SUMMARY OF FINDINGS

5.2.1 Objective one: Determining the Socio-demographic profile of the families.

A socio-demographic questionnaire was administered to understand the participants' background, such as accommodation status, family composition, work, and economic status. The results of the study indicated that the participants were female farmers who headed the household and were unemployed. The participants stayed in small, overcrowded households with no running water or electricity. The participants were caregivers to children and had very little money to spend on food.

5.2.2 Objective two: Determining the Anthropometric of the participants.

The results of the study indicated that the BMI of the participants ranged from all the classifications from WHO. Underweight had the lowest percentage, normal weight and overweight had the highest percentages including the three categories of obesity. The underweight participants' status could be explained by the fact that the participants did indicate that they either reduced their meal sizes, cut the number of meals they have in a day and sometimes go the whole day without food. The majority of the participants were either overweight or obese. The major contributing factors could be the high consumption of carbohydrate-based diets and poor dietary diversity.

5.2.3 Objective three: Determining the food security status of each of the participants.

The results of the study highlighted that the participants were food insecure since they normally had very little money to buy food, and the money they had was sometimes not enough to buy the food that was needed for the households. Moreover, the participants indicated that they sometimes ran out of food and did not have more money to buy food, so they had to either cut down the portion size of the meals and number of meals or borrow food from neighbours. In extreme cases, the participants sold some of their assets to buy food.

5.2.4 Objective four: Determining the nutritional knowledge, attitude, and behaviour of the participants.

One of the objectives of the intervention was to educate the small-scale female farmers on nutrition based on the South African dietary guidelines in order to promote a healthy lifestyle and well-being. The results indicated that there was still room for improvement as some of the questions the participants could not answer correctly.

5.2.5 Objectives five and six: Determining the dietary food variety intake of the participants.

The results indicated that there was micronutrient deficiency as some of the vital nutrients DRI recommendations were not met. The participants consumed more cereals and starchy foods as indicated in the top 20 foods, and this can be identified with the high carbohydrate DRIs. There was very little variety in the diet in relation to vegetables and fruits.

5.2.6 Objectives seven and eight: Determining the agricultural knowledge practices and the participant's acceptability levels and production preferences for various crops.

The results indicated that the participants owned fields and used the fields to plant their crops, but the participants did not get support from the government to utilise the fields to their ability. The participants also relied only on old agriculture practices and did not use any new technology or recent research in agriculture regarding sustainable agriculture under climate change.

5.2.7 Objective nine: Determining the participant's acceptability levels, food preparation and food preservation practices for various crops.

The results of the study indicated the type of vegetables the participants preferred to plant, consume, and preserve. Some of the preferred vegetables were included in the intervention study. The participants planted the vegetables in Phases one, two and three. Some of the planted vegetables were either sold to the public to generate money to buy more seeds and the other vegetables were for household consumption. Some vegetables were consumed fresh, and the rest were preserved to extend the shelf life of the vegetables and prevent food wastage.

5.2.8 The summary of a sustainable nutrition-sensitive agriculture toolkit in the form of training manuals.

The toolkit intervention's purpose was to increase food production and improve food and nutrition insecurity. The intervention implemented the theory, which indicated strong conceptual links between sustainable agriculture, nutrition-sensitive and sustainable community food systems with three categories: the development, validation, and implementation of the intervention to achieve production of fresh vegetables for household consumption and market, and sound nutrition knowledge for improved nutrition outcomes.

- **The sustainable agriculture program which focuses on agriculture practices and the use of greenhouse tunnels for fresh produce production.**

The results indicated that there was a steady increase in the production of fresh vegetables with the use of Greenhouse tunnels under irrigation and temperature control. There was also a steady improvement in agricultural knowledge and practices. This could be identified by the increased yield of a variety of crops, increased nutrient-dense foods, and reduced post-harvesting food loss. The results also indicated that the participants had an understanding of the market and products (agribusiness and agro products).

- **The sustainable nutrition-sensitive agriculture program which focuses on nutrition education.**

The results showed that there was an improvement in nutrition knowledge through

communication on nutrition education. There was also improvement in nutrition knowledge on the safe handling of food, food preparation practices, and food preservation practices to maximise nutrition adequacy and minimise food wastage at the household level.

5.3 LIMITATIONS

Corrective measures had to be developed and implemented to rectify shortcomings identified in each phase, and this was time-consuming.

The intervention period was short due to costs. After phase one, many corrective measures were implemented, and as a result, the vegetable yield started to increase in phase two and more in phase three. Unfortunately, for some vegetables, more time was required to find corrective measures and train the participants, but the project had to come to an end because there were no more funds.

During the intervention, the participants forgot important information because the lessons were not repeated and incorporated into the participants' daily activities, especially the nutrition lessons.

5.4 STRENGTHS

- The comprehensive toolkit specifically developed for this study can be used by other researchers interested in training in sustainable nutrition-sensitive agriculture.
- The study chose small-scale female farmers, which created opportunities for female farmers by outsourcing greenhouse tunnels and educating them on how to use them.
- The study focused on the Sustainable Development Goal to “End hunger, achieve food security and improved nutrition and promote sustainable agriculture” (SDG2), recognises the inter relations amongst supporting sustainable agriculture, enhancing small-scale farmers, encouraging gender equality, ending rural poverty, safeguarding healthy lifestyles, undertaking weather alteration, and other matters addressed within the set of 17 Sustainable Development Goals in the Post-2015 Development Agenda.

The research study tried to meet some of these elements by:

- Supporting Sustainable Agriculture by introducing Greenhouse tunnels with temperature control and irrigation systems. Practising both old and new agriculture practices and incorporating technology and research.
- Empowering small-scale farmers by selecting active female farms who own land for cultivating from the age of 20 and above.
- Promoting gender equality by selecting females heading households who are caregivers and unemployed.
- Ending rural poverty by selecting two rural villages (Mpharane and Maqoala) in the district of Mohale's Hoek Lesotho.
- Ensuring healthy lifestyles by introducing and educating the female farmers on nutrition.
- Tackling climate change by introducing Greenhouse tunnels with temperature control and irrigation system.

5.5 RECOMMENDATIONS

- A longer duration of the intervention implementation is required so to improve the livelihoods of the participants. Nutrition-sensitive agriculture is needed and should be considered and understood, especially the role of biodiversity in enhancing dietary quality, nutritional variety, and seasonality in the food supply. Besides enhancing agricultural systems to close the nutrition gap, efficient storage, and food processing technologies to prolong shelf-life are needed. If processing is poor, high food losses can cause food insecurity or increase the risk of producing unsafe and unhealthy food. Food storage and processing technologies, specifically at the household level, are challenging and often not applicable to traditional crops.
- Supporting and encouraging family farming is important because family farmers are the key agents in developing strategies for food and nutrition security. Family farmers have huge potential to help ensure that food systems contribute to healthier diets, ensuring the environmental, social, and economic sustainability of our food systems. Supporting family farmers also means managing land rights and developing enabling policies and

investment plans.

- To ensure sustainability, female farmers should be provided with continuous training and repetition of training on community food systems under production, processing, and distribution. The interventions should promote both the agri-business and agro-products because it introduces a business sector that offers business activities, products and services which encompasses farming and farming-related commercial activities such as marketing and selling of fresh produce (vegetables) and processed foods in the form of preserved products using bottling to prolong the shelf life and create a variety of products.
- Multistakeholder support is required to ensure sustainability, especially under the six areas of the Nutrition Decade, which include the following relevant topics to sustainable food systems: sustainable, resilient food systems for healthy diets, social protection and nutrition education, and safe and supportive environments for nutrition at all ages.
- Implementing nutrition-sensitive agriculture interventions required nations to amend and create new policies prioritising nutrition-sensitive agriculture as a key driver in overcoming malnutrition.
- Formal food gardens should be established at household levels to increase access to vegetables as a government subsidy because they are less cost-effective.
- Introduction and training on the planting and use of indigenous crops that are available in rural areas should also be included in the training manuals.
- Continuous training should be provided to female farmers on nutrition education, such as menu planning and healthy eating. The two problems in nutrition are undernutrition and overnutrition; it is important to educate individuals with the necessary nutrition information and skills to consume the correct diet. Such education should cover the improvement of family food supplies and more efficient utilisation of available food and economic resources.

5.6 CONCLUSION

As global food prices continue to increase because of natural disasters, war, climate change and so on, all these elements have an influence on the increased rates of poverty, which contribute to food insecurity, and the well-being and nourishment status of people and in most situations, defenceless groups such as females, and children. Food insecurity entails nutrition insecurity, and both can be addressed by integrating agriculture and nutrition because agriculture has great possibilities because of the various ways in which it can impact the primary determinants of nutrition outcomes by enhancing global food availability and access and improving household food security, dietary quality, salary, and women's empowerment.

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Appendix A: Ethical Approval from DUT

Institutional Research Ethics Committee
Research and Postgraduate Support Directorate 2nd Floor, Berwyn Court

Gate 1, Steve Biko Campus Durban University of Technology
P O Box 1334, Durban, South Africa, 4001 Tel:

031 373 2375

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http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

5 July 2023

Ms Mothepu
C 3126
Illovo
Amanzimtoti

Dear Ms Mothepu

DEVELOPMENT, VALIDATION AND IMPLEMENTATION OF A SUSTAINABLE, NUTRITION- SENSITIVE AGRICULTURE TOOLKIT TO ADDRESS FOOD AND NUTRITION INSECURITY IN LESOTHO

Ethics Clearance Number: IREC 029/19
The DUT-Institutional Research Ethics Committee acknowledges receipt of your notification regarding the piloting of your data collection tool.

Kindly ensure that participants used for the pilot study are not part of the main study. In addition,

the DUT-IREC acknowledges receipt of your gatekeeper permission letter.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the DUT-IREC according to the DUT-IREC SOP's.

Please note that any deviations from the approved proposal require the approval of the DUT-IREC as outlined in the DUT-IREC SOP's.

IT IS COMPULSORY FOR A STUDENT OR RESEARCHER TO APPLY FOR RECERTIFICATION ON AN ANNUAL BASIS. THE FAILURE TO DO SO WILL RESULT IN WITHDRAWAL OF ETHICS CLEARANCE. IT IS THE RESPONSIBILITY OF THE RESEARCHER AND THE SUPERVISOR TO APPLY FOR RECERTIFICATION.

Please note that you are required to submit a Notification of Completion of Study form together with an abstract to the DUT-IREC office on completion of your study.

Yours Sincerely
Professor J K Adam
Chairperson: DUT-IREC

Appendix B: Ethical Approval from Lesotho

Lesotho

Ministry of Health

P.O Box514

Maseru 100

REF: 10212-2019

Date: 15 June 2023

To **Lisebo Mothepu,**

Durban University of Technology

Dear Ms.Mothepu

Re: Development, validation, and implementation of a Sustainable, Nutrition-Sensitive Agriculture toolkit to address food and nutrition insecurity in Lesotho.

The Ministry of Health Research and Ethics committee is pleased to inform you that your proposal has been **APPOVED** after reviewing your progress report on your study as stipulated from your proposal. We hereby authorise you to continue the study according to the activities and population specified in the protocol.

Please note that an annual report, if applicable, must be submitted at least 6 weeks before the expiry date.

All serious adverse events associated with this study must be reported promptly to the MOH Research and Ethics Committee. Any modifications to the approved protocol or consent forms must be submitted to the committee prior to implementation of any changes.

We look forward to receiving your progress report and final report at the end of the study. If you have any questions, please contact the Research and Ethics Committee at rcumoh@gmail.com (or) 22226317.

Dr. Nyane Letsie

Director General Health Services

Appendix C: Information Letter (in English)

LETTER OF INFORMATION

Dear Resident

Thank you for allowing me to explain to you my research study for your consideration

Title of the Research Study: **DEVELOPMENT, VALIDATION AND IMPLEMENTATION OF A SUSTAINABLE, NUTRITION-SENSITIVE AGRICULTURE TOOLKIT TO ADDRESS FOOD AND NUTRITION INSECURITY IN LESOTHO**

Principal Investigator/s/researcher:

Lisebo Mothepu

Co-Investigator/s/supervisor/s:

Professor Carin Napier

Why is it important to do this study?
The purpose of the study was to introduce and educate rural female farmers about agribusiness and agro-processing (agro-food industry) through the use of Greenhouse tunnels.
The research study aligned its focus with the trajectory of food and nutrition security under the UN and the UNA in relation to addressing poverty, hunger and food and nutrition insecurity, as indicated in chapter 2 under the literature review, in chapter 3 outlining the methodology, and also in the intervention (NSA toolkit) of the study. Furthermore, the study 16 focused on Sustainable Agriculture, Sustainable NSA and Sustainable Local Food Systems so as to address food insecurity and nutrition insecurity in Mpharane village and Maqoala village in Lesotho.
The main aim of the research study was to develop, validate, and implement the impact of a sustainable NSA toolkit for rural small-scale women family farming to provide for household consumption and local small-scale commerce to improve food and nutrition insecurity.

What will it involve?

- The Lesotho Kingdom Ministry of Health and Social Welfare and chief village of Mpharane has been approached to get permission from the local Government for the study to be undertaken.
- I will need you to sign a consent form to indicate that you agree to participate in the study after I explained all the procedures to you
- If you agree you will be asked to complete 7 questionnaires in an interview situation it could take up to 1:30 hour.
- The questionnaires will include:

- A Socio- demographic questionnaire
- Three 24-hour food recall questionnaires.
- A Food Frequency Questionnaire to determine the food variety and dietary diversity.
- We will also weigh, measure your height, waist circumference and blood pressure, we will not ask you to remove your clothing except for shoes and jerseys
- Health and Behavioural questionnaire.
- Agricultural practices and traditional food intake questionnaire.
- Participation is voluntary and you can withdraw at any time with no penalty**.**

Risks or Discomforts to the Participant: All measurements and weighing will be done in a private. You will be requested to remove shoes and jackets and jerseys only and will not be requested to undress.

Benefits to the community: please remember that the information will be presented of the community as a whole and no individuals will be highlighted. The anonymous results of the study will be shared with the chief after the study has been concluded with the hope that interventions can be planned in the community for any identified problems. If you have any personal nutrition questions or concerns we are prepared to come back to you after the data collection to assist you.

Please note the following:

- Participation is voluntary and you can withdraw at any time with no penalty.
- No pay will be given to any of the participants.
- It won't cost you anything to participate in this study.
- You will be given a participant number so no names will be used in the study**.**

Research-related Injury:

For any questions or concerns please feel free to contact my supervisor or our Ethics committee

Persons to Contact in the Event of Any Problems or Queries:

Supervisor: Prof. Carin Napier

Researcher: Lisebo Barbara Mothepu Cell: 0848761673

Supervisor contact: 031 373 2326 carinn@dut.ac.za

The Institutional Research Ethics administrator: 031 373 2900.

Complaints can be reported to the DVC: TIP, Prof F. Otieno on 031 373 2382 or dvctip@dut.ac.za.

Appendix D: Consent Forms (in English)

INSTITUTIONAL RESEARCH ETHICS COMMITTEE
(IREC) CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, _____ (name of researcher), about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant Thumbprint	**Date**	**Time**	**Signature / Right**

I, _____ (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____	_____	_____
Full Name of Researcher	**Date**	**Signature**
_____	_____	_____
Full Name of Witness (If applicable)	**Date**	**Signature**
_____	_____	

Appendix E: Information Letter (in Sesotho)

Lengolo la thakisetso

Moahi ea ratehang oa Mpharane

Ke le leboha homenahane ka nako le mamello ena ekhethehileng eo ke efiloeng hore ke hlalose maikemisetso a lipatlisiso tsa thuto eaka ea sekolong mabapi le tikoloho ena ea Mpharane.

Sehloho sa lipatlisiso tsa lithuto.

Lipatlisiso tsa khaello ea lijo le kemo e ntlafetseng ea mmele mabapi le hokula 'meleng ea bonkhono le bontatemoholo hara sebaka sene sa Mpharane, Lesotho.

Motsamaisi oa lipatlisiso tsa lithuto

Lisebo Barbara Mothepu, B. Tech: Consumer Sciences Food and Nutrition

Hloho ea motsamaisi oa lipatlisiso tsa lithuto

Professor Carin Napier

Bohlokoa ba ho etsa lipatlisiso tsena

Lipatlisiso tsa thuto ena libohlokoa haholo sechabeng, hobane lifana ka kutluisiso le tharollo mabapi le bophelo ba bonkhono le bontatemoho. Hobane ho fumanehile hore bonkhone le bontatemoholo ke sehlopha sa batho se shebaneng le mathata a mangata malebana le hohlokomela malapa le likhutsana hara tlala tsena tse kholo, hobane muso o fana ka lipenshene tse tlase, hona hoetsa hore bophelo bobe thata haholo.

Lintho tseo litlabe li akarelelitse lipatlisiso tsa

- Lekala la Muso oa Lesotho la Bophelo le Social Welfare le Morena oa motse oa Mpharane ba se ba kopiloe hore lipatlisiso tsena tsa lithuto li tsoele pele.
- Moahi ea tlang ho nka karolo mabapi le li patlisiso tsa lithuto tsena o tla tlameha ho hlapanya kapa ho itekena lengolong hore o oa lumela hore o tla nka karolo lipatlisiso tsa lithuto. Tsena ka ofela litla etsahala ha hoqetoa hohlalosa lipatlisiso tsa thuto ena ka kakaresto.
- Ha o lumelana le seboletsueng, o tla kupuoa ho araba litokomane tse supileng tsenang le lipotso. Litokomane ka kakareletso litla nka hora e lengoe ho araba lipotso tsa teng kaofela
- Litokomane tsena li tla be liakaretsa:
- A Socio- demographic questionnaire (ke ho hlahloba boemo ba bophelo ba motho ka kakaretso)
- Three 24-hour food recall questionnaires (ke ho hlahloba lijo tseo motho a lijeleng maelana le lihora tsena)

- A Food Frequency Questionnaire to determine the food variety and dietary diversity (ke ho hlahloba hore na motho o ja mefuta efe ea lijo ka hofapana)
- Anthropometrics measures (Boima ba mele, bophara ba letheka, bolele ba motho, hape le khatelo ea tsamaiso ea mali etla lekoloa. Ho tla lebeloa hore motho ea etsoang li tlhatlhubo a hlobole li a paro tse buima le lieta, eseng liphahlo kaofela).
- Coping Strategy questionnaire (ke hohlahloba hore na motho o etsa joang hore u funane lijo ka nako ea tlala).
- Health and Behavioural questionnaire (ke hohlahloba horena maemo a bophelo ba hao a maemong a joang le mekhoa ea bophelo bamotho bo joanng)
- Agricultural practices and traditional food intake questionnaire (ke hohlahloba hore na maemo a temo a eme joang)
- Ho nka karolo liphatlisiso tsena ke ka ho rata hoa motho, motho a ka ikhula nako efe kapa efe ha a batla **Melemo ea ho etsa lipatlisiso tsa lithuto tsena motseng o na ke hore**:Morena oa motse o tla fuoa litokomane tsa qetelo ea lithuto, hore a tle a khone ho matlafatsa motse oa lona, hape ha e ba hona le motho eana le lipotso malebana le bophelo ba hae o tla fumana tlhakisetso ka mora hore lipatlisiso li phetlalatsoe.

Lintlha tsa bohlokoa:

- Ha motho a nka karolo lipatlisisong tsena tsa lithuto ke ka ho rata hoa motho, motho a ka tlohela ha a batla.
- Ha hona motho ea tla pataloa hore a nke karolo ho lipatlisiso tsena tsa lithuto.
- Ha hona sebelisoa lebetso la motho, motho ea tlang ho nka karolo lipatlisisong tsena tsa llithuto o tla fuoa nomoro.

Ha hona le likotsi tse ka etsahalang malebana le lipatlisiso tsena tsa lithuto

- Ha o batla tlhakisetsomaelana le lipatlisiso tsa lithuto ke kopa o botse Professor Carin Napier, kapa Ethics committee.

Batho bao o ka iteanyang le bona ha o na le lipotso, kapa mathata mabapi le lipatlisiso tsa lithuto tsena

- **Hloho ea lipatlisiso tsa lithuto:** Prof. Carin Napier D Tech: Food Service Management
  : +27 31 373 2326 carinn@dut.ac.za
- **Motsamaise oa lipatlisisos:** Lisebo Barbara Mothepu B Tech Consumer Science Food and Nutrition: Cell: 0848761673 lisebomothepu@yahoo.co.uk
- **The Institutional Research Ethics administrator (Lekala la lipatlisiso tsa thuto)**
  : +27 31 373 2900.
- Litletlebo li ka lebisoa ho: DVC: TIP, Prof F. Otieno on 031 373 2382 or dvctip@dut.ac.za

Appendix F: Consent Forms (in Sesotho)

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC)
CONSENT

Litumelano tsa honka karolo lipatlisisong tsa lithuto tsena

Ke ea lumela hore ke fuoe lithlalosetso tse hlakileng maelala li lipatlisisos tsa thuto ho tsoa ho motsamaise oa lipatlisiso. _____ (Lebitso la motsamaisi oa lipatlisiso) le mabapi le karolo e ke tla be ke e etsa - Research Ethics Clearance Number: _____,

- Ke balalile lengolo me ke utluisisa karolo e ketla beng ke e etsa maelana le lipatlisiso tsa thuto ena (**Lengolo la tlhakisetso)** .
- Ke ea elelloa hore liphumano tsa lipatlisiso tsa thuto ena li tla buoa ka lilemo, letsatsi la thlaho, le boemo ba ka.
- Ke fana ka tumello hore mosebetsi ona o ka kengoa ka hara komphutha ea motsamaise oa li patlisiso tsa lithuto
- Ke ea lumela hore hara nako fela nka ikhula lipatlisisong
- Ke ile ka fuoa menyetla e mengata ea hore ke botse lipotso maelana li lipatlisiso tsa thuto e na
- ke ea utluisisa hore lintho tsohle tse ka fumanoang lipatlisisong tsena tsa thuto ke ka lifumana hake libatla

_____	_____	_____	_____
Lebitso le feletseng la motho ea	**Letsatsi**	**Nako**	**Ho iteken~~a hoa mon~~ona nka karolo lipatlisisong tsa thuto**

Ke ea hlapanya hore motho enoa ea tekeneng ka holimo ka mona ke mohlaluselitse mabapi le maemo,ka kakaretso a lipatlisiso tsena tsa thuto e tlotsoroa ke, _____ (Lebitso la motsamaisi oa lipatlisiso).

_____	_____	_____
Lebitso la matsamaisi oa lipatlisisos	**Letsatsil**	**Itekena**
_____	_____	_____
Lebitso la mopaki (Known to the participant and is literate)	**Letsatsi**	**Itekena**

Appendix G: Fieldwork training manual

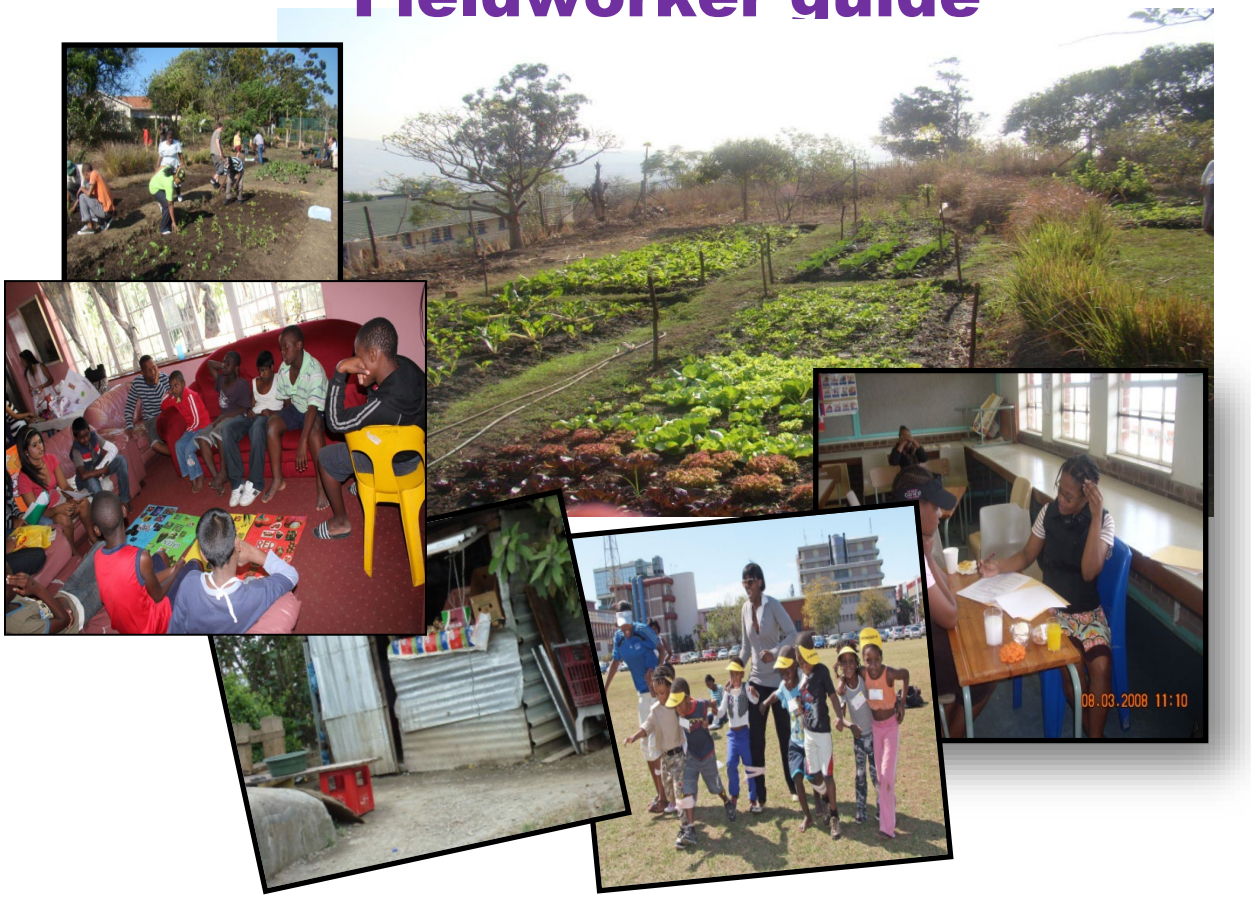
DUT DURBAN UNIVERSITY OF TECHNOLOGY

FACULTY OF APPLIED SCIENCES

Department of Food and

Service Learning

Fieldworker guide



CONTENTS **PAGE**

1. INTRODUCTION

Welcome to Fieldwork, this is a stimulating opportunity to work with the Department of Food and Nutrition researchers and their communities around Durban. Research fieldwork in communities cannot be conducted without the assistance of fieldworkers.

Fieldworkers are the key to the success of community studies. They act as interviewers, collect physical measurements or observe features in the participants. Often in community studies fieldworkers can also enter people's homes and interview them there. Data collection in the community is often hard work; if people are not available repeat visits need to be made. Fieldworkers should be well trained in the survey methods being used in a specific study, to ensure reliable data. As part of Work Integrated Learning all 3rd year Food and Nutrition Consumer Sciences students must take part in data gathering of one or more research project in the department.

What is a Field Worker?

The field worker is an extremely important person in this project. In fact, this research would not be possible without the field workers. The field workers are the people who must interview the subjects (the people chosen to take part in the research) and get correct and accurate information from them. The subjects must feel at ease with the field worker so that they will not feel threatened or intimidated and will willingly answer the questions to the best of his or her ability

2. ENQUIRIES

The following staff members are concerned with field work:

Senior Lecturer/Researcher : Prof C. Napier
S9 Level 3, Room 312

Tel. No. : 031 373 2326
E-mail : carinn@dut.ac.za

Service Learning lecturer/Researcher : Miss H Grobbelaar
S9 Level 3, Room 308

Tel. No. : 031 373 2328

E-mail : heleeng@dut.ac.za

Research Assistant : Andile Mtolo
S9 Level 3

Tel. No. :
E-mail :

3. FIELDWORK REQUIREMENTS

- All 3rd year students will be expected to attend a fieldworker training course separately or as part of Nutrition 3.
- Each student must complete at least 20 hours of Service Learning of which include fieldwork in one or more of the current research projects in the department of Food and Nutrition Consumer Sciences, a time sheet will be signed by the researcher in charge of the project to control the hours worked.
- Fieldworkers will **not** be remunerated for the 20 hours of Service Learning completed, any fieldwork completed by a fieldworker over and above the 20 hours will be paid at a rate per hour.
- The researcher in charge of the project will complete an assessment sheet for mark allocation for this part of the Work Integrated Learning (WIL) Module.
- Service Learning marks add up to approximately 20% of the final mark for WIL.
- Students can be expected to do any of the following tasks as part of their 20 hours:
    - Fieldwork in a community
    - Data capturing
    - Participating in a community upliftment project
    - Assisting with other research activities, e.g. Departmental Research Day

Details regarding the logistics will be discussed at the training session and each researcher will inform participating students of dates, times and venues.

4. ASSESMENT CRITERIA

DEPARTMENT OF FOOD AND NUTRITION CONSUMER SCIENCES

SUBJECT: Work-integrated Learning

LECTURER/RESEARCHER ASSESSMENT: Academic Service Learning component

Student name:_____

Student number: _____

ASSESSMENT CRITERIA	excellent 5	Good 4	Fair 3	Poor 1-2	Unacceptable 0	Your mark
Arrived timeously						
Professional appearance						
Approached task in an organised manner						
Worked effectively as a team member						
Patience and respect shown towards subjects						
Anthropometrical measurements were correctly applied (if applicable)						
Accurate and detailed recording of information(if applicable)						
All details included in completion of forms(if applicable)						
Followed the task through to the end(if applicable)						

Number of hours completed: _____ Total Score_____

General comments:

_____

_____

_____

Researcher Signature: Date:

_____ _____

5. FIELDWORKER CODE OF CONDUCT

5.1 BEHAVIOUR

In order to be a successful interviewer, a field worker must have (or develop) the following characteristics:

1. Friendliness: the field worker must be able to make each subject feel relaxed and not threatened in any way. The subject must feel that the field worker sees him or her as a person, not just another number that must be dealt with.
2. Respect: the subject must be treated with respect at all times. For example, he must be greeted politely, thanked for his time and co-operation; he must not be forced to answer a question that he is not willing to answer. The field worker must never show if she disagrees with something the subject has said.

3. Patience: each subject has to be asked the same questions in the same way. This means that the field worker must ask the same questions over and over, which can be very tiring and irritating. However, the field worker may never show that she is impatient or irritated even when the subjects are slow to answer or when they do not understand the questions. She must be able to control her own feelings and hide them when necessary.

4. Reliability: the field worker must be reliable, she must pay attention to detail, record all answers accurately, not skip over questions or make up answers herself.

5. Enthusiastic and Motivated: the field worker must be enthusiastic about the research. She should be doing it because she really wants to and not just because it's just a job.

6. Flexible: a good field worker is able to adapt to circumstances. She is aware that things do not always work out as planned and sometimes she will have to work under difficult and uncomfortable conditions.

7. Neat Appearance: the field worker must always look neat and well groomed, but never overdressed. The following guidelines for dress should be followed:
   - wear neat, simple and comfortable clothes
   - do not wear badges or emblems of organisations, churches, etc. as these may influence the way subjects answer.
   - dress so that the subject will concentrate on the interview and not on the way you are dressed.

5.2 CONDUCTING THE INTERVIEW

If the subjects in a project are children, the parents and/or caregivers will need to be involved in the interview process to verify information that is needed for the questionnaires. If the subjects are adolescents they can usually remember what they ate and can answer their own questions. If the questions need to be translated the interviewers must be careful not to change the focus of the question.

1. How do I begin?

- Greet the subject politely and introduce yourself.
- Ask what language the subject would prefer to speak.
- Explain what the interview is about. Let the subject ask questions about the research. Reassure the subject that the answers are confidential and that neither the subject nor his or her address will be identified.
- Put the subject at ease. Be flexible and sensitive to the subject. Some subjects may be tense or apprehensive. In such cases, talking about something general, e.g. the weather may put the subject at ease.

2. How do I conduct the interview?

- During the interview direct the questions to the subject, but if it is a child and he or she cannot answer, ask the parent/caregiver for the information needed.
- Ask the questions exactly as they are written on the questionnaire. Try even to keep your tone of voice the same for each subject so as not to lead the subject or to give him an idea of how you want him to answer. You may have to explain a question or use different wording if the subject cannot understand it.
- Ask the questions in the order that they appear on the questionnaire. If the subject refuses to answer the question, record the lack of response and go on to the next question.
- Follow the instructions on the questionnaire. Sometimes it may seem that a subject has already answered a question when he answered a previous one, but the interviewer must still answer the question. For example, the questions about polony and atchaar. Start the question: "We have already mentioned this, but…".
- Do not lead the respondents. Do not try to influence the way the subject answers. Keep your facial expression friendly, but neutral. Never show surprise or shock or approval to the subject's answers. Try to avoid unconscious reactions such as nodding the head, frowning, raising the eyebrows. Never give your own opinions.
- Keep the tone of the interview conversational. Be friendly and courteous. Do not make the subject feel as if he or she is taking an examination or is on trial be familiar with the questionnaire so that you can ask questions conversationally rather than reading them stiffly. The questionnaire is designed to keep the amount of writing to a minimum. However, if a subject gives a long response

to an 'other' question, say, 'excuse me while I write that down'. Don't make the subject feel as though you have forgotten he is there.

- Keep control of the interview. Do not let the subject go off into irrelevant conversation. If he or she does, bring him or her gently back to the interview.
- Allow the subject time to think; do not hurry him to answer. However, if he is silent for too long, repeat the question, or 'prompt' him. For example, say 'you have told me how you cook cabbage; now please tell me how you cook pumpkin.
- Follow the instructions on the questionnaire for recording the responses. Record all responses, including negative responses or refusals to answer.
- **Make sure that you have written in the subject's number.**

3. How do I end the interview?

Tell the subject that you have finished the interview.
Reassure him that everything he has told you is confidential.
Thank him for his time and cooperation. Direct him to the next stage. Greet him.

6. INTERVIEW EXAMPLE

24-HOUR FOOD RECALL QUESTIONNAIRE

The 24-hour recall is a questionnaire on what the subject has eaten the day before over a 24 hour period. Often the 24-hour recall is used to establish whether the QFFQ is valid or not. It is important to think of the 24-hour recall questionnaire as being a totally separate questionnaire and not a cross-reference to the QFFQ. Therefore, the answers to the questionnaire need to be very detailed. You will need to ask what is eaten and drunk, what type of food or drink is consumed, the brand name, the preparation method and the quantity consumed. Remember to include spreads, sugar and milk to tea / coffee, snacks, sweets, juices, sauces, salts and other condiments.

Example: The subject is asked what she has in the morning on waking up.

I: What do you have in the morning when you wake up?

S: I drink tea and then have porridge.
I: How do you take your tea?
S: With 2 sugars and a little milk.
I: How big is the spoon and is it level or heaped? (*Showing the teaspoon*).
S: It is like that spoon and I also have it heaped.
I: What type of porridge did you eat and how much did you have? (*Showing a bowl or cup*).
S: I had soft mealie meal porridge and I had about 2 of those cups to the fill in a bowl.
I: Do you put anything else in the porridge?
S: Yes, 2 spoons of sugar, like my tea, and a little margarine about 1 spoon.
I: At about what time was this meal?
S: At 6 am.
I: Where did you have this meal?
S: At home.

Time (approximately)	Place (Home, school, etc)	Description of food and preparation method.	Amount	Amount in g (office use Only)	Code (office use only)
From waking up to going to work, or starting day's activities					
6 am	**Home**	**Tea, rooibos**	**1 cup/mug**		
		With milk, full cream	**little milk – 2 tablespoons**		
		And sugar, white	**2 heaped tsp**		
		Soft mealie meal porridge	**2 cups**		
		With sugar, white	**2 heaped tsp**		
		And margarine, hard brick	**1 tsp**		

7. Portion sizes

FOOD	Smaller than smallest	Between small and medium	Between medium and large	Between large and very large	Larger than large/very large
Stiff porridge	125 g	275 g	425 g	600 g	800 g
Soft porridge	125 g	275 g	425 g		575 g
Samp and beans	100 g	200 g	375 g	600 g	800 g
Rice	70 g	105 g	190 g		310 g
French fries	30 g	90 g	185 g		340 g
Fried beef	15 g	45 g	80 g		120 g
Beef with bone	45 g	75 g	120 g		180 g
Meat stew	55 g	165 g	275 g		385 g
Sausage/ Wors	20 g	50 g	90 g		135 g
Offal	20 g	60 g	100 g		140 g
Pilchards	15 g	45 g	90 g		150 g
Mashed pilchards	15 g	45 g	90 g		240 g
Fried fish	50 g	70 g	105 g		155 g
Cabbage, potato and onion	15 g	45 g	75 g		105 g

FOOD	Smaller than smallest	Between small and medium	Between medium and large	Between large and very large	Larger than large/very large
Spinach, potato	15 g	45 g	75 g		105 g
Tomato and onion gravy	10 g	30 g	60 g		100 g
Pumpkin	15 g	35 g	60 g		80 g
Carrots, potato	45 g	65 g	80 g		95 g
Green mealie	50 g	110 g	180 g		260 g
Beetroot salad	10 g	30 g	65 g		85 g
Fat cake	20 g	50 g	70 g		90 g
Bread	15 g	45 g	80 g		120 g
Margarine	2,5 g	7,5 g	12,5 g		17,5 g
Dumpling	20 g	70 g	125 g		175 g
Apple	70 g	130 g	195 g		265 g
Banana	40 g	60 g	95 g		130 g
Canned peaches	30 + 10 g	70 + 15 g	110 + 25 g		150 +35 g
Custard	5 g	20 g	35 g		65 g
Atjar	10 g	45 g	80 g		120 g
Polony	5 g	15 g	30 g		45 g
Peanuts	5 g	20 g	60 g		105 g
Cheese curls	6 g	18 g	38 g		62 g

Other questionnaires

The researcher may also use any of the following questionnaires:

Food Frequency Questionnaire

Socio-demographic questionnaire

Nutrition knowledge questionnaires

Appendix H: SOCIO-DEMOGRAPHIC QUESTIONNAIRE

SOCIO-DEMOGRAPHIC QUESTIONNAIRE

This questionnaire covers certain aspects of your life, including work and personal details, health and illness, lifestyle and social life that is relevant to health. The answers to these questions will be kept strictly confidential and the information will not be identifiable on any reports or publications.

1. GENERAL INFORMATION

Participant number:……..……. Date: ……

Please answer all questions by marking the correct answer with **X,** except where otherwise indicated.

2. PERSONAL INFORMATION

2.1 Your role in the family

Mother	Grandmother	Father	Grandfather	Other, specify…….

2.2 How old are you?_____ years

2.3 Gender:

Male	Female

3. ACCOMMODATION AND FAMILY COMPOSITION

3.1 Where do you live?

Mpharane ☐ Maquala ☐

3.2 Do you live in?

Farm	Squatter camp	Rural village	Hostel	Township	Other, specify……...

3.3 How are you currently living?

Homeless	
Living with relatives	
Living with friends	
Hostel accommodation	
Squatter home	
Rented house/flat	
Own house/flat	
Employees Properties	
Other, specify…….	

3.4 Do other people live in the house with you?

Yes	No

3.5 How many people are permanent residents living in the house with you? (Only if these people eat and sleep in this house at least 4 days a week?)

1	2	3	4	5	6	7	8	9	10	10+

3.6 How long have you been staying permanent in this house?

< 1 year	1-5 years	>5 years

3.7 In what type of house are you staying?

Brick	Clay	Grass	Wood	Zinc/shack

3.8 How many rooms does your house have?

1 room	2 rooms	3 rooms	4 room	>5 rooms

3.9 Are there other houses/shacks within the same yard of the main house?

Yes	No

3.10 Do you have the following facilities/ services at home?

Yes	No

3.10.1 Water

Tap in the house	
Tap outside the house (in yard)	
Borehole	
Spring / river / dam water	
Fetch water from elsewhere	

3.10.2 Toilet facilities

None	
Pit latrine	
Flush / sewage	
Bucket system	
Other, specify…….	

Waste removal	Yes	No	3.10.3
Tarred road in front of house	Yes	No	3.10.4
Gravel road in front of house	Yes	No	3.10.5
Access to electricity	Yes	No	3.10.6

3.11 To what extent do you have problems with the state of your house (e.g. size, repairs, damp, etc.)?
……

3.12 Do you have problems with the following?

Mice/ Rats	
Cockroaches	
Ants	
Flees	
Mosquitoes	
Geckos	
Frogs	
Snakes	
Bed Bugs	

3.13. What is the floor inside your house made of?

Cement	
Tiles	
Carpet	
Dirt	
Sand/mud	
Dung	

Other, please state	

4. WORK STATUS AND INCOME AND FOOD AVAILABILITY AND ACCESS

4.1. Are you currently employed?

Yes	No

If YES, go to Question 4.5.

4.2. If NO, how would you describe your current status (tick one box only)?

Unemployed	Retired	Housewife	Student	Other, specify……

4.3. Are you actively looking for paid employment at the moment?

Yes	No

4.4. How long have you been unemployed?

< 6 months	6-12 months	1-3 years	> 3 years

4.5. If YES (question 4.1) is your current job a:

Permanent position	Temporary position	Fixed term contract	Other, specify……..

4.6. Are you doing part time jobs as a second job on weekends and school vacations?

Yes	No

4.7 What is the exact title of your current job?
(Including self-employed)

4.8. What is the total income in the household per month?

R0- R500	R501-R1000	R1001-R1500	R1501-R2000	R2001-R2500	R2501-R3000
R3001-R3500	R3501-R4000	R4001-R4500	R4501-R5000	R5001-R6000	R6001-R7000
R7001- R8000	R8001- R9000	R9001- R10 000	>R10 000		

4.9. Please specify the monthly income in the household (if willing)……..

4.10. How many people e.g. partner, relatives & others (including yourself) contributed to your household income from any source, (including wages/salary from paid employment, money fromsecond or odd jobs income from savings investments, pension, rent or property, benefits and or maintenance etc.) in the last 12 months?

People	0	1	2	3	4	5	6	7	8	9

4.11. How often do you buy food?

Every day	Once a week	Once a month	Other, specify……

4.12. Where do you buy food?

Tuck shop	Street vendor	Wholesalers	Supermarket	Other, specify……

4.13 What type of transport do you use to get around?

Taxi	
Bus	
Own car	
Bicycle/ Motorbike	
Other Specify	

4.14. How much money is spent on food PER MONTH? (Tick only one box)

R 0 – R 200	R 201 – R 300	R 301 – R 400	R 401 – R 500	R 501 – R 600	R 601 – R 700	R 701- R800	R801- 1000
R1001- R1200	R1201- R1400	R1401- R1600	R1601- R1800	R1801- R2000	>R2001		

4.15. How often does it happen that you do not have enough money to buy food? for you and your family?

Always	Often	Sometimes	Seldom	Never

5 EDUCATION AND LANGUAGE

5.1. What is your highest education level?

None	Primary School	Standard 8	Standard 10	College/FET	Other post school

5.2 What language is spoken mostly in the house?

Sesotho	Zulu	Xhosa	English	Other, specify……

5.3 How many children (in the household) have birth certificates?

None	1	2	3	4	5	6	7	8	All

5.4 How many children have completed their immunisation schedule?

None	1	2	3	4	5	6	7	8	All

5.5 Has any children in your household died in the past?

Yes	No

Reason: ……..

5.6 Number of children attending school

None	1	2	3	4	5	6	7	8	All

5.7 How do the children get to school?

Walk	Bus	Taxi	Parents car	Other, specify…….

Food practices in the household

Tick one block for every question:	Father	Mother	Sibling	Grandma	Grandpa	Aunt	Uncle	Cousin	Friend	Other
5.8 Who is mainly responsible for food preparation in the house?										
5.9 Who decides on what type of food is bought for the household?										
5.10 Who is mainly responsible for feeding/serving the children?										
5.11 Who is the head of this household?										
5.12 Who decides how much is spent on food?										

5.13 How many meals do you eat per day?

0	1	2	3	> 3

5.14 Where do you eat most of your meals?

Home	Friends	Work	School	Other, specify…….

5.15 Where do your children eat most of their meals?

Home	Friends	School	Other, specify…….

6. ASSETS

6.1 Does your home have the following items and how many?

	Yes	**No**
Electrical stove		
Gas stove		
Primus or paraffin stove		
Microwave		
Hot plate		
Radio		
Television		
Refrigerator		
Freezer		
Telephone/ Cell phone		
Bed with mattress		
Mattress only		
Lounge suite		
Dining room suite		
Electrical iron		
Electrical, kettle		
Car		
Bicycle		
Motorbike		

6.2 What type of fuel do you usually use for food preparation?

Wood fire	Paraffin	Electricity	Gas	Coal/Charcoal	Other, specify……

6.3 What type/s of material are your pots made off (tick all relevant options)?

Cast iron	Aluminium	Stainless steel	Clay	Other, specify……

THANK YOU

Appendix I: Anthropometric Measurements

FOOD AND NUTRITION CONSUMER SCIENCES

Section A: **Anthropometric Measurements**

1. Number/Name of the subject……
2. Community:……..…

3. Date of birth	Year	Month	Day

4. Gender	Male	Female

Section B:

1. Body weight (kg)	1. Body weight (kg)	2. Height/Length (cm)	2. Height/Length (cm)
kg	kg	cm	cm

3. Waist circumference	3. Waist Circumference	4. Blood pressure	4. Blood pressure
cm	cm	/	/

FOOD AND NUTRITION CONSUMER SCIENCES

Anthropometric Measurements

Section A:

1. Number/Name of the caregiver……
2. Community:……..…

3. Date of birth	Year	Month	Day

4. Gender	Male	Female

Section B:

1. Body weight (kg)	1. Body weight (kg)	2. Height/Length (cm)	2. Height/Length (cm)
kg	kg	cm	cm

3. Waist circumference	3. Waist Circumference	4. Blood pressure	4. Blood pressure
cm	cm	/	/

Appendix J: FFQ LIST OF FOODS AND FOOD GROUPS DIVERSITY

FFQ LIST OF FOODS AND FOOD GROUPS DIVERSITY

Participants number……

PLEASE INDICATE THE FOOD YOU ATE DURING THE PAST SEVEN (7) DAYS BY AN (X)

GROUP 1: Flesh Foods (Meat, Poultry, Fish) Diversity	Y	N
Meat (Chicken)		
Meat (Beef)		
Meat (Mutton, Lamb)		
Meat (Pork)		
Meat (Goat)		
Dried Meat (Biltong)		
All Mince		
All Tribe/Offals/Runners and Heads		
Fish (fresh / whole)		
Tinned Fish (Pilchards/Tuna)		
Processed Meats (Viennas / Polony, Russians, Boerewors Sausage)		
Seafood (Prawns, Mussel's, Calamari, Crab, Shrimp, Crayfish)		
GROUP 2: Eggs Diversity	**Y**	**N**
Eggs		
GROUP 3: Dairy Products Diversity	**Y**	**N**
All Milk		
Evaporated milk (Unsweetened)		
Condensed milk		
Maas/ Inkomasi		
All Cheese		
Custard		
Ice Cream		
GROUP 4: Cereals, Roots and Tubers Diversity	**Y**	**N**
All Rice		
Maize (Pap, Mealie Rice, Mealie Meal, Samp, Porridge, Corn on the cob, Popcorn, Sweet Corn)		

Macaroni/Pasta/Spaghetti (Pasta and noodles)		
All Bread (White/ Brown/ Whole Wheat)		
Dumpling/Steamed Bread/Fat Koek		
Scones/Biscuits		
Mageu		
Breakfast Cereals (Corn Flakes, Oats, Weet Bix, Matabela)		
All Tubers/Roots (Amadumbe, Sweet Potato)	**Y**	**N**
Potatoes		
GROUP 5: Legumes and Nuts	**Y**	**N**
All Beans Dried		
Dried Peas		
Lentils		
Peanuts and Nuts		
Soya		
GROUP 6: Fruits and Vegetables Diversity	**Y**	**N**
Orange/red/yellow vegetables (carrots)		
Green vegetables (broccoli)		
Leafy vegetables (Spinach, kale, collard greens)		
Starchy vegetables (potato, rutabaga, squash)		
Other vegetables		
Orange/red/yellow fruits (orange)		
Berries (strawberries)		
Stone fruits (peach)		
Other fruits		
GROUP 7: Oils and Fats Diversity	**Y**	**N**
Butter		
Sunflower oil		
Margarine		
Lard		
Salad dressing/oil		
Potato Crisps		
Coffee Creamer (Cremora, Ellis Brown)		

THANK YOU

Appendix K: 24 – HOURS RECALL QUESTIONNAIRE

24 – HOURS RECALL QUESTIONNAIRE

Participants number……

Date: _____ / _____/ _____

Tick what the day was yesterday:

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Would you describe the food that you ate yesterday as typical of your habitual food intake?

Yes	1	No	2

If not, why? _____

I want to find out about everything you ate or drank yesterday, including food you pick from the veld. Please tell me everything you ate from the time you woke up to the time you went to sleep. I will also ask you where you ate the food and how much you ate.

Time (approximately)	Place (Home, school, etc)	Description of food and preparation method.	Amount	Amount in g (office use Only)	Code (office use only)
From waking up to going to work, or starting day's activities					

Time (approximately	Place (Home, school, etc)	Description of food and Preparation method.	Amount	Amount in g (office use Only)	Code (office use only)
Middle of the day (Lunch time)					
During the afternoon					
At night (dinner time)					

During the morning at work or at home					

Time (approximately	Place (Home, school, etc)	Description of food and preparation method.	Amount	Amount in g (office use Only)	Code (office use only)
After dinner, before going to sleep					

* Do you take any vitamins (tablets or syrup)	Yes	1	No	2 X
Give the brand name and dose of the vitamin/tonic:				

THANK YOU

Appendix L: HOUSEHOLD FOOD SECURITY

HOUSEHOLD FOOD SECURITY QUESTIONNAIRE

Participants number……

N.	Question	Answer		
		Often	Sometimes	Never
1.	In the past 12 months, we have been worried whether our food would run out before we got the money to buy more.			
2.	In the past 12 months, the food that we bought just didn't last and we didn't have money to get more.			
3.	In the past 12 months, we couldn't afford to eat balanced meals.			
		Yes	No	
4.	In the last 12 months, did you or other adults in the household ever cut the size of your meals or skip meals because there wasn't enough money for food?			
4.1	(If yes to question 4) How often did this happen?	○ Almost every month ○ Some months but not every month ○ In only 1 or 2 months		
		Yes	No	
5.	In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?			
6.	In the last 12 months, were you ever hungry, but didn't eat, because there wasn't enough money for food?			
7.	In the last 12 months, did you lose weight because there wasn't enough money for food?			
8.	In the last 12 months did you or other adults in your household ever not eat for a whole day because there wasn't enough money for food?			
8.1	(If yes to question 9) How often did this happen	○ Almost every month ○ Some months but not every month ○ In only 1 or 2 months		
Questions 9 – 18 were asked only if the household included children age 0 – 17)				
N.	Question	Answer		
		Often	Sometimes	Never
9.	In the last 12 months, we relied on only a few kinds of low-cost food to feed our children because we were running out of money to buy food.			
10.	In the last 12 months, we couldn't feed our children a balanced meal, because we couldn't afford that.			
11.	In the last 12 months, the children were not eating enough because we just couldn't afford enough food.			
		Yes	No	
12.	In the last 12 months, did you ever cut the size of any of the children's meals because there wasn't enough money for food?			

13.	In the last 12 months, were the children ever hungry but you just couldn't afford more food?		
14.	In the last 12 months, did any of the children ever skip a meal because there wasn't enough money for food?		
14.1	(If yes to question 16) How often did this happen	○ Almost every month ○ Some months but not every month ○ In only 1 or 2 months	
		Yes	No
15.	In the last 12 months did any of the children ever not eat for a whole day because there wasn't enough money for food?		

THANK YOU

Appendix M: HOUSEHOLD HUNGER SCALE QUESTIONNAIRE

HOUSEHOLD HUNGER SCALE QUESTIONNAIRE

Participant: .....

A.1. HOUSEHOLD FOOD SECURITY QUALITATIVE QUESTIONS (DURING LAST 12 MONTHS)

Q.1.1 What do you consider as basic daily food requirement for your household?

……

Q.1.2 Considering basic daily food requirements as minimum food intake required forlife: do you think that the basic daily food intake of your household has improved?

Yes **No**

If yes, to what extant?

a. Slightly better
b. Better
c. Much better

If no, then?

a. Same
b. Worse
c. Much worse

Q.1.3 Did you or other household members ever skip a meal because there was notenough money to buy food over last 12 months?

a. Once a week
b. Once a month
c. Once in 3 months

d. Once in 6 months
e. Never skipped the meal.
f. Don't know

Q.1.4 Did you or other household members ever not eat for a whole day because of lackof money to buy food?

a. Once a week
b. Once a month
c. Once in 3 months
d. Once in 6 months
e. Never happened.
f. Don't know

Q.1.5 Did you or other household members ever eat less than you or they would haveneeded to eat?

a. Once a week
b. Once a month
c. Once in 3 months
d. Once in 6 months
e. Never
f. Don't know

Q.1.6 Sometimes people lose weight because of not having enough to eat. In the past 12months did you lose weight due to not enough food?

a. Yes
b. No
c. Don't know

Q.1.7 Did you ever cut the size of children's meals due to not enough food available?

a. Once a week
b. Once a month
c. Once in 3 months
d. Once in 6 months
e. Never
f. Don't know

Q.1.8. Did any of the children ever skip a meal due to not enough food?

a. Once a week
b. Once a month
c. Once in 3 months
d. Once in 6 months
e. Never
f. Don't know

Q.1.9 Did any of the children ever not eat for a whole day because of lack of money tobuy food?

a. Once a week
b. Once a month
c. Once in 3 months
d. Once in 6 months
e. Never
f. Don't know

Q.1.10 "I worried whether our food would run out before we got money to buy more".What was the frequency of this situation?

a. Once a week
b. Once a month
c. Once in 3 months
d. Once in 6 months
e. Never
f. Don't know

Q.1.11. In your opinion what is a balanced meal?

……

Q.1.12 "We could not afford to eat balanced meals" what was the frequency?

a. Once a week
b. Once a month
c. Once in 3 months
d. Once in 6 months
e. Never
f. Don't know

Q.1.13 "We could not feed the children a balanced diet due to lack of money" what wasthe frequency?

a. Once a week
b. Once a month
c. Once in 3 months
d. Once in 6 months
e. Never
f. Don't know

Q.1.14 How you dealt with such situation (food shortage) over last 12 months?(Tick all that apply)

a. Borrowing from friends, neighbors, relatives, etc.
b. Stick to simple food (e.g. dal roti or roti piaz)
c. Reduce expenditures on health
d. Reduce expenditures on education
e. Adults skip meals once a day
f. Selling assets (e.g. cycle, motorcycle, bull, farm equipment, etc)
g. Others (Please specify)

……

Q.1.15 Due to heavy flooding in the country general price level is expected to increasewith expected shortage of food items, how you will deal with such situation, any planning? **Yes** **No**

If yes, please explain……

INCOME AND EXPENDITURE DATA.

A.2.2 Household Expenditures

In the past 30 days, if there have been times when you did not have enough food or money to buy food, how often has your household had to:

3.1) Rely on less expensive and preferred food?

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week
e) Never

3.2) Borrow food, or rely on help from friends or relatives?

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week
e) Never

3.3) Buy on Credit?

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week
e) Never

3.4) Send household members to eat elsewhere

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week
e) Never

3.5) Limit Portion sizes at mealtimes?

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week
e) Never

3.6) Reduce the number of meals eaten in a day?

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week
e) Never

3.7) Skip entire days without eating?

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week
e) Never

3.8) Restrict consumption by adults in order for small children to eat?

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week
e) Never

3.9) Sell some belongings in order to get money to buy food?

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week
e) Never

3.10) Gather wild food, hunt, or harvest immature crops?

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week
e) Never

3.11) Consume seed stock held for next season or rent out the livestock?

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week
e) Never

3.12) Do small pieces of work for food/money?

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week
e) Never

3.13) Contribute to food stokvel in order to ensure food over a scarce period?

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week
e) Never

3.14) Children have to leave school in order to work for food?

a) All the time? Every day
b) Pretty often? 3-6 */week
c) Once in a while? 1-2 */week
d) Hardly at all? <1*/week

Appendix N: Nutrition Knowledge Questioner

Participant: _____

Nutrition Knowledge and Nutrition Assessment questions

Section 1: The first few items are about what advice you think experts are giving us.

1. Do health experts recommend that people should be eating more, the same amount, or less of the following foods? (tick one box per food).
2. How many servings of fruit and vegetables per day do experts advise people to eat as a minimum? (One serving could be, for example, an apple or a handful of chopped carrots) (tick one)

1.1 Which type of dairy foods do experts say people should drink? (tick one)

Full fat (e.g. full fat milk)	
Reduced fat (e.g. skimmed and semi-skimmed milk	
Mixture of full fat and reduced fat	
Neither, dairy foods should be avoided	
Not sure	

1.2 How many times per week do experts recommend that people eat oily fish (e.g. salmon and mackerel)? (tick one)

1-2 times per week	
3-4 times per week	
Everyday	
Not sure	

1.3 How many times per week do experts recommend that people eat breakfast? (tick one)

3 times per week	
4 times per week	
Everyday	
Not sure	

Not sure	

1.4 Which of these diseases is related to how much salt (or sodium) people eat? (tick one)

Hypothyroidism	
Diabetes	
High Blood Pressure	
Not sure	

1.5 Which of these options do experts recommend to prevent diabetes? (tick one)

Eating less refined foods	
Drinking more fruit juice	
Eating more processed meat	
Not Sure	

1.6 To maintain a healthy weight people should cut fat out completely. (tick one)

Agree	
Disagree	
Not sure	

1.7 To maintain a healthy people should eat a high protein diet. (tick one)

Agree	
Disagree	
Not sure	

1.8 Eating bread always causes weight gain. (tick one)

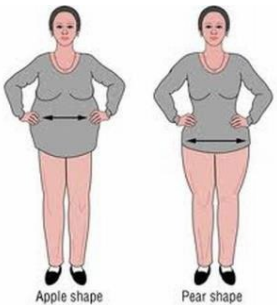
Agree	
Disagree	
Not sure	

1.9 If someone has a Body Mass Index (BMI) of 23kg/m², what would their weight status be? (tick one)

Underweight	
Normal weight	
Overweight	
Obese	
Not sure	

1.10 If someone has a Body Mass Index (BMI) of 31kg/m², what would their weight status be? (tick one)

Underweight	
Normal weight	
Overweight	
Obese	
Not sure	



Participant: _____

Nutrition Knowledge and Nutrition Assessment questions

1. Do health experts recommend that people should be eating more, the same amount, or less of the following foods? (tick one box per food)

2	
3	
4	
5 or more	
Not sure	

2. How many servings of fruit and vegetables per day do experts advise people to eat as a minimum? (One serving could be, for example, an apple or a handful of chopped carrots) (tick one)

1.1 Which type of dairy foods do experts say people should drink? (tick one)

	More	Same	Less	Not Sure
Fruit				
Food and drinks with added sugar				
Vegetables				
Fatty Foods				
Processed red meat				
Wholegrains				
Water				

Full fat (e.g. full fat milk)	
Reduced fat (e.g. skimmed and semi-skimmed milk	
Neither, dairy foods should be avoided	
Not sure	

1.2 How many times per week do experts recommend that people eat oily fish (e.g. salmon and mackerel)? (tick one)

1-2 times per week	
3-4 times per week	
Everyday	
Not sure	

1.3 How many times per week do experts recommend that people eat breakfast? (tick one)

3 times per week	
4 times per week	
Everyday	
Not sure	

1.4 According to the SA dietary guidelines, how much of a person's diet should be made up of starchy foods? (tick one)

Quarter	
Third	
Half	

Not sure	

1.5 Which of these diseases is related to a low intake of fiber (tick one)

Bowel disorders	
Anaemia	
Tooth decay	
Not Sure	

1.6 Which of these diseases is related to how much sugar people eat? (tick one)

Bowel disorders	
Anaemia	
Tooth decay	
Not sure	

1.7 Which of these diseases is related to how much salt (or sodium) people eat? (tick one)

Hypothyroidism	
Diabetes	
High Blood Pressure	
Not sure	

1.8 Which of these options do experts recommend to prevent diabetes? (tick one)

Eating less refined foods	
Drinking more fruit juice	
Eating more processed meat	
Not Sure	

1.9 To maintain a healthy weight people should cut fat out completely. (tick one)

Agree	
Disagree	
Not sure	

1.10 To maintain a healthy people should eat a high protein diet. (tick one)

Agree	
Disagree	
Not sure	

1.11 Eating bread always causes weight gain. (tick one)

Agree	
Disagree	
Not sure	

1.12 If someone has a Body Mass Index (BMI) of 23kg/m², what would their weight status be? (tick one)

Underweight	
Normal weight	
Overweight	
Obese	
Not sure	

1.13 If someone has a Body Mass Index (BMI) of 31kg/m², what would their weight status be? (tick one)

Underweight	
Normal weight	
Overweight	
Obese	
Not sure	

Appendix O: AGRICULTURAL AND KNOWLEDGE PRACTICES QUESTIONNAIRE

AGRICULTURAL AND KNOWLEDGE PRACTICES QUESTIONNAIRE

Participants number……

SECTION 1 – LAND ACCESS AND USE

1. Land for Farming: Plot or Field			
N.	Question	Answer	
1.1	Does any person in this household have the right to use (have access to) any land for erable farming, that is, to grow and cultivate crops on? Including small gardens attached to the dwelling.	Yes No	
1.1.1	If yes, Is this land	Private (Own farm) Private (Rented) Other – Specify	 …… ……
1.2	How's the plot location	Rural – isolated: far from a market and a major city Rural, with easy access to a market Peri-Urban – major city Peru-Urban – Nairobi	
1.3	How's access to the market?	Local market Urban market Rely on middlemen of agricultural products Access to supermarkets Access to export/exporters Link to individual via internet or other means Other – explain	 …… …… …..
1.4	What is the total size of all land that is available to household members for growing crops?	… .....hectares	(*Record in hectares*)
1.5	What are the sources of water, if any, used on the land used for growing crops?	River/Stream Dam Borehole Tank Municipality Rain Neighbour Other – explain	(*Select up to three answers*) …… …… ……
1.6	About how much of the land used for growing crops is the household able to water from these sources?	Less than half About half More than half	

		All None	
1.7	Does the household have the right to sell any part of the land it uses for growing crops?	Yes No	
1.8	How much do you think the household would be able to get for the land if it sold the land it uses for growing crops?	R……	
1.9	Of the land that is available to the household for growing crops, was any of it rented out to other people in the past 12 months?	Yes No	
1.10	Did the household have to pay rent for any of the land used for growing crops in the past 12 months?	Yes No	
2. Agricultural production			
N.	Question	Answer	
2.1	In the past 12 months, did this household grow crops or keep livestock for sale, exchange or home consumption?	Yes No	
2.1.1	If yes: Was the household able to sell what was farmed over the year for more than R20 000?	Yes No	
3. Other farming income			
N.	Question	Answer	
3.1	Did the household receive anything in the form of subsidies or drought relief in the past 12 months?	Yes No	
3.1.1	If yes: How much was it worth in rand?	R……	
3.2	In the past 12 months, did the household receive anything by providing a service to other farmers, for example, ploughing or planting?	Yes No	
3.2.1	If yes: How much was it worth in rand?	R……	
3.3	Does this household own other non-mechanical farm tools (spades, hoes, etc.)?	Yes No	
3.3.1	If yes: Approximately how much could you sell them for?	R……	
4. High Tunnel Experience and Management			
N.	Question	Answer	
4.1	Have you ever grown crops in a high tunnel or hoop house?	Yes No	
4.1.1	Do you currently use high tunnels/hoop houses?	Yes No	
4.1.2	If so, how many?	…… …… ……	
4.1.3	How old are they?	…… …… ……	
4.2	During which months do you grow crops in your high tunnel?	Fall (Sept – Nov) Winter (Dec – Feb) Spring (Mar – May) Summer (June – Aug)	
4.3	What crops have you grown in a high tunnel?	…… …… ……	

		…… ……	
4.4	What benefits do you expect from growing in a high tunnel?	Able to grow new crops in winter/spring/fall Able to grow harvest crops earlier Higher quality crops Cleaner crops (less washing required) Reduced disease pressure Other – explain	…… …… …….
4.5	What challenges have you experienced growing in a high tunnel?	Irrigation or water limitations Nutrient imbalance Salt accumulation Managing large temperature fluctuations Deciding what to grow Soil filth/compaction/texture	
4.6	What fertilizer do you use in your high tunnels?	Synthetic Manure Compost Combination Other – explain	…… …… ……
4.7	Do you use cover crops in the high tunnel?	Yes No	
4.7.1	If yes, which cover crops?	…… …… …… …… …… ……	
4.7.2	During what months/which season?	Fall (Sept – Nov) Winter (Dec – Feb) Spring (Mar – May) Summer (June – Aug)	
5. Experience with Environmental Quality Incentives Program (EQIP) or other government assistance programs			
N.	Question	Answer	
5.1	Have you heard of the financial support for high tunnels available from NRCS through the EQIP?	Yes No	
5.1.1	If yes: how did you hear about EQIP?	Flyer or handout from NRCS) Workshop Conference Other – explain	(*through which organization?*) …… ……

			(*which?*) …… …… . …… …… .
5.2	Have you personally used EQIP funding for a High Tunnel?	Yes No	
5.3	Are there any barriers preventing you from building or using a high tunnel?	Access to NRCS EQIP assistance programs/eligibility Not a US citizen Land tenure Unsure how to grow in a high tunnel Doesn't fit in my marketing/growing plan Other – explain	(*tick all that apply*) …… …… .
5.4	What other agriculture related government programs have you heard about?	Conservation Stewardship Cooperative Conservation Partnership Initiative On-Farm Energy Initiative Organic Initiative Other – explain	 …… …… .
5.6	What could make high tunnel EQIP support more approachable?	Translate into local language Organize a workshop with translation Have a staff person come to my farm Other – explain	 …… …… .
5.7	What format would information be most useful in?	In-person workshops Websites/online resources Printer/paper handouts	(*tick all that apply*)
5.8	What are your general feelings about instances programs such as the high tunnel initiative?	Completely satisfied Somewhat satisfied Dissatisfied	
5.8.1	In relation to answer given on 5.8, why?	…… …… …… …… …… ……	
5.9	How would you rate your overall satisfaction with government assistance programs for minority and immigrant farmers?	Completely satisfied Somewhat satisfied Dissatisfied	

Appendix P: FEEDBACK ACCEPTABILITY QUESTIONNAIRE

DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE

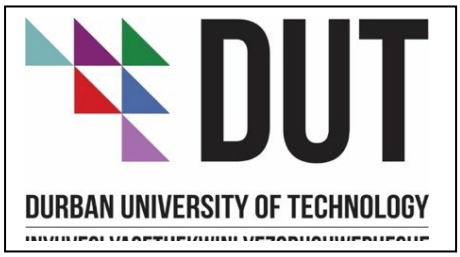
FEEDBACK ACCEPTABILITY QUESTIONNAIRE

Participants number……

Instructions: Please write down the vegetables that you prefer to plant and eat.

GROUP 6: Fruits and Vegetables Diversity
Orange/red/yellow vegetables (carrots)
1.
2.
3.
4.
5.
Green vegetables (broccoli)
1.
2.
3.
4.
5.
Leafy vegetables (Spinach, kale, collard greens)
1.
2.
3.
4.
5.
Starchy vegetables (potato, rutabaga, squash)
1.
2.
3.
4.
5.
Other vegetables
1.
2.
3.
4.

Appendix Q: FOOD PREPARATION & PRESERVATION QUESTIONNAI



FOOD PREPARATION & PRESERVATION QUESTIONNAIRE

Participants number……

1. **Where do you get your produce to bottle? (Check all that apply)**

□ Backyard garden
□ Community garden
□ Farmer's market
□ Pick your own
□ Greenhouse tunnels
□ Other, please specify:

2. **Why do you preserve foods? (Check all that apply)**

□ Save money
□ Control ingredients for health
□ Increase fruit and vegetable intake
□ Preserve family traditions
□ Concern about food safety
□ Preserve excess garden harvest
□ Other, please specify:

3. **What preservation method(s) do you use? (Check all that apply)**

□ Water bath canning
□ Pressure canning
□ Pickling foods
□ Freezing fruits and/or vegetables
□ Drying foods
□ I have never used any food preservation methods

□ Other, please specify:

4. The following statements are about the instructor.

The instructor:	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1. Was well prepared	1	2	3	4	5
2. Was interested in helping me.	1	2	3	4	5
3. Showed respect for all persons attending the program.	1	2	3	4	5
4. Stimulated me in wanting to learn.	1	2	3	4	5
5. Answered questions clearly.	1	2	3	4	5
6. Related program content to real-life situations.	1	2	3	4	5
7. Gave clear expectations.	1	2	3	4	5
8. Held my attention.	1	2	3	4	5
9. Presented information that will help me.	1	2	3	4	5

Appendix R: THE DELPHI TECHNIC QUESTIONNAIRE (BOTH HARDCOPY AND ONLINE)

DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE

THE TITLE OF THE INTERVENTION
A SUSTAINABLE NUTRITION-SENSITIVE AGRICULTURE TOOLKIT

A crop-based approach to address food and nutrition insecurity through the use of greenhouse tunnels in rural communities

The toolkit objectives:

- To sustainably improve food and nutrition security among poor agricultural households in rural areas through productivity promotion.
- To improve the livelihoods of poor rural households by increasing their household food consumption and proceeds through agricultural activities/ production, value addition and trade in agricultural (Rural Marketing, Agribusiness and Agroproducts (value- chain development)).
- To increase incentives (and decrease disincentives) for availability, access, and consumption of diverse, nutritious, and safe foods through environmentally sustainable production, trade, and distribution.

Identification

Country…….

Province/ district……...

Date of round one of data collection…….

Surname and signature of expert panel…….

1.1 Is the toolkit's main objectives clear?

YES	NO

Substantiation of answers and Recommendation.

1.2 Does the toolkit clearly indicate who will benefit from the intervention?

YES | No

Substantiation of answers and Recommendation.

1.3 Is the toolkit components (researcher and participants training manual) appropriate?

YES | NO

Substantiation of answers and Recommendation.

1.4 Is the toolkit promoting suitability through capacity building/development for the participants?

YES | NO

Substantiation of answers and Recommendation.

1.5 Is the toolkit promoting suitability through technological sustainability for the participant?

YES | NO

1.6 Is the toolkit promoting suitability through economic sustainability for the participates?

YES NO

Substantiation of answers and Recommendation

_____
_____
_____
_____
_____

1.7 Is the toolkit promoting suitability through gender equality for the participants?

YES NO

Substantiation of answers and Recommendation

_____
_____
_____
_____
_____

1.8 Is the toolkit promoting suitability through environmental sustainability for the participants?

YES NO

Substantiation of answers and Recommendation

_____
_____
_____
_____
_____

1.9 Has the toolkit incorporated explicit nutrition (nutrition promotion and education) objectives?

YES	NO

Substantiation of answers and Recommendation

_____

1.10 as the toolkit incorporated explicit improve processing, storage, and preservation objectives?

YES	NO

Substantiation of answers and Recommendation

_____
_____
_____
_____
_____

Thank you.

- Questionnaire as a link.

https://forms.office.com/Pages/ResponsePage.aspx?id=0TAZS_QStUC0jL2GEXQp2HtLCz7SniNKoHMoYL3EE6FURVVRRFo0WTNSSFpYTFZWUzNBUjU3QzBWQS4u

Appendix S: THE DELPHI TECHNIQUE FEEDBACK FROM THE EXPERTS

The Delphi Technique Validation Stage of the Toolkit

The report on stage 1, stage 2 and stage 3			
Questionnaire questions	**Recommendations from the experts**	**Implemented correction by the researcher**	
Are the toolkit's main objectives clear?	The objectives could be clarified a bit more; for example, you mention agricultural practices (which ones? - be a bit more specific), which promote sustainability, which is one of the key activities that promote sustainable agriculture, since these practices can be adopted besides using a greenhouse.	*Insert these objectives;* Understanding sustainable community and agricultural food systems in the production of food practices to improve agricultural knowledge, increase yield variety crop, increase nutrient-dense foods and reduce post-harvesting food loss through: 1. Understanding the steps involved in pre-planning. 2. Understanding planting and caring for seedlings. 3. Understanding the steps involved in post-planting. 4. Identifying steps involved in both the pre- and post-harvesting stages. (pg. 6, Booklet)	**Participant's Manual** **Pg 6 - Added Key Objectives**
	The second objective falls under the use of greenhouses which has its own benefits as a mitigation factor against climate change for only selected crops. So, make those clearly separate methods one is technology based the other is improving production patterns that are sustainable. Will some crops be produced sustainability and specific ones using greenhouse?	***The vegetables chosen are planted in the greenhouse tunnels.*** After securing finance, insert a picture of installation of greenhouses tunnels. Also after 1 before land preparation insert a picture of installation of the greenhouse tunnels. (pg. 7, 8, 15 booklet), (pg. 19, 45 researcher).	**Participant's Manual** **Pg 7 - Added Installation of greenhouse** **Pg 8, 15 – Added installation of greenhouse tunnel with temperature control and irrigation.** **Researcher Manual** **Pg 19 - Added Installation of greenhouse** **Pg 45 - Added installation of greenhouse tunnel with temperature control and irrigation.**
After planting	Participants need to be educated on how to maintain the soil and greenhouse tunnels after planting and harvesting.	Step 6: after planting (pg. 11 booklet)	**Participant's Manual** **Pg 11 – Added Step 6**

Plant Protein	Participants need to be educated on plant protein as a cheaper source of protein rather than meat.	Both in the two-training manual	**<u>Participant's Manual</u>** **Pg 25 – Added Plant Protein Definition** **<u>Researcher Manual</u>** **Pg 52 -53**
Does the toolkit clearly indicate who will benefit from the intervention?	Nutrition Education you can indicate that is linked to addressing what? Micronutrient Deficiency? Dietary Diversity? Are Upscaling targeting women and ultimately impacting the vulnerable groups infants and children? Your introduction should indicate that this women in agriculture empowerment which is a major issue in addressing sustainability.	Nutrition knowledge in understanding safe handling of food and food preparation practices to maximise nutrition adequacy and minimise food waste at household level. (pg. 24 booklet), (pg. 47 researcher). ***Table 4 page 54 has summarised the micronutrient deficiency and dietary diversity.*** Understanding gender equality and creating readily available opportunities for women farmers (pg.6 booklet), (pg. 10 research) Please insert in the introduction.	**<u>Participant's Manual</u>** **Pg 6 – Added Understanding gender equality and creating readily available opportunities for women farmers in paragraph 1.** **Pg 24 – Added Micronutrient deficiency and dietary diversity.** **<u>Researcher Manual</u>** **Pg 10, para 4 - Added Understanding gender equality and creating readily available opportunities for women farmers.** **Pg 49 – Reworded Nutrients definition to include micronutrient deficiency and dietary diversity.**
Is the toolkit components (researcher and participants training manual) appropriate?	Yes, it is but as highlighted issues around water usage must be considered.	Gathering and using raining water using tanks and connecting them to the irrigation when there is shortage of water. (pg. 25 researcher step 3 irrigation) (pg. 10 booklet irrigation)	**<u>Participant's Manual</u>** **Pg 10 – Added Gathering and using rainwater, stored in tanks, and connected to irrigation systems, is a sustainable solution for water shortage situations (water harvesting).** **<u>Researcher Manual</u>** **Pg 25, Step 3 – Added Gathering and using rainwater, stored in tanks and connected to irrigation systems, is a sustainable solution for water shortage situations.**
Is the toolkit promoting suitability through capacity building/development for the participants?	Yes, youth can also be a consideration so women along youthful age.	The study population is between the ages of 31 to 70 years. The point will be inserted in chapter 5 under the recommendations.	**NA**

Is the toolkit promoting suitability through technological sustainability for the participant?	Yes, it can be if alternative ways to ensure energy generation sources (as load shedding is a challenge) to ensure the system is well maintained. Community members must encourage them to have effective monitoring systems to ensure it's best kept for optimal production.	The research study is conducted in Lesotho and there is no loadshedding. The point will be inserted in chapter 5 under the recommendations. Outsourcing funding for solar panels to use to reduce the cost of electricity.	**NA**
Has the toolkit incorporated explicit improve processing, storage, and preservation objectives?	Further preservation methods can be incorporated and not only bottling in the recipes you have provided and consider the consumer profile by enhancing products formulated. Bottled potato is not commonly consumed in that manner.	3.2.2 Food Processing and Preservation does cover. Page 79 to 80 does cover some of the preservation as alternatives. Basotho woman plant potatoes and it was decided to teach them how to preserve them so they can add them to their meals.	**NA**
Please contribute an input to the context of the training manuals	Consider other terms to be included for the community to understand e.g. processing, pre-post harvesting, inputs, green house tunnels.	Insert the definitions	**Terms, alphabetically - Added processing, pre- post harvesting, inputs, greenhouse tunnels definitions.**
	The crops (such as tubers- potatoes, onions, beetroots) and specific containers have to be used for that and don't get commonly grown in greenhouses (more your tomatoes and lettuces cucumbers grow better there). You will be exploring here and require time and practice. Also, you have to use a lot of land (energy, water etc.) which is costly. If you will incorporate all these crops, then you have put in specific containers. In essence be specific on which crops will be grown in there since most of your recipes are using these crops as a reference and considering the cost and sustainability of this project.	The point will be inserted in chapter 5 under the recommendations. Greenhouse tunnels have transformed sustainable agriculture programs, revolutionizing small-scale and large fresh produce cultivation. Unlike traditional systems that rely on open fields, greenhouse tunnels provide a controlled environment that safeguards crops from adverse weather conditions, pests, and diseases. This controlled environment enables year-round cultivation, extending growing seasons, and ensuring consistent yields. With precise control over crucial factors like temperature and humidity, greenhouse tunnels optimise growing conditions, leading to accelerated plant growth and superior crop quality (pg 19 Researchers Manual)	**NA**
	Pg 11. Could have a heading as "TOOL KIT CONCEPTUAL FRAMEWORK (pg. 11 seems to have very minimal focus (1.1-1.3) and the emphasis. From 1.4 you have more emphasis even in your writing style it seems bolder hence	Add introduction to the framework.	**Pg 11, para 1 – Added introduction to section.** ***Please have editor proofread page numbers. These have shifted because of the additional section.**

	I recommend you put that page as a framework		
	You can rephrase the first sentence to: This toolkit is designed to empower and provide active engagement of women in the agriculture sector by focusing on agri-business and agro-products. INTRODUCTION CHAPTER 1. Chapter 2 should also include the benefits of greenhouses at the beginning as opposed to traditional production system.	Elaborate on greenhouse vs traditional pg 19.	**<u>Researchers Manual</u>** **Pg 10 – Updated introduction: This toolkit is designed to empower and provide active engagement of women in the agriculture sector by focusing on agri-business and Agro-products.** **Pg 19 -20** • **Added difference between greenhouse vs traditional production system under introduction.** • **Moved Site Selection to page 20.**
	Figure 2.8 talks about supermarkets and export in the value and if that is the projection, you need to consider the issues of compliance with retail requirements (Food Business Operating Certificate-FBO, Global Gap required by retailers, ….) since farmers have to comply. The needs to be factored in growing the agribusiness. GAP is not properly giving instructions on the process.	Remove the words supermarkets and use community free market.	**Pg 12 – Changed Retail and markets to community free market** **Pg 32, Fig 2.7 – Changed retail to community free market** **Pg 33, Fig 2.8 -Changed producer to farmer and Convenience store to Community free market.**
	I think quality assurance and food safety should be labelled as section 2.2 covering all those aspects. This section is important for addressing safety of food for food to be secure plus also addressing issues of quality for agribusiness to thrive which is currently lacking in many farmers.	Add information	**Pg 34 – Added 2.3 Vegetable and food safety as its own heading.**

The kit looks more visual now than before and more practical. However, just consider the following comments below.

Pg 1 ensure you justify your page.

The terms/definitions are removed they should be included you have indicated that the training manual is for beginners' new terms must be there.

Pg 6 the manual is designed to promote gender equality rather than understanding it since, you are not determining anything gender related in your kit but providing knowledge-based solutions.

Pg 6 rather refer as training outline rather than sections cover.

Pg 6 your objectives seem like you are understanding only and not providing an intervention. I would combine objective 1 and objective 2 and rephrase-

- Introducing fundamental components of vegetable production and nutrition education
- Determining agricultural and nutritional knowledge post-introduction
- Implementing a suitable training tool kit measuring pre and post training programme rollout

GREENHOUSE PLANTING TECHNIQUES

Pg 7 production involves understanding the entire value chain process (not just a farmer's decision-making process) other players are essential in the process. Just rephrase that.

Pg 8 block two just align the font size it looks different from the entire blocks. Also have 2.1 land preparation for greenhouse installation. 2.2 Installation of greenhouse tunnels with temp control, planting plot design and irrigation. I suggest you rephrase like this.

Steps must be clearly explained

3. Fertilizer application

4. Crop planting per allocated plot

5. Crop irrigation

Transplanting (I understand that transplanted is done first in trays then exported to the actual plot designed, then you prepare the land). Have a look at your layout it is a bit confusing

6. Crop rotation

You cannot start with 10 then 11 it should be vice versa 12 and 11 and these can be combined it's still under pest control

13 Rephrase to Plant safety and protection

14. Rephrase to Harvesting and post-harvest handling

PG 9 then section when to plant: even though you are using a greenhouse to plant and not conventional method: Planting seasons will be more applicable to open field planting. You can just indicate field planting which crops grow when e.g., spinach August-April. You can plant different crops

you should specify this for general information and mention your selected crops. Highlight the benefits of using greenhouse in this regard.

Pg 10 your wks is abbreviated check that it is not on the abbreviation list.

In Pg 14 in you harvesting record you can include post-harvest loss and reason so that they can monitor any problems with production as part of their records, since the usage of green house is meant to minimise crop loss in general.

Should not the general guidelines you are providing be part of lesson 1??? And should test 1 is lesson 2 ??? In my view you are already doing a knowledge exchange platform in your guidelines especially if you will communicate this verbally. Unless you had planned to give them written information.

Pg 17 should also be pest and disease management.

Also, pest and disease identification should all be next to each other so that they can relate block 10 and the one which should be 15 should be together. Just check the box with disease identification blocks are not labelled.

I think your sections are very confusing they should be broken down and put all relevant information. You can consider putting sections as below

3.1 Planting of potato and management

3.2 Planting of Swiss chard spinach and management

3.3 Planting of tomato and management

3.4 Planting of Cabbage and management

I do not understand how you are testing your knowledge. What will be the indicator after getting started? Maybe consider doing a check list/evaluation sheet where they can tick if it was achievable for crops planted.

NUTRITION KNOWLEDGE

Check page 24 first sentence nutrition sensitive shouldn't be 1 word

Your nutrition knowledge has a testing component (in the part 2 session) as indicated you should consider that for the agricultural section as well.

Appendix T: FACILITATOR TRAINING MANUAL AND PARTICIPANTS HANDOUT BOOKLET

A SUSTAINABLE NUTRITION-SENSITIVE AGRICULTURE TOOLKIT

Facilitator's Training Manual

A crop-based approach to address food and nutrition insecurity through the use of greenhouse tunnels in rural communities

Lisebo Mothepu

A SUSTAINABLE NUTRITION-SENSITIVE AGRICULTURE TOOLKIT

A crop-based approach to address food and nutrition insecurity through the use of greenhouse tunnels in rural communities

Lisebo Mothepu

2023. This manual is presented to the Faculty of Applied Sciences in the Department of Food and Nutrition, at Durban University of Technology, in partial fulfilment for the requirements of the PhD: Food and Nutrition.

FOREWORD

A Sustainable Nutrition-Sensitive Agriculture Toolkit

Africa faces challenges in meeting its food security needs, with millions suffering from hunger and malnutrition. Innovative and sustainable approaches to agriculture that prioritize nutrition are needed to address these challenges. The Sustainable Nutrition-Sensitive Agriculture Toolkit provides practical guidance for planning, establishing, and implementing sustainable agriculture programs that prioritize nutrition and food security in African contexts.

The toolkit is organized into three chapters. The first chapter provides an introduction to the food-based approach to agriculture, including nutrition, planning, and establishing steps for implementing the Sustainable Nutrition-Sensitive Agriculture Toolkit in the community.

The second chapter introduces sustainable nutrition-sensitive agriculture programs, with a focus on using greenhouse tunnels for fresh produce production. This chapter is divided into four parts: aspects of production, site selection and installation of greenhouses, guidelines for planting in the greenhouse tunnels, and general planting techniques. The second part of this chapter focuses on nutrition intervention, covering topics such as food, nutrition and nutrients, guidelines for healthy eating, and sample menus.

The third chapter is focused on promoting local food systems and agribusinesses. It includes guidance on food handling, preparation, and preservation, as well as information on bottling food products.

The Sustainable Nutrition-Sensitive Agriculture Toolkit aligns with the UN’s goals for food security and recognizes the importance of African-made resources in promoting sustainable development. This toolkit is a valuable resource for individuals and organizations seeking to enhance food security, promote health and well-being, and contribute to the sustainability of the planet. By prioritizing nutrition in farming systems, communities can improve their food security and support sustainable development.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to everyone who has contributed to my journey and supported me throughout the years. Without their support, I would not have been able to achieve what I have today.

First and foremost, I want to thank my mother, Mothulo Mothepu, for her unwavering support, encouragement, and love. Her dedication to my success has been invaluable, and I could not have accomplished any of this without her.

I also want to thank my son, Mothepu Dumisa, for being patient with me and understanding the sacrifices I had to make to pursue my dreams.

I would like to thank Molise Ramaili and Sine Maphumulo for being there for me every step of the way, and for their continuous support and encouragement.

I am grateful to Dr Naicker, Prof Duffy, Dr Oparinde, and Prof Napier for their academic guidance and support throughout my studies.

I would also like to extend my gratitude to the LNDC, DUT, and Piquant foods for their financial support.

Thank you all for your unwavering support and encouragement.

SUMMARY OF THE 3 SECTIONS

ABBREVIATIONS

ARC	Agricultural Research Council
CBO	Community-based organisation
cm	Centimetre
CONSORT	
EC	
FAD	Fund for Agricultural Development
g	gram
GI	
GOL	Government of Lesotho
ha	hectare
IPM	Integrated Pest Management
K	Potassium
kg	Kilogram
kJ	Kilojoule
m	meter
mL	millilitre
MRC	Medical Research Council
N	Nitrogen
NGO	Non-governmental organisation
UN	United Nations
RDA	Recommended dietary allowance

TERMS

Cited from Faber, M., Laurie, S., Ball, A.-M., & Andrade, M. (2013). *A crop-based approach to address vitamin A deficiency in South Africa.* Pretoria, South Africa: South African Food Data System, Centre of Excellence in Nutrition, University of Pretoria.

Agricultural inputs: All consumables that are needed to make a crop grow, for example, fertiliser, pesticide, seeds, labour, etc.

Caregiver: Usually a member of the family, in whose care the child is

Crop rotation: A system of crop production in which the various crops are grown in succession on the same piece of land and in a certain sequence, in such a way so that that no crop is planted on the same piece of land for more than once in three years.

Crop-based approach: A food-based approach that focuses on the production and consumption of foods, especially those rich in micronutrients, as well as their absorption and utilisation in the body. The approach is flexible and includes a strong nutrition education component. The basis of the crop-based approach is the involvement of the community and local government in the design, implementation, management, monitoring and evaluation of the project/programme.

Cure: Preparing crops for storage by drying. Results in extended storage life e.g. of butternut/pumpkin fruit and sweet potatoes.

Diabetes: A medical condition where the body does not produce insulin or the insulin does not work well, and as a result glucose from the blood cannot enter the cells of the body as a result the blood sugar is too high.

Fieldworker: In the context of this manual a fieldworker can be a community member, a volunteer, etc who collects data or is involved in project activities.

Food-based approach: Strategies to improve the micronutrient status and well-being of populations through food production, dietary diversification, food fortification, and biofortification of staple foods.

Food-based dietary guidelines: A set of nutrition messages used to teach nutrition.

Fortified: Extra nutrients were added to the food.

Greenhouse tunnels: Enclosed structures, typically made of transparent materials, designed to create a controlled environment for plant cultivation by trapping heat and allowing sunlight to penetrate, thus extending the growing season and protecting crops from adverse weather conditions.

Health eating plan: A diet that provides the foods that supply the correct amount, or nutrients needed for health; also known as a balanced diet.

Imifino: A collection of various dark-green leaves that are eaten as a vegetable; the leaves either grow wild or come from vegetables such a pumpkin.

Inputs: Resources, materials, or substances used in agricultural production, including seeds, fertilizers, pesticides, machinery, labour, and other essential components.

Micronutrients: Natural substances found in small amounts in food (vitamins and minerals) as compared to macronutrients (e.g. carbohydrates, protein and fat) which are found in larger amounts.

Pest: Any organism (e.g. some bacteria, insects, fungi, mites, nematodes, rodents) injuring or detrimental to a beneficial plant. Alternatively referred to as pests and diseases.

Pesticides: Any chemical or physical agent that destroys, prevents, repels or attacks pests in order to control pests.

Pre-post harvesting: Activities and practices carried out both before and after the actual harvesting process, encompassing tasks such as field preparation, planting, crop management, and storage.

Processing: The conversion or transformation of raw materials or agricultural products into a different form or state through various techniques or methods.

Underweight: Low weight-for-age, with other words the child weighs too little for his/her age; the child can be either thin or short for his/her age. This reflects a combination of chronic and acute malnutrition.

Vitamin A-rich vegetables: In the diet, vitamin A can be found in the form of either preformed vitamin A, which is found in foods of animal origin, or provitamin A carotenoids (mostly beta-carotene), which is found in foods of plant origin. Vitamin A-rich vegetables refer to orange fleshed vegetables (e.g. carrot, butternut, pumpkin, orange sweet potato), as well as dark-green leafy vegetables (e.g. Swiss chard), which are good sources of provitamin A carotenoids.

CONTENTS

LIST OF TABLES AND FIGURES

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CHAPTER 1 INTRODUCTION

This toolkit is designed to empower and provide active engagement of women in the agriculture sector by focusing on agri-business and Agro-products. The aim is to encourage sustainable agriculture, local community food systems and nutrition-sensitive agriculture.

These systems are important in order to improve food and nutrition insecurity and attempt to end hunger at community level, household level and individual level.

The toolkit has two programmes:

I. The Sustainable Agriculture Programme

Which focuses on:

• Agriculture practices and use of greenhouse tunnels for fresh produce production.

II. Sustainable Nutrition-Sensitive Agriculture Programme

Focuses on:

• Nutrition education.

The toolkit is developed for rural small-scale female family farming to provide household consumption and local small-scale commerce and is implemented in **Mpharane village** and **Maqoala village in the district of Mohale's Hoek Lesotho.**

The toolkit is designed to understanding gender equality and creating readily available opportunities for women farmers.

Lesotho is a member of the United Nations (UN), and Lesotho's goals are aligned with the UN's goals in addressing poverty, hunger and food and nutrition insecurity. The toolkit's foundation is rooted in the United Nations (UN) and its agencies, aimed at supporting research and addressing poverty, hunger, and food insecurity in both developed and developing countries. In addition, the entities such as the International Fund for Agricultural Development (FAD) and 2016-2025 United Nations Decade of Action on Nutrition specifically the UN Decade of Family Farming (2019-2028) were used as the basis for the development of the two programmes. (For further information please see Chapter 2 of Mothepu, L. 2023).

1.1 TOOL KIT CONCEPTUAL FRAMEWORK

The Toolkit's conceptual Framework (figure 1.1), provides an overview of how a food-based approach was to tackle local community food systems and nutrition-sensitive agriculture. This section begins by providing definitions for a food-based approach, agriculture, and nutrition, laying the foundation for understanding the significance of food in the context of our toolkit.

1.2 Food-based Approach

From the practical point of view, the implementation of the food-based approach requires a national effort in order to support the production of nutrient rich foods and to promote consciousness of nutrient bioavailability, so that people may obtain all nutrient potential from foods.

1.3 Agriculture

Agriculture is the art and science of cultivating the soil, growing crops and raising livestock. It includes the preparation of plant and animal products for people to use and their distribution to markets.

Agriculture provides most of the world's food and fabrics. Cotton, wool, and leather are all agricultural products. Agriculture also provides wood for construction and paper products.

These products, as well as the agricultural methods used, may vary from one part of the world to another.

1.4 Nutrition

The term nutrition broadly covers all processes through which we obtain, prepare and eat food. It further describes what different foods are made of (i.e. nutrients) and the processes through which our bodies make use of the nutrients to enable us to perform daily activities such as work.

Apart from focussing on what we should eat, nutrition is also concerned with promoting aspects or personal and environmental hygiene and sanitation, promoting good health seeking behaviours and providing care for all household members so that they are healthy.

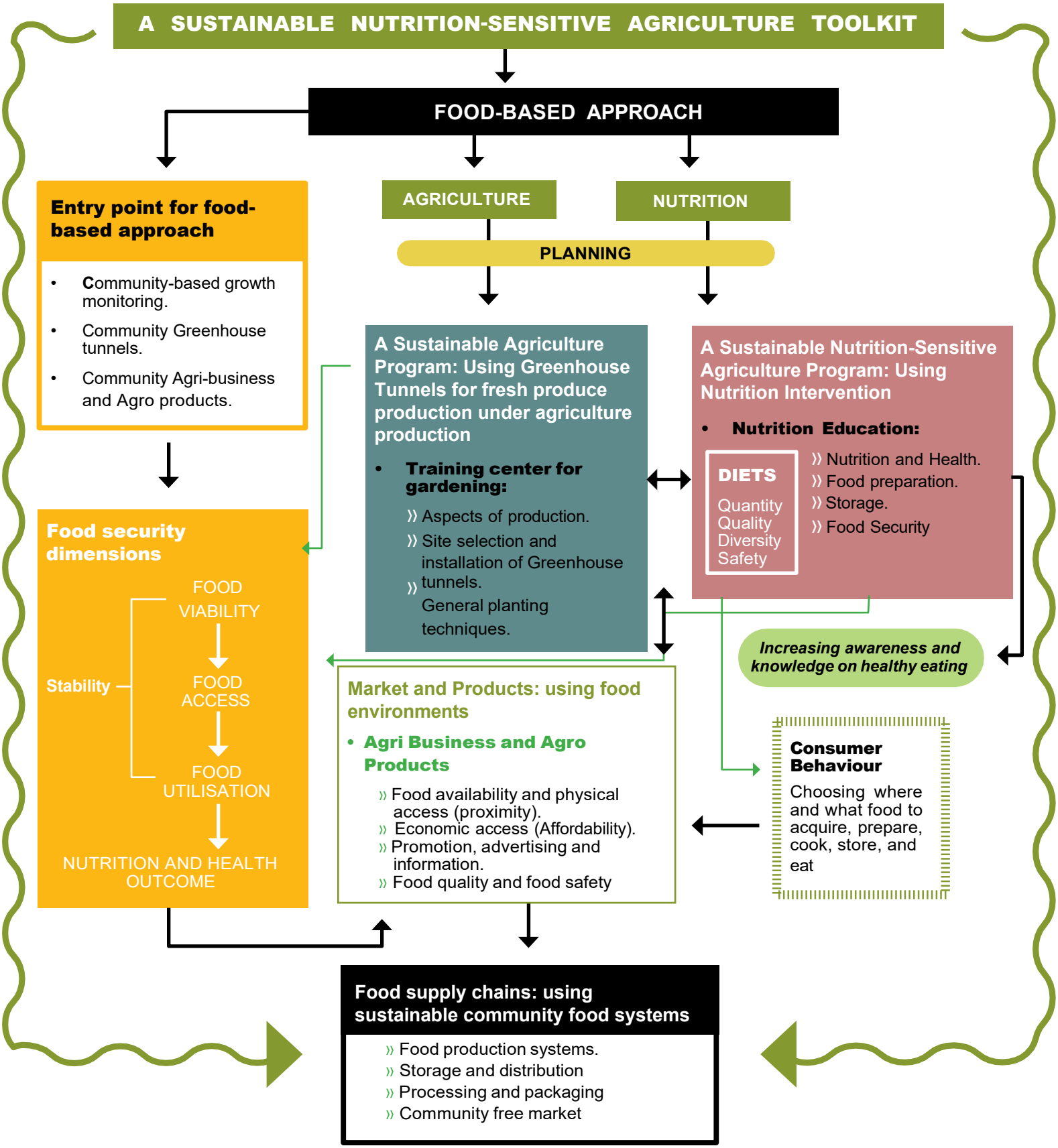


Figure 1.1: *The flow diagram of a Sustainable Nutrition-Sensitive agriculture toolkit adapted from the Schematic overview of the food-based approach to address vitamin A deficiency development in South Africa (Faber and Laurie, 2011), the four Dimensions of Food Security (Yadav Sharma Bajagai 2021) and conceptual framework of food systems for diets and nutrition. Source: (High Level Panel of Experts (HLPE) 2017).*

PLANNING AND ESTABLISHING STEPS IN IMPLEMENTING THE SUSTAINABLE NUTRITION-SENSITIVE AGRICULTURE TOOLKIT IN THE COMMUNITY

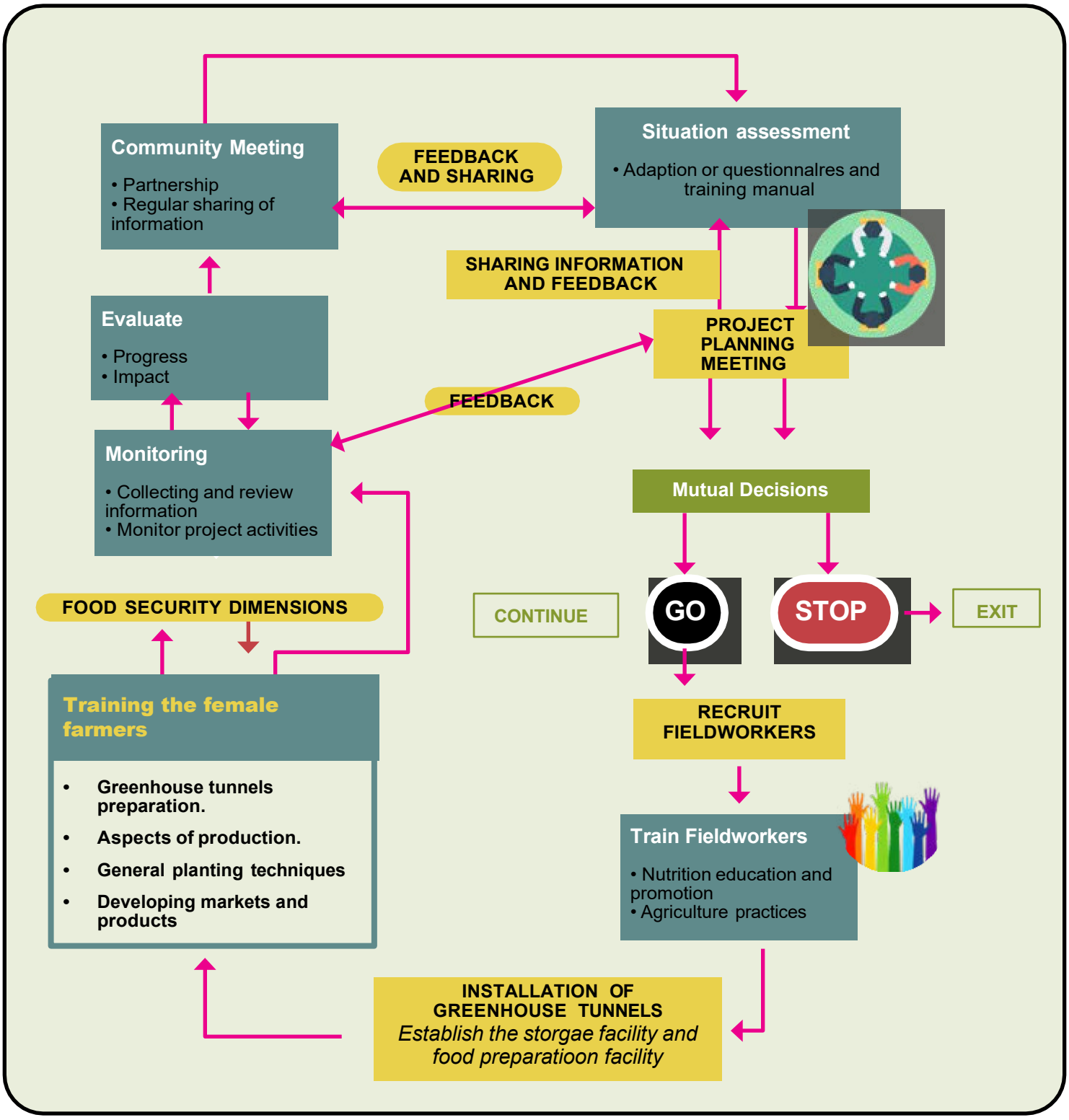


Figure 1.2: *Adapted Schematic overview of the steps that should be followed when implementing a sustainable nutrition-sensitive agriculture toolkit (Faber and Laurie, 2011).*

1.5 PLANNING AND ESTABLISHING STEPS IN IMPLEMENTING THE SUSTAINABLE NUTRITION-SENSITIVE AGRICULTURE TOOLKIT IN THE COMMUNITY

Step 1: Community meeting with a group or individuals who can potentially provide the information (learning about the community)

As indicated in 3.2 in Chapter 3 of the dissertation under Ethical Consideration. A meeting with the councillor of the district of Mohale's Hoek was arranged in order to obtain permission to conduct the research in the two villages of the district and a letter was given to him explaining the research study.

A meeting was arranged to meet with the chiefs from the two villages and information letters regarding the research study was given to the chiefs from **Mpharane village** and **Maqoala village.** The meeting was conducted in order to discuss the research project and gain permission to conduct the study in the villages.

The chiefs will assist in creating a community forum made-up of five local women from each village to explain and inform all parties about the study that will take place in the villages. The ten women will help the researcher understand the dynamics and interests of the women residing in the two villages, the community forums will also help with the adaptation of the research questionnaires so that the questionnaires can be tailored towards the community's needs. The community forums will also help with adapting the training manuals.

Step 2: Situation assessment

After the adaptation of the research questionnaires and training manuals, a pilot study was conducted with five community members (female) from each village in order to ensure questionnaire and training manual validity and reliability, for

the adapted questionnaires and training manual. The thirty women from the two villages were excluded from the main research study.

Feedback

The results of the situation assessment should be read to and discussed with the community. They should be presented in a language, format and level that are understood and can be applied in the community. Findings should be presented in a manner that would not have unfavourable effects on any individual.

Enrolment (Screen/assessed for eligibility)

Once all the questionnaires have been adapted a probability sampling was used to obtain the sample population and sample size. After the probability sampling, the simple random sampling was used in order to obtain the desired sample size of 127 female participants. As indicated in figure 3.2. simple random sampling in Chapter 3 of the dissertation.

The 63 female participants from each village were provided with information letter outlining the purpose, aims and objectives of the study. The letter was translated into Sesotho to allow for all the participants to have access to the information and to give the opportunity to ask questions and raise any concerns. This is indicated in figure 1.3. of this toolkit.

For the participants that cannot read, the letter was read to them in Sesotho and explained to them in details by the researcher. Once the participants have clear understanding of the study, they will then be requested to sign a consent form and for the participants that cannot Write they were requested to use a fingerprint or draw an X.

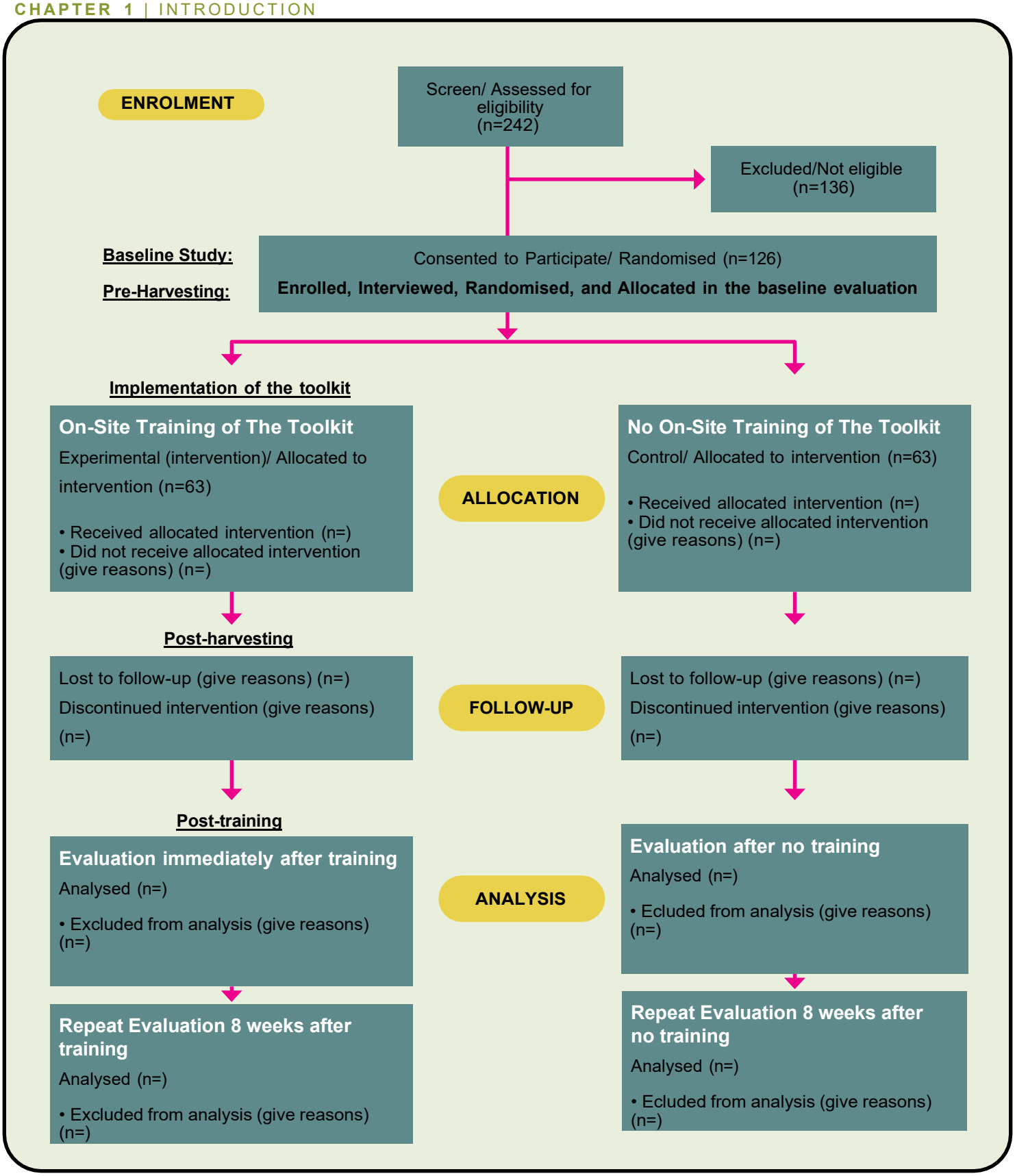


Figure 1.3: *The Adapted CONSORT flow diagram of the progress through the phases of a parallel randomised controlled trial (R) of two groups (that is enrolment, intervention allocation, flow-up, and data analysis) (Moher, Schulz, Altman 2001, Orlando, Thomaier, Abernethy and Chen 2017 and Bhide, Shah and Acharya 2018)*

CHAPTER 2
INTRODUCTION TO SUSTAINABLE NUTRITION-SENSITIVE AGRICULTURE PROGRAMMES

2.2. A Sustainable Agriculture Programme Using Greenhouse Tunnels.
2.3. A Sustainable Nutrition-Sensitive Agriculture Programme Using Nutrition Intervention.

Photo credit: USAID photo by Morgana Wingard.

Introduction

Nutrition-sensitive agriculture is a crop-based approach to agricultural development that puts nutritionally rich foods, dietary diversity, and food fortification at the heart to overcoming malnutrition and micronutrient deficiencies. This approach stresses the multiple benefits derived from enjoying a variety of foods, recognising the nutritional value of food for good nutrition, and the importance and social significance of the food and agricultural sector for supporting rural livelihoods. The overall objective of nutrition-sensitive agriculture is to make the global food system better equipped to produce good nutritional outcomes.

Nutrition-Sensitive Agricultural Production Can Be Implemented in Three Main Areas:

- **Making food more available and accessible.**

Increasing agricultural production makes more food available and affordable, which improves both the health and the economic status of the community. Sustained income growth in turn has a sizeable effect on reducing malnutrition.

- **Making food more diverse and production more sustainable.**

Increasing diversity in food production and promoting sustainable production practices like conservation agriculture, Water management and integrated pest management can improve nutrition levels without depleting natural resources. Family farming, home gardens and homestead food production projects can make a wider variety of crops available at the local level.

- **Making food itself more nutritious.**

Fortification can prevent micronutrient deficiencies by enhancing micronutrient content in foods through processing, plant breeding and improved soil fertility. In addition to changes in the agriculture sector, governments can promote nutrition-sensitive agriculture by incorporating nutrition-sensitive concepts into relevant farm policies and programs.

How to use the manual

The manual has been divided into 3 sections to allow for three separate sessions to take place and not overload workers with too much information in one go. **The sections cover:**

Section 1: Sustainable Agriculture Practises
Section 2: Nutrition and Health
Section 3: Food Handling, Preparation and Preservation and Market

2.2 A Sustainable agriculture programme using greenhouse tunnels for fresh production under agriculture production implementation

Greenhouse tunnels have transformed sustainable agriculture programs, revolutionizing small-scale and large fresh produce cultivation. Unlike traditional systems that rely on open fields, greenhouse tunnels provide a controlled environment that safeguards crop from adverse weather conditions, pests, and diseases.

This controlled environment enables year-round cultivation, extending growing seasons, and ensuring consistent yields. With precise control over crucial factors like temperature and humidity, greenhouse tunnels optimize growing conditions, leading to accelerated plant growth and superior crop quality.

Part 1: Aspects of Production

Production involves:

- Decision making

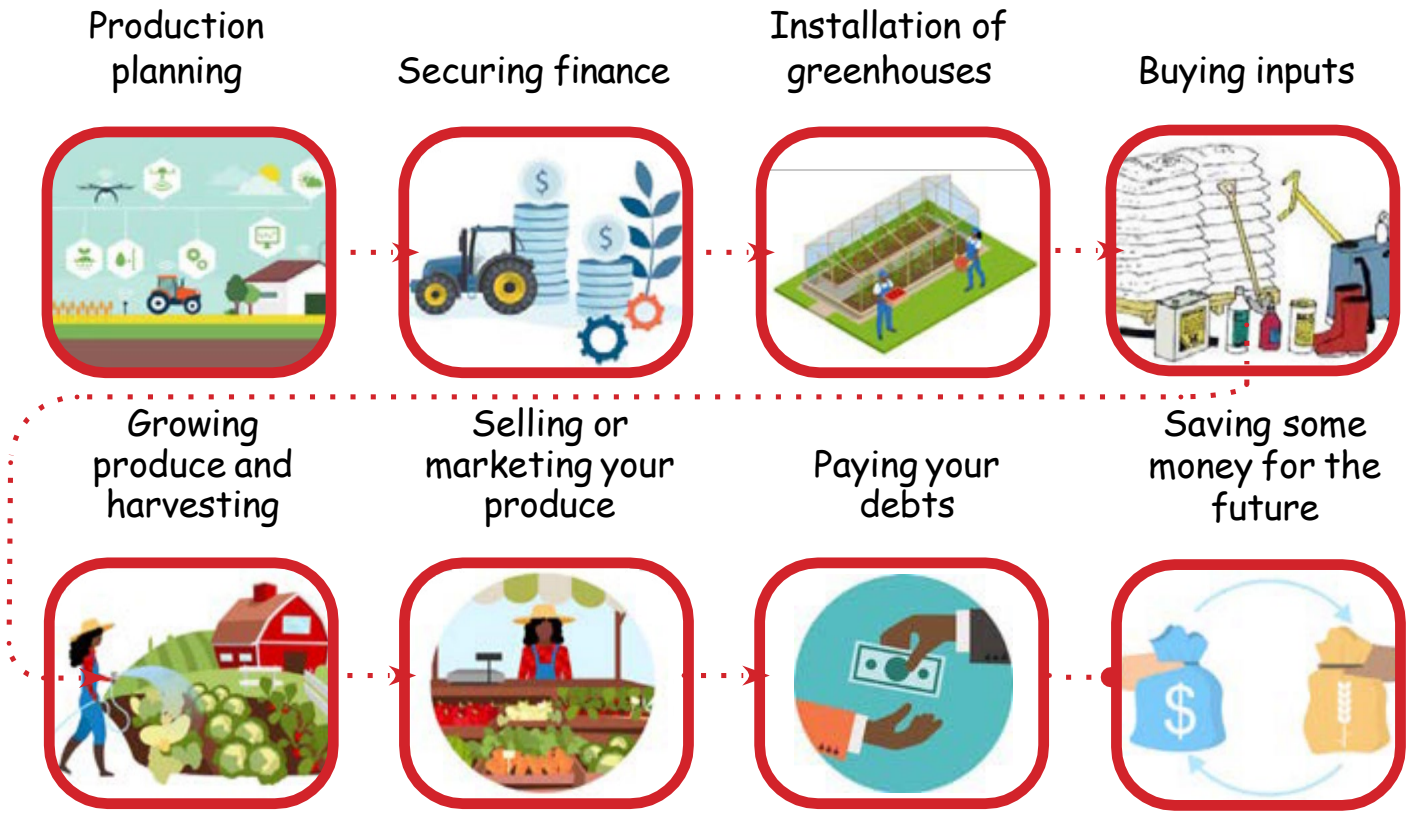
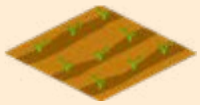


Figure 2.1: *Aspects of Production*

Part 2: Site Selection and Installation of Greenhouse Tunnel

i. Site Selection

Identifying both the fields for planting and installing the greenhouse tunnels.



Making sure that the site gets at least 6 full hours of sunlight daily (for vegetables).

Considering availability of water. Considering past uses of the land.

Identifying both the fields for planting and installing the greenhouse tunnels.

Figure 2.2: *Site Selection*

ii. Preparing And Developing the Fields

Cleaning the fields.

Developing and designing the plantation on the fields.

Gathering the resources such as tools, seeds, greenhouse tunnels.

Deciding on the field sizes, mark the fields clearly with field names.

Including plans for a storage area for tools and other equipment, as well as a compost area.

Arranging for land preparation.

Figure 2.3: *Preparing and Developing the Fields*

iii. Installation Of Greenhouse Tunnels

Lesotho National Development Corporation (LNDC), Government of Lesotho (GOL) under Lesotho Ministry of Trade and Lesotho Ministry of Agriculture donated three Greenhouses tunnels

10m WIDE x 30m LONG x 4m Treated mild Steel tunnel with irrigation system for the research. The three sponsors will also be contributing to tools, seeds and improvement of the soil.

The construction of the 3 greenhouse tunnels

Specifications

- 10m wide x 30m long x 4m high
- New 200-micron plastic
- Installation
- Net for covering the complete tunnel (sawed 7 installed)
- Strapping
- Hoist for flaps
- Flaps included in price manual
- Gates included in price

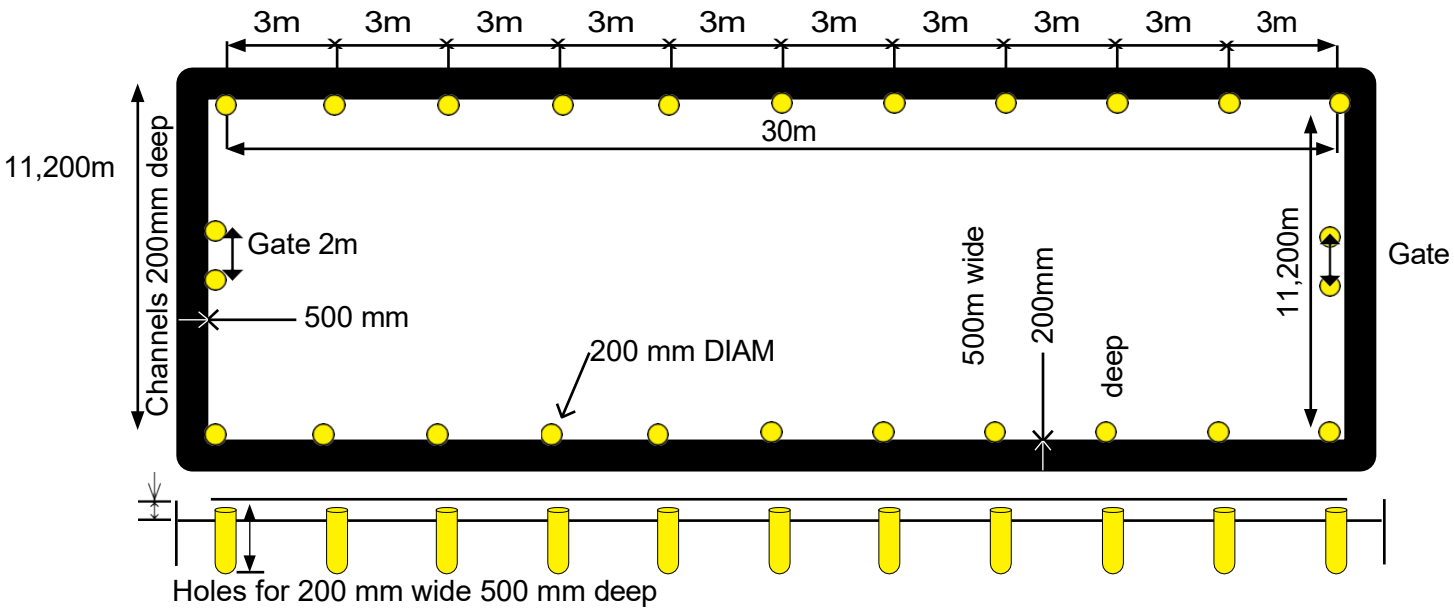


Figure 2.4: *10m x 30m Tunnel Digging Sketch*

Irrigation system of the greenhouse tunnels

- 500m x 16mm x 40cm sp dripper pipe
- Irrigation Pipes and fittings (set)
- Pump station Jnr auto 2 valves Complete include
- 1 x security cage housing
- 1 x computerised pump
- 1 x 4station controllers with relays
- 2 x Solenoid valves (neatly assembled)
- Tanks 5000L
- Installation of irrigation system

Cooling system and heater

- 8.6m Complete wet wall system
- 8.6m Water gutter system
- 8.6m x 1.2m x 100mm Pads
- Heavy duty Fans, 380, 0,75Kw
- Pipe works and pumps
- 500LT wet wall tank
- steel pipe support system
- Temperature controller with thermostat
- Installation of cooling system
- 5kw Fan electric heaters

Construction requirements for the installation of the greenhouse tunnels

- Electricity and water must be supplied to the site while construction takes place.
- Water supply to mixing tanks and electricity.

Preparation prior to installation of the greenhouse tunnels

- Levelling and cleaning the soil area.
- Digging of holes for poles and channels for plastic fold in.
- Supplying sand, cement and stone.

Part 3: Guidelines For Planting in The Greenhouse Tunnels

Growing vegetables in tunnels can be only successfully if the farmer pays much attention to good management in farming as well as marketing. A farmer can have a bumper yield only if he or she follow all right procedures.

In the modern time and era, we are living today, a greenhouse tunnel is a precious investment one can have, it is the best way to grow vegetables in a small area, and it's recommended to have an area of 300m ² which can accommodate 900 plants.

With a controlled water supply an all-year crop can be guaranteed, with an estimated planting period of 3 months, and 6 months of harvesting after every crop. Crop rotation is recommended. During wet seasons tunnels can be kept dry inside while white and black floor plastic keeps weeds down.

The convenience of a greenhouse tunnel is the increased productivity it offers, whether you are a hobby gardener, needing plants to run a nursery for profit or practicing self-sufficiency on a family holding/ farm on either a small or large scale. Controlling of diseases is not nearly as difficult as on open land farming and it can be more easily managed.

The reason for building a tunnel with half-moon arches, is to allow maximum sunlight, and also to make it more resistant against strong wind and rain. It is covered with 200-micron plastic film or 40% netting or both, as preferred. Stainless steel 409 structures are more durable especially for coastal regions as galvanized steel will eventually rust. There are various sizes, customised sizes -and for many selective farmers multi span is available which have the benefit of being cooler and more spacious as it can be fitted on a smaller area. Smaller sizes 3m x 6m x 2.5m and 5m x 9m x 3m is more popular for household use.

Commercial farmers make use of a 10m x 30m x4m tunnel as it can accommodate 900 plants on the 300m². All tunnels should preferably have 2 ventilation flaps and 2 gates in order to control/regulate temperature, and be opened during warm weather and closed during cooler seasons. It's recommended to have roll-up sides which work with sling for the same reason, that is to open both sides of the tunnel. Wet walls can be installed in tunnels with fans for cooling down during warmer conditions, the only drawback is that it is quite expensive but affordable. Fans can be used as an alternative.

Heating systems are available to control temperature during winter where temperature should not drop below ≤10ºC which will result in slowing down plant growth. By utilising the tunnel to maximum extent summer can be prolonged by installing a heating system e.g. paraffin, diesel, gas, electric and most cost-effective coal heating system. At temperatures ≥35ºC will also have a negative effect on growth.

1. AREA TO DO FARMING

The area for farming must not be too cold in winter nor too hot in summer. This will help to reduce the costs of mechanisms to control the temperature. If there is no choice and if the land if the area is very cold in winter, a heating system must be used. Examples: mulching plastic, gas heaters, electric heaters, and boilers.

In very hot areas, it is a good to have a tunnel with shade net or with roll-up ventilation flaps, cooling systems also can be used. Examples are cooling fan, wet walls or cooling mist.

2. PH AND EC LEVELS

It is necessary to have a water analysis done before water is used to irrigate the plants. This helps a farmer to determine which mixture of fertilisers will be suitable for the plants. The farmer should take at least a 1 litre water sample to any Agricultural institution for testing.

It is recommended that a farmer to has EC/ PH meters. It is advisable to test water regularly. Water should be tested before mixing with fertilisers because water is not always stable. Test water again before watering the plants. And thirdly test the water which is inside but at the bottom of the planting bags. Too many salts in the planting bags may affect the production.

3. SEED SELECTION

There are several varieties of seeds for every vegetable, and some do better in winter while some do not. Please ask seed suppliers to provide you with the right variety to suit the season in which you want to plant.

Basic list of what can be grown in Tunnels:

In South Africa, popular crops include a variety of vegetables such as artichokes, baby marrows, brinjals, broccoli, cabbage, catnip, celery, chilli peppers, cucumbers, dill, garlic, green beans, lettuce, mushrooms, onions, peas, potato, and spinach. The fruit crops grown in the region consist of strawberries, tomatoes, and watermelon. Additionally, herbs and flowers like catnip and ornamental flowers are also cultivated.

4. PREPARATION

Step 1

Level the soil nicely. It is advisable to make floor level run down with a slope for water to run off. The trenches should at least 5cm to 10cm deep and 65cm in width in a 10m x 30m tunnel. 6 trenches should be dug along the length of the tunnel.

Tunnel sterilisation

Previously used tunnels need to be sterilised with Glutathione (Formalin) using a spraying machine. This will eliminate any contamination from bacteria, fungus, viruses, and pests. Ensure that the whole tunnel is treated with the solution to have a lasting effect; this action is of high importance and should be performed preferably after each season. Duration of the planting season is for 9 months, from September to May annually in Lesotho.

Step 2: Preparation of soil and floor covering

Levelling of soil and removal of all weeds, trees stones and rocks are necessary to position the tunnel structure. It is recommended that the floor area is on a downward trend with a slope of no more than 300 degrees to make it possible for more effective water drainage.

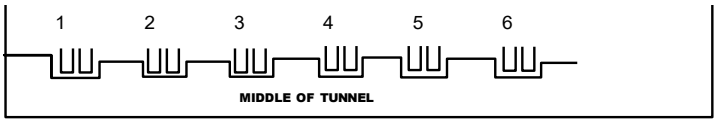
Digging of channels should be 50mm deep and 600mm wide, a total of 6 (six) channels along the length for a standard 10m wide X 30m long tunnel. To simplify the layout should start in the center of the tunnel, from

centre line measure 450mm either side of the center. The next two channels should be 750mm from the centre, the spacing of the channels should be exactly 1.5m apart, leaving a 900mm pathway between the rows. Floor sheeting can be fitted to cover the channels; two options are available:

a. **The** 11,5m wide X 31m Long, 150m deep

b. The 750mm x 200m, 150um (Not advisable as this will result experiencing difficulty in combating weeds, diseases and pest control.)

The floor sheeting is fitted with white side upwards as it reflects light better than the black side, the purpose of the black side of the sheeting is to keep soil dry, eliminate weeds, insects, fungus, diseases, and bacteria.



Step 3: irrigation

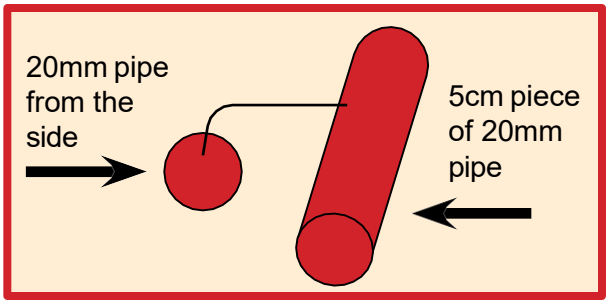
Gathering and using rainwater, stored in tanks, and connected to irrigation systems, is a sustainable solution for water shortage situations.

Options:

Dripper Irrigation. The most common dripper used is 2-liter/hour and 4-liter/hour; it is a small round unit, a manifold fit on top of the dripper. Flexi pipe should be cut into lengths of 500mm - 600mm and connected to a manifold. An arrow is attached to the end of each pipe. Into 20mm pipe make holes using a nail, 800mm apart. Dripper set is pressed into each hole. One method is drip irrigation that optimises water supply. It allows for frequent application of low levels of soluble nutrients.

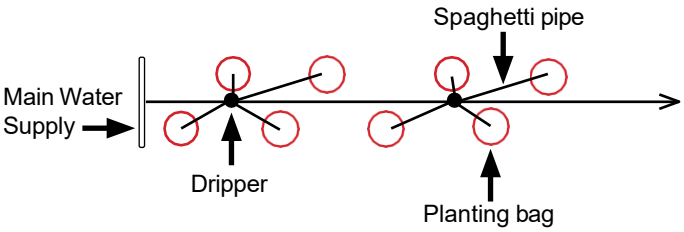
Spaghetti Irrigation

Cut 1.5mm spaghetti pipe into 500-600mm lengths. Holes are made in 20m trench line pipes, and the spaghetti pipe is pressed into the 20mm pipe. These spaghetti pipes should be cut with a diagonal edge to prevent blockage by pushing it in too deep. Each planting bag should be fitted with a spaghetti pipe, and spaced 400mm apart. To prevent water leakage ensures that the holes are not too big. The other loose end of the spaghetti pipe should be pushed through the upper side of the bag (after the bag has been placed on the floor) to keep it in position in a 5cm piece of 10mm pipe. This is to prevent water from spraying over the edge of the bag and to ensure that water goes into the sawdust.



Bag staggering

This works in combination with the dripper irrigation system. For best results it is recommended to use a mixture of SA pine sawdust. After filling the bags, they should be placed in the trenches, on top of the white side of the floor plastic, and each trench should have two single rows of bags. The bags should be staggered and arranged in an upright position, forming a straight line with a 400mm spacing from the center of one bag to the center of the next, with a single row of 75 bags in a 30m tunnel, and thereafter 150 bags in a double row; this will be a total of 900 bags per tunnel = 3 plants per square meter.



Bag staggering should be diagonal.

Start with one bag next to a dripper, then every second bag thereafter. Non-treated pine sawdust is used for a growing medium; it's available in both a rough and fine texture. It is important to have a good balance between the two textures as too rough sawdust will cause water to drain too quickly. Too fine sawdust will cause the ratio of air and water not to be optimally absorbed and growth will not be stimulated. The bags need to be filled right to the top with the growing medium. After all the preparation has been done, the tunnel is ready to use for planting. Ensure that all the fertiliser has been diluted properly. Water twice daily at 09h00 and 13h30 until water leaks through the holes at the bottom of each bag. Smaller plants can be watered once daily in the morning. During winter the plants should not be watered after 13h30 as this will result in the vegetables getting damaged e.g., tomatoes can crack. However, potassium contributes to the firmness of the fruit, but it also has the effect of cracking the fruit due to absorption of the mineral. Crop support should be fitted above each line of bags consisting of horizontal steel wires. Each plant should be tied to the steel wire with twine, and extra support will be needed once the plants start growing to their full potential and get taller. Once all the plants have reached the required size, the seedlings can be transplanted.

5. MAKING YOUR OWN SEEDLINGS

There is a strong case for growing your own seedlings because in most cases the germination rate of most vegetable seedlings is good. There are different kinds of seedling trays depending on the number and size of the holes. Most preferable are the 200-hole ones. The advantage of planting trays with bigger holes is that it keeps moisture better than smaller ones. Both seedling trays will give the same success.
It is recommended to use growth mix or growth medium which has a micro-element, as this will help in the plant growth and retain moisture better so that the plants will not get dry.
When the seeds start to germinate, the seedlings will start sprouting. Keep on watering them until they have enough roots.

When the seed starts to germinate, the seedlings will start shooting out. Keep on moistening until they have enough roots.

will know if the roots are sufficiently developed by trying to pull the seedlings out of the seedling tray hole, and you see that they come out together with the growing medium. In winter you can make a steel rack to fit your seedling trays. Ensure that the rack has adequate spacing so that the seedlings do not encroach on each other. Cover them with plastic during the night and remove the plastic during the day. If it is very cold, you can put in an electric heater. If the colour of the leaves of the seedlings looks pale or brownish it is recommended to water them with a mixture of Nitrosol (use the correct ratio as written on the label of the bottle).

6. TRANSPLATING OF THE SEEDLINGS

Make sure that your pump, all irrigation pipes, and planting bags are ready. Open a round hole on top of the sawdust at least 8cm in diameter and 6cm deep. Fill the hole with growing medium. Once all the holes are filled, position the drip arrow right at the centre of the bag.

Make a mixture of fertilisers as follows and as instructed depending on the vegetable. For example:

- **1kg Hydroponic mix to every 1000 litres of water.**
- **0.5kg Calcium nitrate to every 1000 litres of water.**

Mix each type of fertiliser with water separately in a bucket, then pour it into the tank of water and run the pump to mix the solution for 5 minutes.

Set your pump to run for 5 minutes to allow water to flow into the bags. With the help of a stick which is able to penetrate the small holes on the bottom of your seedling tray, start removing the seedlings while you plant them in bags ion the centre. Do not plant them too deeply. Planting should be done in the late afternoon as this will help the plants to stabilise during the cooler part of the day. As soon as you finish transplanting, you should give the plants enough water. You will know if the amount of water is adequate when water starts coming out of the side holes of the planting bags.

When all the plants have been planted, make a mixture of 10ml proplant/ propamocarb to 10 litres of water. Water every plant with 500ml - 1000ml of the mixture; this will help to prevent damping and help root development.

7. FERTILISER APPLICATION AND GROWING PERIOD OF THE PLANTS

(A practical example: application for cucumber)

The fertilisers which are mostly recommended are Hydroponic mix, calcium nitrate and potassium sulphate. Remember that you start applying potassium sulphate only when your plants start flowering and bearing small fruits.

Use the prescription mixture below:

Week 1 to Week 2
- 1kg Hydroponic mix to 1000 litres of water
- 0.5kg calcium nitrate to 1000 litres of water

Week 3 onwards
- 1.5kg Hydroponic mix to 1000 litres of water
- 1kg calcium nitrate to 1000 litres of water
- 0.7kg potassium Sulphate to 1000 litres of water.

Make sure that you have a plastic bucket and mix one kind of fertiliser separately with some water. Stir nicely before you put it in the fertiliser mixing tank. Always make sure that the mixture of fertilisers is properly dissolved

by re-circulating it in a fertiliser mixing tank before using it in the tunnel or use a Dosatron injector. The amount of water required for your plants will differ from winter to summer. In winter you only need to give the plants water twice a day, for example, between 09.00 and 13.00. In summer, water three times a day, for example, at 08.00, 11.00 and 13.00. The average guideline is 2 litres of water in winter and 3 litres of water in summer per plant per day. You will know when there is enough water in the bags by checking if it starts coming out through the side holes.

NOTE:
Up to 20% over irrigation is needed to prevent high salt levels in bags. You need to measure the EC of water in the bottom of the bag on regular basis. If the EC gets higher than 2.5, it means that salinity rises. Reduce the amount of fertilizers to prevent salting. If EC reading is correct the normal quantity can be used.

8. FLUSHING OF IRRIGATION PIPES

It is recommended to flush out your irrigation pipes to remove excess salt and dirt from irrigation systems. It is not recommended to use clean water to flush the pipes, rather use water with half strength fertiliser. Switch the pump to run on manual and remove the end caps at the end of the 20mm pipes inside your tunnel one at a time.

At first you will see dirty water coming out; wait until clean water comes out then replace the cap while someone removes the next one.

Use the same procedure for all the pipes in the tunnel. This can be done on a monthly basis depending on the filter system used in the irrigation system.

9. TRELLISING OF PLANTS

Most plants require a trellising twine line allowing you to wind the plant around it. This line will be fastened to an adjustable trellising hook. The hook is hooked to a steel wire that is strung above each row of bags. The steel wire is fastened to a wire rope cable at the front and back of the tunnel. The wire rope cable runs from the wide side of the tunnel on both sides.

The wires must be 4m long and attached to a hook. When the plants reach a height where they are about to fall down, you need to start winding them around the loosened twine a few times and then press them in a semi-circle 8cm away from the plants and 5cm deep. The twine must not be too tight. This helps the plant to remain in the bag even if there is a strong wind. The remaining twine on the hook helps when the farmer turns the plant upwards because it can be loosened easily. All the side shoots and suckers must be removed regularly as the plants grow. When the plant reaches the wire then the main stem must be twisted back over the wire and directed back

to the ground again. If the stem is 1 meter from the ground, you should allow two side shoots to grow all the way to the base of the plant. From these side shoots you can harvest a lot but if the main trunk is about knee height from the ground you need to break out the growth point. Then the side shoots will still grow and produce more.

There are several ways to attach fruit plants to a trellis. We will limit ourselves to the breakout of curved fruits. Curved fruits are produced when the plant produces too many fruits and gets heavy. There are some other reasons too, but this will be discussed under diseases.

All these methods work and can be applied with success. What is of the utmost importance is to remove all the fruits from the ground up to knee height (40cm above the top of the planting bag). The reason for this is that the plant will then be able to use its energy for growth and have strength to handle a lot of stress later in the growing process. The second reason is so that the fruit will not touch the ground and will not rest on top of the sawdust in the bag which may cause the fruit to become yellow or curved.

10. PICKING AND PACKING

(A practical example: application for cucumber)

In most cases a farmer may pick cucumbers twice a week, for example, on Monday and Thursday. This will prevent cucumbers from becoming over mature. If the plants are well cared for and produce too many fruits, the chances are that the plant will get heavy. In that case the farmer may need to pick three times a week, for example, on Monday, Wednesday, and Friday. It is important to pick three times a week to prevent the plants from stress due to the heavy weight of the fruits and to help them to maintain good growth.

Cucumbers are wrapped in plastic wrapping for hygiene and to extend the life span, before shrink. Use 380mm wrapping plastic to wrap them. After this you start grading while you pack them in cucumber boxes. If you have a contract, you pack them according to the contract. There are different sizes of boxes depending on the size of the cucumbers you want to pack. Most of the time they are marked “M,” “L” and “XL.” If the cucumbers are too big to fit in these boxes, you can put them in banana boxes marked as “XXL” or “JUMBO”. Check that the boxes are marked with the correct quantity of cucumbers packed in. If they are not marked, the average number of cucumbers is 15 to 17 in a box. The number of smaller cucumbers may go up to 20 so then just mark them “S.”

11. MARKETING OF THE FARM PRODUCE

It is recommended that you start looking for the market before you start growing. This will help you to determine how much you should grow and will boost your confidence in the production process. The area where the farm is situated is important. If you are situated far away from the vegetable market it will be helpful for you to find a place in your area where you can sell your produce. You can go to local shops, show them your products, and try to sell them. If you are nearby the fresh produce market, you can take your cucumber crop to an agent. Make sure that you indicate on the marketing letter how many boxes you deliver.

TEMPLATE FOR SIZING PRODUCTION

Vegetables	Cabbage	Spinach	Green beans	Carrots	Peppers	Onion	Tomatoes	Butternut	Potatoes	Beetroot
Production Season	All year round	All year round	All year round	All year round	All year round	All year round	All year round	All year round	All year round	All year round
Area to plant	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)
Seeds Required	5g – 10g	50g	800g – 1000g	20g – 40g	30g – 50g	25g – 35g	1.5g – 5g	20g – 40g	25g	20g – 40g
Plant Population	200 – 750	700 – 900	400	10 000 – 20 000	200 – 740	5 000 – 8000	200 – 450g	100 – 150	450 000 – 550 000	10 000 – 20 000
Planting spacing in row	30cm – 50cm	15cm	30cm – 50cm	5cm – 8cm	40cm – 45cm	5cm – 8cm	30cm – 50cm	50cm – 70cm	150cm – 260cm	20cm – 2cm
Spacing between rows	60cm – 90cm	45cm	60cm – 90cm	30 cm – 50cm	75cm – 90cm	30cm – 45cm	75cm – 150cm	120cm – 150cm	20cm – 30cm	5cm – 10cm
Compound federalizer kg/ha	42648	42589	6	1.2 – 2.0	6 – 10	42651	10 – 15	4 – 6	1300 – 2100	1.2 – 2.0
AN top-dressing kg/ha	1 – 2.5	1	Not necessary	1.0kg	1 – 2.5	1 – 2.5	0.8 – 1	2	1	1.0kg
Manure kg/ ha	250	250 – 500	250 – 500	100 – 200	250	50	250 – 500	100 – 250	250	100 – 200
Day to harvest	70 – 160 days (depending on the season and variety)	120 - 160 days (depending on the season and variety)	60 - 90 days (depending on the season and variety)	70 – 120 days (depending on the season and variety)	120 - 220 days (depending on the season and variety)	120 - 220 days (depending on the season and variety)	80 - 120 days (depending on the season and variety)	60 - 120 days (depending on the season and variety)	120 - 150 days (depending on the season and variety)	60 - 90 days (depending on the season and variety)
Harvest duration	15 – 40 days	60 – 150 days	14 – 30 days after flowering	20 days	30 – 60 days	Done when 50% of the tops have wilted or collapsed	60 days	30 days	30 days (start to harvest 2 – 3 weeks after leaves and stems have died)	30 days
Post harvesting handling	Heads are cut and harvested individually	Tie 10 leaves into bundles. Store in the shade and keep cool and moist	Pods are picked when seeds are well developed but still sweet, soft, and juicy. Store in a cool place	Roots are lifted by hand, or a garden fork is used to harvest when they are about 2cm in diameter	Fruits are cut and harvested individually	Fruits are cut and harvested individually	Ripe fruits are picked when dull red to full red colour but still firm	Heads are cut and harvested individually	Use a fork or single furrow plough to lift potatoes. (do not leave potatoes lying in the sun)	Roots are lifted by hand, or a garden fork is used to harvest when they are about 2cm in diameter
Normal packaging	Heads	Bundles	Pockets	Pockets	Fruits	Sacks	Box	Heads/ pockets	Pockets	Bundles/ pockets
Estimated production	200 – 750	1500	80 – 150	250 – 500	70 – 100	300 – 700	200 – 600	200 – 300	7kg – 10kg pockets	250 – 500

IMPORTANCE OF POSTHARVEST MANAGEMENT

i. Reducing postharvest losses

- A global agenda under the United Nations Sustainable Development Goal (SDG) 12.3 targets a 50% reduction of per capita global food waste at the retail and consumer levels and food losses along production and supply chains, including post-harvest losses by 2030.
- SDG 12.3 recognises that about one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons of food per year worth nearly USD one trillion. These losses account for about one-fourth of water used in agriculture, total cropland area, and total fertilizer use, and produce about 3.3 billion tons of CO2 emissions yearly.
- In developing countries, about 65% of lost food occurs at the production, processing and post-harvest stages.
- Reducing food loss and waste can save money for farmers, businesses, and households; can feed more people; and can alleviate pressure on climate, water, and land resources.

- *Specifically, postharvest loss reduction can:*
  - Increase market share and competitiveness of smallholders.
  - Stimulate growth of agribusiness industries, such as input suppliers (e.g. packaging, processing ingredient) and logistics providers (e.g. transport, storage).
  - Generate more employment and income opportunities and stimulate the rural economy.
  - Promote gender equality as more women are involved in post-harvest and marketing operations.
  - Improve human nutrition and health.

- Vegetables are high income and nutritious food crops. Reducing post-harvest losses reduces poverty and food insecurity.
- Cross-cutting strategies to reduce food losses include:
  - Developing loss measurement protocols
  - Setting loss reduction targets
  - Increasing investment in loss reduction in developing countries.
  - Supporting collaborative initiatives to reduce losses.

ii. Postharvest losses of vegetables

- Postharvest losses of vegetables are serious in developing countries due to lack of knowledge, techniques and facilities for produce handling and processing and poor marketing systems. The corresponding loss of food and economic opportunities contributes to poverty, food insecurity and malnutrition, which mostly affect smallholders who dominate vegetable industries.
- Lack of postharvest options has led to total loss of production.
- Post-harvest loss is usually absorbed by farmers as reduced farm gate price and by consumers as increased purchase price.
- Post-harvest losses vary with crop, location, production season, value chain, and value chain actor.
- For the major vegetables (tomato, eggplant, leaf mustard and cauliflower) in Bangladesh, Cambodia and Nepal, post-harvest losses range from 19-35% of production. AVRDC also assessed earlier vegetable losses in three Southeast Asian countries and found an average loss of about 17% equivalent to 1.5 million metric tons worth USD 461 million annually.
- Unseen losses are the loss of nutrients (e.g., vitamin C) and wholesomeness (e.g., pathogenic microbes and pesticide residues.
- Loss of vitamin C, which is usually used as nutritional indicator, may range from 27-100% depending on the conditions during the post-harvest period. Loss of B vitamins, particularly thiamine and B6,
varies from 7-70%. Carotenoids and fibre loss is relatively stable.
- Faulty post-harvest practices, such as poor hygiene and use of contaminated wash water, provide opportunities for contamination by toxin-producing and pathogenic micro-organisms.
- Food safety is a global issue and compliance with food safety assurance systems (e.g., GAP, GMP and HACCP) is a prerequisite to access high-value export markets.

iii. Value chain approach to reducing postharvest losses

- This ensures real needs and problems are addressed and interventions fit into the system.
- In general, the approach has three components:

- **Value chain analysis losses are assessed and the needs and priorities for intervention are determined.**

- **Technology generation adaptive research optimizes and suits available technologies to local conditions. Research to develop new technologies can also be conducted.**

- **Building capacities technological and non-technological interventions are introduced to capacitate value chain actors for better control of quality and volume of produce and for more competitive marketing. These may include training programs, workshops, exposure visits, linking to markets, input suppliers and finance, and technical backstopping.**

- Promote gender equality asmore

VEGETABLE VALUE CHAINS

i. Value chain

- Chain of activities from input supply (seed, fertilizer, chemicals) and retail.
- Value chains vary considerably in length and complexity, depending on the producer and the target market.

ii. Traditional value chain

- Traditional value chains are long and complex, involving several intermediaries with high transaction costs. Figure 2.7 shows a typical traditional chain for vegetables prevalent in developing countries. There are other more complex chains when vegetables are brought from one province to another set of intermediaries.
- Traditional chains are largely supply driven with little coordination. They are a low technology system usually with no temperature control and rely on selling the produce within one day after harvest. Loss of produce could be very high particularly under adverse climate conditions.
- Traditional chains may involve both informal and formal rural and urban markets. Produce is moved from rural to urban areas through a chain of intermediaries such as assemblers and wholesalers supplying produce to urban markets and commission brokers acting on behalf of large, long-distance traders.

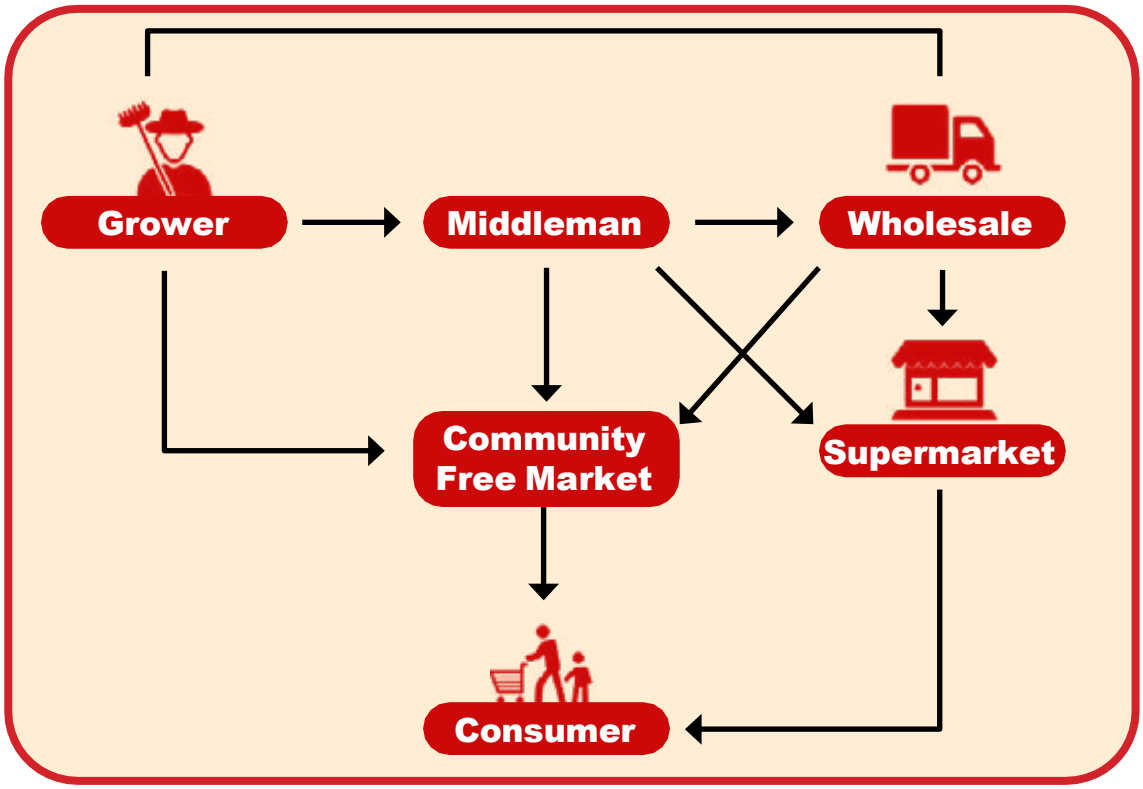


Figure 2.7: *Typical Traditional value chain for vegetables*

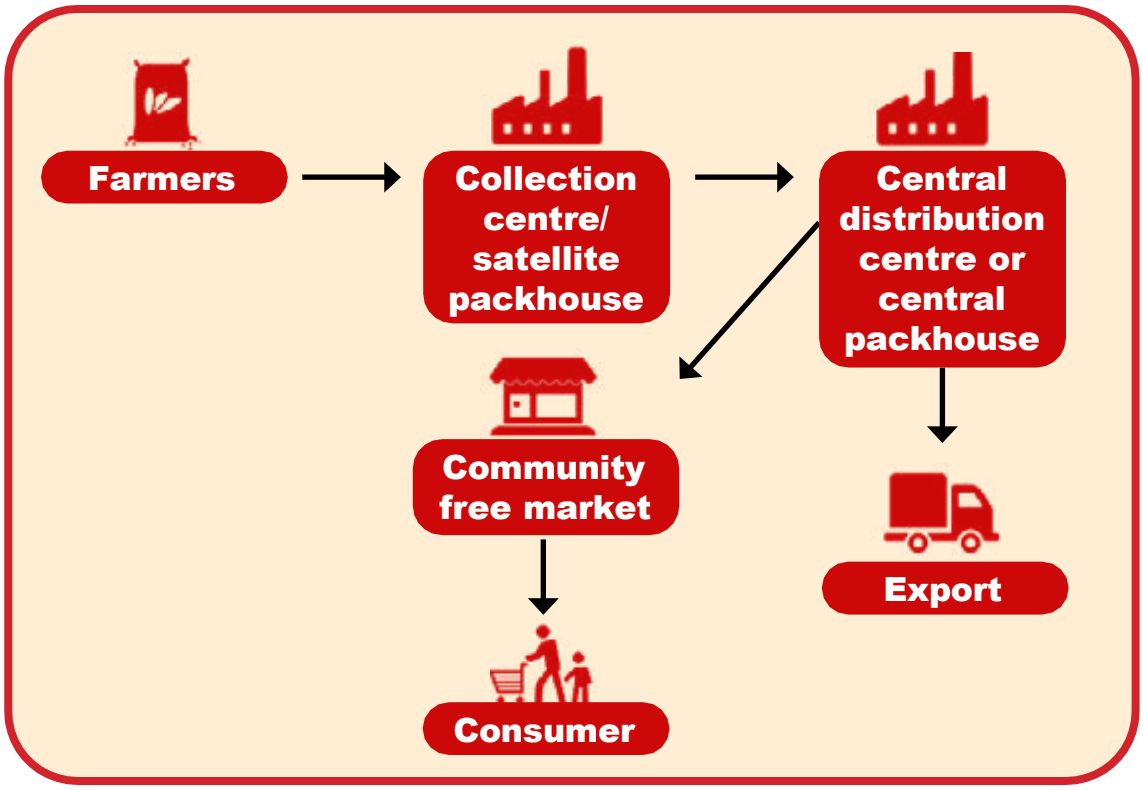


Figure 2.8: *Typical Modern Value chains.*

- Wholesale and semi-wholesale markets are located within or near to major urban centers and may be supplied by purchasing/assembly centres in rural areas or directly from farms, particularly those in per urban areas. Produce is supplied either by agents, traders or by farmers themselves.

iii. Modern value chain

- This chain is usually well coordinated and driven by consumer requirements. They evolved with the proliferation of supermarkets/hypermarkets and the increase in trans-national/cross border trade.
- Figures 2.8 shows a typical modern value chain.
- Farmers are contracted with guaranteed price. Depending on the crop, the harvested produce is sorted and packed on the farm and brought to the collection center (satellite packhouse) for quality checking, sorting, treatment, packing, pre-cooling, and cold storage. Small, refrigerated trucks collect and bring the produce to the central packhouse were produce is processed and packed to a high standard of efficiency and hygiene. Low grade or excess produce is usually sent for food processing. The packed produce is transported to supermarkets in refrigerated trucks or in refrigerated container vans for export shipment. If distribution cannot be done on the same day of arrival, storage is done in a central cold room. The cold chain system is operational in both cases.
- Export chains of vegetables vary with the degree of vertical coordination. Vertically-integrated exporters are exporters who grow produce on their own farms, arrange shipping to overseas destinations and even distribute the goods to supermarkets

and wholesalers in foreign markets. Other groups of exporters are those who consolidate produce from contract growers directly and those who consolidate produce procured by brokers who in turn consolidate produce from farmers in spot market transactions or through farmer groups.

iv. Postharvest chain

- Postharvest activities are conducted starting at the farm (harvesting and field handling), packhouse or processing plant, and during transport and marketing (Figure 2.9). These are separately described in later topics.

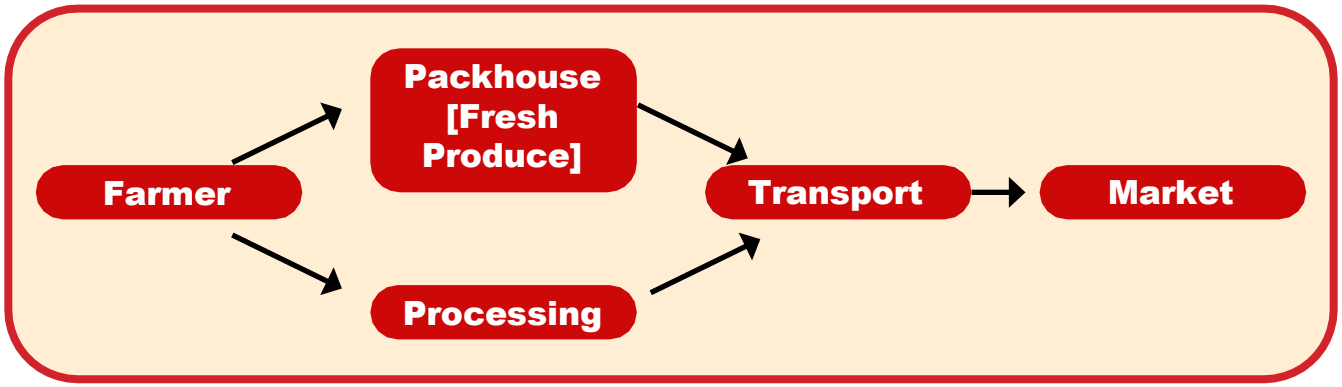


Figure 2.9: *General chain of postharvest activities*

2.3 VEGETABLE QUALITY AND FOOD SAFETY

i. Quality

- Quality is the composite of product characteristics that impart value to the consumers.

  Low quality | produce not meeting consumer expectations

  Acceptable quality | produce satisfying consumer expectations

  High quality | produce exceeding consumer expectations

- Product saleability depends on quality developed during production and enhanced post-harvest operations.
- Consumer expectations of quality should drive production and postharvest operations. Consumers usually buy with their eyes (appearance quality) but repeat sales are determined by unseen internal quality attributes.
- Vegetables possess quality credentials as rich sources of vitamins, minerals, dietary fiber, and even pharmaceutical components. This provides an opportunity for promoting marketing and consumption.
- However, vegetables are often perceived to be unsafe due to the general knowledge of heavy pesticide use during production and poor hygiene and use of toxic preservatives (e.g. formaldehyde) after harvest. Exacerbating factor is the widely publicised food poisoning cases associated with consumption of fresh vegetables.

ii. Quality components

- Appearance (visual) quality for fruit-vegetables may include right maturity or colour, right size and shape, being glossy, and free of defects such as shrivelling, spots or rot; for leafy vegetables, fresh-looking, well-formed or well-shaped, right size, right maturity, right colour, not turgid or wilted, free of defects such as rot, physical damage, or yellowing.

Measurement: Measurement use of rating scales (e.g. visual quality rating, color index, and defects rating) with quality and color charts colorimeter or Chromameter (quantitative color); gloss meter; weighing scale; caliper

- Texture (feel) - firmness; tenderness, Crunchiness, solidity or compactness (cauliflower, broccoli and cabbage),

Measurement penetrometer: texture analyser, finger feel with rating scale; curd arrangement in cauliflower and broccoli.

- Flavor (eating quality) - aroma, taste, sourness, spiciness.

Measurement: sensory quality evaluation by panellists using hedonic scale or descriptive scoring; refractometer for soluble solids content; titration system for titratable acidity; pH meter; differential absorbance (DA) meter for non-invasive measurement of chemical attributes and firmness

Sensory testing is the only sure way to determine what the consumer thinks about vegetables. However, sensory evaluation is not suitable for routine use and the best way is to find objective measurements that correlate with sensory attributes.

- Nutritional quality vitamins, minerals, lipids, protein, carbohydrate, phytonutrients (antioxidants and flavonoids) and dietary fibers.

Measurement: standard chemical analysis

- Food safety (see also next topic) - pesticide residues (most important safety issue among consumers), microbial contamination (number one food safety concern among health authorities and scientists), natural toxicants (e.g. oxalates and nitrates), natural contaminants (e.g. mycotoxins, bacterial toxins and heavy metals (e.g. lead, cadmium and mercury), and environmental pollutants.

Measurement: ATP hygiene meter or standard plating methods for microbial enumeration; pesticide residue meter; standard chemical analysis

- Credence attributes - additional dimension of quality that has evolved in international markets and depends on the method of production, regardless of whether the method of production has a visible or analyzable impact on the produce. Examples of credence attributes include sustainable environmental profiles or fair-trade conditions.

iii. Quality loss

The nature of quality loss depends on the type of produce (Figure 2.10):

- Tomato, chili - overripening, shrivelling, rot
- Eggplant - shrivelling, rot
- Beans, bitter gourd, cucumber shrivelling, yellowing, rot
- Leaf mustard, kale and other leafy type - wilting, yellowing, rot
- Cabbage, head bacterial soft rot, wilting of outer leaves
- Cauliflower - browning, bacterial soft rot, desiccation
- Broccoli - yellowing, bacterial soft rot, desiccation

Figure 2.10: *Nature of quality loss of vegetables tomato rots, chili shriveling, bean rot, cucumber yellowing, eggplant rot, leaf mustard yellowing and cabbage soft rot.*

iv. Quality monitoring

- Grade standards are used for monitoring quality in value chains. They ensure that produce complies with buyer's requirements.
- Grade standards facilitate labelling, provide a basis for reporting on market prices, and are the legal framework used for the settlement of commercial disputes.
- Quality standards take into account many factors, such as:

- definition of the produce

- minimum requirements (cleanliness, appearance, flavour, odour, maturity)

- definition of different classes or grades based on quality characteristics, acceptable product size, presentation of the produce in terms of their uniformity and packaging, information on the package such as origin of the produce, grade, size, storage conditions and methods of handling, and approved pesticides and maximum residue levels (MRL).

v. Food safety

- Assurance that food will not cause harm to the Consumer when it is prepared and/or eaten according to its intended use.
- Assuring food safety is for consumer protection, a universal mandate.

vi. Food safety assurance

- Measures taken during production and postharvest (handling, storage and distribution) to ensure that product consumption does not represent a risk to human health.
- Expands market access and market confidence.
- Hazard is a biological, chemical or physical agent in food with the potential to cause an adverse health effect.
- Risk is the probability of a hazard occurring.
- Produce is vulnerable to hazards at every step of the chain.
- Biological hazards include pathogenic organisms (e.g. Eschirichia coli and Salmonella) and spoilage organisms, insect pests, animals etc.
- Sometimes, pathogenic microbial load may be insufficient to cause product decay but may be enough to cause human illness.
- Produce that appears to be perfect could be microbiologically contaminated and thus could represent a risk to consumer health.
- Chemical hazards include pesticides and other chemical residues; they have less dramatic and immediate effects than microorganisms but have long term effects on human health and have direct and indirect effects on the environment, flora and fauna. Other chemical hazards include toxic elements, such as lead, cadmium, arsenic and zinc, and naturally occurring compounds, such as oxalates in green leafy vegetables and alkaloids (e.g. solanine) in potatoes.
- Chemical hazards can be introduced during production through fertilizers, antibiotics, phytosanitary products and growth regulators.
- Chemical hazards can also be introduced during postharvest operations through waxes, phytosanitary products and detergents.
- Physical hazards include glass, wood, stones, hair, plastic, and metals.
- Hazards and their associated risks are increasing because vegetable are primarily consumed in the fresh form and/or with minimal cooking, there is increasing emergence of new foodborne pathogens, and global trade of vegetables is increasing.
- Food safety hazards should be prevented throughout the value chain.

vii. Costs associated with food safety outbreaks

To the consumer

- Costs of medical care
- Missed work and lost wages
- Expenses for care
- Chronic disease
- Waste of time

vii. Costs associated with food safety outbreaks (cont.)

To the exporter

- Loss of market access and credibility
- Loss of foreign revenue
- Loss of competitiveness
- Loss of reputation

To the vegetable sector

- Complaints and produce rejection
- Closure of business
- Penalties
- Disputes
- Loss of prestige
- Cost of corrective actions (investments)

To the government

- Health care costs
- Loss of foreign revenue
- Lack of consumer confidence

viii. Role of growers and handlers

- Personnel associated with growing and harvesting should apply Good Agricultural Practice (GAP) and protect harvested produce from contamination.
- Personnel associated with growing and harvesting should apply Good Hygienic Practices (GHP) in the field and in all handling operations and protect harvested produce from contamination.
- Personnel should ensure proper sanitation of harvesting equipment and tools, packhouse facility, equipment and surroundings, containers, and transport systems. Sanitation is about attention to detail.
- Proper records must be kept in order to facilitate traceability.
- Keep records on seed quality; pesticide application; water quality irrigation and washing in packhouse); soil analysis; pest control program; postharvest treatment, cleaning and maintenance program (establishment, machinery, tools, etc.); and workers' training.

ix. Good Agricultural Practice (GAP)

- Sanitary procedures in production, harvesting, packing and shipping to prevent or minimize contamination with human pathogens.

Farm resources

- Factors to consider include irrigation water, general soil quality, land use, and proximity of the farm to animals, manure or faecal matter and hazardous water storage areas.
- Enteric pathogens are common contaminants of vegetables, where contaminated irrigation water or sewage sludge are used fertilizer.
- Most vegetables contain nutrients that can support growth of pathogens that are difficult to control or eradicate. Prevention measures at each stage of the value chain, rather than relying on treatments to eliminate contamination.
- Human resource in the farm plays a role in the spread of pathogenic microorganisms. Workers' training and GAP are important to prevent the problem.

- A properly implemented GAP program should include consideration of the history of land use; worker hygiene and sanitary facilities; control of wildlife and pests; water quality and application of water; and management of soil fertility.

- Documentation of manure use, water test results and food safety awareness training of workers are also critical elements.

Farm manure

- Animal manure (biofertilizer) or other waste products are often used to promote plant growth and soil fertility but could lead to contamination of fresh produce with foodborne pathogens.
- Manure should be treated (i.e. composted, dried, heated or decontaminated in some other way) prior to application in the field.
- Manure must not be spread between crops if direct contamination is likely.

Agricultural water

- Water used in production can introduce pathogens into the value chain.
- Water sources must be frequently tested for microbial contamination.
- In situations where water quality cannot be controlled (e.g. water from river or lake), producers should use other good practices to minimize risk of contamination, such as minimizing contact of water with the edible portion of the plant.

Animal faecal contamination

- Wild and domestic animals and birds often roam rural landscapes and can pose a contamination risk.
- Steps must be taken to exclude the presence of these animals in production areas during the growing and harvesting season.
- If herds of animals are known to frequent or roam in certain agricultural plots, alternative plots should be selected or a diversion/containment strategy implemented.

Workers' Training

- All workers must be trained in hygiene practices with constant reinforcement of the importance of personal hygiene and sanitation
- Workers must also be adequately equipped with hand washing and sanitation facilities in accordance with specific requirements.

Good hygienic practice (GHP)

- Practices to ensure safety throughout the food chain, with emphasis on prevention and control of microbiological hazards.
- A horizontal component of GAP and Good Manufacturing Practice.
- Basic rules for hygienic handling, storage, processing, distribution and final preparation of food along the food production chain are set out in the Codex General Principles of Food Hygiene.
- These include requirements for the design of facilities, control of operations (including temperature, raw materials, water supply, documentation and recall

- procedure), maintenance and sanitation, personal hygiene and training of personnel.
- GHP forms an integral part of all food safety management systems including Hazard Analysis Critical Control Point (HACCP).

Good manufacturing practice (GMP)

- Practices to prevent and control hazards associated with vegetable postharvest chain, ensuring a safe and wholesome product, while minimizing the negative impact of those practices on the environment and on workers' health.
- Areas of concern include personnel hygiene, location of facilities (packhouse, storage), sanitary operations, sanitary facilities and controls, equipment and utensils, and processes and controls.

Hazard Analysis Critical Control Point

- A systematic approach that identifies potential sources of contamination in food production systems, establishes methods for detecting the occurrence of contamination, and clearly prescribes corrective actions to prevent consumption of contaminated foods.
- HACCP basic principles (e.g. Figure 2.11):

  (1) assessment of hazards

  (2) determine critical control point (CCP) to control the hazards

  (3) establishment of CCP limits

  (4) establishment of CCP monitoring procedures

  (5) corrective action when deviations from CCP limits occur

  (6) verification system

Flow Process	Hazard Category	CCF	Critical Limit	Monitoring	Frequency	Corrective Action	Record Keeping	Verification
Washing	Microbial	Water Cb and pH	Clz 100 ppm, pH 6-7	Test Kit, pH meter	Every Hour	Adjust water chemistry, re-pair system, hold produce, rewash	Clz and pH record	Random sampling, microbial count

Table 1: *Sample HACCP model for fresh produce washingin the packing house*

- HACCP prerequisite programmes include GAP, GHP and GMP.
- In practical terms, GAP, GMP and GHP are incorporated into the code of practices and protocols for certification under a generic concept of *Good Agricultural Practice.*

HARVESTING AND FIELD HANDLING

i. Harvest maturity

- Quality cannot be improved after harvest. It is therefore important to harvest vegetables at optimum maturity.

- **Tomato:**

- Harvest at the mature-green, breaker, pink or firm-ripe stage depending on the purpose for which they are grown, duration of shipping, or distance from production to market or point of consumption.

- For distant markets or if longer storage period is desired, tomatoes are harvested mature-green or less ripe (e.g. breaker stage). Being a climacteric fruit, mature-green tomatoes can ripen normally and can develop optimum quality. Immature fruit will not develop full colour and flavour and will deteriorate faster.

- Mature-green fruit is determined by cutting fruit sample and the seeds will slide without being cut. Gel formation is advanced in at least one locule and jellylike material is forming in other locules. Fruit having similar size and appearance are considered mature. Experienced pickers gauge mature-green fruit based on full size and glossy appearance.

- Mature-green fruit can better withstand rough handling during shipping thus losses are minimized. However, mature-green fruit may not be of desired ripeness when they reach the point of sale or utilization. So, additional holding for normal ripening to occur or artificial ripening treatment become necessary. Pink or red-ripe fruit are usually desired by consumers and processors.

- For nearby markets, tomatoes can be harvested at the breaker, pink or firm-ripe stage which can be easily and non-destructively seen.

- **Eggplant:** Harvest fruit at immature but of full size (high yield) or size desired by markets before seeds begin to enlarge and harden. Firmness and glossiness are also maturity indicators and can be combined with the number of days elapsed from flowering (10-40 days depending on variety). Overmature fruits are pithy, bitter, hard and may show yellowing.

- **Cauliflower:** Harvest at the tight curd stage and when full size. Over-maturity is marked by elongation of individual curd.

- **Leafy mustard, Chinese kale and other leafy vegetables:** Harvest when full size but young/immature, combined with the number of days elapsed from planting. Overmature leaves are tough and bitter. Older leaves also turn yellow more quickly than younger leaves.

- **Cabbage:** Harvest heads when firm. Firmness (compactness or solidity) is determined by hand pressure. Compact head is only slightly compressed with moderate hand pressure. Some sample heads may be cut longitudinally and if the internal stem is too long, the head is already overmature. Delaying harvest even a few days beyond maturity can result in split or cracked heads and increased incidence of rots. Immature heads are puffy (have hollow spaces inside) since the inner leaves are not fully developed, making them more susceptible to damage. Yield is also lower and shelf life is shorter than mature ones.

- **Chili:** Harvest fruit when ripe, at least 80% reddening; can also be harvested green for specific purpose but green fruit will not ripen normally as chili is non-climacteric.

- **Bitter gourd, cucumber, eggplant and yardlong bean:** Harvest at desired size but young/immature and tender. Over-maturity is indicated by yellowing in bitter gourd and prominent seed bulging in beans.

ii. Time of harvest

- Harvesting at cooler times of the day minimizes product heat load and increases work efficiency of pickers. Care should be observed because the plants and leaves are brittle (high water content) and prone to damage. It is also important to protect from damage the developing plant or fruit for subsequent harvest.
- In some cases, harvesting when the sun is up is practiced since the produce is less brittle and more resistant to damage during subsequent handling. In this case, the harvested produce should be moved to a shaded area to reduce heat load and water loss. The produce should also be allowed to dissipate heat before packing. High product temperature accelerates quality deterioration due to increased water loss and respiration.
- Harvesting in the later part of the day is advantageous in certain cases. The produce is less turgid, hence less prone to physical damage. Sugar content in leafy vegetables is also high as a result of photosynthesis during the day which could slow down leaf yellowing after harvest.
- Harvesting during or just after rain is not recommended as wet condition (rainwater on the leaves or fruit) favours microbial growth and enhances tissue breakdown. If harvesting cannot be avoided during rainy days, the produce must be washed and dried properly before packaging.

iii. Harvesting method

- Carefully harvest produce to minimize physical injury and preserve quality.
- Use harvesting aids as they can reduce labour cost, improve harvest efficiency, maintain produce quality, and speed the harvest and field handling. Protective clothing should also be worn for pickers' protection from plant hairs or trichomes (tomato, eggplant, cucumber, okra) or sap (chili) that may cause skin burning or allergy. Fingernails of pickers should be trimmed before harvesting to avoid nail-wounds on the produce.
- **Tomato, eggplant, cucumber and other**

fruit-vegetables: Cut the calyx-stem free from the plant. Avoid pulling fruit to prevent removal of stem end and damage of plant and fruit for subsequent harvest. Pulling fruit from the plant may remove the pedicel, exposing the stem-end which in tomato, is the main avenue for water loss and respiratory gases.

- **Cauliflower:** Harvesting should be done with great care to prevent damage to the highly sensitive turgid curds. Cauliflower should never be handled at the curd portion of the head. Cauliflower should never be allowed to roll or scuff across a harvest -conveyor belt, table, or other work surface. Bruising is very common and leads to rapid browning and decay.
- **Leafy mustard:** Harvest single leaves or whole plants with a knife. Care must be observed to avoid leaf tearing and petiole breakage.
- Cabbage and Chinese kale should be cut with knife rather than snapped or twisted to avoid damage and irregular cut and stalk length. Broken stalks are more susceptible to microbial decay. The knife should be sharpened to reduce effort and lessen picker's fatigue. The stalk should be cut flat or smooth and as close to the head as possible. Extra leaves act as cushion during handling and may be desired in certain markets. Yellowed, damaged, or diseased wrapper leaves should be removed.
- Fields may be harvested several times for maximum yield and desired quality, so care is needed to prevent damage to the plants for subsequent harvest.
- Use harvesting containers with smooth surfaces (e.g. plastic or metal buckets or trays). They facilitate collection with minimal or no damage to the produce. Cotton bag or small bucket tied to the picker's waist can also be used. Total weight per container should preferably be less than 20 kg for one person to easily carry.

iv. Field handling

- Proper implements and care in handling the produce from field to packhouse reduce damage and preserve quality.
- Harvested produce is usually placed in collection containers, preferably plastic crate as it can protect produce from damage better than bamboo basket (Figure 19). ruit harvested at different stages of ripeness can be sorted during the harvesting and field handling operations by either placing them in separate containers.
- In the farm, harvested produce is often exposed to the sun and in direct contact with the soil which is a rich source of pathogenic and spoilage microorganisms. To avoid these, use appropriate ground cover, field sorting table and makeshift shed.
- Harvested mustards or Chinese kale can be exposed to the sun for about 30 minutes to induce temporary wilting and reduce handling damage. Subsequent washing to remove dirt could cool and rehydrate the produce. Similarly, cabbages are exposed to the sun or allowed to stay in the field for about one hour as practiced in Cambodia. This will dry out the out butt end, the usual entry point of soft rot bacteria. Since washing is not advisable, cabbages should be allowed to dissipate heat under shade before packing.
- Sorting and packing (packhouse operations), and loading to vehicle for transport to market can be done in the field

Benefits of Using Greenhouse Tunnels

- Planting in tunnel saves space.
- Tunnel plants are a ⅔ more expensive however one will have a more successful crop due to healthier plants.
- Water consumption is less.
- Temperature can be controlled.
- Saving on pesticides, sprayed only on the plants individually (no unnecessary wasting).
- Saving on fertiliser, as the fertiliser is dissolved in the water and available to the plants by using drip irrigation.
- A saving on fertiliser, insecticides and pesticides as wind and rain will have no influence on washing or blowing away the above.
- Controlling weed by making use of floor plastic; weeds cannot grow under the black side of the plastic, also controls and limits growth of moulds.
- Always plan ahead for seasonal changes, allowing for at least 2-3 weeks of preparation, as some plants may benefit from this extra time to thrive.
- It is of importance to determine the market demand before planting for the specific region.

ADVANTAGES OF SELLING PRODUCE DIRECT TO LOCAL SHOPS.

***No market commission will be taken of**
***Direct payment by most of the shops**
***Lesser packing costs**
***More stable price**
***Sure, of sales**
***In most cases less transport cost**

Figure 2.11 *Benefits of Using Greenhouse Tunnels*

PART 4: GENERAL PLANTING TECHNIQUES:

Production Involves:

Time of Operations: when to do what

Pre-Harvesting and Pre-training

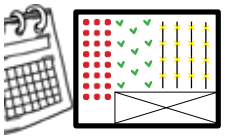
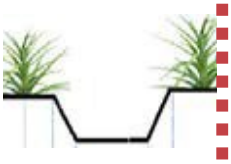
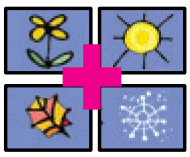
 **1.** Planning/ Production Calendar on annual crops	 **2.** Install greenhouse tunnels with temp control and irrigation.	 **3.** Land Preparation and Garden Layout	 **4.** Rotation	 **5.** Fertilization
 **6.** Planting	 **7.** Water	 **8.** Transplanting	 **9.** Ridging	 **10.** Management
 **11.** Pest and Disease Control	 **12.** Disease Identification Requirements of Plants	 **13.** Pests Identification	 **14.** Safety	 **15.** Harvesting
 **Season Extension**				

Table 2 *General Planting Techniques*

Season Extension

- Early season plant
- Floating Raw Cover
- High Tunnel/Hoop House Construction

PART 5: DEVELOPING MARKET AND PRODUCT

Direct Sales

- **Basic Supplies for setting up a farmers' Market stand**
- **Community supported Agriculture (CSA)**

Wholesales

- **Restaurant wholesales**
- **Institutional wholesales**
- **Grocery wholesales**

Post-Harvesting and Post-Training

Seedling Production

Marking Compost

Production Record

Financial Records

Evaluation after Training

Repeat Evaluation 8 weeks after training

2.3 A SUSTAINABLE NUTRITION-SENSITIVE AGRICULTURE PROGRAM USING NUTRITION INTERVENTION.

2.3.1 Introduction

We all need food to allow us to be alive; to grow and be active and in the case of women, it can sustain the growth of a baby. What we eat (our diet) has the power to keep or make us and our children healthy and give us a better life.

In the context of that production, which is very labour-intensive, it is important to point out that the diet of the workers will impact, not only on their health and thus their ability to function physically and mentally, but also on their labour productivity.

This section covers: the definition of nutrition, the role of nutrients in our body, the food sources of these nutrients, the importance of adequate feeding, the concepts of “a balanced diet’ and “food and nutrition security.”

- **Determining a nutrition intervention:**

The nutrition diagnosis and its ethology drive the selection of a nutrition intervention. Nutrition intervention strategies are selected to change nutritional intake, nutrition-related knowledge or behaviour, environmental conditions, or access to Supportive care and services. Nutrition intervention goals provide the basis for monitoring progress and measuring outcomes.

- **Nutrition Education**

A formal process to instruct or train a patient/ client in a skill or to impart knowledge to help patients or clients voluntarily manage or modify food, nutrition and physical activity choices and behaviour to maintain or improve health.

2.3.2 FOOD, NUTRITION AND NUTRIENTS

Guidelines for Healthy Eating

Food is a source of nutrients needed for life and health; it is part of the way people live. The way individuals and their families eat is shaped by many different factors.

Some of these factors include:

- *The foods eaten by their parents and the ways they prepare these foods.*
- *The foods that their own family prefer to cat because they like the taste.*
- *The traditional and cultural backgrounds of communities.*
- *The amount of money available to spend on food.*
- *Foods available in local shops and markets.*
- *Advertisements and promotions for foods.*
- *Knowledge about food choices for good health.*

A diet that provides foods that supply the correct amount of nutrients.

	**Healthy eating plan**	needed for health; it has enough food and a variety of clean, safe food. Some peogie call this a balanced diet; that term is difficult to evaluate and explain, and the word diet is often associated with slimming diets. A healthy eating plan can include some foods that have low nutritional value (such as sweets or chips) when most of the meals, most of the time, are made from foods from the food guide.
	**Food groups**	Most foods contain many different nutrients, the foods in the food groups used for nutrition education contain similar amounts of the main nutrients. The foods in one group are usually used in a similar way in a mixed meal.
	**Mixed Meals**	An eating plan is likely to be healthy when it has three or more mixed meals each day. Most mixed meals will include a starchy food, and foods from different food groups. The daily eating plan should include food from most of the food groups, most days of the week. Fish, chicken, lean meat or eggs can be included when they can be afforded.
	**Portion**	A portion is the amount of food that a person eats of one food at one time. Members of the same family may have different portion sizes of some foods, e.g. active men will have a bigger portion of starchy food than women, but they may have the same portion size of vegetables. A single portion of food may have one or more units (food guide units) that are eaten at one time.

	**Unit/Food Guide Unit**	A unit of food within a food group is calculated based on the nutritional value of the food, and this amount is then stated. Thus, a single unit of each food in a food group provides a similar amount of nutrients as other units in that same group. The unit sizes of different foods are described in different ways, for example 1 slice of bread (starchy food), 1 apple (vegetables and fruit) or 1 cup of milk (milk group).
	**Food**	Food is defined as any substance containing nutrients (such as carbohydrates, proteins, and fats) that can be ingested by a living organism and metabolized into energy and body issue. In essence, food stimulates growth, helps us to stay alive and produces energy.
	**Nutrients**	Nutrients are chemical substances extracted from food during digestion, enabling the body to function properly. They are classified as macronutrients (carbohydrates, proteins, fats) and micronutrients (vitamins, minerals). Micronutrient deficiency occurs when essential vitamins and minerals are inadequately absorbed or consumed, resulting in health issues and specific deficiencies like iron, vitamin A, or iodine. Dietary diversity, achieved through consuming a variety of foods, ensures sufficient nutrient intake, fostering overall well-being. In summary, nutrients are vital for optimal health, with macronutrients and micronutrients playing different roles, while dietary diversity supports balanced nutrition.
	**Nutrition**	The term nutrition broadly covers all processes through which we obtain, prepare and eat food. It further describes what different foods are made of (i.e. nutrients) and the processes through which our bodies make use of the nutrients to enable us to perform daily activities such as work. Apart from focussing on what we should eat, nutrition is also concerned with promoting aspects or personal and environmental hygiene and sanitation, promoting health seeking behaviours and providing care for all household members so that they are healthy.

Classification of foods on the basis of the key nutrients they supply

Different foods can be grouped into different groups depending on the major nutrients they provide. According to this classification there are:

- **Energy giving foods**
- **Body building foods**
- **Protective foods**
- **Water** *(sits outside of the classification but it is mentioned here as it is also essential for the human body to function properly).*

Most foods provide more than one nutrient. Many energy giving foods are also sources of proteins and micronutrients, while many body building foods also provide energy and micronutrients.

> **The Guidelines for Healthy Eating** provides information about the amount and kinds of foods that people need to eat most days to get the nutrients needed for good health. Using the information in the **Guidelines for Healthy Eating** also helps people not to get too much of some nutrients, such as energy, saturated fat and salt (sodium).
>
> Most choices of foods should be ones that are the most nutritious choices from the food group. Most of these choices will be low in saturated fats, low in added sugar and added sodium; and will provide essential nutrients.

The amount of energy that a person needs from their daily food intake is dependent on a number of factors, including:

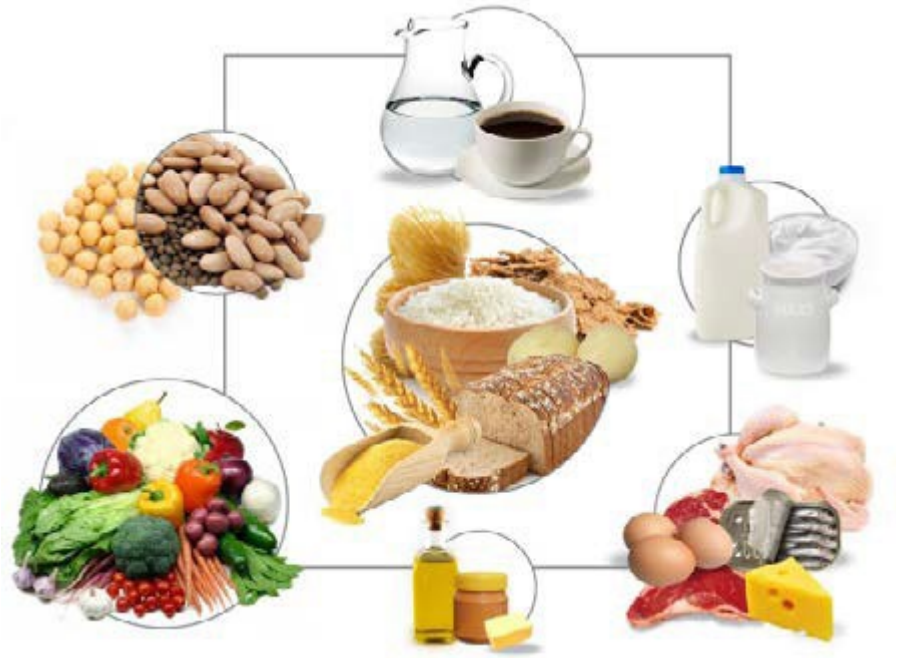
Gender **Age** **Activity levels.**

The **food guide**[1] includes information on the number of units of food from each group needed each day; and it includes information on the size of each food group unit. A typical portion of some foods will be made of 1 unit of that food (e.g., one unit of fruit is one apple), while other people typically eat many units at one time (e.g. a teenage boy may have 4 units of starchy food for breakfast, his portion of soft porridge will be 2 cups).

The food guide includes information on the number of units of food from each food group given at three different typical energy levels.

[1] As of 2020, only seven countries in Africa report having dietary guidelines (Food-based dietary guidelines (2023) *Food and Agriculture Organization of the United Nations.* Available at: https://www.fao.org/nutrition/education/food-dietary-guidelines/regions/africa/en/ (Accessed: April 19, 2023). This manual uses the SOuth African Food Guide as the closest country to Lesotho and having similar climates, and demographics.

2.3.3. The South African **Food Guide**



i. Energy Giving Foods Or Go Foods

Energy giving foods provide the energy needed by our bodies to:

- *Perform activities such as walking, digging, working*
- *Maintain normal physiological processes such as breathing and all other process within our bodies*

Energy giving foods are mainly rich in the food nutrients **carbohydrates or fats.** We obtain carbohydrates through eating plant-based foods. The main examples of carbohydrate containing foods include millet, Irish potatoes, sweet potatoes, cassava, *posho* (made from maize or other flour), sorghum, yams, rice, plantain (*matooke*) and bread.

Fats and oils are usually solid, semi-solids or liquid depending on their chemical composition and environmental temperatures. Examples of fats and oils commonly consumed in our diets include liquid oils (sunflower oil, *mukwano* oil), ghee, suet (fat normally found on kidney and meat of cattle and sheep).

Apart from being good sources of energy, fats and oils also add flavour and taste to food. They further insulate the body, cushion vital organs and are essential for the absorption and utilisation of fat-soluble vitamins A, D, E and K. Thus, a very low consumption of fats and oils may lead to a deficiency of these vitamins predisposing our bodies to disease and/or symptoms associated with a lack of these vitamins. The benefits of vitamins will be discussed later in this session.

When a person consumes excessive amounts of energy giving foods and doesn't utilise this energy through physical activity, this results in surplus energy being converted and stored by the body as excess fat. This puts affected individuals at risk of developing coronary heart disease, high blood pressure and certain types of cancers.

ii. Body Building Foods Or Grow Foods

Body building foods or GROW foods are those rich in the food nutrients called proteins. They are essential for growth, boosting body immunity against infections and diseases, the formation of all tissues, including muscles, bones, teeth, skin and nails and for wound repair.

Bodybuilding foods come from **two major sources**:

1. **Animal-based foods** *and related products: fish, meat, poultry, eggs, milk and yoghurt.*
1. **Plant-based foods** *and related products: mainly beans (include soybeans) and peas.*

Animal-based foods provide a richer source of proteins that are more easily utilised by the body than those supplied by plant-based foods. We can increase household intake of animal-based proteins by domesticating certain animals and birds. The birds (hens, ducks) can be eaten but also lay eggs, which are a rich source of proteins. Animals like rabbits are also relatively easy to rear they do not require much space to be kept, are not too demanding in as far as feeding is concerned and have high multiplication rates. The quality of proteins from plant-based foods

can be improved by eating a combination of different such foods, e.g. rice and beans. The proteins missing in beans are present in rice so when these are eaten in combination one can also obtain a good supply of proteins for the body. It is therefore important to eat a mixture of plant-based foods in our diets and even more so if access to animal-based foods is limited.

We have different protein requirements at different ages: children require more protein-rich foods than adults because they are growing. Pregnant women should also eat plenty of protein-rich foods because they need to feed themselves as well as their growing baby. The same is true or lactating/ breastfeeding mothers whose bodies need to be able to produce breast milk.

Examples of locally available plant-based foods rich in proteins:

Examples of locally available animal-based foods rich in proteins:

- *Meat, fish, eggs, milk and milk products including yoghurt and fermented milk*

iii. Protective Foods or Glow Foods

Protective foods include vegetables and fruits. These foods are rich in vitamins and minerals which are required by the body for physiological functions such as the strengthening of the immune/defence system and to prevent conditions such as anaemia (resulting from iron deficiency), night blindness (resulting from Vitamin A deficiency), goitre (resulting from iodine deficiency) and rickets (resulting from a lack of Vitamin D and calcium). Some vitamins and minerals are also essential for the production of energy by the body and maintaining water balance in the body.

Vegetables

Vegetables are a rich source of several vitamins and minerals. In addition, vegetables add taste, flavour and colour to our meals. Common vegetables include: spinach, kale, pumpkin leaves, cowpea leaves, carrots, cassava leaves, green pepper.

Fruits



A variety of fruits are grown and are accessible in the markets including bananas, peaches, mangoes, passion fruit, pineapple, jackfruit, oranges, lemons and other citrus fruits. The deep yellow- or orange-coloured fruits are richer in vitamins, particularly vitamin A.

Table 4: Examples of vitamins and minerals, their functions and food sources

Nutrient	Function	Food sources
Vitamin A	• Strengthens our immunity which helps us fight off infections. • Improves vision in dim light. • Keeps the skin and the linings of some parts of the body, such as the nose, healthy.	Dark green leafy vegetables such as spinach, broccoli, and carrots. But also: pumpkin, liver, fish, kidney, and dairy produce such as yoghurt, eggs, fortified margarine.
Vitamin D	• Helps the body absorb calcium. • Keeps bones and teeth healthy.	Sun light, fish liver oils, milk, fortified margarine, eggs, liver.
Vitamin E	• Helps maintain cell structure by protecting cell membranes.	Soya, groundnuts, fortified margarine, or oil, wholegrain cereals, eggs, peanut butter, tomatoes.
Vitamin K	• Helps with blood clotting.	Vegetables such as spinach, lettuce, cauliflower, and cabbage, broccoli, fish, liver, meat, eggs.
B group Vitamins	• Help the body release energy from food. • Keep the skin, eyes, and the nervous system healthy.	Millet, sorghum, beans, peas, eggs, liver, meat, milk, fresh fruit, green leafy vegetables, wholegrain cereals.
Vitamin C	• Helps with wound healing. • Strengthens our immunity which helps us fight off infections.	Citrus fruits such as oranges, lemons and tangerines, red and green peppers, tomatoes, broccoli, potatoes
Folic acid	• Helps form healthy red blood cells. • Helps reduce the risk of central nervous system defects such as spina bifida in unborn babies.	Leafy green vegetables such as spinach, broccoli, and lettuce, liver, beans, peas, fruits such as oranges, bananas, avocados, and melons.
Iron	• Helps make red blood cells, which carry oxygen around the body.	Liver, meat, offal, beans, millet, sorghum, ground nuts, eggs, most dark green leafy vegetables such as amaranthus and parsley.
Calcium	• Helps build strong bones and teeth • Helps muscles and nerve's function • normally • Helps to ensure blood clots normally	Milk, cheese and other dairy foods, green leafy vegetables, such as cabbage and okra.
iodine	• Helps to regulate the thyroid gland (in the neck) which controls the development of the body, including the brain, and regulates physiological processes (or metabolism).	iodised salt, sea food

Water

Water is essential for the human body to function properly. As the body cannot store water, it requires fresh supplies of safe, clean water every day. The amount a person needs to drink depends on a variety of factors such as environmental temperature and activity level. E.g. if you work hard in hot weather you may need to drink more. All drinks such as tea, coffee, fruit juice count towards the recommended daily total of at least 8 glasses a day (for an adult). The body requires water for many reasons:

- *To transport nutrients around the body.*
- *To make blood, saliva, tears and sweat.*
- *To enable body processes such as digestion.*
- *To keep the mouth and lungs moist, and to keep the skin moist and cool.*

2.3.4. THE GUIDELINES FOR HEALTHY EATING

THE FIRST GROUP OF GUIDELINES PROVIDE GENERAL MESSAGES TO PROMOTE A HEALTHY LITESTYLE:

Enjoy a variety of foods • Be active! • Drink lots of clean, safe water.

ENJOY A VARIETY OF FOODS

	Key Messages	Food Intake and Body Weight
The enjoyment of food is one of life's pleasures. Eating is about more than satisfying hunger, it is also a part of family life, social events and celebrations.	► Healthy eating plans include a variety of foods from each of the food groups.	► Reaching and maintaining a healthy weight requires an eating plan that supplies all the nutrients needed; including the right amount of food energy.
Having a variety makes meals more interesting and helps to ensure that an eating plan supplies all nutrients	► Variety also means including foods from two or more food groups at each meal, these are called mixed meals. ► Variety also means preparing foods in different ways.	► The most common forms of overnutrition are overweight and obesity. These are usually caused by: ► Eating more than the body needs, especially food rich in energy (often with alot of fat and /or sugar). ► An inactive lifestyle, where one does not get enough exercise from activities such as sport, walking or physical work.
Mixed meals are usually eaten three times a day (breakfast, lunch and supper). Eating regular mixed meals, of a similar size, is key to having a healthy eating plan.	► People eat because they enjoy food; recommended eating patterns must be tasty and acceptable.	► Overweight & obese people should decrease the amount of food energy intake and increase energy expenditure. By eating the correct types of foods, in the correct amounts, and being active.

BE ACTIVE !

Information on physical activity is just as important as information on healthy eating; both are essential parts of a healthy lifestyle. They are linked in that the way a person eats will influence their ability to be active and their activity levels will influence how much they can eat. The human body is designed to be active, yet many people spend a lot of time sitting in chairs. This type of sedentary lifestyle is a risk factor for many chronic diseases; inactivity is harmful to health.

Being active means moving parts of the body and using the muscles. This should increase the heart rate and rate of breathing. It can be from activities that are part or daily living or work, from sport or from doing exercises.

Key Messages

Regular physical activity has many benefits, including the following:

- ▶ It increases blood supply to the heart, lungs and the muscles.
- ▶ It reduces the risk of developing cardiovascular disease (CVD), high blood pressure and diabetes.
- ▶ Burns up energy and builds muscle, which helps with body weight management.
- ▶ Strengthens bones, reduces the risk of developing osteoporosis.
- ▶ Increases strength and flexibility of joints and muscles.

People who are active for long periods in hot weather must have enough water drink. Children who are doing sports or playing games may need to be reminded to have something to drink.

Teachers and parents must ensure that drinking water is readily available.

DRINK LOTS OF CLEAN, SAFE WATER

Water is essential for life. Water is lost via the kidneys, the bowels, the skin and the lungs. Most of these losses occur without our conscious knowledge. Water that is lost must be replaced by liquids from food and drinks.

Children and adults need about 6 - 8 glasses of liquid a day; most of that should be from water and drinks made with tap water. There are no health benefits to binge drinking water; when excess water is consumed it will be excreted as urine.

Drinking water is not always readily available, or may not be the beverage of choice, education to achieve the message in the guideline reminds people of the need to plan their fluid intake, just as they plan their food intake. People may wish to drink tea or coffee; they must be reminded to have it with little or no sugar.

Regular consumption of sugary drinks is not recommended, they can damage the teeth and contribute to excess energy intake; this leads to weight gain. Many commercial drinks are high in sugar including fruit juice, sports drinks and flavoured, water type drinks.

Key Messages

- ▶ Drink clean, safe water every day as recommended.
- ▶ Water is the most abundant and the most important nutrient in the body.
- ▶ Blood is made mostly of water, as are the lungs, muscles, and brain.
- ▶ The body uses water to regulate body temperature, carry digested foods, remove

2.3.5. BALANCED DIET

We looked at 'what our bodies need to be healthy. Here we will look at 'how much we need of each of the foods- this is being referred to as 'adequate nutrition'. A diet that is able to provide all the recommended (adequate) amounts of nutrients in the right amounts and quality for the body to perform all its physical and physiological activities depending on one's age, sex and physical activity level is called a "balanced diet".

This implies that all the main food types (carbohydrates, fats, proteins, vitamins, minerals, and water) are eaten in correct proportions throughout the daily life of an individual. Balanced diets benefit individuals, families, communities and the nation at large.

To attain/maintain a balanced diet, we should eat:

• **Starchy foods |** e.g. millet, rice, potatoes, cassava, matooke. Starchy foods should make up around one third of everything we eat.

• **Fruits and vegetables |** A vital source of vitamins and minerals. We should try to eat a variety of fruit and vegetables each day, ideally 5 portions in total (e.g. 3 types of vegetables and 2 fruits).

• **Meat, fish, eggs, beans, nuts and seeds |** These foods are all good sources of protein, vitamins and minerals.

• **Milk and dairy foods |** Milk and dairy foods such as fortified yoghurt are good sources of protein, vitamins A, D, and B group vitamins and the mineral calcium.

Moderate amount of food high in fat and/or sugar | Fats and sugar are both sources of energy for the body. In addition, fats help transport fat soluble vitamins. Health recommendations stipulate a modest intake of fat and sugar. An excess of these foods can lead to being overweight or obese as well as the development of other diseases like diabetes and heart disease. Given the high energy requirements for estate tea workers, restrictions on fat and sugar intake are likely to be unnecessary.

The second group of guidelines help to plan good mixed meals:

- *Make starchy foods part of most meals.*
- *Eat plenty of vegetables and fruit every day*
- *Eat dry beans, split peas, lentils, and soya regularly.*
- *Fish, chicken, lean meat or eggs could be eaten daily.*
- *Drink milk, maas or yoghurt.*
- *Use fat sparingly; choose vegetable oils rather than hard fats.*

The following guidelines give messages about the use of foods that are commonly used but can be harmful when too much is used.

- *Use salt and foods high in salt sparingly.*
- *Use food and drink high in sugar sparingly.*

Make starchy food part of most meals

Worldwide, but especially in developing countries, starchy foods, (cereals, grains and some root vegetables), are the main source of dietary energy. They also contribute micronutrients and dietary fibre when eaten in minimally processed forms (unrefined products). The types of starchy foods eaten in South Africa also contribute plant protein to the diet.

These foods cost less than many other foods, when used as part of most meals they help to satisfy the appetite, without costing too much. Refined maize meal and bread are the most commonly eaten starchy foods in South Africa. Other examples of foods commonly eaten are rice, pasta, oats, sorghum, maize on the cob and breakfast cereals.

Key Messages

- This is the way that most people eat, they do not have to change their eating plan to achieve this guideline. They may have to change the starchy foods that they choose, or the amounts that they eat.
- Fortified maize and bread are good choices of starchy foods, especially for people whose diet has a minimal variety; these people will benefit from the extra vitamins and minerals added to fortified foods.
- Add foods from other food groups to the starchy food to make good mixed meals.

Food fortification

Research in South Africa showed that many people do not get enough of some key nutrients from their food intake. Some of the nutrients that were missing were ones that are not found in foods that are affordable and readily available. Mandatory food fortification is a way to increase the intake of these nutrients, without people having to change their eating plans.

Maize meal and bread were identified as food vehicles for the food fortification programme in South Africa as many of the people who needed to increase their intake of vitamins and minerals eat these foods, on a regular basis.

Information on different starchy foods

The glycaemic index (GI) describes the way that carbohydrate-containing foods are absorbed by the body. Foods with a higher glycaemic index are absorbed to the blood stream, as glucose, faster than those with a lower glycaemic index. The GI use is only important for rating those foods that supply larger amounts of carbohydrate in the diet. Starchy food choices with a low GI is good choices.

Whole grains are grains, mainly from cereal crops, which have all the grain components i.e. endosperm, bran and germ. Examples are whole grain breakfast cereal, mealies on the cob and cut corn, popcorn, rolled oats, barley, brown rice, cracked wheat, and sorghum. Eating whole grains regularly reduces the risk of CVD, Some types of cancer, type 2 diabetes, insulin resistance, stroke and high blood cholesterol.

Eat plenty of vegetables and fruit everyday

Vegetables come from many different parts of plants, including the leaves, roots, tubers, flowers, stems, seeds, and shoots. Vegetables contain small amounts of carbohydrates, sugars, and many contain fibre. The vegetables that are high in starchy carbohydrates (potatoes, sweet potatoes) are listed in the starchy food group.

Fruit forms from the flower on the plant and contains the seeds of the plant. There are many types of fruit available in South Africa, with some being in season at all times of the year. Fruit is sweet tasting because it contains sugar; this is in the form of glucose, fructose and / or sucrose. Fruit also contains fibre, especially in the edible skins. Pure fruit juices also belong to this group but have less fibre than fresh fruit.

Vegetables and fruit are rich sources of vitamins and minerals and have many health benefits. Some of the health benefits of an eating plan that contains recommended amounts of these foods include:

- *Lower risk of heart disease and stroke*
- *Lower risk of high blood pressure*
- *Protection against some types of cancer*
- *Preventing and relieving constipation*
- *Help promote eye health (prevent cataract and macular degeneration)*
- *They are filling, but low in energy; so help control total energy intake from meals.*

Key Messages

- Encourage people to eat vegetables in at least one or two mixed meals a day. Fruit can be eaten with meals, or as a Snack between meals. Portion sizes of two or three vegetables can be generous (more than one unit at a time) when a variety of vegetables are not available. People should enjoy a variety of vegetables and fruit.
- Vegetables should be eaten every day, and not only on weekends.
- Everyone should have one vegetable or fruit a day that provides beta carotene (the precursor of vitamin A.) Examples are carrots, pumpkin, butternut, spinach, imifno, mango, pawpaw, yellow peaches, and nectarines. **(Note: oranges and cabbage do not contain beta carotene).**
- Prepare vegetables and fruit with little (if any) added fat, sugar and salt. Vegetables with beta carotene should be lightly boiled and served in meal that has fat, or else have a little oil added. This will enable to body to absorb the beta carotene.
- Children are more likely to enjoy eating vegetables when they have eaten a variety from an early age (i.e. from 6 months) and when they see their parents' enjoying vegetables.
- There are many health benefits from eating at least the recommended amount of vegetables and fruit.
- Vegetable and fruit juice are not recommended as a regular replacement for fresh vegetables and fruit. They do not have much fibre and are high in sugar.

Eat dry beans, split peas, lentils and soya regularly

Adding dry beans, split peas, lentils and soya to a meal increases the nutrient content or the meal. Legumes are rich and economical dietary sources of good quality plant protein, carbohydrates, minerals, vitamins and phytonutrients and soluble and insoluble dietary fibre. Eating foods from this group decrease the risk of a wide variety of degenerative diseases such as heart disease, diabetes, and different types of cancer. Eating these foods even helps to combat being overweight because they enhance satiety. They contain low GI starch, so when used, they help to maintain healthy blood sugar levels.

These foods have their own food group because they make many contributions to health. All South Africans should be encouraged to eat these foods regularly, whether or not they are eating chicken, fish and meat.

Key Messages

- Every week plan to include meals that use dry beans or soya instead of meat or chicken.
- Use dry beans, lentils, peas and soya as an ingredient in mixed dishes, such as samp and beans, rice and lentils, beans in vegetable sauce with pasta.
- Including dry beans, split peas, lentils and soya to the diet increases the nutrient content of the meal. They are a good source of plant protein, energy and fibre.
- Dry beans or soya can be cooked with meat or chicken dishes, this will improve the overall nutritional value of the dish (less fat, more fibre) and reduce the cost of each serving.
- Foods in this food group have a valuable role to play in improving the nutritional quality of the eating plan of many people in South Africa.
- Regular consumption of foods in this group makes a big contribution to the reduction of risk of developing some chronic diseases, and the nutritional management of the diseases when they have developed.

Fish, chicken, lean meat or eggs could be eaten daily

These foods are popular food choices for many people in South Africa, and they often need little encouragement to eat them. However, these foods do cost more than foods in the other food groups and should not be used often when the family has a limited budget for food. The guideline explains that foods from this group could be eaten daily not that they should be eaten daily. The food guide unit serves show that only one option from the list could be included each day.

The foods in this group come from animals, with their main nutritional contribution usually recognised as protein. This protein is bundled with other important nutrients such as iron, zinc, niacin (a B vitamin), and vitamin B12.

Cheese is included in this group but should not be the food type chosen most often. This is because it is high in fat and salt. Organ products from animals, such as liver and kidneys are also part of this food group.

The iron in animal foods is more easily absorbed by the body than the iron in plant foods. The exception to this is the iron in eggs, which is non haem iron.

Fish with fatty flesh (pilchards, mackerel, and salmon) provide omega 3 fatty acids, a nutrient that is found in very few food sources. These foods are good choices. Many of these foods also have a high content of fat, most of which is saturated fat. Saturated fat has a negative influence on health, so people are advised to use lean types of meat and to remove fat and skin from chicken. Processed meat (sausages, salami, and polony) is high in salt and fat. These types of products should not be used often.

Key Messages

- Encourage people to eat these foods in the recommended quantities, and not in large portions.
- Cost is not necessarily an indication of the nutritional value of the foods in this group. It is mostly unaffordable.

Drink milk, maas or yoghurt every day

Milk, maas and yoghurt are the three types of milk products that are important in this food group. There are a wide variety of products available; milk can be fresh, long life or dried and it is available in many pack types and flavours. The best choices are those types that are low in fat or fat free (skim), and if sweetened have sugar added sparingly.

Cheese is also included in this group but should not be the food type chosen most often. This is because it is high in fat and salt. The foods in this group are recognised as being the main food contributor of calcium (a mineral). They also supply protein, riboflavin (a B vitamin), vitamin B12, and the mineral potassium.

Key Messages

- Use low fat or fat free (skim) milk products; this is to lower the amount of saturated fat in the eating plan.
- Use milk and milk products with little or no added sugar.
- Enriched soya milk can be used as an alternate to milk.
- Some dairy products are high in fat, and low in the essential nutrients supplied by low fat milk and are not listed in the food guide (e.g. ice cream, milk based frozen dessert).

Use fat sparingly; choose vegetable oils rather than hard fats

The body needs some oils and fats from foods. Oils and fats can be found naturally in plant foods (like peanut butter and avocado) or animal-derived foods (like meat and chicken). They can also be added to foods and meals by spreading tub margarine on bread or using sunflower oil to brown onions for a stew.

The total amount of fat and oil in the diet should be limited, because too much fat increases the risk for weight gain and the development of high blood fat levels. Since fried foods are always high in fat, frying food is not recommended as a regular cooking method. Many foods from restaurants and takeaway shops are cooked with a lot of fat and therefore are not healthy choices.

Saturated fat is found in foods from animals (like meat, chicken and full cream milk). It is also found in many processed foods (like biscuits, pies, and chips), if these foods are eaten, the servings should be small and eaten occasionally.

People who need extra energy can add extra oil or high-fat plant foods to their diets. These can be combined with other foods, for example using more margarine on bread or adding peanut butter to porridge, or served alone, such as eating some avocado for a snack.

Key Messages

- Fat is an essential nutrient in the eating plan; the type of fat and the amount eaten are important.
- Many people have to decrease the amount of fat in from animal foods their eating plan (full cream milk, fatty meat, skin of the chicken, high fat processed foods) and replace it will oil (sunflower, canola, olive) and plant foods with oils (avocado, peanut butter).
- Fats play a role in the absorption of the fat-soluble vitamins A, D, E and K.

Use Salt and Foods High in Salt Sparingly

It is believed that a high salt intake leads to an increase in blood pressure in genetically susceptible persons; if the high salt intake is maintained over the long-term it will lead to hypertension.

The total daily intake of salt should be less than 5g of salt (sodium chloride); this equates to a recommended maximum intake of 2500mg of sodium. Some of the salt in the eating plan comes from salt added during cooking and at table, but most comes from salt added when processed foods are produced and when salt-based seasonings and sauces are used in home food preparation.

Key Messages

- We only need a small amount of salt from our food to maintain health.
- In South Africa salt must be iodated (by law) to prevent iodine Deficiency Disorder.
- A high salt intake is a risk factor for the development of high blood pressure.

EXAMPLES OF HIGHER AND LOWER SALT FOOD CHOICES FROM THE FOOD GROUPS			
	Food Group	**Lower Salt Foods**	**Higher Salt Foods**
	**Starchy foods**	Some breakfast cereals Some savoury crackers Dry maize, rice, pasta	Some breakfast cereals Some savoury crackers Maize, ice, pasta cooked with a lot of salt. Some types of bread
	**Vegetables and fruit**	All fresh vegetables and fruit. Frozen vegetables with no seasoning or sauce.	Canned vegetables Vegetables with sauces/seasoned Vegetable juice
	**Dry beans, peas, lentils, soya**	All dry beans, peas, lentils. Plain soya mince.	Canned beans Some flavoured soya mince
	**Fish, chicken, lean meat, eggs**	All fresh types.	Processed meat (ham, bacon, polony, sausages, biltong) Frozen chicken with added brine Canned fish in brine (undrained) Salted fish (snoek, pickled herring) Cheese
	**Milk**	Milk, maas, yoghurt.	Cheese

Table 5: *Examples of higher and lower salt food choices from the food groups.*

Use sugar and food and drinks high in sugar sparingly

A small amount of sugar can be added to foods and drinks like soft porridge or tea to improve the taste. Foods made with sugar, like jam, may be used to make a mixed meal or a snack. Sweets and cold drinks may be eaten occasionally but should not be eaten instead of mixed meals, or when a person does not have money for groceries.

Sugar provides energy but has no other nutrients. It can be enjoyed as part of a healthy eating plan but should not replace nutrient dense foods. Some people may get too much energy from sugar, especially if they use a lot of sugar in tea/ coffee, drink a lot of sugar sweetened cold drinks or use a lot of foods high in sugar (some of which are also high in fat). Like all foods sugar should be used in moderation, and foods high in

sugar should not be eaten instead of good mixed meals.

Sugar is not illustrated in the food guide because sugar is not essential for a healthy eating plan; a daily intake amount is included but does not have to be used.

Key Messages

- Sugar can be enjoyed in a healthy eating plan, when used sparingly. Use milk and milk products with little or no added sugar.
- Sugar and many foods made with sugar do not provide vitamins and minerals to the eating plan; these foods should not be eaten instead of good mixed meals.
- Frequent consumption of sugar, especially between meals, is a risk factor for decay.
- Frequent consumption of sweetened cold drinks and fruit juice can lead to obesity when the total energy value of the eating plan is higher than needed.

Information about the use of alcohol.

The use of alcohol has a long history and is an ingrained part of life in many cultures.

However, the abuse of alcohol is pervasive in many communities, and this has negative health and social consequences; use of alcohol during pregnancy is harmful to the unborn baby, alcohol abuse has negative social, lifestyle, and economic consequences for families and communities. Alcohol is not illustrated in the food guide as it is not required in an eating plan.

People who regularly drink alcohol should be aware of the energy contribution made by alcoholic drinks and the mixers they may be served with.

Key Messages

- Alcohol is not required; health workers should not encourage anyone to drink alcohol.
- Pregnant women and children under the age of 18 must not drink alcohol.
- Alcohol abuse has many severe negative consequences.
- People who use alcohol should do so sensibly, that means within recommended limits. This is one drink a day for women, and two for men.
- People who have been advised not to take alcohol for medical reasons (e.g. because it interferes with the action of some mediations or because it can lead to abuse) should not do so.

2.3.6. PUTTING IT ALL TOGETHER

Menu Planning

Information from the Guidelines for Healthy Eating should be used to design a healthy eating plan. The food eaten should mostly come from good mixed meals, while only some should be from snacks in between. It may be difficult to decide what is a snack and what is a meal, but the difference between the two is not important. What is important is the total food intake at the end of the day or week. Children need to eat about 3-6 times a day to take in all the food they need. People with high energy needs, such as very active men, and teenage boys may need snacks between meals to achieve their food needs.

You can use these steps to plan good, mixed meals.

- *Identify the meals and snacks that will be eaten during the day and remember to include times to have something to drink.*
- *Start with a starchy food, as a starchy food should be part of most meals. Starchy foods may also be part of some of the snacks. Other foods should be eaten together with the starchy food.*
- *Include plenty of vegetables and fruit during the day. Use one vegetable or fruit that contains beta-carotene each day. When available, usea variety of vegetables and fruit.*

Plan for other foods to be eaten with the starchy food and vegetables, including some or all of the following:

- dry beans, split peas, lentils and soya
- oil or plant foods with plant oil (avocado, peanut butter)
- milk, maas or yoghurt
- fish, chicken, lean meat or eggs.

These can be added for additional flavour:

- sugar or sugar-containing foods
- iodated salt or other seasoning used during food preparation.

Remember that other steps for a healthy lifestyle are:

- Be active!
- Drink lots of clean, safe water.

i. Food Guide Unit Servings

	FOOD GROUP	FOODS	UNIT
	Starchy foods	Bread, brown/ white Porridge, soft Maize meal, dry Potato, cooked Rice, cooked Samp, cooked Pasta, cooked Breakfast cereal Cut corn, mealie kernels Whole grains, cooked Popcorn, popped, no salt or fat added	1 slice 1/2 cup 3 heaped tablespoons 1 medium 1/2 cup 1/2 cup 1/2 cup Varies 1/2 cup 1/2 cup 2 cups
	Vegetables and fruit	All fresh / frozen vegetables (not potatoes) Raw leafy vegetables All fresh fruit	2 cup cooked 1 cup raw 1 piece medium sized fruit e.g. apple, banana. 2 pieces of small fruit e.g. apricots, plums piece large fruit e.g. grapefruit. 1 cup chopped fruit 2 cup fruit juice 2 tablespoons raisins
	Dry beans, split peas, lentils, soya	Dry beans, cooked Lentils, split peas, cooked soya mince	1/2 cup 1/2 cup 30g
	Fish, chicken, lean meat, eggs	Fish, white Fish, high fat Chicken, no skin Meat, lean Eggs, hens Liver Cheese, yellow	1 large piece 1 small piece 1 medium breast Size palm, sliced 1Omm 2 3 cube 30mm3/40g/size of a matchbox
	Milk, maas, yoghurt	Milk (low fat or skim preferred) Maas (low fat preferred) Yoghurt, low fat/fat free;	I cup I cup limited 1 tub, 100ml added sugar
	Fat/oil	Oil (sunflower, canola, olive or other plant oil) Tub margarine Peanut butter	1 teaspoon 1 teaspoon 1 heaped teaspoon
	Sugar	Sugar, brown or white Jam	1 teaspoon 1 heaped teaspoon

Table 6: *Food Guide Unit Serves*

2.3.7. Healthy Eating Plan Patterns

To have a healthy eating plan:

- *Eat the right amount for your needs- examples of food intake plans for three different energy levels are given.*
- *Choose a food intake pattern that suits the food you have available to you and that you can afford.*
- *Enjoy a variety of foods from each food group Within a day, from week to week and during the year when different foods are available.*
- *Use foods from most of the food groups, most days of the week.*
- *Most of the eating plan will consist of foods from plants; some foods from animals may be included.*
- *Water is an important part of healthy eating, make plans to be sure you have water available during the day.*

There are many ways of creating a healthy eating plan. Two different patterns are given in the tables below. These are based on the ***Guidelines for Healthy Eating*** and allow individual preferences to be taken into account. These recommended eating plans are based on all the food groups, and provide the energy and nutrients needed by children, teenagers and adults of average height and moderate activity levels.

Additional units from the food groups will be needed by people who are taller than average and/or who are very active. Discretionary foods (foods with little nutritional value) may be eaten on occasion instead of some of the units of starchy foods.

Energy needs for different groups of people

	ENERGY INTAKE KILOJOULES (KJ) PER DAY	
Age Group	**Men/Boys**	**Women/Girls**
5 - 9	6500	6 500
10 - 13	8 500	8 500
14 - 18	10 500	8 500/10 500
Adults	10 500	8 500
Sedentary Adults/Older Adults	8 500	6 500

Table 7: *Energy Needs for Different Groups of People*

Food Intake Pattern A

AGE GROUP ENERGY LEVEL	STARCHY FOODS	VEGGIES	FRUIT	DRY BEANS, SPLIT PEAS, LENTILS, SOYA	FISH, CHICK-EN. LEAN MEAT, EGGS	MILK, MAAS, YO-GHURT	FAT, OIL	SUGAR
6 500 kJ	8	3	1	1	1	1	4	2
8 500 kJ	11	3	1	1	1	1	6	6
10 500 kJ	15	3	1	1	1	1	8	6

Food Intake Pattern B

AGE GROUP ENERGY LEVEL	STARCHY FOODS	VEGGIES	FRUIT	DRY BEANS, SPLIT PEAS, LENTILS, SOYA	FISH, CHICK-EN. LEAN MEAT, EGGS	MILK, MAAS, YO-GHURT	FAT, OIL	SUGAR
6 500 kJ	5	3	2	1	2	1	4	2
8 500 kJ	7	3	1	1	2	2	6	6
10 500 kJ	10	5	2	1	2	2	8	6

Table 8: *Food Intake Patterns A, B*

Pattern A includes more units of starchy foods than Pattern B; this is similar to the way many people in South Africa eat. Pattern A does include more vegetables and fruit than most people are eating, as this is a food group that many people do not include in their meals often enough. **Pattern B** has more units from all the food groups, except starchy foods. This pattern has more of the foods from animals (fish, chicken, lean meat, eggs and milk), but still includes foods from all the plant food groups.

All the food groups make a unique contribution to the eating plan, and they should not skip out any e.g., they may typically not worry to include vegetables, or may eat meat instead of beans.

Skipping out food groups will result in the eating plan not having all the nutrients. Many people eat many foods that are not included in the food group lists. These people should be encouraged to choose the foods listed most often, as these provide more nutrients than highly processed food options that are not listed. Examples of changes that they could make are:

1. *Use brown bread instead of bread rolls, the flour used to make bread rolls is not fortified.*

2. *Use fresh fruit instead of fruit juice, it is more filling and has more fibre.*

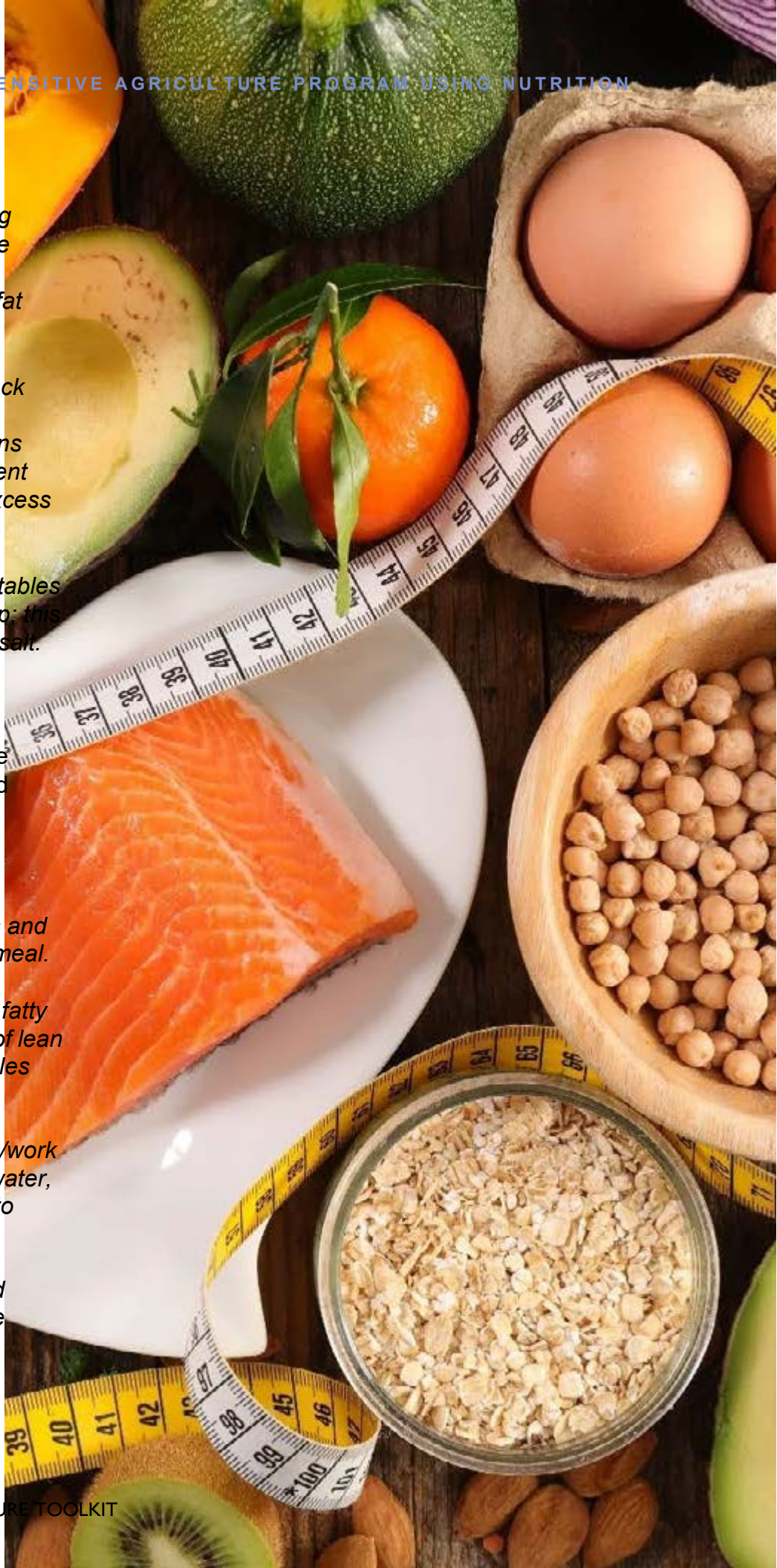
3. *Cook meals using fresh ingredients instead of buying readymade meals; these are likely to be cheaper, more nutritious and have a lower fat and salt content.*

4. *Eat fruit or yoghurt as a snack between meals instead of a packet of chips; these options contribute to the day's nutrient intake and do not contain excess fat and salt.*

5. *Make soup from fresh vegetables instead of using packet soup; this will be nutritious and low in salt.*

Some people have eating plans that should be adjusted to take into account the messages in the guidelines and the recommended quantities from the food guide.
Examples are:

- *Replacing large servings of starch with smaller servings and including vegetables in the meal.*
- *Replacing large servings of fatty meat with smaller servings of lean meat and including vegetables and beans in the meal.*
- *Taking a food box to school /work with sandwiches, fruit and water, instead of buying fried potato chips and a cold drink.*
- *Using low fat milk in tea and coffee instead of tea/ coffee whitener.*



2.3.8 SAMPLE MENUS

Menu 1

BREAKFAST	Soft maize porridge Milk Sugar	Breakfast cereal Milk Sugar	Soft maize porridge Milk Sugar

MID MORNING SNACK	Brown bread Margarine Jam	Banana	Brown bread Margarine Cheese

LUNCH	Brown bread Margarine Jam Apple	Brown Bread Margarine Boiled egg	Brown Bread Peanut butter Jam

SUPPER	Beef and bean stew Beef Beans Onion Tomato Carrot Spinach Margarine Phuthu	Chicken Stew Chicken Oil Onion Carrot Rice Butternut Tomato	Samp and beans Samp Margarine Beans Tomato Onion Green beans

DAILY	Milk Sugar Water	Milk Sugar Water	Milk Sugar Water

Menu 2

BREAKFAST	Breakfast cereal Milk Sugar	Soft maize porridge Milk Sugar	Brown Bread Peanut butter Jam

SCHOOL MEAL	*Soya mince stew* *Rice* *Butternut*	*Samp* *Beans* *Apple*	*Sour Milk* Phuthu Pap Banana

SCHOOL SNACK (FOOD BOX)	Brown bread Margarine Jam	Brown Bread Margarine Jam	Brown Bread Peanut butter Jam

AFTERNOON SNACK (AFTER SCHOOL)	Maas	Brown Bread Margarine Egg	Brown Bread Margarine Jam

SUPPER	Curry Bean Stew with Vegetables Sugar Beans Onion Tomato Carrot Phuthu pap	Pilchard Kedgeree Pilchards Onion Tomato Rice Carrot salad	Savoury Lentil Stew Lentils Tomato puree Onion Green Beans Rice Butternut chunks

DAILY	Milk Sugar Water	Milk Sugar Water	Milk Sugar Water

Menu 3

BREAKFAST	High fibre cereal Milk, low fat Sugar Raisins	Oats porridge Milk, low fat Sugar Apple puree	Muesli Milk, low fat Sugar

MID MORNING SNACK	*Soya mince stew* Cottage cheese	*Banana*	*Apple Slices*

LUNCH	Barley salad Barley Vegetables Olive oil Herbs and spices	Sandwich Brown Bread Tub Margarine Cold Chicken Green Pepper	Salad Cut Corn Vegetables Nuts Sprouted lentils Vinegar, Olive Oil

SUPPER	Chicken stew Chicken Oil Chick Peas Onion Carrot Rice Tomato and Cucumber Salad	Homemade FIsh Pie hake Pilchards Tomato Potato Butterbeans Green Peas	Pasta Primavera Pasta Onion Peppers Tomatoes Mushrooms Zucchini Olive Oil Herbs

DAILY	Milk Sugar Water	Milk Sugar Water	Milk Sugar Water

2.3.9. FOOD AND NUTRITION SECURITY

At the start of the module, we defined the terms 'food' and 'nutrition' and further highlighted how these relate to our health. This session adds the term 'security' to food and nutrition and explains the inter-relationship and difference between food security and nutrition security.

We also observed in the introduction that tea estate workers were not food and nutrient secure as they did not eat adequately (only 3 out of 15 food groups were used).

What Is Food Security?

When food security is achieved this means that: ***"Each person has (physical and economic) access at all times to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life."***

In other words, to be **'food secure**' at individual, household, village, or community level, food should be:

Available: refers to the physical presence of food, be it from own production or from the market or shops.

Accessible: refers to households and all individuals within those households having sufficient resources such as money, labour, time and knowledge to obtain appropriate foods for a nutritious diet.

Utilisable: Individuals should be able to eat and absorb in their bodies the available and accessible food. There should be no diseases or ailments like diarrhoea, malaria, worm infestation that prevents individuals from benefiting from the food eaten.

Sustainable: Individuals should feel confident that they will have enough food to feed their family tomorrow, and in the next weeks, months and years. Food should therefore be available, accessible, and utilizable at all times.

What Is Nutrition Security?

Sustainable access to food does not necessarily mean that all household or community members will be healthy. There are other factors in addition to food security that help ensure the achievement of individual, household and community health:

- There is a need to provide ***adequate care*** for the young, the sick, the elderly, the physically handicapped and all other household members. Care can mean ensuring that all individuals have eaten according to their needs, that those who are sick are treated, and that women are supported to exclusively breastfeed their children for the first 6 months.

- There is also the need to ***adequately prevent and control diseases*** so that foods eaten can be used by our bodies. This necessitates having measures in place which prevent, control and treat any diseases. Such measures can include maintaining environmental hygiene and sanitation, taking children for immunisation, attending antenatal clinics by pregnant mothers, seeking medical treatment for any infections, deworming children and all other household members.

From the above, we observe that three conditions must be fulfilled if all individuals

are to be healthy: ***food security, adequate care and adequate prevention and control of diseases.*** It is only when these conditions are fulfilled that a household or community can be nutrient secure.

Nutrient security is more than food security. Individuals, households and communities can only attain good health and nutrition if the three conditions of nutrient security; food security, adequate care, and adequate prevention and control of diseases are achieved.

How Can Food And Nutrition Security Be Improved On The Tea Estates?

In order to achieve food and nutrition security among tea estate workers, the underlying factors holding individuals back from accessing and utilising food, providing care for household members and seeking treatment for all ailments would need to be addressed. The challenges will need to be addressed at different levels; at household level as well as at estate management level.

Actions that can be taken by the workers/ households:

- Development of household and community gardens so that a wide variety of fruits and vegetables can be grown. The following nutritious foods can be grown beans, peas, ground nuts and various kinds of green leafy vegetables such as amaranthus (dodo), spinach, kale (sukuma wiki), cabbages, as well as red/orange/yellow-coloured vegetables such as chilli peppers (habanero), carrots, tomatoes. Fruit trees can be planted and yield lemons, oranges, mangoes, avocadoes, pineapples, passion fruit, etc.

- Constructing food stores such as granaries to preserve surplus food and provide food in times of scarcity.

- Household domestication of birds and animals (rabbits, cows, goats, chicken, ducks, etc.) can provide milk, ghee, meat and increase household income through selling some of the products.

- Preserving and basic processing of food, through methods such as solar drying or fermentation which can improve the nutrient content of some foods and increase the availability of seasonal foods (e.g. mangoes, tomatoes, cabbage).

- Practicing exclusive breastfeeding for children below 6 months and giving those 6-24months nutrient-rich foods 4-5 times a day, in addition to breast feeding.

Actions that can be taken by the estate management:

- Allowing workers to grow food in the labour lines and possibly, on other idle land on the estate (e.g. on some estates in India, workers are allowed to grow rice).

- Using idle estate land for growing fruit trees, e.g. citrus fruits (rich in Vitamin C), avocadoes or mangoes and distributing this among the workers.

- Allowing workers to construct food stores and/or develop communal food storage facilities.

- Allowing the workers to keep livestock in a way that is manageable for the estate (it works in other countries like India where estate workers have cows and chickens). It would enable relatively cheap access to animal-based proteins.

- Better equipped health facilities and more health-focused campaigns / sensitisation among the workers, e.g. on breast feeding and child feeding.

- Arranging transport to local markets.

Buying food products in bulk and selling it on to the workers who will then benefit from economies of scale (e.g. cooking oil, rice, fruits)

- Providing nutrition, cooking and food preservation lessons.

- Promoting economic activities through which households can obtain extra income that can then be used to purchase food.

How to ensure adequate care for all Household Members

- Effectively using the available resources to ensure that food is available to all household members.

- Attending to all household members who are sick.

- Nurturing the physical and social development of children (e.g. allowing children to play and socialise).

- Promoting general family happiness where all members can freely interact and eat food as a family (i.e. controlling violence in a household and/or community).

How to prevent and control diseases

- Promoting individual, household and community hygiene

- Ensuring that all children are immunised according to recommended health schedules.

- Effective treatment of infections, e.g. diarrhoea, malaria, worm infestations, etc.

- Improving health seeking behaviours such as women seeking antenatal care during pregnancy, women giving birth at health facilities, individuals going for regular medical check-ups and seeking early treatment for illnesses.

SUMMARY SECTION 1: FOOD & NUTRITION SECURITY

Table 9: *Food Groups*

We need a balanced it to stay healthy. Children also need it to grow well, both physically and mentally. Eating a diverse diet means eating many different foods each day so that we consume lots of different nutrients. These nutrients keep us healthy in different ways e.g. Iron helps the body to make new red blood cells which carry around oxygen. Vitamin C fights off illnesses and protein is the body's primary building block for muscles, bones, skin and hair. Most food provide more than one nutrient we need to eat all of the food in the right amounts.

Types of Nutrients	Foods that contain these nutrients	Benefits of these nutrients
Proteins	Animal -based: fish, meat, eggs milk, yogurt. Plant-based: beans, peas, lentils.	Build and repair our bones.
Carbohydrates	Millet, sweet potatoes, sorghum.	Gives us energy.
Fats	Sunflower oil, ghee, suet.	Gives us energy.
Vitamins and minerals	Fruits- mango, orange, pineapple. Vegetables- spinach, cabbage, pumpkin, green beans and green pepper.	Protects against illness. Help produce energy. Maintain water balance.
	Clean water and other drinks	Hydration

Nutritious diets do have to be expensive; key is to consume a variety of locally available/grown food on a daily basis.

CHAPTER 3: MARKET AND PRODUCTS USING FOOD ENVIRONMENTS UNDER AGRIBUSINESS AND AGROPRODUCTS

3.1 Introduction

Ensuring food safety and hygiene is important at individual, household and community level. It ensures that foods are safe for human consumption and that individuals do not develop any food-borne illnesses. This module equips participants with an understanding of key food safety and food hygiene issues and how these can be maintained within households and communities. The module explores different areas with regard to food safety including food spoilage, food storage and food poisoning.

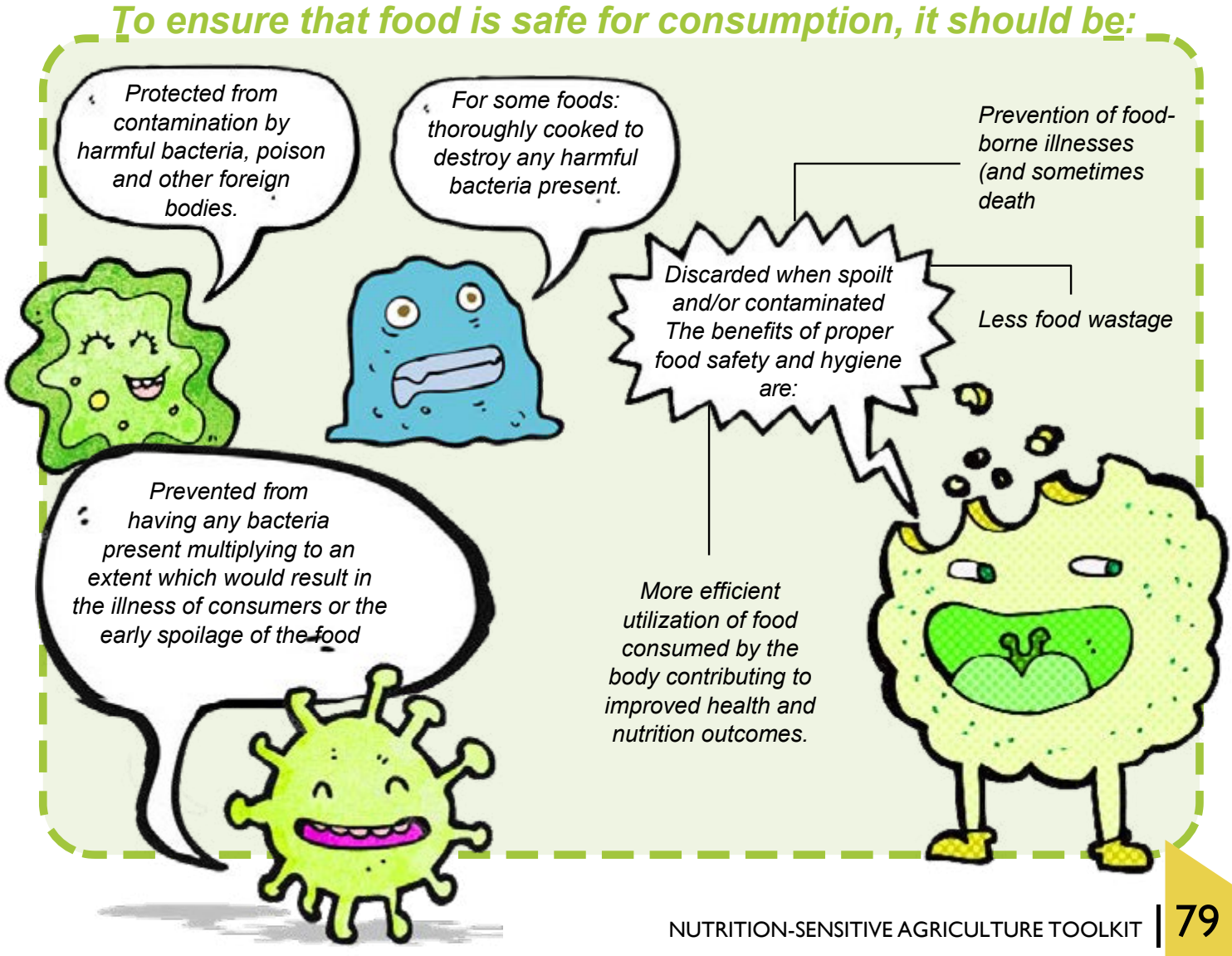
3.2 FOOD HANDLING, FOOD PREPARATION AND FOOD PRESERVATION

3.2.1. The Concept of Food Safety and Hygiene

Once food has been harvested, gathered, or slaughtered, enzymes and bacteria become active in this food which cause it to deteriorate in texture and composition until it eventually becomes unfit for consumption. This deterioration is known as decay and leads to eventual food spoilage. Food safety and hygiene entail undertaking a series of measures to avoid spoilage and contamination of food.

At the core of maintaining food safety is the need for proper food handling (including cooking), storage and preservation as these greatly influence how long food can stay fit for consumption.

Food is considered safe for human consumption when it is free from substances like contaminants, toxins and micro-organisms that can cause undesirable reactions in the body when such foods are eaten.



PROTECT THE QUALITY AND SAFETY OF YOUR FOOD

Germs in the environment and on food can easily multiply and contaminate foods. Eating contaminated food can lead to serious illness. To reduce the risk of food poisoning it is important to follow the basic rules of good hygiene at all times when handling and storing foods. The World Health Organisation has produced a publication called "The five keys of food safety;" this provides detailed messages to promote a safe food supply. A summary of the points is given below.

i. Keep hands and surfaces clean

- Wash your hands before handling food and often during food preparation.
- Wash your hands after going to the toilet.
- Wash and disinfect all surfaces and equipment used for food preparation.

ii. Separate raw and cooked food

- Separate raw meat, chicken and fish from other foods.
- Use separate equipment and utensils, e.g. knives or cutting boards for handling raw foods.

iii. Cook food thoroughly

- Cook food thoroughly (especially chicken, fish, meat and eggs) to kill bacteria.
- Bring foods like soup and stew to the boil to ensure they have reached 70°C. For meat and chicken, make sure that juices are clear, not pink.
- Reheat previously cooked food thoroughly.

iv. Keep food at safe temperatures

- Do not leave cooked food at room temperature for more than two hours.
- Refrigerate all cooked and perishable food promptly.
- Keep cooked food hot before serving.
- Do not store food too long, even if in the refrigerator.
- Do not thaw frozen food at room temperature.

v. Use safe water and raw materials

- Use safe water or treat it to make it safe.
- Select fresh and wholesome foods.
- Choose foods processed for safety, e.g. pasteurised milk.
- Wash vegetables and fruit, especially if eaten raw.

3.2.2. Food Processing and Preservation

Why process food?

The family food security depends on the regular supply of diversified and adequate food in terms of quantity and quality during the whole year.

The production of the majority of food is on a seasonal basis (practiced in certain period of the year). For this reason, we have to think about how to increase the food availability of this period.

Food can rot (going off) in different ways: by internal reactions between its components, by the reaction of the components with water and air or through enzymatic and toxic effects due to the development of micro-organisms and to the presence of chemical elements.

So, food processing is done to:

- Slow down the rotting process interfering into the physical and chemical reactions, reducing the development of unwelcome micro-organisms.
- Increase the food flavour.
- Make the food more attractive for the consumer.
- Facilitate its commercialisation.

In summary:

The food processing allows increasing the food availability beyond the area and the period of production, guaranteeing its supply and increasing the food security at National and Household level.

Main methods of food processing

Figure 3.1: *Methods of Food Processing*

Freezing

This reduces the temperature of the food so that microorganisms cannot grow, yet some may still survive. Enzyme activity is too slowed but not stopped during freezing.

Drying

Drying removes most of the moisture from the foods thus micro-organisms cannot grow and enzyme action is slowed down. Dried foods should be stored in airtight containers to prevent moisture from rehydrating the products and allowing microbial growth.

Canning

It is the process in which foods are placed in cans or jars and heated to a temperature that destroys microorganisms and inactivates enzymes. Air is driven from the cans or jars during heating, and as it cools, a vacuum seal is formed. The vacuum seal prevents other microorganisms from decontaminating the food within the jar or can.

Main Steps in Food Processing

1. Choose only good quality and fresh vegetables and fruits. Fruits shouldn't be green, but they shouldn't either have reached complete ripening.
2. Wash the products well in order to remove the dust.
3. Wash hands carefully and sterilise all the tools you are going to use, such as: tablecloth, cooking pots, recipients, etc.
4. Processing and Preservation

Facilitators' Notes 2

STERILISA TION OF POTS/ BOTTLES

How to sterilise pots/ bottles

1. Wash the recipients (also taps and corks) with soap and water. Dry well with running water.

2. Put the clean recipients into a cooking pot coated with a cloth or wooden grid.

3. Put some water into the cooking pot, filling it until the half of its capacity. Close the lid and let it boil for 15 minutes.

4. While the water is boiling, put inside the cooking pot the tabs and corks of the recipients that will be used in order to keep the conserves. Let them boil for 5 minutes.

5. Take out the taps and corks from the cooking pot in which they have boiled, using a clean wooden spoon.

6. Put the pots turned upside down on a clean cloth, out of air currents in order to avoid that the recipients break (due to the thermo shock). The pots shouldn't be dried with a cloth, but naturally.

7. Do not touch with your hands inside the pots/bottles, taps or corks.

8. Put the label on the pots/bottles (type of preserves, date of production, used ingredients, etc.).

Facilitators' Notes 3

PRESERVATION METHODS

1. Preservation by chemical action

Acids, salts and sugars are the prime food preservatives. The acids found in fruits help in preservation of jams, juices and marmalades.

2. Preservation by the addition of sugar

Sugar is generally added in the processing of jams, jellies and sweets. A concentration of 65% sugar preserves the food by drawing out water from the food and preventing micro-organisms from growing. The fruit must be boiled, after which the sugar is added in variable amounts, depending on the kind of fruit and the product being prepared. The mixture must then continue to boil until it reaches a high level of soluble solids, 65-70% which allows for its preservation. The addition of sugar combines with certain fruit substances to produce a gel-like consistency, which characterizes the texture of jams and jellies. To achieve this, appropriate acidity levels and sugar content, together with pectin, form a proper gel. Individual characteristics of the fruit products depends on type of fruit used, preparation method, proportions of the various ingredients in the mixture and the cooking method.

3. Preservation by adding salt

Pickled vegetables and fruits are fermented products. The particular fruits or vegetables used depend on availability and include red/white cabbage, cucumbers,

onions, garlic, cauliflower, tomatoes, under ripe mangoes, grapes, peaches and pears. The growth and fermentation of vegetables by more than one species of lactic-acid bacteria are influenced by especially salt concentration and temperature. The wrong temperature and/or salt concentration can produce the wrong bacterial population resulting in soft and hollow pickles with off-flavours. In fermentation salt plays a role in sorting the micro-organisms permitted to grow on the basis of salt tolerance.

3.2.3. Processing Fruit and Vegetables

Preservation by reduction of water content

Drying of fruits and vegetables

Drying is one of man's oldest methods of food preservation. It is also the most widely used method of food preservation. Drying of foods yields highly concentrated material nutritionally. Dehydration which means removal of water is presently done by drying by artificially produced heat under carefully controlled conditions of temperature, humidity, and air flow. The drying rate depends on temperature, humidity and speed of air, type of drier and size of food pieces with fruit and vegetables generally drying at 38-60 c. The drying process is critical in that air temperature and circulation must be monitored to avoid microorganism growth and spoilage. Dried products are easy to store and have long shelf life, reduced weight and bulk for transport and distribution costs and provide raw materials for further processing. However, there are risks such as loss of quality in drying products, contamination is high and case hardening may occur. The removal of moisture prevents the growth and reproduction of micro-organisms causing decay and minimises many of the moisture mediated deterioration reactions:

- It brings about substantial reduction in weight and volume minimizing packing, storage and transportation costs.
- Dehydration involves the application of heat to vaporize water and some means of removing the water.
- Drying which employs high temperatures for short times does less damage to food than drying processes employing lower temperatures for longer times.

Blanching

Blanching is the process of heating vegetables sufficiently to inactivate enzymes. Enzymes are the biological catalysts that facilitate chemical reactions in living tissue. If certain enzymes are not inactivated; they will cause colour and flavour to deteriorate during drying and storage. Blanched vegetables, when dried, will have better flavour and color than unblanched ones. Blanching - exposing fruit and vegetable to hot or boiling water or steam - as a pre-treatment before drying has the following advantages:

- It helps clean the material and reduce the number of micro-organisms present on the surface.
- It preserves the natural colour in the dried products; for example, the carotenoid (orange and yellow) pigments dissolve in

small intracellular oil drops during blanching nd in this way they are protected from oxidative breakdown during drying.

- It shortens the soaking and/or cooking time during reconstitution.
- When the blanching time is completed cool the product immediately to prevent over blanching.
- As a rule, fruit is not blanched due to damage from heat sogginess, and juice loss.
- You may blanch with hot water or with steam.

Water blanching usually results in more leaching of vegetable solids, but it takes less time than steam blanching under kitchen conditions.

With water: Use only enough water to cover the product. Bring the salty water (at a ratio of 5 liters water to 50g/5 tablespoons salt) to a boil and gradually stir in the vegetable. Re-use the same water for additional lots when blanching the same vegetable, adding new water as necessary. Keep the lid on the kettle while blanching.

Sun and solar drying

Drying Practices

- A large quantity of same maturity raw material should be used.
- Remove damaged parts, wash in clean water, trim and cut into 3-7 mm sizes (use same thicknesses).
- Bananas, tomatoes and other vegetables or fruit are sliced with stainless-steel knives or similar equipment's.
- As a general rule: plums, grapes, etc. are dried as whole fruits without cutting/slicing.
- To prevent bananas, apples etc. slices from going brown they must be kept under water until drying can be started.
- The main problems for sun drying are dust, rain and cloudy weather.

Preservation by concentration with sugar, acid and salt

Sugar preservation

70% sucrose in solution will stop growth of all micro-organisms in foods. Fruits can be preserved in sugar in form of jams, jellies, marmalades, juices, squash or whole fruits. A concentration of 60% sugar can preserve fruits for as long as one year.

Preservation with salt

Salt levels of about 18% to 25% in solution generally will prevent all growth of micro-organisms in

foods.

Preservation with acid (Vinegar)

- Fruits and vegetables can be preserved in vinegar and sugar, and then stored in glass containers.
- Fruits and vegetables stored in vinegar can keep for as long as two years or more and also improves in flavor e.g. chutney, pickles and sauces.
- Removal of water by concentration also increases the level of food acids in solution (particularly significant in concentrated fruit juices).

ASSESSING PROGRESS

Pair-Wise Interviews Among JFFLS Participants[1]

This exercise allows participants to assess each other's management practices and adoption of improved practices at their households and thus provides for informal evaluation of JFFLS impact.

Participants are stimulated to reflect upon reasons and constraints for adoption both in their own context and among their fellow farmers.

Objectives:

- *To evaluate management practices on individual JFFLS members' farms.*
- *To share experiences among participants.*
- *To think about constraints and opportunities in relation to applying the knowledge gained in the FFS on individual farms.*

TIME:

1 hour during the 1st session and 2 hours during the 2nd session.

Note: This exercise should be applied towards the **end** of the JFFLS cycle.

Materials:

Large sheets of paper and coloured pens

Steps:

During The 1st Session:

1. Inform the participants that they will be visiting each other's farms to conduct farm interviews. Half of the group will be visiting another member, and the other half will host a visit on their farms.

2. Ask the participants to split in small groups and develop a checklist of issues and questions to explore during the farm visit. The questions should relate to the impact of FFS at household and farm level, and on the use of the knowledge gained through FFS, including adoption of practices. In particular the questions should cover issues such as food security situation, efforts to ensure enough high-quality food, storage of seed and grain, and experiences with processing of products.

3. Randomly, divide the participants in two groups and tell one group that they will be the ones conducting interviews, and the other group will be the ones hosting the farm visit. Thereafter, pair each of the persons in the "interviewers" group with a person from the "farm visit host" group. Take into consideration the distance between participants when finalizing the pairs.

4. Tell all that during the coming week they have to arrange in their pair for the farm visit and interview to take place, and that during the following session the interviewer will report on the findings of the visits. The information gathered during the interview should be documented in a record book.

[1] Adapted from Discovery-based Learning on Land and Water Management: Practical Guide for Farmer Field Schools (FAO and IIRR, 2006).

During The 2nd Session

1. Ask each “interviewer” to summarise the finding of the farm visit interview, and especially explain in what way their fellow FFS member appears to have made use of the knowledge gained in the FFS, and any constraints and/or opportunities related to the uptake of practices.

2. In plenary discuss the results of the exercise. Some suggested questions for processing discussion:

- Does there appear to be a trend among group members in relation to which practices are adopted or not?
- What are the key factors affecting the transfer of knowledge gained in the FFS to the individual farms?
- How did the “farm visit hosts” perceive the exercise - did the interview exercise make them think of issues they had not previously thought of?
- How can the transfer of knowledge from the FFS to the household/farm level be improved and/or quickened?

Dried Leafy Vegetables

1. Prepare blanching solution and bring to the boil.
2. Select and wash the vegetables in cold water.
3. Chop the vegetables and blanch for 3 minutes.
4. Drain the vegetables well.
5. Dip in cold water (same time as blanched) to avoid further cooking.
6. Spread the blanched vegetables on drying trays in thin layers.
7. Load the dryer and keep turning till crisp dry.
8. Remove from the dryer.
9. Pack the dried vegetables in clean and moisture proof containers.
10. Remove as much air as possible from the container and seal well.
11. Label the package with the name of the product, date of processing and expiry, method of pretreatment and source.
12. Store in cool, dry, dark place.

Ingredients

Mangoes, lemons, water.

Dried Mango Slices

1. Select and weigh hard ripe fresh mangoes.
2. Wash the fruits thoroughly in clean water.
3. Peel the mangoes and slice into uniform slices.
4. Prepare lemon juice: water solution (1:20).
5. Then arrange the sliced fruits on drying trays in single layer and sprinkle with lemon juice.
6. Load the trays in the dryer (the dryer should face the sun).
7. Shift the trays in the dryer and occasionally turn the slices until dry.
8. Unload the dryer.
9. Sort and pack the dried slices in moisture proof containers.
10. Store in cool, dry, dark places.

Note: 15 kg fresh mangoes give 1 kg dried.

Ingredients

Mangoes, lemons, water.

Paw Paw Jam

Jam Setting Test | Flake test. Using the stirring spoon, scoop some jam from the boiling mixture then raise it about one foot (30 cm) above the pan and out of reach of the steam. Hold the spoon horizontally for a few seconds then pour the jam from the spoon. If the jam falls in clear drops, it is set. If it runs on a continuous flow, it needs to be cooked a little longer and tested again.

1. Wash ripe pawpaw, cut into halves and scoop the seeds.
2. Scoop flesh and pound to make a pulp.
3. Wash the lemons and squeeze out the juice.
4. Measure the ingredients and boil under moderate heat stirring continuously until thick.
5. Test for setting (See below).
6. Pour the jam into clean hot sterilized jars.
7. Cover and seal immediately.
8. Process the packed jars.

Cold plate test: Pour a little amount of the jam onto a cold plate and wait to cool. When cold, press the jam with a finger, if it forms wrinkles and a skin form on top then the jam is ready.
During this testing, the rest of the jam should be removed from the fire to avoid overcooking.

Ingredients

3 cups pawpaw pulp
3 cups sugar
0.5 cup lemon juice

Tomato Sauce

1. Clean and cut tomatoes.
2. Cook till soft and then pass through a sieve.
3. Put into a pan and add all the other ingredients mixing well.
4. Bring to boil and reduce heat to simmer in an open pan until the consistency is that of a thick cream.
5. Pour into hot bottles and process for 30 minutes and seal.

Ingredients

2 kg ripe tomatoes
0.25 cup sugar
1 teaspoon salt
A pinch cayenne pepper
2 cups vinegar
0.5 teaspoon ground ginger
0.5 teaspoon ground mace
0.5 teaspoon paprika

Facilitators' notes 6

Fruit and vegetable selected recipes

Passion Fruit Squash

1. Wash the fruits and cut into halves.
2. Scoop out the flesh with pips.
3. For each cup of flesh and pips, add 0.5 cup water.
4. Sieve the mixture to get juice. Add two tablespoons of lemon juice.
5. For every 2 cups of fruit juice add one cup of sugar.
6. Heat the mixture slowly until the sugar is dissolved. Do not boil.
7. Pour the hot juice into a clean hot bottle, cover and process.

Ingredients

Passion fruits,
Lemon juice,
Sugar.

Protect the quality and safety of your food

Germs in the environment and on food can easily multiply and contaminate foods. Eating contaminated food can lead to serious illness. To reduce the risk of food poisoning it is important to follow the basic rules of good hygiene at all times when handling and storing foods. The World Health Organisation has produced a publication called "The five keys of food safety1"; this provides detailed messages to promote a safe food supply. A summary of the points is given below.

KEEP CLEAN

- Wash your hands before handling food and often during food preparation.
- Wash your hands after going to the toilet.
- Wash and disinfect all surfaces and equipment used for food preparation.

SEPARATE RAW AND COOKED

- Separate raw meat, chicken, and fish from other foods.
- Use separate equipment and utensils, e.g. knives or cutting boards for handling raw foods.

COOK THOROUGHLY

- Cook food thoroughly (especially chicken, fish, meat and eggs), to kill bacteria.
- Bring foods like soup and stew to the boil to ensure they have reached 70 °C. For meat and chicken, make sure that juices are clear, not pink.
- Reheat previously cooked food thoroughly.

KEEP FOOD AT SAFE TEMPERATURES

- Do not leave cooked food at room temperature for more than two hours.
- Refrigerate all cooked and perishable food promptly.
- Keep cooked food hot before serving.
- Do not store food too long, even if in the refrigerator.
- Do not thaw frozen food at room temperature.

USE SAFE WATER AND RAW MATERIALS

- Use safe water or treat it to make it safe.
- Select fresh and wholesome foods.
- Choose foods processed for safety, e.g. pasteurised milk.
- Wash vegetables and fruit, especially if eaten raw.

RECIPE NAME: BOTTLED BEETROOT
PORTION MASS: 200g/ 1 Jar.

Ingredients
200g Fresh Beetroot
Salt
100ml White Vinegar
40g Brown Sugar

Method
1. Sterilise the jar, and the lid and place the jars in the hot water bath.
2. Rinse beetroot thoroughly, peel, grate, and place on a tray and sprinkle enough salt to cover the beetroot and leave to sweat for 30 minutes.
3. Rinse out the salt with boiling water. Repeat the rinsing 2 times.
4. Mix the drained beetroot with sugar, vinegar and add the mixture into a sterilised jar in the hot water bath. Remove the bubbles and tightly seal the jar.
5. Leave the jar in the hot water bath for 2 minutes then remove the jar and place on the cooling rack at room temperature.
6. Label and store in a cool, dark, dry place.

RECIPE NAME: BOTTLEDBUTTERNUT
PORTION MASS: 200g/ 1 Jar.

Ingredients
200g Fresh Butternut
Salt
250ml Boiling Water
5ml White Vinegar
5g Brown Sugar

Method
1. Sterilise the jar, the lid and place the jar in the hot water bath.
2. Rinse butternut thoroughly, peel, slice, and place on a tray. Sprinkle enough salt to cover the butternut and leave to sweat for 30 minutes.
3. Rinse out the salt with boiling water. Repeat the rinsing 2 times.
4. Pour the boiling water, sugar, vinegar and drained butternut into a small pot and boil for 2 minutes.
5. Add the mixture into a sterilised jar in the hot water bath. Remove the bubbles and tightly seal the jar.
6. Leave the jar in the hot water bath for 2 minutes then remove the jar and place on the cooling rack at room temperature.
7. Label and store in a cool, dark, dry place.

RECIPE NAME: BOTTLED CARROTS
PORTION MASS: 200g/ 1 Jar

Ingredients
200g Fresh Carrots
Salt
250ml Boiling Water
5ml White Vinegar
5g Brown Sugar

Method
1. Sterilise the jar, the lid and place the jar in the hot water bath.
2. Rinse carrots thoroughly, peel, slice, and place on a tray. Sprinkle enough salt to cover the carrots and leave to sweat for 30 minutes.
3. Rinse out the salt with boiling water. Repeat the rinsing 2 times.
4. Pour the boiling water, sugar, vinegar and drained carrots in a small pot and boil for 2 minutes.
5. Add the mixture into a sterilised jar in the hot water bath. Remove the bubbles and tightly seal the jar.
6. Leave the jar in the hot water bath for 2 minutes then remove the jar and place on the cooling rack at room temperature.
7. Label and store in a cool, dark, dry place.

RECIPE NAME: BOTTLED GREEN BEANS
PORTION MASS: 200g/ 1 Jar

Ingredients
200g Fresh Green Beans
Salt
250ml Boiling Water
5g Brown Sugar

Method
1. Sterilise the jar, the lid and place the jar in the hot water bath.
2. Rinse green beans thoroughly, trim, slice, and place on a tray. Sprinkle enough salt to cover the green beans and leave to sweat for 30 minutes.
3. Rinse out the salt with boiling water. Repeat the rinsing 2 times.
4. Pour the boiling water, sugar, and drained green beans in a small pot and boil for 2 minutes.
5. Add the mixture into a sterilised jar in the hot water bath. Remove the bubbles and tightly seal the jar.
6. Leave the jar in the hot water bath for 2 minutes then remove the jar and place on the cooling rack at room temperature.
7. Label and store in a cool, dark, dry place.

RECIPE NAME: BOTTLED POTATOES
PORTION MASS: 200g/ 1 Jar

Ingredients
200g Fresh Potatoes
Salt
250ml Boiling Water
5ml White Vinegar
5g Brown Sugar

Method
1. Sterilise the jar, the lid and place the jar in the hot water bath.
2. Rinse potatoes thoroughly, peel, slice, and place on a tray. Sprinkle enough salt to cover the potatoes and leave to sweat for 30 minutes.
3. Rinse out the salt with boiling water. Repeat the rinsing 2 times.
4. Pour the boiling water, sugar, vinegar and drained potatoes in a small pot and boil for 2 minutes.
5. Add the mixture into a sterilised jar in the hot water bath. Remove the bubbles and tightly seal the jar.
6. Leave the jar in the hot water bath for 2 minutes then remove the jar and place on the cooling rack at room temperature.
7. Label and store in a cool, dark, dry place.

RECIPE NAME: BOTTLED SPINACH
PORTION MASS: 200g/ 1 Jar

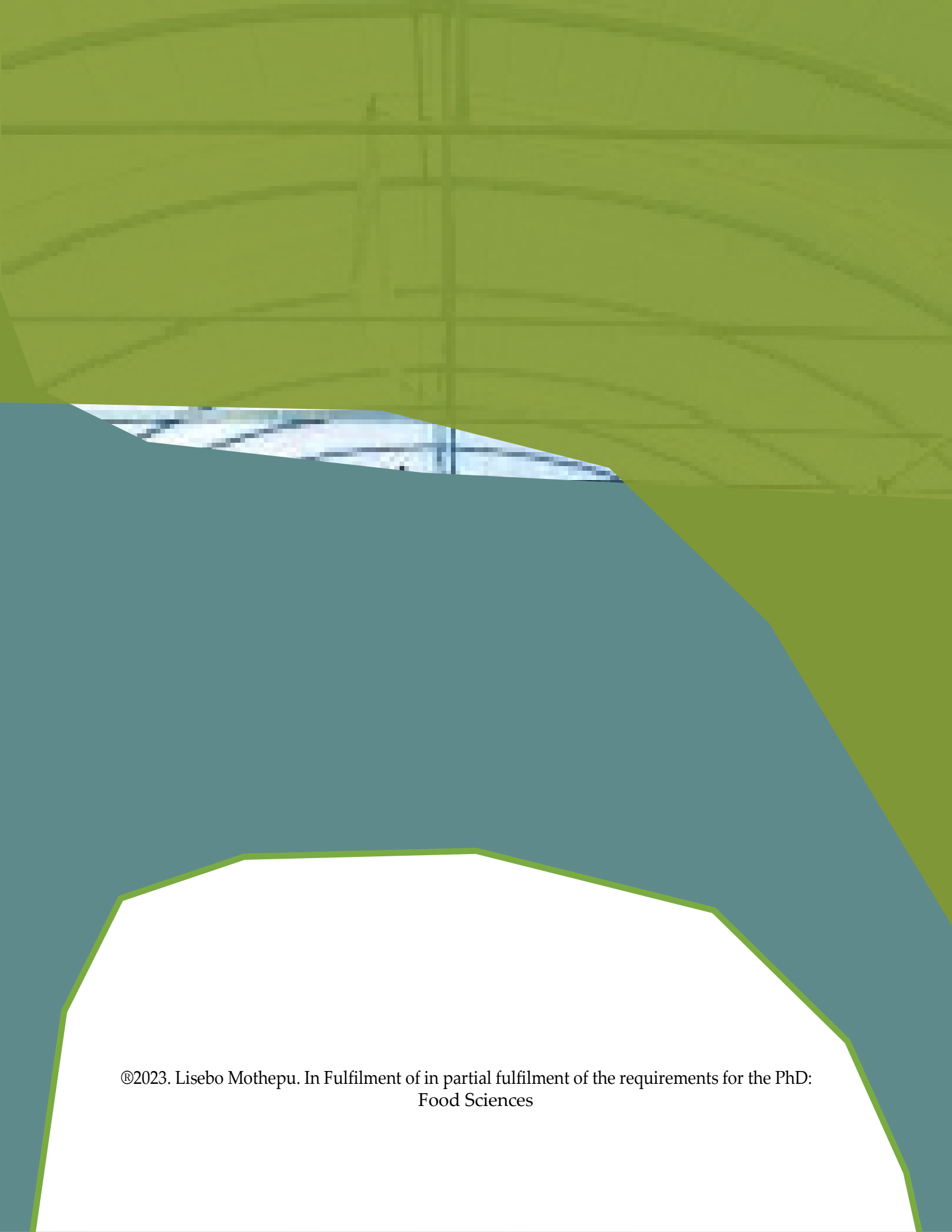
Ingredients
200g Fresh Spinach
Salt
250ml Boiling Water
5g Brown Sugar

Method
1. Sterilise the jar, the lid and place the jar in the hot water bath.
2. Rinse spinach thoroughly, chop and place on a tray. Sprinkle enough salt to cover the spinach and leave to sweat for 30 minutes.
3. Rinse out the salt with boiling water. Repeat the rinsing 2 times.
4. Pour the boiling water, sugar, and drained spinach in a small pot and boil for 2 minutes.
5. Add the mixture into a sterilised jar in the hot water bath. Remove the bubbles and tightly seal the jar.
6. Leave the jar in the hot water bath for 2 minutes then remove the jar and place on the cooling rack at room temperature.
7. Label and store in a cool, dark, dry place.

RECIPE NAME: BOTTLED TOMATOES
PORTION MASS: 200g/ 1 Jar

Ingredients
200g Fresh Tomatoes
Salt
250ml Boiling Water
5ml White Vinegar
5g Brown Sugar

Method
1. Sterilise the jar, the lid and place the jars in the hot water bath.
2. Rinse tomatoes thoroughly, peel, grate, place on a tray and sprinkle enough salt to cover the tomatoes and leave to sweat for 30 minutes.
3. Rinse out the salt with boiling water. Repeat the rinsing 2 times.
4. Mix the drained tomatoes with sugar, vinegar and add the mixture into a sterilised jar in the hot water bath. Remove the bubbles and tightly seal the jar.
5. Leave the jar in the hot water bath for 2 minutes then remove the jar and place on the cooling rack at room temperature.
6. Label and store in a cool, dark, dry place.

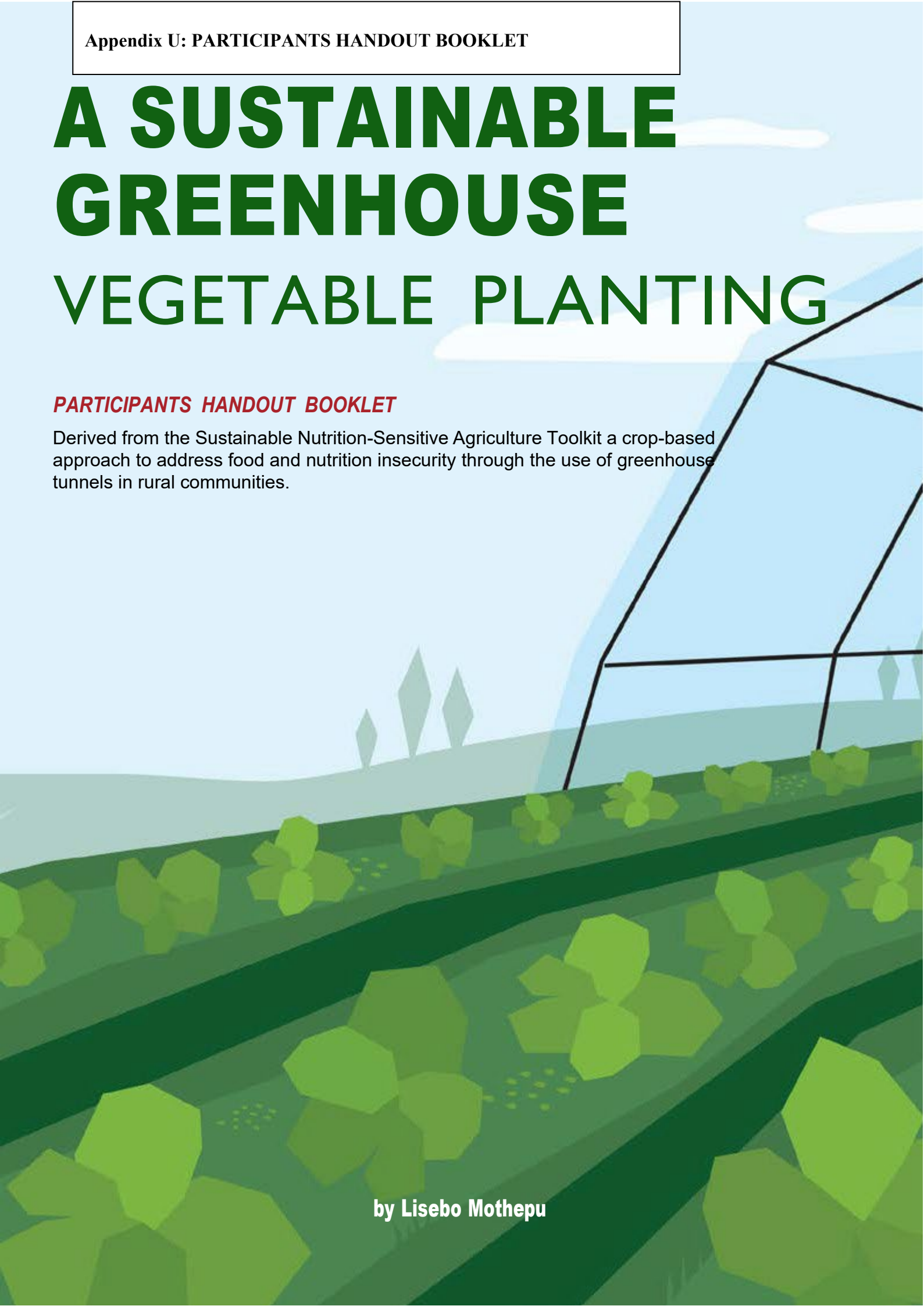


Appendix U: PARTICIPANTS HANDOUT BOOKLET

A SUSTAINABLE GREENHOUSE VEGETABLE PLANTING

PARTICIPANTS HANDOUT BOOKLET

Derived from the Sustainable Nutrition-Sensitive Agriculture Toolkit a crop-based approach to address food and nutrition insecurity through the use of greenhouse tunnels in rural communities.



by Lisebo Mothepu

SUSTAINABLE **GREENHOUSE** VEGETABLE PLANTING

A TRAINING MANUAL FOR BEGINNNERS

A step-by-step guide for beginners to cultivate vegetables in Lesotho for the year. This manual is presented to the Department of Food and Nutrition Consumer Sciences Faculty of Applied Sciences, in partial fulfilment of the requirements for the PhD: Food and Nutrition

by Lisebo Mothepu

2023

FOREWORD:

Sustainable Greenhouse Vegetable Planting Training Manual for Beginners

Lesotho faces significant challenges in meeting its food security needs, with many households lacking access to nutritious and affordable foods. In addition, climate change and extreme weather conditions continue to threaten agriculture productivity and food security in the country. **The Sustainable Greenhouse Vegetable Planting Training Manual for Beginners** provides practical guidance on how to establish and maintain a greenhouse for year-round vegetable production in Lesotho.

This manual is designed as a step-by-step guide for beginners, providing clear instructions on how to cultivate vegetables in a sustainable and environmentally friendly manner. The manual covers a range of topics, including selecting the right site for the greenhouse, choosing appropriate greenhouse materials, preparing the soil, selecting the right vegetable varieties, and managing pests and diseases.

The manual also emphasizes the importance of sustainable agriculture practices, including the use of natural fertilizers and pesticides, composting, and water conservation. By prioritizing sustainability in greenhouse vegetable production, communities can enhance their food security while contributing to the sustainability of the planet.

The Sustainable Greenhouse Vegetable Planting Training Manual for Beginners aligns with Lesotho's goals for sustainable development and recognizes the importance of locally sourced resources in promoting sustainable agriculture. This manual is a valuable resource for individuals and organizations seeking to enhance food security, promote health and well-being, and contribute to the sustainability of the planet.

We hope that this manual will inspire and empower you and your community in Lesotho to establish sustainable greenhouse vegetable production systems, enabling you to grow fresh and nutritious vegetables year-round, and ultimately contributing to the well-being of your families and communities.

TERMS

Cited from Faber, M., Laurie, S., Ball, A.-M., & Andrade, M. (2013). *A crop-based approach to address vitamin A deficiency in South Africa.* Pretoria, South Africa: South African Food Data System, Centre of Excellence in Nutrition, University of Pretoria.

Agricultural inputs: All consumables that are needed to make a crop grow, for example, fertiliser, pesticide, seeds, labour, etc.

Caregiver: Usually a member of the family, in whose care the child is

Crop rotation: A system of crop production in which the various crops are grown in succession on the same piece of land and in a certain sequence, in such a way so that that no crop is planted on the same piece of land for more than once in three years.

Crop-based approach: A food-based approach that focuses on the production and consumption of foods, especially those rich in micronutrients, as well as their absorption and utilisation in the body. The approach is flexible and includes a strong nutrition education component. The basis of the crop-based approach is the involvement of the community and local government in the design, implementation, management, monitoring, and evaluation of the project/ programme.

Cure: Preparing crops for storage by drying. Results in extended storage life e.g. of butternut/pumpkin fruit and sweet potatoes.

Diabetes: A medical condition where the body does not produce insulin or the insulin does not work well, and as a result glucose from the blood cannot enter the cells of the body as a result the blood sugar is too high.

Fieldworker: In the context of this manual a fieldworker can be a community member, a volunteer, etc who collects data or is involved in project activities.

Food-based approach: Strategies to improve the micronutrient status and well-being of populations through food production, dietary diversification, food fortification, and biofortification of staple foods.

Food-based dietary guidelines: A set of nutrition messages used to teach nutrition.

Fortified: Extra nutrients were added to the food.

Greenhouse tunnels: Enclosed structures, typically made of transparent materials, designed to create a controlled environment for plant cultivation by trapping heat and allowing sunlight to penetrate, thus extending the growing season, and protecting crops from adverse weather conditions.

Health eating plan: A diet that provides the foods that supply the correct amount or nutrients needed for health; also known as a balanced diet.

Imifino: A collection of various dark-green leaves that are eaten as a vegetable. the leaves either grow wild or come from vegetables such a pumpkin.

Inputs: Resources, materials, or substances used in agricultural production, including seeds, fertilizers, pesticides, machinery, labour, and other essential components.

Micronutrients: Natural substances found in small amounts in food (vitamins and minerals) as compared to macronutrients (e.g. carbohydrates, protein and fat) which are found in larger amounts.

Pest: Any organism (e.g. some bacteria, insects, fungi, mites, nematodes, rodents) injuring or detrimental to a beneficial plant. Alternatively referred to as pests and diseases.

Pesticides: Any chemical or physical agent that destroys, prevents, repels or attacks pests in order to control pests.

Pre-post harvesting: Activities and practices carried out both before and after the actual harvesting process, encompassing tasks such as field preparation, planting, crop management, and storage.

Processing: The conversion or transformation of raw materials or agricultural products into a different form or state through various techniques or methods.

Underweight: Low weight-for-age, with other words the child weighs too little for his/her age; the child can be either thin or short for his/her age. This reflects a combination of chronic and acute malnutrition.

Vitamin A-rich vegetables: In the diet, vitamin A can be found in the form of either preformed vitamin A, which is found in foods of animal origin, or provitamin A carotenoids (mostly beta-carotene), which is found in foods of plant origin. Vitamin A-rich vegetables refer to orange fleshed vegetables (eg. carrot, butternut, pumpkin, orange sweet potato), as well as dark-green leafy vegetables (e.g. Swiss chard), which are good sources of provitamin A carotenoids.

CONTENTS

ABBREVIATIONS

ARC	Agricultural Research Council
CBO	Community-based organisation
cm	Centimeter
g	gram
ha	hectare
IPM	Integrated Pest Management
K	Potassium
kg	Kilogram
kJ	Kilojoule
m	meter
mL	mililitre
MRC	Medical Research Council
N	Nitrogen
NGO	Non-governmental organisation
RDA	Recommended dietary allowance

INTRODUCTION TO THE TRAINING MANUAL

Welcome!

You're about to start a journey on using greenhouse tunnels in your community. This manual is derived from the sustainable nutrition-sensitive agriculture toolkit. A manual designed to promote gender equality and creating readily available opportunities for women farmers.

The toolkit has two programmes:

The Sustainable Agriculture Programme

which focuses on:

• Agriculture practices and use of greenhouse tunnels for fresh produce production.

Sustainable nutrition-sensitive agriculture programme

which focuses on:

• Nutrition education.

In this booklet you'll find information and techniques for starting a new project from planning to production, processing and marketing. The manual is divided into 3 sections so that you can easily implement everything step-by-step.

Training Outline:

Lesson 1: Agriculture Practises and General Planting Techniques

Lesson 2: Nutrition Knowledge and Meal Planning

Lesson 3: Food Preparation and Preservation and Developing Market and Product.

Key Objectives

Understating sustainable community and agricultural food systems in production of food practices to improve agricultural knowledge, increase yield variety crop, increase nutrient dense foods, and reduce post harvesting food loss through:

1. *Introducing fundamental components of vegetable production and nutrition education.*
2. *Determining agricultural and nutritional knowledge post-introduction.*
3. *Implementing a suitable training tool kit measuring pre and post training programme rollout.*

SECTION 1: AGRICULTURE PRACTISES AND GENERAL PLANTING TECHNIQUES

A sustainable agriculture programme using greenhouse tunnels for fresh produce production under agriculture production implementation.

PRE-HARVESTING

Part 1: Getting Started with Production

Production involves production involves understanding the entire value chain process (not just a farmer's decision-making process) other players are essential in the process.

Production planning

Securing finance

Installation of greenhouses

Buying inputs

Growing produce and harvesting

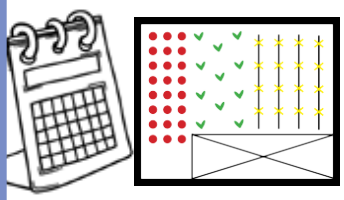
Selling or marketing your produce

Paying your debts

Saving some money for the future

Production Involves:

Time Of Operations: When To Do What

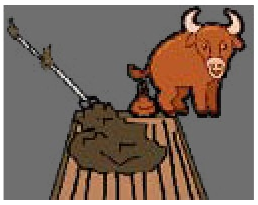


1.
Planning/ Production Calendar on annual crops

2.1.
Land preparation for greenhouse installation

2.2.
Install greenhouse tunnels with temp control, planting plot design & irrigation

3.
Rotation



4.
Fertiliser application

5.
Crop planting per allocated plot

6.
Crop Irrigation

7.
Transplanting

8.
Ridging

9.
Management

10.
Disease Identification Requirements of Plants

11.
Pest and Disease Control

13.
Plant Safety and protection

14.
Harvesting and post-harvesting handling

Season Extension

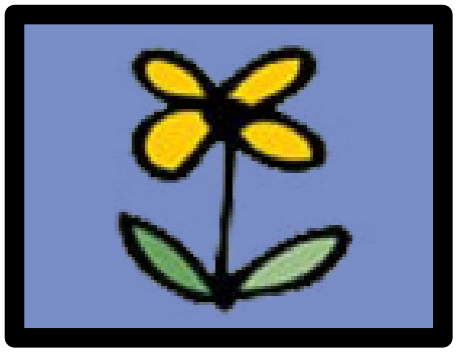
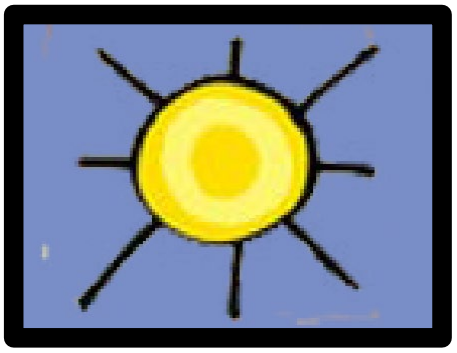
STEP 1

Whe To Plant

Greenhouse planting, with its controlled temperature and irrigation, is ideal for year-round cultivation.

Optimum times to plant:

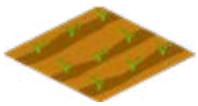
Feb - Mar and
Aug - Nov

STEP 2: SEED SELECTION

Choosing Where to Grow Your Seeds

Identifying both the fields for planting and installing the greenhouse tunnels.



Making sure that the site gets at least 6 full hours of sunlight daily (for vegetables).

Considering availability of water. Considering past uses of the land.

Identifying both the fields for planting and installing the greenhouse tunnels.

TEMPLATE FOR SIZING PRODUCTION

Vegetables	Cabbage	Spinach	Green beans	Carrots	Peppers	Onion	Tomatoes	Butternut	Potatoes	Beetroot
Production Season	All year round	All year round	All year round	All year round	All year round	All year round	All year round	All year round	All year round	All year round
Area to plant	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)	100m² (10m x10m)
Seeds Required	5g – 10g	50g	800g – 1000g	20g – 40g	30g – 50g	25g – 35g	1.5g – 5g	20g – 40g	25g	20g – 40g
Plant Population	200 – 750	700 – 900	400	10 000 – 20 000	200 – 740	5 000 – 8000	200 – 450g	100 – 150	450 000 – 550 000	10 000 – 20 000
Planting spacing in row	30cm – 50cm	15cm	30cm – 50cm	5cm – 8cm	40cm – 45cm	5cm – 8cm	30cm – 50cm	50cm – 70cm	150cm – 260cm	20cm – 2cm
Spacing between rows	60cm – 90cm	45cm	60cm – 90cm	30 cm – 50cm	75cm – 90cm	30cm – 45cm	75cm – 150cm	120cm – 150cm	20cm – 30cm	5cm – 10cm
Compound federalizer kg/ha	42648	42589	6	1.2 – 2.0	6 – 10	42651	10 – 15	4 – 6	1300 – 2100	1.2 – 2.0
AN top-dressing kg/ha	1 – 2.5	1	Not necessary	1.0kg	1 – 2.5	1 – 2.5	0.8 – 1	2	1	1.0kg
Manure kg/ ha	250	250 – 500	250 – 500	100 – 200	250	50	250 – 500	100 – 250	250	100 – 200
Day to harvest	70 – 160 days (depending on the season and variety)	120 - 160 days (depending on the season and variety)	60 - 90 days (depending on the season and variety)	70 – 120 days (depending on the season and variety)	120 - 220 days (depending on the season and variety)	120 - 220 days (depending on the season and variety)	80 - 120 days (depending on the season and variety)	60 - 120 days (depending on the season and variety)	120 - 150 days (depending on the season and variety)	60 - 90 days (depending on the season and variety)
Harvest duration	15 – 40 days	60 – 150 days	14 – 30 days after flowering	20 days	30 – 60 days	Done when 50% of the tops have wilted or collapsed	60 days	30 days	30 days (Start to harvest 2 – 3 weeks after leaves and stems have died)	30 days
Post harvesting handling	Heads are cut and harvested individually	Tie 10 leaves into bundles. Store in the shade and keep cool and moist	Pods are picked when seeds are well developed but still sweet, soft, and juicy. Store in a cool place	Roots are lifted by hand, or a garden fork is used to harvest when they are about 2cm in diameter	Fruits are cut and harvested individually	Fruits are cut and harvested individually	Ripe fruits are picked when dull red to full red colour but still firm	Heads are cut and harvested individually	Use a fork or single furrow plough to lift potatoes. (do not leave potatoes lying in the sun)	Roots are lifted by hand, or a garden fork is used to harvest when they are about 2cm in diameter
Normal packaging	Heads	Bundles	Pockets	Pockets	Fruits	Sacks	Box	Heads/ pockets	Pockets	Bundles/ pockets
Estimated production	200 – 750	1500	80 – 150	250 – 500	70 – 100	300 – 700	200 – 600	200 – 300	7kg – 10kg pockets	250 – 500

Heads are cut and harvested individual y

STEP 3: SEEDLING SELECTION

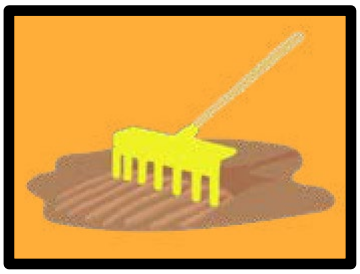
Making Your Own:
Buy quality seeds. sow 4-5 Weeks before transplanting

- **Buy Seedlings:** Order from nursery 6 wks in advance.
- Collect, keep wet and transplant the same day.

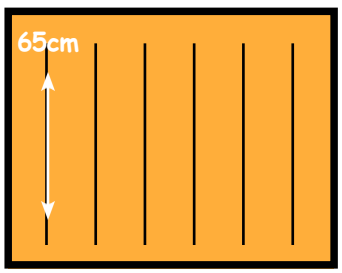
STEP 4: PREPARING AND DEVELOPING THE FIELD

Level The Soil

300-degree slope for water to run off.

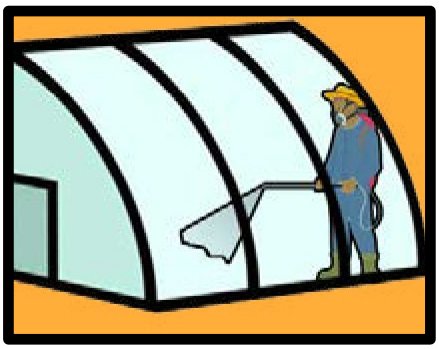


6 trenches dug:
5 - 10cm deep, 65cm wide in 10m x 30m tunnel



Tunnel Sterilisation

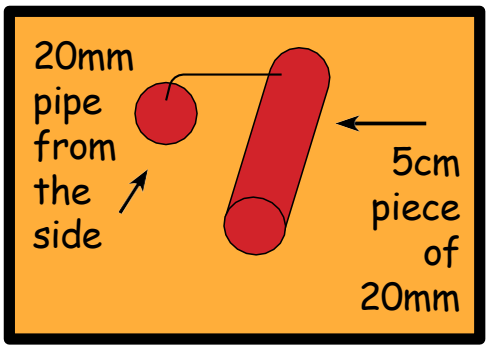
machine spray with Glutathione (Formalin).
9 months, Sep-May



Black and White FLoor Sheeting
11,5m wide x 31m Long, 150mm
*White side up

Irrigation

Gathering and using rainwater, stored in tanks, and connected to irrigation systems, is a sustainable solution for water shortage situations.



STEP 5: TRANSPLANTING

Optimum time:
late afternoon

Fill sawdust hole
with grow mix

Wet seedling trays
before taking them out.

water plants immediately

mix 10ml preplant/propamocarb
to 10 litres of water. Water every

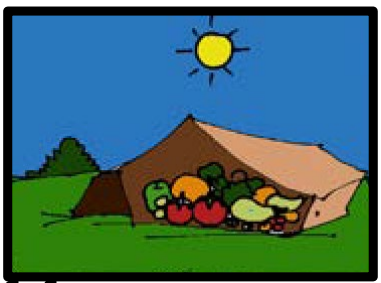
STEP 6: AFTER PLANTING

Harvesting

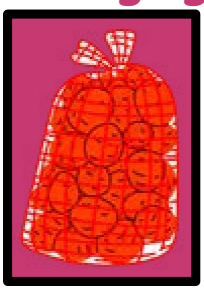
Processing

Marketing

Storage



Packaging



LESSON 1: PRODUCTION RECORD

ACTIVITY	WHO	DATE	COST
Type of Seedlings/seed ordered	Dineo x2 Spinach	01/01//2023	R1
Fertiliser Applied	Mpho: Natural x2 bags	01/01//2023	R1
Seeds/ seedlings planted	Mpho: x2 bags cucumber	01/01//2023	R1
Crop watered	Mpho	01/01//2023	
Weed Control	Mpho Dineo	01/01//2023	
Pest Control	Mpho: 10ml of propalgate	01/01//2023	R1
Harvesting	Mpho Dineo	01/01//2023	
Land cleared after harvesting	Mpho Dineo	01/01//2023	
Next crop rotation	Mpho Dineo	01/01//2023	

HARVESTING RECORD

Crop Type	How much harvested	How much processed	How much Sold
Spinach	20	14	10

TEAR HERE

PRODUCTION RECORD

ACTIVITY	WHO	DATE	COST
Type of Seedlings/seed ordered			
Fertiliser Applied			
Seeds/ seedlings planted			
Crop watered			
Weed Control			
Pest Control			
Harvesting			
Land cleared after harvesting			
Next crop rotation			

TEAR HERE

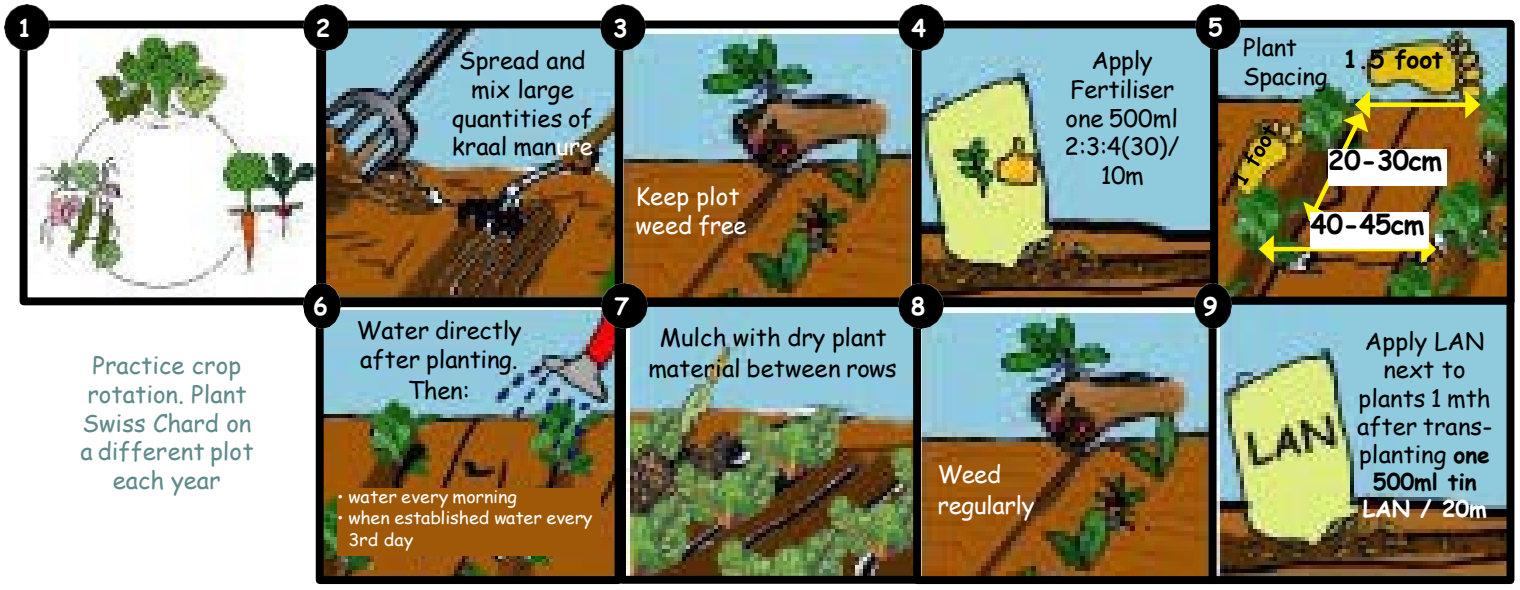
HARVESTING RECORD

Crop Type	How much harvested	How much processed	How much Sold	Post-harvest loss and reason

Planting Of Swiss Chard Spinach and Management

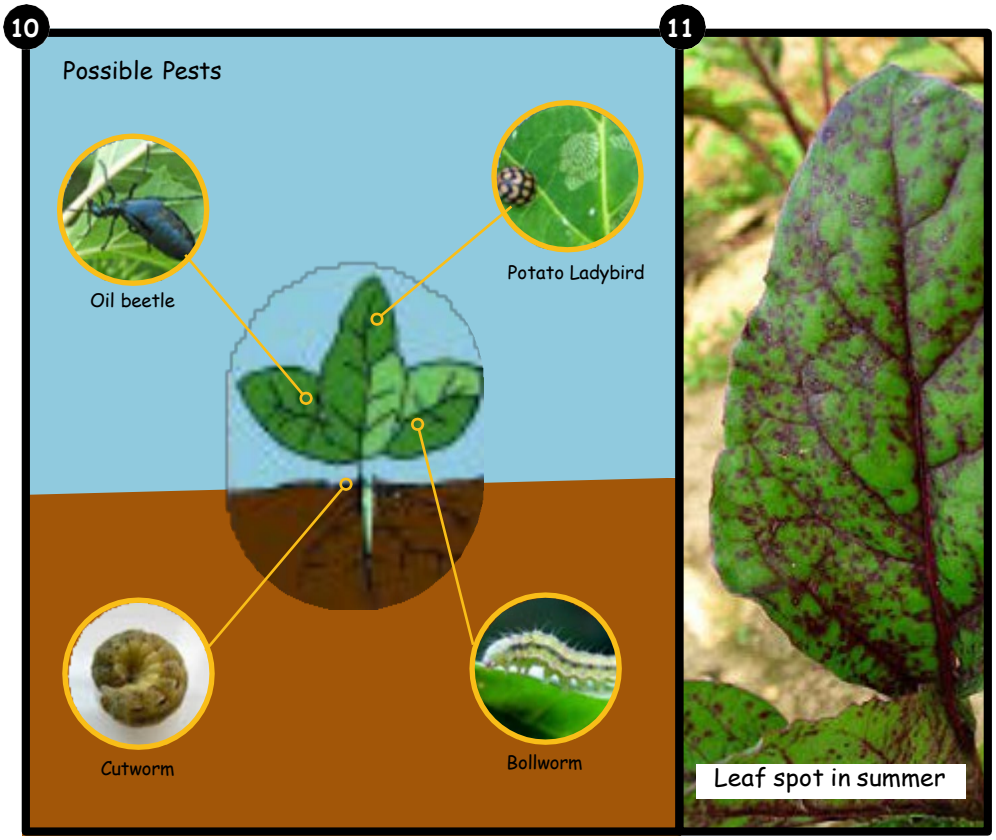
	J	F	M	A	M	J	J	A	S	O	N	D
Optimum plant/ trans-plant times		●	●					●	●	●	●	
Sow seeds	●						●					

LAND PREPARATION, TRANSPLANTING AND MANAGEMENT

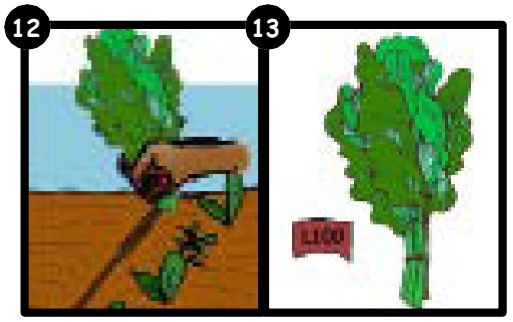


Practice crop rotation. Plant Swiss Chard on a different plot each year

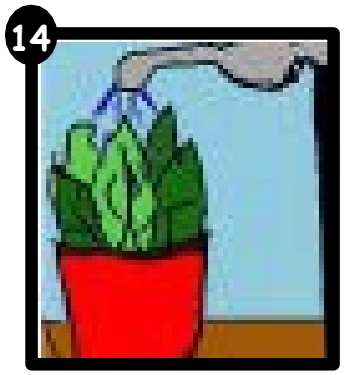
PEST & DISEASE MANAGEMENT



HARVESTING



When picking, always leave 3 mature leaves on a plant. Harvest, tie in bundles and sell immediately.



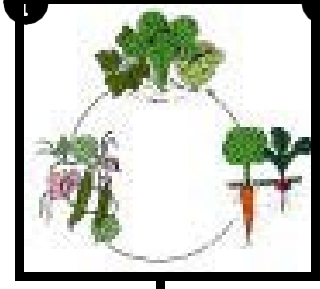
or put stems in water tokeep fresh and crisp

Planting of potato and management

	J	F	M	A	M	J	J	A	S	O	N	D
Optimum plant/ trans-plant times							●	●	●	●		

FERTILISATION

1

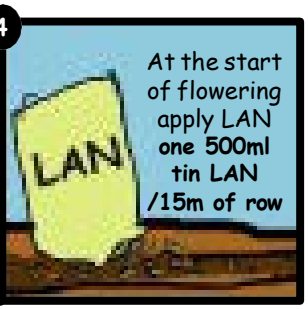


2

On the day of planting: apply fertiliser in furrow.

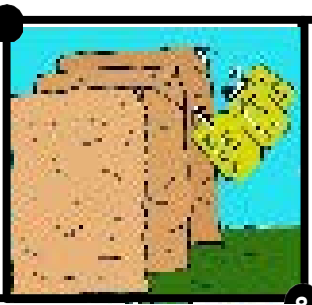
3

4



Practice crop rotation. Plant Swiss Chard on a different plot each year

PLANTING

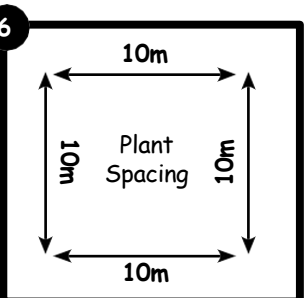


USE GOVERNMENT CERTIFIED SEED.
ORDER SEED POTATOES IN MAY OR JUNE

Cultivars To Be Used and time to harvest:
BP1 • 4 months
Astrid • 5 months
Mnandi • 5 months

*NEVER PLANT YOUROWN GROWN SEED

6



7

Small tubers; 20cm apart
Medium large tubers; 30cm apart

8

9

10

RIDGING

11

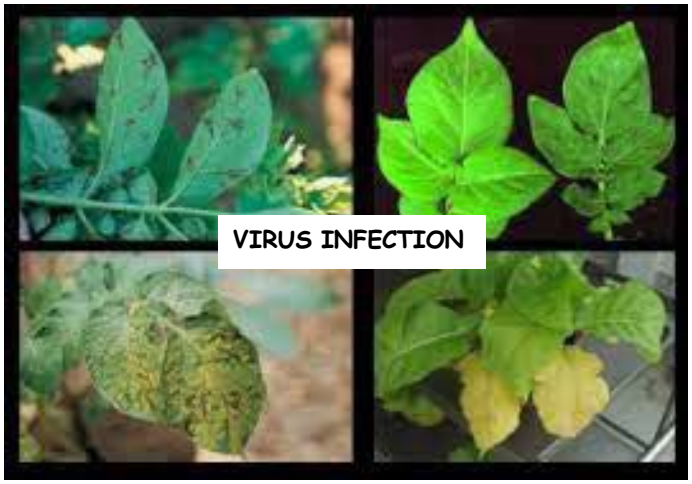
12

13

14

If necessary, spray potatoes [mainly BP 1] with dithane M45 Every 7 days adter start of flowering

DISEASE IDENTIFICATION



HARVESTING

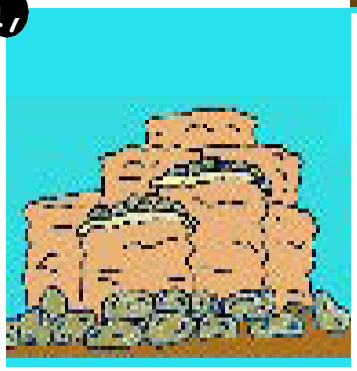
15

Harvest with a fork or single furrow plough to lift potatoes.

*Do not leave potatoes in the sun

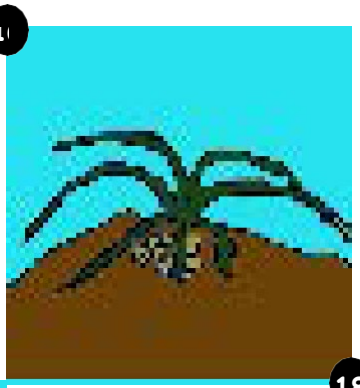
17

Keep harvested potatoes in a dry, cool, and dark place



OR IN

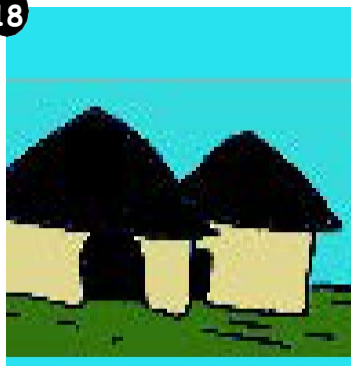
16



Harvest 2-3wks after leaves and stems have died.

Harvest before weeds damage and cover potatoes

18



Planting of Tomato and Management

	J	F	M	A	M	J	J	A	S	O	N	D
COOL-COLD AREAS									●	●	●	●

LAND PREPARATION

Measure contours if necessary to prevent erosion

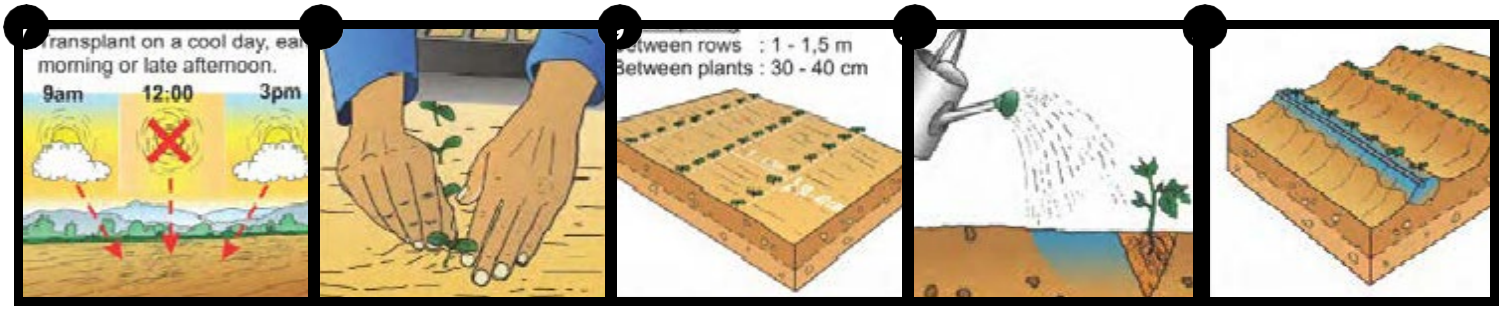
Disk in or cut down previous crop cover

Buy lime, fertiliser and manure as recommended

Broadcast lime and spread kraal manure 1 month before planting and inch into soil

Form ridges is land is sloped and apply fertiliser 1-2wks before planting

TRANSPLANTING AND MANAGEMENT



Transplant on a cold day. Early morning or late afternoon.

Transplant healthy, turgid plants with a well-developed root system, and stem thickness of +- 8mm.

Plant Spacing
between rows: 1-1.5m
between plants: 30-40cm

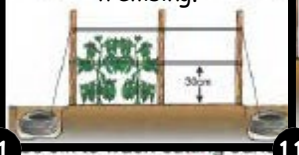
Water plants immediately after planting.

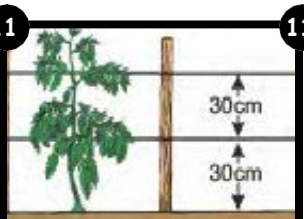
Plant roots deep enough to reach water and for drip irrigation.

Day	1	2	3	4	5	6	7
Young (Wk 1-3)	1L		1L		1L		1L
Mature (Wk 4+)			3L			3L	

Mulch along rows with leaves, grass or straw.

Actively growing tomato plants need support. This is known as trellising.





Add an extra wire stand or bailing twine as plants grow.

Topdress with LAN 3-4 and 6-8 weeks after planting.

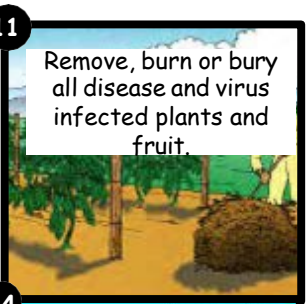
3 bags per Hectare (15g/m²) or 1X500ml oil tin per 34m²

Weeks	1	2	3	4	5	6	7	8
Application	X	X	✓		X		✓	

At 8-9 weeks after transplanting, apply KCL.

2 bags per Hectare (10g/m²) or 1X500ml oil tin per 50m²

Weeks	1	2	3	4	5	6	7	8	9	10
Application	X	X	X	X	X	X	X	✓		



Remove, burn or bury all disease and virus infected plants and fruit.

Look on top **AND** under the leaves.

Week 1	Week 2
① Dithane	① Dithane
	MIX ② Copper Oxychloride
	①+② MIX

Use a knapsack sprayer to apply chemicals to both sides of tomato leaves

NB: keep tools clean. Use jik to wash cutting surfaces

Check plants for pests and diseases eery week.

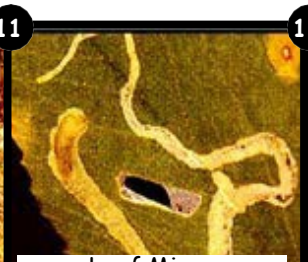
Chemical control Spray plants once a week for prevention of common diseases.

Burn or bury remaining plant material after harvesting. Rotate crops every 3-4 yrs.

COMMON PESTS AND DISEASES

Aphids

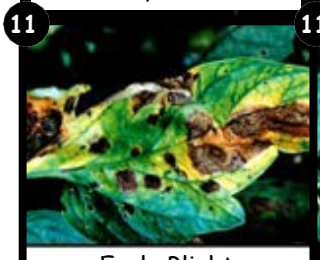
Red Spider Mite



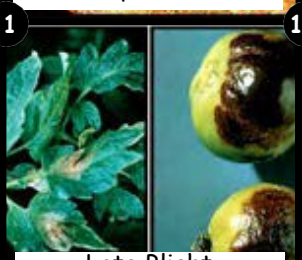
Leaf Miner

Cutworm

Bollworm



Early Blight



Late Blight

Powdery Mildew

Septoria Leaf Spot

Fusarium Wilt

Bacterial Spot & Bacterial Speck

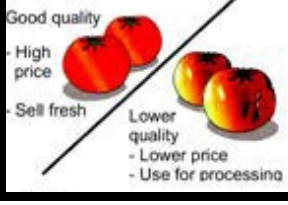
HARVESTING

Harvest ± 3 months after planting. Pick light pink, softening fruit.

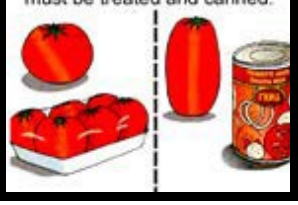
Harvesting will last for ±3 - 4 months if pests and diseases are controlled properly.

Place picked tomatoes in a crate and store in a cool place.

Separate the tomatoes into good quality, large ones and smaller or marked tomatoes.



Place tomatoes in punnets or packets. Processed tomatoes must be treated and canned.



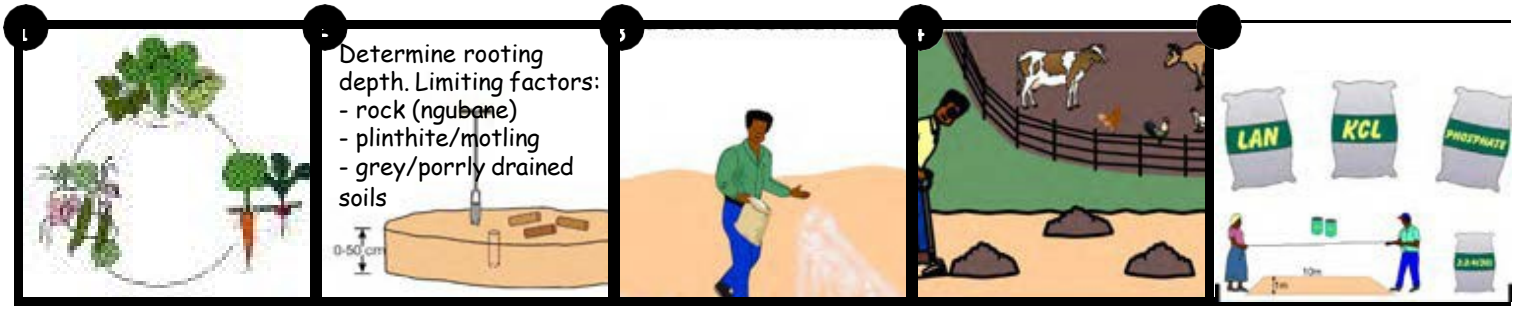
Yields:
Up to 40 or 50 tonnes per hectare, depending on climate and management.

TONNES					
Cool climate	10	20	30	40	
Warm climate	10	20	30	40	50

Planting Of Cabbage and Management

	J	F	M	A	M	J	J	A	S	O	N	D
cool area	●	●	●					●	●	●	●	●
warm areas	●	●	●	●	●	●	●	●	●	●	●	●
hot areas			●	●	●	●	●					

LAND PREPARATION, TRANSPLANTING AND MANAGEMENT

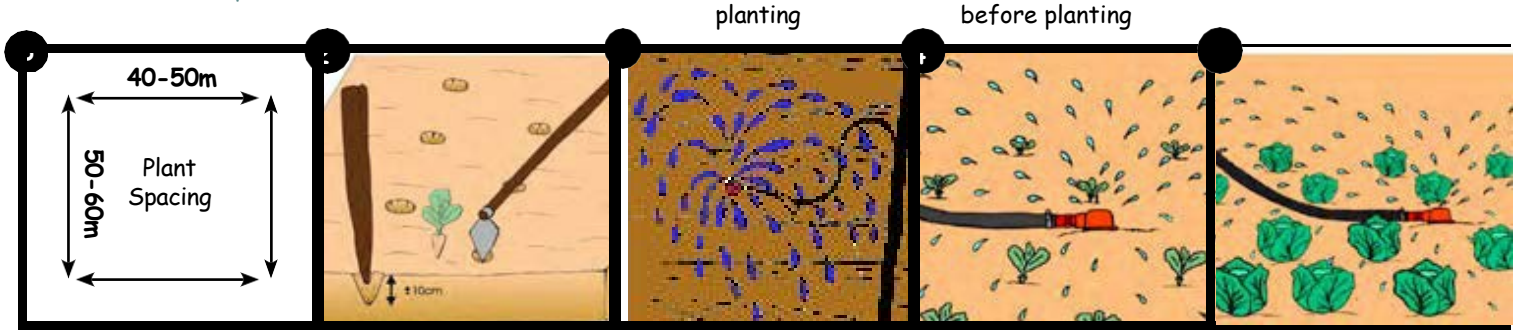


Crop rotation will prevent disease build -up

apply lime if recommended atleast 1 month before planting

if available, spread and mix large quantities of kraal manure 1 month before planting

Apply Fertiliser one 500ml 2:3:4(30)/ 10m



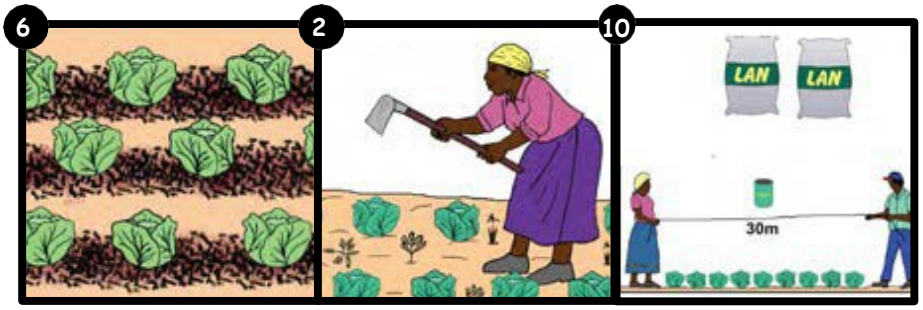
Stagger plants to minimize interplant competition for light, nutrients, water

Use a stake or v-shaped hoe to make a **10cm depth** hole in soil

Irrigate directly after transplanting. Then +25ml per week

Young plants: 2-3 times week, the first 3-4 weeks

Mature plants: 1 a week until harvest

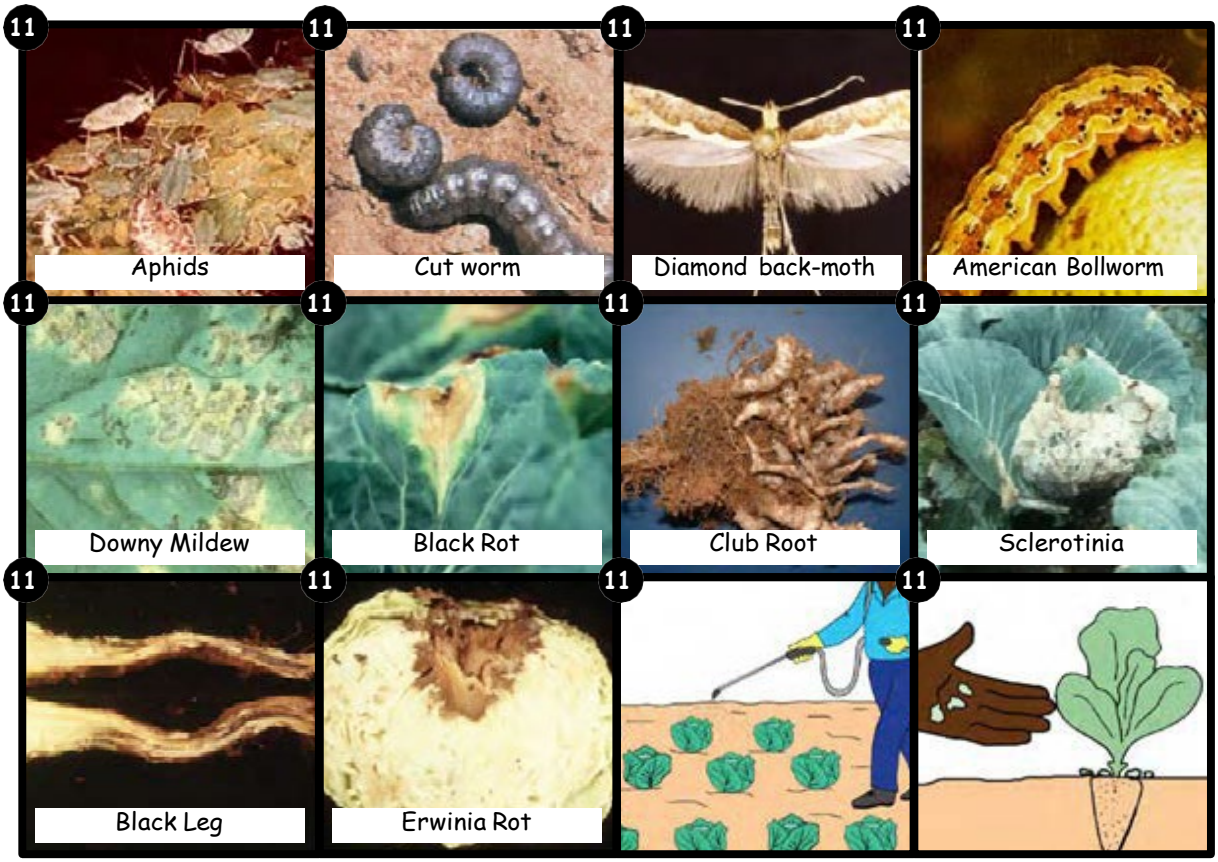


Add mulch of dried leaves, grass and other plant material.

Keep soil weed free. Use weeds as mulch.

Top-dress with LAN 3-5 wks after transplanting **one 500ml tin LAN /30m**

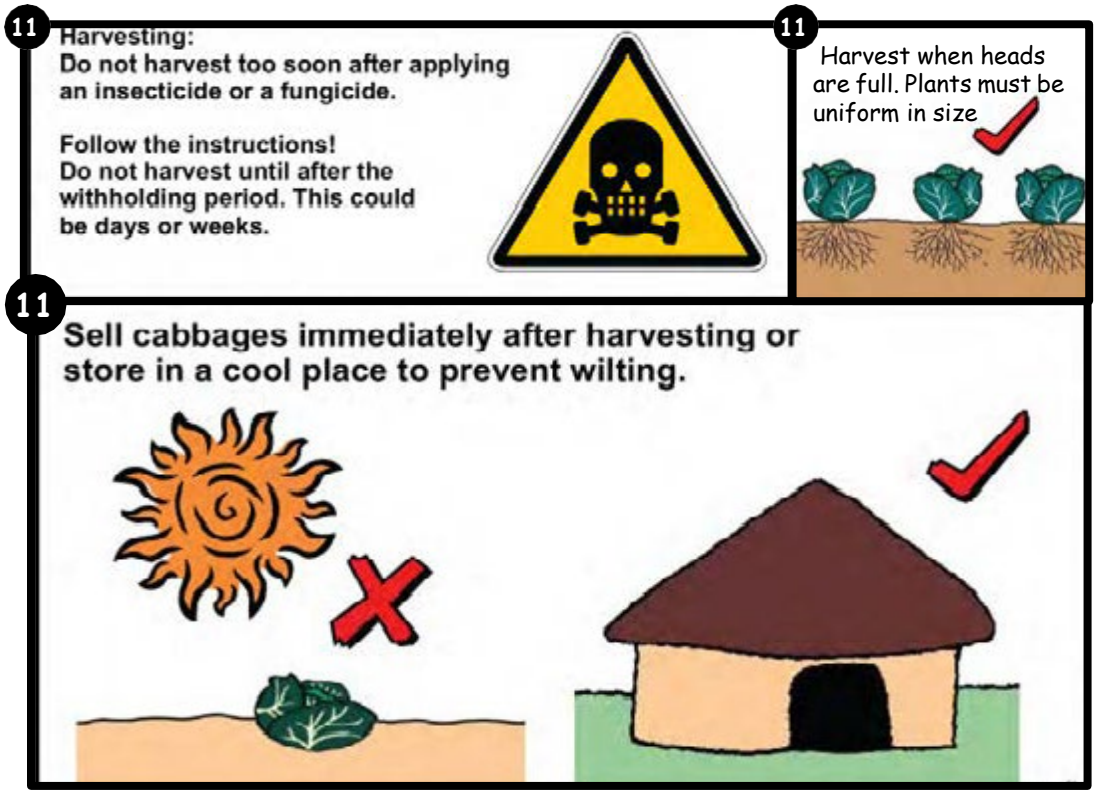
PEST CONTROL AND DISEASE



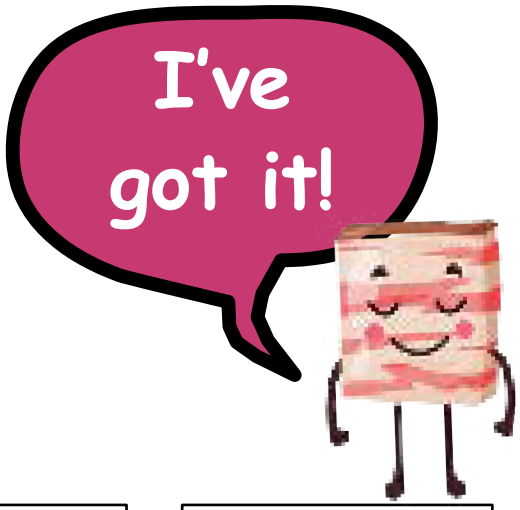
Spray only with registered insecticides and fungicides.

Apply cutworm bait immediately after transplanting.

HARVESTING



LESSON 1: TEST YOUR KNOWLEDGE



Let's See What We Know

Objectives:

- To understand pre-and post-production.
- To correctly identify the production processes.

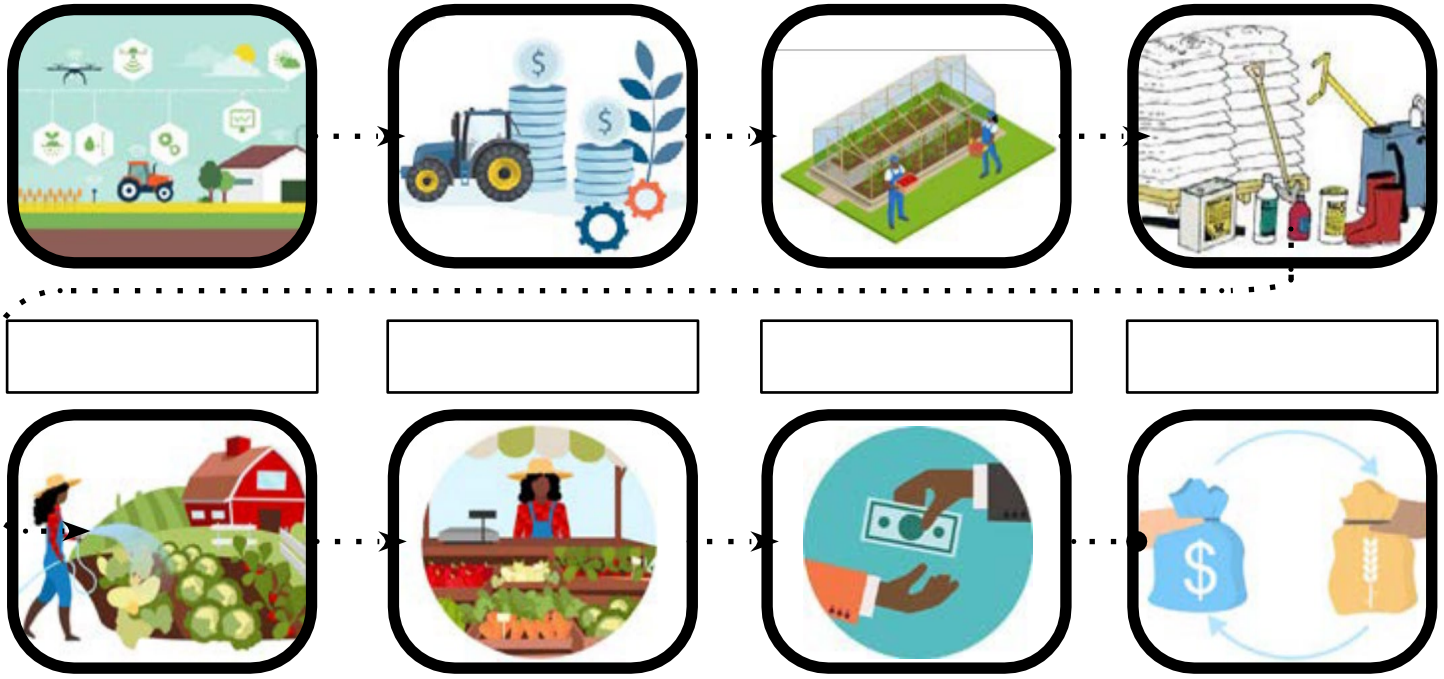
Materials

- Pen

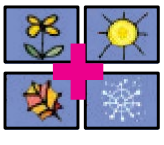
Instructions

Correctly label the steps in the following processes.

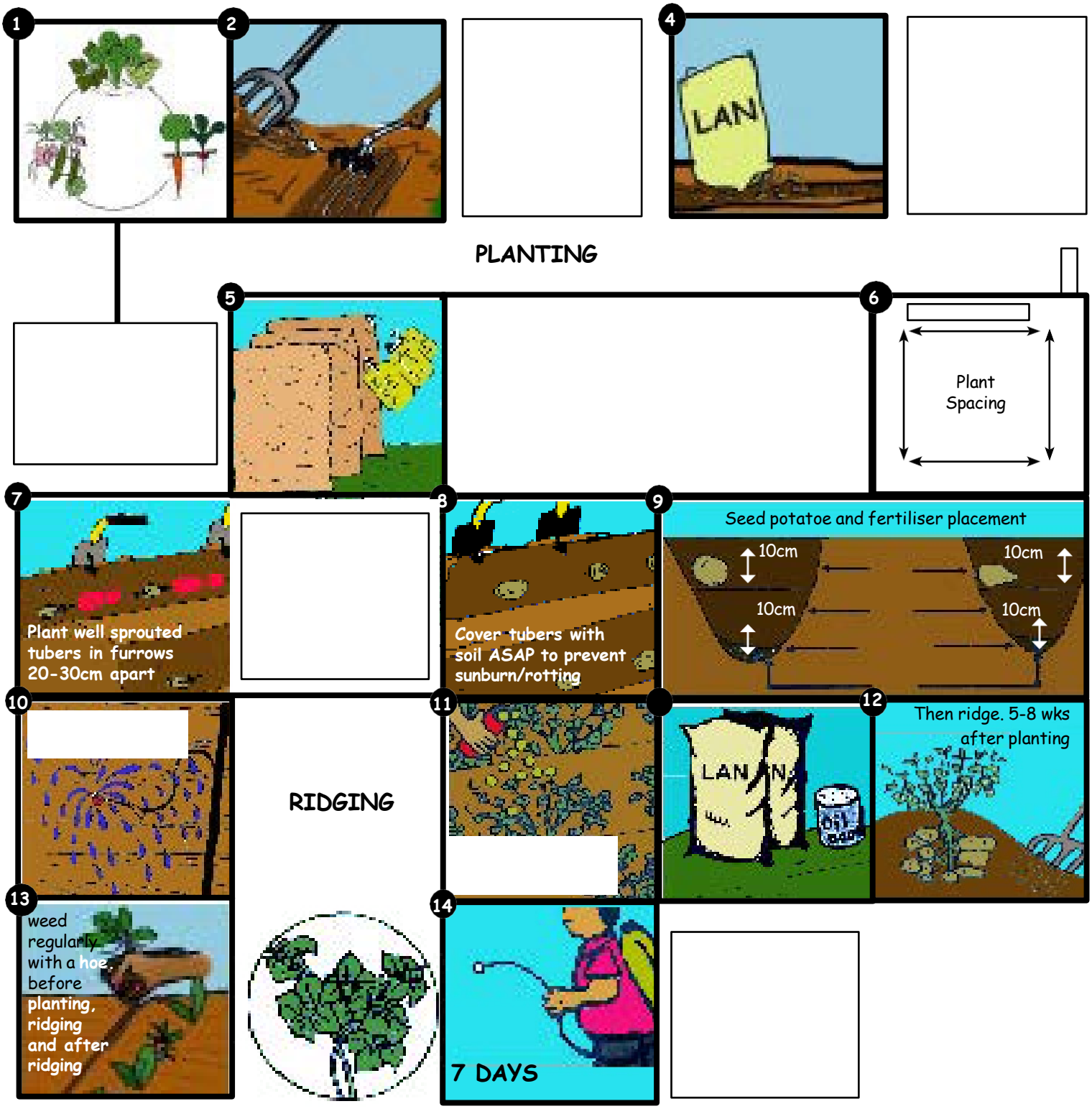
1. Getting Started with Production



2. General Planting Techniques



3. How to Plant Potatoes pg 18.



A sustainable nutrition sensitive agriculture programmeusing nutrition iintervention under nutrition education.

INTRODUCTION

Food allows us to live a healthy, active lifestyle. What we eat (our diet) has the power to keep or make us and our children healthy and give us a better life.

OVERVIEW:

- *Food, Nutrition and Nutrients*
- *Meals And Meal Planning*
- *Food And Nutrition Security*

Key Objectives

1. *Differentiate between food, nutrients, and nutrition.*
2. *Understand the classification of food into different food groups.*
3. *Name the nutrients and discuss their importance in the body.*
4. *List the primary food sources for each of the nutrients*
5. *Understand what food is and nutrition security and how it can be achieved.*

GETTING TO KNOW NUTRITION

What is Nutrition?
The term nutrition broadly covers all processes through which we obtain, prepare and eat food. It further describes what different foods are made of (i.e. nutrients) and the processes through which our bodies make use of the nutrients to enable us to perform daily activities such as work.

Apart from focussing on what we should eat, nutrition is also concerned with promoting aspects or personal and environmental hygiene and sanitation, promoting health seeking behaviours and providing care for all household members so that they are healthy.

What are Nutrients?
Nutrients are the chemical substances found in food. They are extracted from food as it passes through our digestive system and are used by the body to perform its functions.

Nutrients are divided into two broad categories **MACRONUTRIENTS** and **MICRONUTRIENTS.**

1. Macronutrients are required by the body in large amounts, they include carbohydrates, proteins and fat.
2. Micronutrients are required in relatively smaller amounts by the body, they include vitamins and minerals.

The body needs a mixture of both macro and micronutrients for it to be healthy and function optimally. We access these nutrients through eating food.

Micronutrient deficiency refers to insufficient intake or absorption of essential vitamins and minerals necessary for optimal health. It can lead to various health problems and nutrient-specific deficiencies like iron, vitamin A, or iodine.

Dietary diversity, on the other hand, emphasises consuming a wide range of foods to ensure adequate nutrient intake and promote overall well-being.

LET'S GET STARTED WITH SOME DEFINITIONS!

1. Healthy eating plan

Diets aren't just about losing weight. Diet actually means ALL all the foods and drinks we eat, even those that aren't slimming. But oviously to enjoy a long and healthy be we need a good diet. This means lifaving a Healthy Eating Plan that tells us the right type of foods to consume in the right amounts.

2. Mixed Meals

Most mixed meals will include a starchy food, and foods from different food groups.

3. Food groups

Most foods contain many different nutrients, the foods in the food groups used for nutrition education contain similar amounts of the main nutrients. The foods in one group are usually used in a similar way in a mixed meal.

4. Portion

Is the amount of food that a person eats of one food at one time.

5. Unit/Food Guide Unit

A unit of food is calculated based on the nutrition it gives you. So one unit of food in a certain food group, could give you a similar amount ot nutrients as other units in that same group. e.g The unit sizes of different foods are described in different ways, for ***example 1 slice of bread (starchy food) or 1 cup of*** milk (milk group).

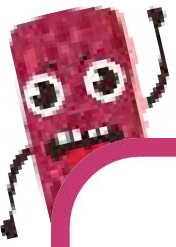
6. Food

Food is defined as any substance that has nutrients (such as carbohydrates, proteins, and fats) that can be ingested by a living organism and metabolised into energy and body tissue.

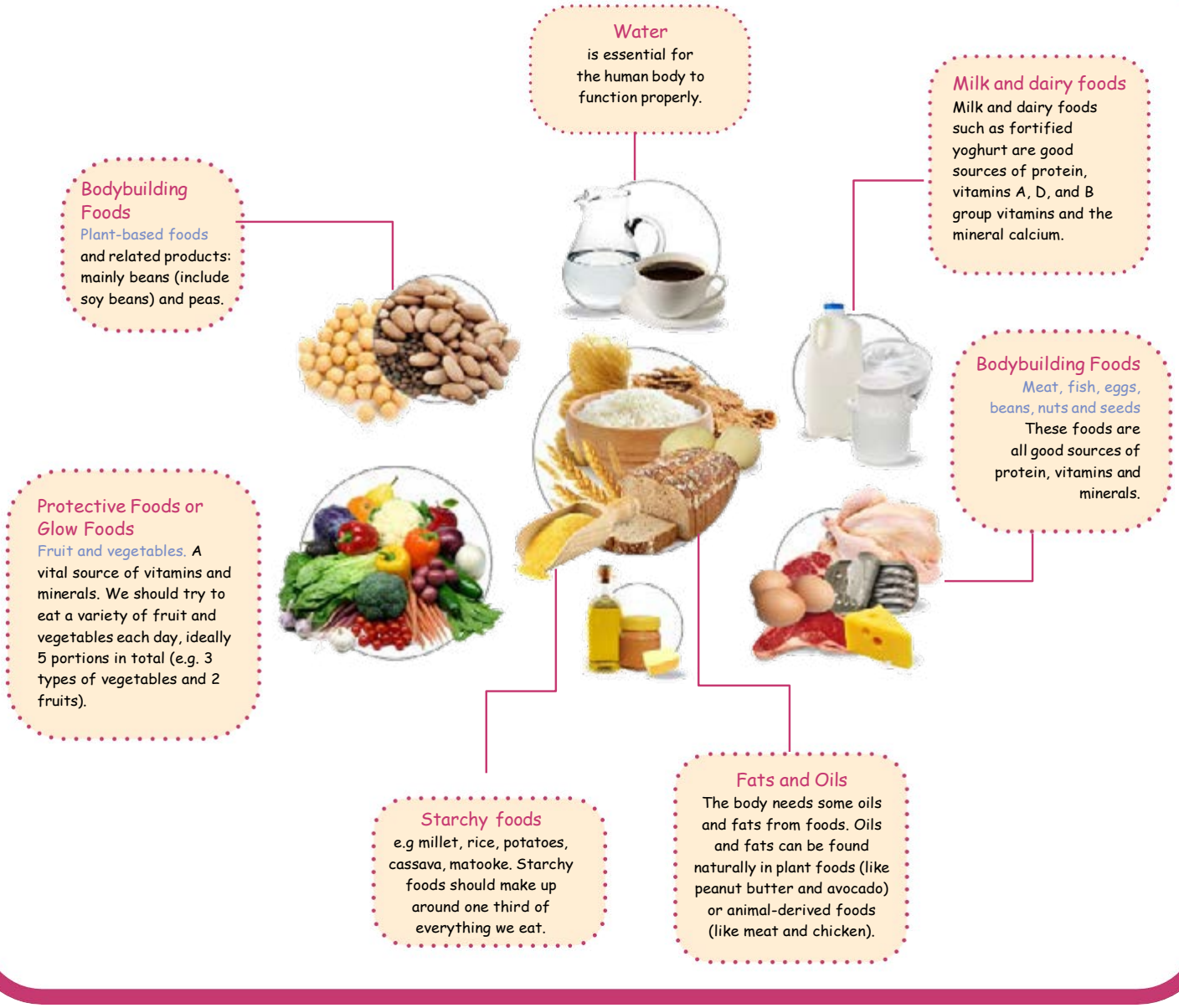
7. Plant Proteins

Eating protein doesn't have to mean eating meat. Plant based proteins are cost-saving and can benefit your health. These proteins include beans, peas and lentils

We use the South African Food Guide to determine how many units of food we need each day, from each food group because according to Food-based dietary guidelines (2023), as of 2020, only seven countries in Africa report having dietary guidelines. South Africa is the closest country to Lesotho and has similar climates, and demographics.



The South African Food Guide



WHAT THE FOOD GUIDE WILL TELL YOU:

- number of units of food from each group needed each day.
- size of each food group unit.
- number of units of food from each food group given at three different typical energy levels.

GUIDELINES FOR HEALTHY EATING

ENJOY A VARIETY OF FOOD

► Healthy eating plans include a variety of foods from each of the food groups.

► Variety also means including foods from two or more food groups at each meal, these are called mixed meals.

► Variety also means preparing foods in different ways.

► People eat because they enjoy food; recommended eating patterns must be tasty and acceptable.

BE ACTIVE!

Regular physical activity has many benefits, including the following:

► It increases blood supply to the heart, lungs and the muscles.

► It reduces the risk of developing cardiovascular disease (CVD), high blood pressure and diabetes

► Burns up energy and builds muscle, which helps with body weight management.

► Strengthens bones, reduces the risk of developing osteoporosis.

► Increases strength and flexibility of joints and muscles.

Drink Lots of Clean, Safe Water

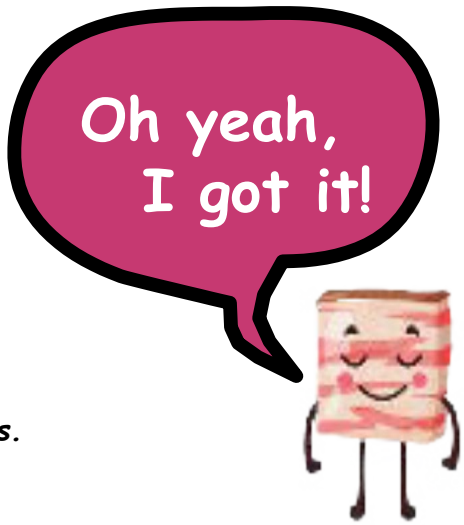
► Drink clean, safe water every day as recommended.

► Water is the most abundant and the most important nutrient in the body.

► Blood is made mostly of water, as are the lungs, muscles and brain.

► The body uses water to regulate body temperature, carry digested foods, remove

LESSON 2: TEST YOUR KNOWLEDGE



Let's See What We Know

Objectives:

- To understand what nutrition and healthy eating habits are.
- To reflect on how eating habits affect our health

Materials

- Pen and Paper, groups of 3

Instructions

Part 1 in groups of 3 answer and discuss the following questions.

1. What is Nutrition?
2. Describe the 2 categories that Nutrients are separated into.
3. What is the Food Guide?
4. How many food groups are there, and can you name them?
5. What are healthy eating habits?
6. What nutrition messages did you not understand?
7. How can you use what you have learned to help friends, family or community members to learn about Healthy Eating?

Part 2: do the following activity individually

1. Make a list of all the foods and liquids you had yesterday, inch chips, water etc
2. Using food guide, fill in the table below which foods you had belongs to which food group.
3. Now, using the food guide unit serves write down how many servings you had.
4. Did you have at least one food from each group?
5. Based on what you learned, how could you improve your diet so that it would include a bigger variety of foods, especially from the grains group and the fruits and vegetables group?

Part 2: Step 1, list your foods and liquids

Part 2: Step 3 and 4, fill in the Food groups for your meal

	intake				
Starchy Foods					
Fruit and Vegetables					
Dry beans etc					
Meat, Chicken, Eggs, fish					
Milk, Maas Yoghurt					
Fat/Oil					
Sugar					

Use the Guidelines for Healthy Eating to design a healthy eating plan.
Incorporate good mixed meals, with snacks in-between.

Make sure you get a balanced intake.
Children
- Must eat about **3-6 times a day**
High energy needs e.g active men, teenage boys
- May need snacks between meals to achieve their food needs.

STEPS TO PLAN GOOD MIXED MEALS

PLAN
Identify the meals and snacks that will be eaten during the day and remember to include times to have something to drink.

MEAL FOUNDATION
starchy food should be part of most of the meals. Other foods should be eaten together with the starchy food.

FRUIT & VEG
When available, use a variety of vegetables and fruit. Use one vegetable or fruit that contains beta-carotene each day.

REMEMBER: BE ACTIVE!
DRINK WATER.

HEALTHY EATING PLAN PATTERNS

To have a healthy eating plan:

Use foods from most of the food groups, most days of the week.

Make a plan with the foods you have available to you and that you can afford.

Enjoy a variety of foods from each food group, within a day, from week to week and during the year when different foods are available.

Eat the right amount for your needs

The eating plan will have plant-based and animal-based foods.

Water is an important part of healthy eating, make plans to be sure you have water available during the day.

Below are 2 eating plans based on the ***Guidelines for Healthy Eating***

ENERGY NEEDS FOR DIFFERENT GROUPS OF PEOPLE

	ENERGY INTAKE KILOJOULES (KJ) PER DAY	
Age Group	**Men/Boys**	**Women/Girls**
5 - 9	6500	6 500
10 - 13	8 500	8 500
14 - 18	10 500	8 500/10 500
Adults	10 500	8 500
Sedentary Adults/Older Adults	8 500	6 500

Additional units from the food groups will be needed by people who are taller than average and/or who are very active. Discretionary foods (foods with little nutritional value) may be eaten on occasion instead of some of the units of starchy foods.

Food Intake Pattern A

AGE GROUP ENERGY LEVEL	STARCHY FOODS	VEGGIES	FRUIT	DRY BEANS, SPLIT PEAS, LENTILS, SOYA	FISH, CHICK-EN. LEAN MEAT, EGGS	MILK, MAAS, YOGHURT	FAT, OIL	SUGAR
6 500 kJ	8	3	1	1	1	1	4	2
8 500 kJ	11	3	1	1	1	1	6	6
10 500 kJ	15	3	1	1	1	1	8	6

Food Intake Pattern B

AGE GROUP ENERGY LEVEL	STARCHY FOODS	VEGGIES	FRUIT	DRY BEANS, SPLIT PEAS, LENTILS, SOYA	FISH, CHICK-EN. LEAN MEAT, EGGS	MILK, MAAS, YOGHURT	FAT, OIL	SUGAR
6 500 kJ	5	3	2	1	2	1	4	2
8 500 kJ	7	3	1	1	2	2	6	6
10 500 kJ	10	5	2	1	2	2	8	6

Pattern A is similar to how people in South Africa eat. It has more units of starchy foods than **Pattern B.**

Pattern A includes more vegetables and fruit than most people are eating, as this is a food group that many people do not include in their meals often enough.

Pattern B has more units from all the food groups, except starchy foods.

All the groups make a unique contribution to the eating plan, and they should not skip out any otherwise you won't get all the nutrients.

Sometimes others have to change their eating plans according to the recommended quantities from the food guide. **Things like:**

- *Replacing large servings of starch with smaller servings and including vegetables in the meal.*
- *Replacing large servings of fatty meat with smaller servings of lean meat and including vegetables and beans in the meal.*
- *Taking a food box to school /work with sandwiches, fruit and water, instead of buying fried potato chips and a cold drink.*
- *Using low fat milk in tea and coffee instead of tea/ coffee whitener.*

SAMPLE MENU

Breakfast

Soft maize porridge	Breakfast cereal	Soft maize porridge
Milk	Milk	Milk
Sugar	Sugar	Sugar

Mid-morning snack

Brown bread	Banana	Cheese
Margarine	Brown bread	
Jam	Margarine	

Lunch

Brown bread	Brown Bread	Peanut butter
Margarine	Margarine	Jam
Jam	Boiled egg	
Apple	Brown Bread	

Supper

Beef and bean stew	Phutu	Samp and beans Samp
Beef	Chicken Stew	Margarine
Beans	Chicken	Beans
Onion	Oil	Tomato
Tomato	Onion	Onion
Carrot	Carrot	Green beans
Spinach	Rice	
Margarine	Butternut	
	Tomato	

Daily

Milk	Milk	Milk
Sugar	Sugar	Sugar
Water	Water	Water

Summary Lesson 2

We need a **BALANCED DIET** to stay healthy. Children also need to grow well. both physically and mentally. Eating a diet with mixed meals lets us get different nutrients. Most foods give us more than one nutrient. We need to eat all of them in the right amounts. Summarize the table below.

TYPES OF NUTRIENTS	FOODS THAT CONTAIN THESE NUTRIENTS	BENEFITS OF THESE NUTRIENTS
Proteins		
Carbohy-drates		
Fats		
Vitamins & Minerals		
Nutritious diets do not have to be expensive; the key is to consumea variety of locally available/grown food on a daily basis.		

MARKET AND PRODUCTS:

DEVELOPING SAFE AND NUTRITIOUS FOODS FOR LOCAL FOOD ENVIROMENTS

Overview

Food safety and hygiene
Food storage, preparation, and preservation
Market and product

Introduction

Food safety is important for everyone. It makes sure that you, your family and or community is safe from illnesses you can get from foods.

This section will help us understand food safety and how we can maintain it. Food preparation with the means to retain nutrients. Food preservation to extend the shelf life of your vegetables and create availability with food out of season. This helps to reduce food security.

Key Objectives

1. *Understand what food safety and hygiene is.*
2. *Demonstrate good practices with*

THE CONCEPT OF FOOD SAFETY AND HYGIENE

Once food has been harvested, gathered, or slaughtered, enzymes and bacteria become active in this food. These little guys cause food to rot and then we can't eat it. This is called DECAY. Food safety and hygiene involves preventing food getting contaminated and spoiling.

Why Process the Food?

Food can rot in different ways:

- by internal reactions between its components,
- by the reaction of the components with water and air or
- through enzymatic and toxic effects, due to the development of microorganisms and to the presence of chemical elements.

So, we process food to:

- slow down the rotting process by interfering with the chemical and physical reactions reducing the development of unwelcome micro-organisms.
- Increase the food flavour.
- Making the food more attractive for the consumer.
- Facilitating its commercialisation.

THE IMPORTANCE OF FOOD HYGIENE AND FOOD SAFETY

Germs in the environment and on food can easily multiply and contaminate foods. Eating contaminated food can lead to serious illness. To reduce the risk of food poisoning it is important to follow the basic rules of good hygiene at all times when handling and storing foods. The World Health Organisation has produced a publication called:

The Five Keys Of Food Safety

KEEP CLEAN

- Wash your hands before handling food and often during food preparation.
- Wash your hands after going to the toilet.
- Wash and disinfect all surfaces and equipment used for food preparation.

SEPARATE RAW AND COOKED

- Separate raw meat, chicken and fish from other foods.
- Use separate equipment and utensils, e.g. knives or cutting boards for handling raw foods.

COOK THOROUGHLY

- Cook food thoroughly (especially chicken, fish, meat and eggs), to kill bacteria.
- Bring foods like soup and stew to the boil to ensure they have reached 70 °C. For meat and chicken, make sure that juices are clear, not pink.
- Reheat previously cooked food thoroughly.

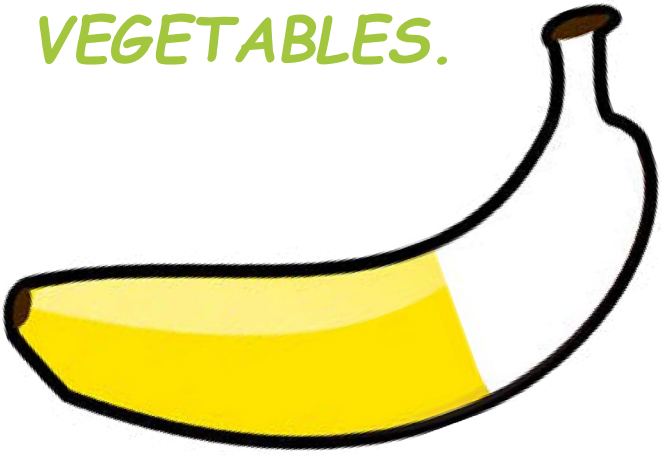
KEEP FOOD AT SAFE TEMPERATURES

- Do not leave cooked food at room temperature for more than two hours.
- Refrigerate all cooked and perishable food promptly.
- Keep cooked food hot before serving.
- Do not store food too long, even if in the refrigerator.
- Do not thaw frozen food at room temperature.

USE SAFE WATER AND RAW MATERIALS

- Use safe water or treat it to make it safe.
- Select fresh and wholesome foods.
- Choose foods processed for safety, e.g. pasteurised milk.
- Wash vegetables and fruit, especially if eaten raw.

NUTRIENT RETENTION DURING PRESERVATION OF VEGETABLES.



Fruit and vegetables play a significant part in protecting an individual from various chronic diseases, which include cardiovascular disease, type 2 diabetes mellitus, obesity and adiposity, macular degeneration, and some cancers. The World Health Organization (WHO) recommends that an individual should eat 400g (five servings of 80 g) of fruits and vegetables a day, and this requirement is evident in both the Dietary Guidelines for Americans and Food-based dietary guidelines for South African (FBDGs). Fruit and vegetables provide the body with essential vitamins and minerals, fiber, and nonessential nutrients known as phytochemicals which have health benefits such as antioxidant, anti-inflammatory, lipid-lowering, blood pressure, and endothelial function.

Guidelines in maximising nutrient retention during preservation in bottling and cooking the following vegetables.

Before consuming vegetables, vegetables typically go through cleaning, washing, peeling, cutting, and cooking if not eaten raw. Heat treatment such as steaming, blanching, and boiling in a small amount of water or adding oil to vegetables affects their nutritional value. Some nutrients are lost during cooking because they are either water-soluble, fat-soluble or heat sensitive.

Preparing vegetables, cooking vegetables, and nutrient loss when you trim or peel vegetables, it is worth remembering that most vitamins and minerals are situated close to the skin surface or outer leaves of most vegetables. If vegetables are thickly peeled, you can lose a large proportion of the food's nutrient value; folate and vitamin C, for example, **25%,** can be lost, and trace elements (microminerals) are also lost by thick peeling but in smaller proportions. Fibre can be lost in large proportions, and protein can be reduced by **10%.** The effect is amplified when you consider the amount of nutrient content that is also lost if vegetables are subsequently boiled – for example, up to **90% of vitamin C** is lost during boiling, calcium levels are reduced by around **50%** along with folate and fibre, trace elements are also lost during boiling and depending on the element this loss can be from **10-20%.** Some foods, e.g. tomatoes, lose **100% of folate and vitamin C** during cooking. When you boil vegetables, vitamins within them dissolve (solubilise) in the water. Suppose you want to avoid this to an extent. In that case, you should consider steaming, grilling, roasting, stir-frying, or micro-waving because these methods generally tend to preserve vitamins and other nutrients far more efficiently than boiling. Temperature can also affect nutrient loss – by keeping the cooking temperature below 100°C; you can considerably improve the retention of the vitamin B group.

Cooked Food - The Benefits

There are advantages to cooked food. It does not always lower the nutrient value. Benefits of cooking food:

- It destroys bacteria and other harmful organisms that can contaminate food.
- It breaks down toxins in some foods that may be harmful in raw food but not when cooked.
- It removes environmental pollutants.
- It makes phytochemicals unavailable in some raw food more available (e.g., in tomatoes).
- The food is tastier.
- It makes indigestible vegetables digestible (by breaking them down).

Vegetables	Nutritional information (per 100g)			Water soluble Or fat soluble	Method of cooking	Cooking Guidelines
Onions 		**Raw**			Sautee, fry, sweat or eat raw	
	Potassium, vitamin C, folic acid, vitamin $B_{6,}$					
	Water	89.7%				
	Protein	1.2g				
	Fat	0.2g				
		8.6g				
	Fiber	1.6g				
	Kilojoules	38				
cabbage 		**Raw**	**Cooked**	**Water soluble vitamins** can leach into cooking water. This means some vitamin content is often lost through evaporation. Degradation will depend on the amount of heat applied. Cooking can also make these vitamins more bioavailable. Conversely, it can also degrade these vitamins, ultimately reducing the overall content. Consuming too much of water-soluble vitamin is difficult because excess is excreted. This group includes the B vitamins and vitamin C. **Water-soluble vitamins:** vitamin C and B vitamins are most vulnerable to degradation during the cooking process, including thiamine (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5), pyridoxine (B6), folic acid (B9), and cobalamin (B12) **Fat-soluble vitamins** are also affected by cooking. They will not leach into cooking water but can leach into fats such as olive oil or butter. These vitamins can degrade with cooking, but not as easily as water soluble vitamins do. When consumed in excess, fat soluble vitamins can be stored in the body's fat deposits. Over time, this accumulation can be dangerous.	Sweat, sauté, fry, blanch, or steam. Eat raw	**If a vegetable's skin is edible don't peal it off.** Many nutrients are concentrated in or just underneath the skin. It also protects vegetables during the cooking process to help retain nutrients. **Limit cooking time.** For the most part, vegetables will retain more nutrients when they are exposed to heat for a shorter time. **When cutting vegetables before cooking, make larger chunks.** If you can minimize the surface area that's exposed to heat, you'll lose fewer nutrients. Do not cook for an extended period, prolonged cooking makes the vegetables lose the nutrients. Do not overcook; the vegetable loses their texture and fibre. Mild vegetables lose flavour when cooked in water (sugar dissolves in cooking medium) therefore: • limit water • limit cooking time
		Potassium Vitamin C, Folic acid, Vitamin $B_{6,}$	Folic acid, Vitamin C, Potassium			
	Water	93%	93.6%			
	Protein	1.2g	1.0g			
	Fat	0.2g	0.2g			
	Carbohydrates	5.4g	4.8g			
	Fiber	1.8g	1.7g			
	Kilojoules	24	21			
swiss chard 		**Raw**	**Cooked**		Sweat, sauté, fry, blanch, or steam Eat raw	
	Raw and cooked Copper, riboflavin, Vitamin $B_{6,}$ calcium	Potassium Vitamin C Vitamin A Magnesium Iron Folic acid	Vitamin C Iron Folic acids			
	Water	92.7%	92.7%			
	Protein	1.8g	1.9g			
	Fat	0.2g	0.1g			
	Carbohydrates	3.7g	4.1g			
	Fiber	1.6g	2.1g			
	Kilojoules	19	20			
Green Beans 		**Raw**	**Cooked**		Sweat, sauté, fry, blanch, or steam	
		Potassium Vitamin C Vitamin A Magnesium Iron Folic acid Thiamine Niacin	Vitamin C Iron Folic acids Potassium Vitamin A Copper			
	Water	90.3%	89.2%			
	Protein	1.8g	1.9g			
	Fat	0.1g	0.3g			
	Carbohydrates	7.1g	7.9g			
	Fiber	1.8g	2.4g			

Vegetables	Nutritional information (per 100g)			Water soluble Or fat soluble	Method of cooking	Cooking Guidelines
Beetroot 		**Raw**	**Cooked Leaves**	**Fat-soluble vitamins:** vitamins A, D, E, and K **Minerals:** primarily potassium, magnesium, sodium, and calcium **Vitamins that are the most unstable when cooked/ processed and stored:** • Ascorbic Acid (vitamin C) • Folic Acid (vitamin B9) • Thiamine (vitamin B1) **Vitamins that are more stable when cooked, processed, or stored:** • Niacin (vitamin B3) • Pantothenic acid (vitamin B5) • Biotin (vitamin B7) • Vitamin D • Vitamin K	Simmer or eat raw Boil: use little water and cook for 10-15 minutes until tender. Steamed: cut into chucks use a colander cook for 15-45 minutes. Eat raw Sauté or fry Eat raw	**Limit the amount of water exposure.** In both preparation and cooking, soaking and cooking vegetables in water will leach out water-soluble vitamins. This is why boiling vegetables should almost always be your last choice if you want to maximize nutrient retention (Simmer and do not boil). Shallow fry, sauté, or stir-fry **Space vegetables out.** By cooking vegetables in a loose pile or single layer, you're heating all of the food surfaces quickly and evenly. The quicker the vegetables cook, the more nutrients they contain. **Blanching** is the plunging of a food item into boiling water for a very short time before removing it and transferring it to cold or icy water. The cold water stops the cooking process. Blanching can remove the bitter taste from some vegetables and can also enhance their colour, making them more appealing. The application of very high heat will kill many microorganisms and will also soften the tough fibres in vegetables.
	Potassium, vitamin A, Vitamin C, riboflavin, magnesium, iron, copper, calcium, thiamine, zinc, niacin,Folic acid, Vitamin B_6					
	Water	89%	90.9%			
	Protein	2.6g	1.1g			
	Fat	0.2g	0.1g			
	Carbohydrates	5.5g	6.7g			
	Fiber	2.9g	2.2g			
	Kilojoules	27	31			
Carrot 		**Raw**	**Cooked**			
	Raw and cooked Vitamin B_6, Folic acids and Magnesium	Thiamine, Vitamin C Vitamin A Magnesium Iron Folic acid	Vitamin C Iron Potassium Copper			
	Water	87.8%	87.4%			
	Protein	0.9g	1.2g			
	Fat	0.1g	0.1g			
	Carbohydrates	3.2g	10.5g			
	Fiber	1.6g	1.9g			
	Kilojoules	43	45			
Red Pepper 		**Raw**				
	Vitamin C, vitamin A, potassium, Vitamin B6, Folic acid	Potassium Vitamin C Vitamin A Magnesium Iron Folic acid Thiamine Niacin				
	Water	92%				
	Protein	0.9g				
	Fat	0.2g				
	Carbohydrates	6.4g				
	Fiber	2g				
	Kilojoules	27				

Vegetables	Nutritional information (per 100g)			Water soluble Or fat soluble	Method of cooking	Cooking Guidelines
Tomato 		**Raw**	**Cooked Leaves**		Sautee, fry or eat raw	**Limit the amount of water exposure.** In both preparation and cooking, soaking and cooking vegetables in water will leach out water-soluble vitamins. This is why boiling vegetables should almost always be your last choice if you want to maximize nutrient retention (Simmer and do not boil). Shallow fry, sauté, or stir-fry **Space vegetables out.** By cooking vegetables in a loose pile or single layer, you're heating all the food surfaces quickly and evenly. The quicker the vegetables cook, the more nutrients they contain. **Blanching** is the plunging of a food item into boiling water for a very short time before removing it and transferring it to cold or icy water. The cold water stops the cooking process. Blanching can remove the bitter taste from some vegetables and can also enhance their colour, making them more appealing. The application of very high heat will kill many microorganisms and will also soften the tough fibres in vegetables.
	Potassium Vitamin C Folic acid Vitamin A,					
	Water	93.8%	92.2%			
	Protein	0.8g	1.1g			
	Fat	0.3g	0.4g			
	Carbohydrates	4.6g	5.8g			
	Fiber	1.2g	1.5g			
	Kilojoules	21	27			
Butternut 		**Raw**	**Cooked**		Boil: Cut 2-4cm cubes use little water and cook for 10-15 minutes until tender. Steamed: cut into chucks use a colander cook for 15-45 minutes.	
	Potassium, Vitamin C Vitamin A, Folic acid, pantothenic acid, and copper					
	Water	93.7%	89%			
	Protein	0.9g	0.9g			
	Fat	0.3g	0.6g			
	Carbohydrates	4.3g	8.8g			
	Fiber	1.6g	2.8g			
	Kilojoules	20	39			
Potatoe 		**Raw**	**Cooked**		Boil	
	Potassium, Vitamin C, Folic acid, Vitamin B_6, copper, niacin, magnesium, iron, pantothenic acid					
	Water	79.4%				
	Protein	2.1g				
	Fat	0.1g				
	Carbohydrates	18g				
	Fiber	1.8g				
	Vitamin C	19mg				
	Kilojoules	79				

Items Required For Food Preservation: Canning

Assortment of jars and lids.

Large pot for sterilising jars.

Small pot for soaking lids.

Kettle for boiling extra water.

A jar rack

A jar lifter for handling hot jars or tongs

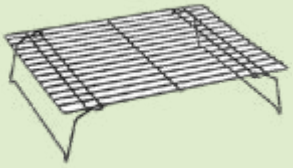
A wide mouth funnel

A ladle

A metal skewer stick

A silicon specular

Cloth towels for cooling jars



A cooling rack

A kitchen timer

Step 1




1. Sort the jars, discard jars with cracks or that are chipped and discard the lids that are dent or rusted.
2. Wash all the jars in hot water with soap then rinse well under running water.
3. When using recycled jars; soak them in warm soapy water over night to remove all the old labels. After removing the labels wash all the jars in hot water with soap then rinse well under running water.




4. In a large pot place the jars and fill both the jars and the pot with water and bring to boil. When the water has reached the boiling point leave the jars to boil for ten minutes.
5. Leave the jars in hot water until one is ready to use them.
6. In a small pot place the lids in hot water but not boiling water. Leave the lids for ten minutes to soften the rub seal.
7. Leave the lids in warm water until you are ready to use them.

Step 2

Preparing the water bath and canning

1. In the canning pot fill the pot halfway with water.
2. Fill the jars using the wide mouth funnel and ladle with the prepared recipe (the recipe will indicate how much space to leave by the lids).
3. Gently use the silicon specular to press down the contents in the jar and use the metal skewer to release the bubbles.

4. Wipe the jars with the clean cloth, use the tongs take the lids from the hot water and place on the jars and seal but not tightly.

5. Place the jars onto the jar rack and gently place the jar rack into the pot filled with halfway water.

6. Turn the stove on bring the water to simmer and allow the water to boil as soon as the water starts to boil vigorously place the pot lid and reduce the heat and let the water boil gently for as long as the recipe calls for. Use the timer to keep the correct time.

Step 4

Cooling down

1. Once the recipe has reached its cooking time, switch off the stove and take the jars out of the pot using the jar lifter.

2. Place the jars on the cooling rack or colling towel and leave enough space between the jars and let the jars to cool at room temperature.

3. As the jars cool down one will hear a little pin sound from the center of the jars' lids. That means the jars are vacuum sealing themselves (this a good sound) and they are ready for storage.

4. Label the jars (name of the product and date it was made).

WATER BATH CANNING TOMATOES

What you will need

- a boiling water bath bottle
- 2 large saucepans
- litre jars, lids and sealing surfaces (flats and rims)
- fresh tomatoes
- bottled lemon juice
- canning salt

Water Bath Method Instructions

1. Fill a large saucepan two-thirds full of hot water to boil.

2. Fill boiling water bath canner half-full of hot water. Put canner on to heat.

3. Examine jars and sealing surfaces to make sure that all surfaces are smooth. Wash jars and sealers (rims) in hot, soapy water. Rinse well. Leave jars in hot water until needed.

4. Put lids (flats) in saucepan filled with water, and place on stove to simmer until needed.

5. Select just enough tomatoes for one canner load. Make sure tomatoes are fresh, firm and red ripe. Wash tomatoes and drain. Put in wire basket, and lower into boiling water in the second large saucepan. Remove after about 60 to 90 seconds, or when skin begins to crack. This depends upon the size of tomatoes – smaller varieties may only take 30 seconds.

6. Dip tomatoes into cold water. Cut out cores and remove skins. You can leave the tomatoes whole or cut them in half. Place in a large pot; add enough water to cover tomatoes. Boil gently for 5 minutes.

7. Remove 1 jar from hot water and drain.

8. Add 2 tablespoons of bottled lemon juice to each quart jar. If using pint jars, use 1 tablespoon lemon juice.

9. Pack hot tomatoes into jar, leaving ½-inch headspace. Pour hot cooking liquid over tomatoes, leaving ½-inch headspace. Add 1 teaspoon canning salt to each quart jar (½ teaspoon for pint jars).

10. Run a nonmetallic spatula between tomatoes and jar to release any trapped air bubbles. Wipe top and threads (the screw threads at the rim) of the jar with clean, damp cloth.

11. Using tongs, remove 1 lid from simmering water and place it flat on top of jar so sealing compound is against jar. Screw band down evenly and firmly.

12. Repeat steps 10 and 11 with all jars. As each jar is filled, stand it on rack in canner of hot, not boiling, water, which should cover jars by 1 to 2 inches. (Add additional water if necessary.) Put cover on canner and bring water to a boil.

13. Process quarts for up to 45 minutes (40 minutes for pints) at a gentle but steady boil.

14. Using tongs, carefully remove jars from bottle and set on a wood or cloth surface, placing jars several inches apart and out of drafts. Do not retighten bands. Allow jars to cool about 12 hours.

15. Remove bands (rims) and test seal. Wash outside jar surface. Store in a dry, dark and cool place.

WATER BATH CANNING GREEN BEANS

What you will need

• Fresh green beans – on average you'll need 1 pound of green beans per pint (or 2 pounds per quart).

• Canning salt (salt is optional but highly recommended).

Preparing Green beans for canning

• Pick your green beans, avoid beans that have blemishes or rust spots, choose beans that are tender, and crisp when snapped. The beans will be the crispest when picked in the morning.

• Rinse green beans thoroughly then strain.

• Trim off ends, string if beans are a string variety, and snap into 1 to 1- and 1/2-inch (bite-sized) pieces.

Water Bath Method Instructions

1. Place pressure canner on stove-top and fill with rack and hot water, water level should be 2 to 3 inches deep. Turn burner on medium heat to keep water at 140 degrees Fahrenheit. Fill a kettle with water and bring to a boil.

2. Wash Mason jars and lids in hot soapy water. DO NOT boil the lids. Canning lid guidelines changed in 2014 and boiling the lids can affect their ability to seal. You do not need to sterilise lids or jars as long as you're processing jars for 10 minutes or longer (which you definitely are when pressure canning). Place freshly washed jars on a clean towel on the counter.

3. Fill Mason jars with green beans to a 1-inch headspace (space from the top of the green beans to the top of the jar). Add 1/2 teaspoon salt to pint jars or 1 teaspoon salt to quart jars (salt is optional but does provide better flavor). Always use canning salt or sea salt with NO added anti-caking agents or ingredients, regular table salt is not recommended.

4. Pour just off the boil water over the top of the green beans until the liquid level reaches the 1-inch headspace.

5. Use a canner bubble/ headspace tool (or ruler if you don't have a headspace tool) to remove air bubbles by running it between the glass and outside of the food. Re-measure your headspace and add extra water if needed.

6. Use a damp cloth and wipe the rim of your glass jar clean. This helps to ensure there's nothing that will inhibit a seal from forming. Place lid and canning band on and tighten to fingertip tight (over-tightening canning bands can cause lids to buckle). Place in the prepared pressure canner.

7. Place lid on the pressure canner and allow to vent for 10 minutes. Then place weight on pressure canner according to your altitude and process for 20 minutes for pint jars or 25 minutes for quart jars. Remove from canner following pressure canning protocol

PRESSURE CAN POTATOES

What you will need

1. 6 pounds white potatoes.
2. Canning salt optional for flavour

Can the potatoes:

1. Spread a kitchen towel on the counter. Use your jar lifter to remove a jar from the canner. Pour out the water and place the jar on the towel. Keep the remaining jars in the canner.

2. Use tongs or a slotted spoon to remove the potatoes from the pot and fill the jar while maintaining about a 1 1/2-inch headspace.

3. If using salt, add up to 1/2 teaspoon to each litre, and up to 1 teaspoon to each litre (Salt is optional but adds a lot of flavor).

4. Add fresh hot water to the jar, leaving a 25.4 mm headspace.

5. Run your bubble popper through the jar to release any bubbles that may be caught in between the potatoes and wipe the rim with a damp towel.

6. Center a lid on the jar, and screw on band until it is fingertip tight. Use the jar lifter to place the jar back on the rack in the canner and repeat with the rest of the jars until the canner is filled, or you run out of potatoes.

7. Secure the lid, leave the vent open, adjust the heat to medium-high, and bring the canner to a boil. Allow the pressure canner to vent for 10 minutes, then place weight on the vent. Follow the directions for your pressure canner.

8. Once the canner has reached the correct pressure (10 pounds of pressure for weighted gauge pressure canner, and 11 pounds for dial gauge canners.), set a timer, and process pints for 35 minutes, and quarts for 40 minutes at altitudes of less than 1,000 ft. Adjust for your altitude if necessary (see note below). Regulate the heat as needed to maintain a steady pressure.

9. When processing time is complete, turn off the heat and let the pressure canner cool and depressurise. The time will depend on your brand and should be between 30 to 60 minutes.

10. When the pressure canner is depressurised, spread a kitchen towel on the counter, remove the weight from the vent pipe or open the petcock, and wait 10 mins for the jars to adjust to the change in pressure.

11. While wearing potholders, unlock the cover and remove the lid while tilting it away from you so that steam does not burn your face. Allow another 10 minutes for the jars to adjust to the change in pressure.

12. Use a jar lifter to remove the jars from canner and place on the towel. Keep the jars upright, and don't tighten bands or check the seals yet. The jars will be hot and bubbling. Let the jars sit undisturbed for 12 to 24-hours to cool.

13. After 12-hours, check that the jar lids have sealed. Do this by pushing on the center of the lid. The lid should not pop up.

14. Remove the screw on bands and wash the jars.

LESSON 3: TEST YOUR KNOWLEDGE

Let's See What We Know

Objectives:

- To understand how we can practise better food safety.

Materials

- Pen and Paper, groups of 3

Instructions

In groups of 3 answer and discuss the following questions.

1. Why is it important to prepare food in a hygienic way?
2. When should we wash our hands? How should we wash and dry our hands?
3. Why is it important to get rid of faeces from adults and children safely? How can we do this?
4. Is the local water supply safe to drink? If not, what should we do?
5. Is the local milk safe to drink? If not, what should we do?
6. Why should we prevent raw meat, poultry and fish from touching other foods?
7. How can we do this?
8. How should we store different types of food (e.g. vegetables, meat, cooked foods)?
9. How should we deal with waste from food?
10. What should we do with mouldy food?

Working With Your Community

This activity will take 2 or more group meetings to complete.

Objectives

- Taking community action
- Applying food safety knowledge to real life

Materials

- Paper and pencils for your group members to each write the interview questions.

Instructions

Compile a survey on food and water safety in the community.

1. Discuss to identify areas of concern about food or water safety in the community or village. Some examples could be:
   - ***Water points,*** *are these clean and in good condition? Are animals kept away?*
   - ***Rubbish disposal,*** *does rubbish and litter just lie around or is it properly disposed of?*
   - ***Food shops and open markets,*** *are these clean? Is food prepared, stored and served safely?*
2. Discuss any areas of possible solutions to any problems.

Let's make a poster!

1. Create an awareness campaign poster for your community educating on Food Safety and Hygiene.

APPENDIX A

FOOD GUIDE UNIT SERVINGS

FOOD GROUP	FOODS	UNIT
Starchy foods	Bread, brown/ white Porridge, soft Maize meal, dry Potato Rice, cooked Samp, cooked Pasta, cooked Breakfast cereal Cut corn, mealie kernels Whole grains, cooked Popcorn, popped, no salt or fat added	1 slice $^1/_2$ cup 3 heaped tablespoons 1 medium potato $^1/_2$ cup $^1/_2$ cup $^1/_2$ cup Varies $^1/_2$ cup $^1/_2$ cup 2 cups
	All fresh / frozen vegetables (not potatoes) Raw leafy vegetables All fresh fruit	2 cup cooked 1 cup raw 1 piece medium sized fruit e.g. apple, banana. 2 pieces of small fruit e.g. apricots, plums piece large fruit e.g. grapefruit. cup chopped fruit 2 cup fruit juice 2 tablespoons raisins
Dry beans, split peas, lentils, soya	Dry beans, cooked Lentils, split peas, cooked Soya mince, dry	$^1/_2$ cup $^1/_2$ cup 30g
Fish, chicken, lean meat, eggs	Fish, white Fish, high fat flesh Chicken, no skin Meat, lean Eggs, hens Liver Cheese, yellow	1 large piece 1 small piece 1 medium breast Size palm, sliced 10mm 2 3 cube 30mm3/40g/size of a matchbox
Milk, maas, yoghurt	Milk (low fat or skim preferred) Maas (low fat preferred) Yoghurt, low fat/fat free;	1cup 1cup limited 1 tub, 100ml added sugar
Fat/oil	Oil; sunflower, canola, olive or other plant oil Tub margarine Peanut butter	1 teaspoon 1 teaspoon 1 heaped teaspoon
Sugar	Sugar, brown or white Jam	1 teaspoon 1 heaped teaspoon