ADDRESSING FOOD AND NUTRITION INSECURITY THROUGH THE DEVELOPMENT AND IMPLEMENTATION OF AN AGRICULTURAL AND NUTRITION EDUCATION PROGRAMME ON LEGUMES FOR OLDER FARMERS LIVING IN MARIANNHILL, KWAZULU-NATAL- SOUTH AFRICA

Dissertation submitted in fulfilment of the requirements for the degree of Doctor of Applied Science in Food and Nutrition in the Department of Food and Nutrition: Consumer Science, Faculty of Applied Sciences at Durban University of Technology

by

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DECLARATION

ADDRESSING FOOD AND NUTRITION INSECURITY THROUGH THE DEVELOPMENT AND IMPLEMENTATION OF AN AGRICULTURAL AND NUTRITION EDUCATION PROGRAMME ON LEGUMES FOR OLDER FARMERS LIVING IN MARIANNHILL, KWAZULU-NATAL- SOUTH AFRICA

Nkumbulo Xolile Mkhize

I Nkumbulo Xolile Mkhize hereby declare that work presented in this dissertation format and has not been presented or previously accepted in substance for any degree and is not being concurrently submitted in candidature for any degree within any other tertiary institution.

Signature: **Date**:

REFERENCE DECLARATION IN RESPECT OF A DOCTORAL DISSERTATION

I Nkumbulo Xolile Mkhize and my supervisors hereby declare that in respect of the following dissertation:

Addressing Food and Nutrition Insecurity through the Development and Implementation of an Agricultural and Nutrition Education Programme on Legumes for Older Farmers Living In Mariannhill, KwaZulu-Natal- South Africa

As far as we know and can ascertain: No other dissertation exists: All references as detailed in the dissertation are completed in terms of all personal communications engaged in and published works consulted.

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DEDICATION

I dedicate this dissertation to all the elderly citiziens of this country and especially to those who have faced so many challenges over decades due to social and racial injustices. Yet, you have managed to rise up from hardship and nothingness but yet raise a generation of young people who will be the leaders of tomorrow. I also dedicate this dissertation to both elderly smallholder and commercial farmers who persist in ensuring that our country has a stable food supply. Your hard work has achieved food security for many regardless of the harsh conditions of climate change and market instability. Without your dedication and perseverance, there would not have been national and household food security in this country. May the nation and the government recognise the role of elderly citizines in our society and acknowledge the challenges they face as a vulnerable group of people. The elderly farming community in particular adds to the pillars of the South African economy. These farmers ensure the survival of a majority of households as they work unstintingly to ensure food security for many of our citizens in various communities.

ABSTRACT

Introduction

Food and nutrition security can be influenced by various external and internal factors that contribute to a compromised wellbeing status amongst older farmers who are considered as a vulnerable group. This group faces diverse socio-economic and health challenges within an evolving food system. The complexity of this challenge persistently requires multisectoral intervention programmes, as reflected in the nature of this study.

Aim and Objectives

The aim of the study was to determine the levels of and address the food intake and nutrition insecurity status of elderly farmers. The main objective was to address the challenges that compromised the health of selected previously non-legume producing farmers by encouraging legume production and consumption amongst them. The findings of the study informed the proposal of appropriate strategies to develop an intervention programme intended to educate the identified elderly farmers and to promote their dietary diversification by means of legume production and consumption.

Methodology

The study employed a cross-sectional design. A baseline study was conducted that aimed at examining variable relationships using a mixed methods approach involving both qualitative and quantitative data collection techniques. A sample of 112 elderly farmers participated in the baseline study, followed by a case-controlled intervention programme that included pre- and post-intervention surveys. The measuring instruments included socio-demographic as well as health and medical surveys to elicit data such as blood pressure, blood indices for glucose and cholesterol due to dietary intake, household food security, legume knowledge, legume acceptability and agricultural practices. The data informed the findings of both the baseline and the intervention phases of the study. The baseline study involved a sample of 112 elderly farmers, whereas the intervention study involved two case controls (n=103) that comprised an experimental group (EG: n=53) and a control group (CG: n=50). Data were obtained for both groups by analysing blood indices, dietary intake, yields of legume

production (EG only) and legume acceptability levels using statistical analyses of variance, significance and trends of pre- and post-intervention surveys over two years. A follow-up survey (FU) was conducted six months after the conclusion of the intervention phase and involved only the EG (n=32), to assess the impact of the intervention programme on their dietary intake and farming practices. The follow-up study thus compared the intervention data of the farmers' consumption and production patterns with data obtained post-intervention. During this latter study, only dietary intake and production levels were measured. All the data were analysed using IBM Statistical Package for Social Sciences (SPSS), Food Finder software, the Mann-Whitney U test, Analysis of Variance (ANOVA) and T-tests for statistical frequencies, variances and correlations.

Results

In the baseline study, 79.5% of the participants were women. The mean age of the participants was 63.3 ± 8.2 years. A diverse legume consumption was not observed as indicated by a low legume food group diversity score (FGDS) for 0-9 varieties with a mean of 3.5 (SD ± 1.70). Legumes were the least (19.0%) preferred crop planted by the farmers prior to the study. In the intervention study, the majority of participants were also women (73.6% in the EG and 66.0% in the CG). Of the six varieties of legumes under study, red kidney beans was the most preferred (141.60 kg/ha^{-1} SD ± 162.11). There was a high significance (*p*=0.001) amongst the six legume varieties produced, which implies that some legumes had a higher yield than others. A comparison between the genders indicated that the women produced 81.70 kg/ha^{-1} (SD ± 77.95), while the men produced 33.63 kg/ha^{-1} (SD ± 166.40). The higher yields produced by the women were significant (*p*=0.011).

Legume consumption improved for the EG because the intervention programme resulted in a significantly (p=0.000) increased dietary diversity score (DDS) of legume intake with a mean (±SD) FGDS from 2.4 (SD ± 1.35) to 5.7 (SD ± 2.56) and a mean (±SD) Dietary Diversity Score (DDS) from 8.59 ± 0.74 to 8.23 ± 1.11, while that of the CG was 3.0 (SD ± 1.82). According to the post-intervention survey, the blood results of the EG indicated nutrient improvement at the 5.0% significance level for blood glucose (*p*=0.038) and cholesterol (*p*=0.008). The blood glucose levels of the EG were statistically significant (*p*=0.037) when this group was compared with the CG in both the pre-intervention and post-intervention surveys. Trend analyses were

conducted and compared between those men and women who participated throughout the study (i.e. participation from the baseline to the post-intervention surveys). It was found that cholesterol (*p*=0.033) and Systolic Blood Pressure (SBP) (*p*=0.013) were statistically significant when the genders were compared across all phases of the study. Data obtained for the EG in the Follow Up (FU) study six months after the intervention study indicated that the production of legumes had declined (71.8%). This was because the legume intake with a mean (±SD) FGDS of 3.0 ± 2.2 indicated a significant (*p*=0.000) drop from 5.7 (SD ± 2.56) with DDS from 8.23 (± 1.11) to 8.81 (± 0.47) at *p*=0.005 significance as determined by the FU survey. It was also found that limited marketing of legumes had occurred, which suggests that the sustainability of legume production and consumption post-intervention by the elderly farmers was a challenge. However, 100.0% of the farmers indicated that they intended to continue their production and consumption of legumes, provided that the constant supply of legumes did not cease.

Conclusions

Evidence was obtained that the intervention project positively impacted the production and consumption of legumes and that the elderly farmers thus diversified their dietary intake for the better during this phase of the study. However, further investigations need to be conducted to explain the decline in consumption and production in the post-intervention period if support for a healthier lifestyle amongst elderly farmers is to be sustained. The technology to produce legumes with high yields to address food insecurity through more appropriate consumption patterns also needs to be explored in greater depth. Because the two streams of knowledge transfer that involved hands-on training of elderly farmers improved legume production and consumption patterns, this study established a sound foundation on which future studies and intervention strategies for food security amongst vulnerable groups may be built.

Key words: Legumes, dietary diversity, nutrition, legume production, legume consumption, food security, elderly farmers

GLOSSARY

Ageing: the process of becoming old and developing characteristics of old age.

Agro-processing: the manufacturing processes of raw materials and intermediate products derived from the agricultural sector.

Agriculture (Agric) Hub: a facility used to help small scale farmers to gain access to profitable and sustainable markets.

Agricultural land: sharing of land areas that are arable, under permanent crops and under permanent pastures. Arable land is under temporary crops (double-cropped areas are counted once); temporary meadows are used for mowing or pasture; land under market is kitchen gardens and land that is temporarily fallow. Land abandoned as a result of shifting cultivation is excluded.

Anthropometry: the use of human body measurements to obtain information about a person's nutritional status.

Body mass index: the ratio of weight-for-height measured as the weight in kilograms divided by the square of height in metres.

Blood serum: contains all proteins not used in blood clotting (coagulation) and all electrolytes, antibodies, antigens, hormones and extra substances.

Blood plasma: the coloured liquid component of the blood that normally holds the blood cells in whole blood in suspension and makes it an extra cellular matrix of blood cells.

Diastolic blood pressure: pressure when the heart is rested between beats.

Systolic blood pressure: pressure exerted against artery walls when the heart beats.

Dietary energy intake: the energy content of consumed food.

Dietary energy requirement: the amount of dietary energy required by an individual to maintain body functions, health and normal activity.

Dietary energy supply: food available for human consumption, expressed in kilojoule per person per day (kJ/person/day). At country level, it is calculated as the food remaining for human use after deduction of all non-food utilizations (i.e., food = production + imports + stock withdrawals − exports − industrial use − animal feed – seed – wastage − additions to stock).

Dietary energy supply adequacy: dietary energy supply as a percentage of the average dietary energy requirement.

Food price index: a price index covering edible food crops that contain nutrients (coffee and tea are excluded).

Food price volatility: a measure of variation in food prices over time.

Food supply: the total stock of food available for human consumption, usually derived from the commodity account.

Food insecurity: a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution or inadequate use of food at household level. Food insecurity, poor conditions of health and sanitation and inappropriate care and feeding practices are the major causes of poor nutritional status. Food insecurity may be chronic, seasonal or transitory.

Food security: 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. Based on this definition, four food security dimensions are identified: food availability, economic and physical access to food, food utilization, and food stability over time.

Hunger: the term hunger is synonymous with chronic undernourishment. It is defined as a craving or urgent need for food or a specific nutrient.

Kilojoule (kJ): a unit of measurement of energy. One kilojoule equals 1 000 Joules. In the International System of Units (SI), the universal unit of energy is the Joule (J).

Legumes: a class of vegetables that includes beans, peas and lentils and are among the most versatile and nutritious foods for human consumption.

Malnutrition: an abnormal physiological condition caused by inadequate, unbalanced or excessive consumption of macronutrients and/or micronutrients. Malnutrition includes under nutrition and over nutrition as well as micronutrient deficiencies.

Metabolic syndrome: the constellation of metabolic abnormalities that include glucose intolerance, abdominal obesity, dyslipidemia, and hypertension.

Minimum dietary energy requirement: in a specified age/sex category, the minimum amount of dietary energy per person that is considered adequate to meet the energy needs at a minimum acceptable BMI of an individual engaged in low physical activity. If referring to an entire population, the minimum energy requirement is the weighted average of the minimum energy requirements of the different age/sex groups. It is expressed as kilocalories per person per day.

Nutrition security: a situation that exists when secure access to an appropriately nutritious diet is coupled with a sanitary environment, adequate health services and care, in order to ensure a healthy and active life for all household members. Nutrition security differs from food security in that it also considers the aspects of adequate caring practices, health and hygiene in addition to dietary adequacy.

Nutrition-sensitive intervention: an intervention designed to address the underlying determinants of nutrition (which include household food security, care for mothers and children, and primary health care services and sanitation) but not necessarily having nutrition as the predominant goal.

Nutritional status: the physiological state of an individual that results from the relationship between nutrient intake and requirements and from the body's ability to digest, absorb and use these nutrients.

Obesity: occurs when the body weight is above normal for height as a result of an excessive accumulation of fat. Obesity is defined as obesity as a BMI (kg/m^2) of 30 or more.

Overweight: occurs when the body weight is above normal for height as a result of an excessive accumulation of fat. It is usually a manifestation of over nourishment. Overweight is defined as a BMI (kg/m^2) of more than 25 but less than 30.

Smallholder farmer: farms on less than 1 hectare and not more than 10 hectares of land. It is family orientated farming involving farming on a small piece of land without using advanced and expensive technologies. Intensive labour is usually involved.

Undernourishment: a state of the body lasting for at least one year. Involves inability to acquire enough food and is defined as a level of food intake that is insufficient to meet dietary energy requirements. For the purposes of this report, hunger is defined as being synonymous with chronic undernourishment.

Undernutrition: the outcome of undernourishment, and/or poor absorption and/or poor biological use of nutrients consumed as a result of repeated infectious disease. It includes being underweight for one's age, too short for one's age (stunted), dangerously thin for one's height (wasted) and deficient in vitamins and minerals (micronutrient malnutrition).

Underweight: a too low weight for age compared to BMI (kg/m$^{2)}$ of less than 18.5 in adults, reflecting a current condition resulting from inadequate food intake, past episodes of under nutrition or poor health conditions.

Waist circumference: an indicator of health risk associated with excess fat around the waist.

Waist to height ratio: is calculated as **waist** measurement divided by **height** measurement.

Waist to hip ratio: waist circumference divided by hip circumference; both are measured in (cm) the same units.

Wasting: a too low weight for height, a severe end of a spectrum of undernutrition that affects the elderly.

Value chain: the addition of value in preliminary agricultural products by combining them with other resources such as tools, manpower, skills and other raw materials. The product passes through various stages of this chain and the product increases in value.

Vitamin A deficiency: A deficiency diagnoised when the serum retinol level is less than 0.70 µmol/L.

ABBREVIATIONS

AADP: Comprehensive Africa Agriculture Development Programme

AHS: Agriculture Hub Station

AIPP: Asia Indigenous Peoples' Pact

AI: Adequate Intakes

ANLP: African Nutrition Leadership Programme

Ca: Calcium

CAC: Coronary Artery Calcium

CHO: Carbohydrates

CDC: Center for Disease Control and Prevention

CG: Control Group

CGIAR: Consultative Group on International Agricultural Research

CIFAD: International Fund for Agricultural Development

CPI: Consumer Price Index

CRD: Complete Randomised Design

DASH: Dietary Approaches to Stop Hypertension

DDS: Dietary Diversity Score

DRI: Dietary Reference Intake

EAR: Estimated Average Requirement

EER: Estimated Energy Requirement

EG: Expiremental Group

FAO: Food and Agriculture Organization of the United Nations

Fe: Iron

FNS: Food and Nutrition Security

FVS: Food Variety Score

FGDS: Food Group Diversity Score

HDI: Human Development Index

GDP: Gross Domestic Product

GFSA: Global Food Security Act

GFSSP: Global Food Security Strategic Plan

Ha: Hectare

Hb: Haemoglobin

HDL: High Density Lipoprotein

HFIAS: Household Food Insecurity Access Scale

HSRC: Human Sciences Research Council

IDA: Iron Deficiency Anaemia

IFAD: International Fund for Agricultural Development

IFPRI: International Food Policy Research Institute

IMF: International Monetary Fund

IPESFS: International Panel of Experts in Sustainable Food Systems

IWGIA: International Work Group for Indigenous Affairs

Kg: Kilogram

kJ: Kilojoules

LDL: Low Density Lipoproteins

LKAEFQ: Legume Knowledge Accaptebility Questionnare

MDER: Minimum Dietary Energy Eequirement

MetS: Metabolic Syndrome

Mg: Magnesium

MNA: Mini Nutritional Assessment

MRC: Medical Research Council

MUT: Mangosuthu University of Technology

NARs: Nutrient Adequacy Ratios

NCD: Non-communicable Disease

NEPAD: New Partnership for Africa’s Development

NifTAL: Nitrogen Fixation in Tropical Agricultural Legumes

OECD: Organisation for Economic Co-operation and Development

PACSA: Pietermaritzburg Agency for Community for Social Action

PPP: Purchasing Power Parity

PSNP: Productive Safety Net Programme

RDA: Recommended Dietary Allowance

RCBD: Randomized complete block design

RFPI: Real Food Price Index

RNI: Recommended Nutrient Intake

SANHANES: South African National Health and Nutrition Survey

SDGs: Sustainable Development Goals

SSA: Sub-Saharan Africa

UA: Urban Agriculture

UL: Tolerable Upper Intake Level

UN: United Nations

UNCTAD: United Nations Conference on Trade and Development

UNDP: United Nations Development Programme

UNPD: United Nations Population Division

WFP: World Food Programme

WHO: World Health Organization

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CHAPTER 1

THE PROBLEM AND ITS SETTING

1.1 Introduction

Food production, availability and utilization are essential pillars of the food security theme which is a global phenomenon. Nutrition, agriculture and health need to be linked to achieve a holistic approach to food security because these factors feed directly into the comprehensiveness of the food and nutrition security theme. When providing interventions from platforms that address food and nutrition security, a comprehensive approach to food security becomes important (Passera *et al*., 2020). In this context, the role of farmers is vital in any intervention that aims to promote agricultural activities. This fact prompted the current investigation into older farmers' practices in and attitudes towards matters of nutrition, where healthy agricultural and dietary practices are vital. Farmers, as constituents of food health practices, play an important role in the food chain as food is needed to feed populations across the globe. Sound food growing and processing practices also contribute to the economy of a country. The capacitation of farmers in terms of crop diversification, nutritional requirements and health issues transforms them from being mere farmers who are inclined towards basic food provisioning, towards being food producers who are agriculturally and nutritionally sensitive to the production systems within the food and nutrition security theme.

According to Silva, Caro and Magaña-Lemus (2016), several authors (Nyantakyi-Frimpong *et al*., 2016a; Rezai, Shamsudin & Mohamed, 2016a) have contributed to the evolving definition of food security and, over the years, this definition has expanded. There are five dimensions or pillars underpinning the food security theme, namely sufficiency, acceptability, stability, nutritional quality and food safety. This chapter will provide a detailed framework for a holistic understanding of these pillars and the manner in which they are interrelated.

With the advent of urbanization and globalization, undernutrition, hunger and obesity walk hand- in-hand. Therefore, collective action has resulted in public initiatives geared towards the development of food and nutrition security (FNS) through collaborative endeavours to eradicate food associated threats (Aliaga & Chaves-Dos-Santos, 2014).

According to Charlton (2016), people in the food production and nutrition profession (and therefore nutrition curricula) across the board need to be capacitated with diverse skills in agriculture, ecology, biodiversity, climate change and science. If access to and success in these fields can be achieved, more effective solutions to current global nutrition challenges will benefit mankind. The academic environment thus needs to craft education projects that are consolidated within these streams as part of knowledge and skills enhancement in the field. Various researchers have also echoed the need for collaborative efforts to combat global health challenges associated with food security issues. These scholars include Sonnino and Hanmer (2016), Malapit and Quisumbing (2015) and Lobstein and Brinsden (2014), who highlight the need for reforms through scholarly research that aims to address food security in alignment with agriculture, nutrition and health and to tackle the food associated challenges faced by society at large. By heeding this call, the results obtained from this current project will thus play a vital role in achieving a synchronized programme that will ensure the confluence of these diverse streams in an attempt to address food security and nutritional status amongst elderly farmers in a selected urban community.

1.2 Food and Nutrition Insecurity: A Global Phenomenon

Understanding the need for food security from a global perspective requires that academics gain a clear understanding of food and nutrition security as a global crisis. This study was thus approached from the perspective that food and nutrition insecurity in the selected study area would be a prototype experience of what is happening globally and, more specifically, in countries facing the challenge of food and nutrition insecurity. Food insecurity is defined as "a situation that exists when there is inadequate food intake, with or without the presence of hunger, leading to underweight" (United Nations Standing Committee for Nutrition [UNSCN], 2013). However, food insecurity is also linked with being overweight as this phenomenon is an escalating trend that seems to co-exist with the definition of food insecurity (Tester, Lang & Laraia, 2015). Food insecurity appears to have branched towards the overweight phenomenon, whereas nutrition insecurity has been linked to a diet that lacks diversity and does not incorporate the recommended nutrient intake as per the guidelines. "Food and nutrition security exists when all people at all times have physical, social and economic access to food which is consumed in sufficient quantities and [has the required] quality to meet their dietary needs and food preferences, and is supported by an environment of adequate sanitation, health services and care, allowing for a healthy and active life" (United Nations Standing Committee on Nutrition [UNSCN], 2013).

Various factors are associated with the threats and challenges that need to be taken into consideration for food and nutrition security globally (refer to Figure 1.1 for affected nations). According to the Food and Agriculture Organization (FAO) (2017), agriculture and nutrition transition will exert pressure on natural food resources because it is estimated that the human population will have grown globally by 10 billion by the year 2050. It is important to take into consideration the fact that Asia and Africa have the fastest population growth rates (FAO, 2017).

Figure 1.1: Map providing a global overview of regions where food insecurity exists
Source: Food Security Information Network (FSIN), (2017)

It is also important to highlight the regions that are highly affected by food insecurity. Figure 1.1 thus presents a visual overview of the regions where food and nutrition insecurity pose a dire threat to the populations that live there.

Even though significant strides have been made in some areas to eradicate poverty globally, people continue to be chronically hungry, with an estimated two billion suffering from micronutrient deficiency. Moreover, regardless of efforts being made to eradicate famine and malnutrition, 653 million people will still face undernourishment by 2030 (FAO, 2017). This means that the global scale of dealing with the exacerbation of the challenge is massive (Refer to Figure 1.2). Against this overwhelming backdrop of suffering the current study aimed to contribute a fraction to society by addressing some of the challenges faced 'out there'.

Food and Nutrition Insecurity Policy Framework

Figure 1.2: Conceptual framework of measures to obtain food and nutrition security at individual and household levels

Source: Foodsecure, (2013)

To achieve this aim, it may be argued that food and nutrition security will only be achieved one step at a time. Figure 1.2 presents a flow diagram of measures to achieve food and nutrition security at individual and household levels in all countries across the globe.

Figure 1.2 illustrates that food and nutrition status is premised on two streams, namely status and stability. Status is strongly connected to the three pillars indicated under status, which are food availability, food access and food utilization. Food stability is also threatened when individuals or families face long- or short-term challenges and these should be addressed by strategies such as decreasing vulnerability, risk prevention, risk mitigation and risk coping. Figure 1.2 also depicts a link between household and individual needs and focuses on the components of the policy framework that should form a strong foundation from which food and nutrition insecurity should be addressed. The FAO and WFP (2019) state that food production and consumption patterns are decreasing and that this affects the coping strategies of both urban and rural households.

The proposed framework presented in Figure 1.2 has been used in various countries to help define and intensively explore some of the threats and challenges that will impact food security in the future. However, although the United Nations Millennium Development Goals (MDGs) established a target for 2015 to address malnutrition, these goals were not sufficient to deal with food and nutrition insecurity threats, as they were not binding on signatory states (Poulsen, McNab, Clayton & Neff, 2015). It is thus projected that globally, around 653 million people will still be undernourished by 2030 and that to end hunger by 2030, almost $265 billion will be required per year (FAO, 2017).

The framework presented in Figure 1.3 highlights two human rights concepts according to the World Food Summit and as defined by the FAO (1996) and the United Nations (2004) (refer to figure 1.3 as a reference). This framework combines both the Right to Food (as a globally adopted concept by many countries) and the Right to Food Guidelines.

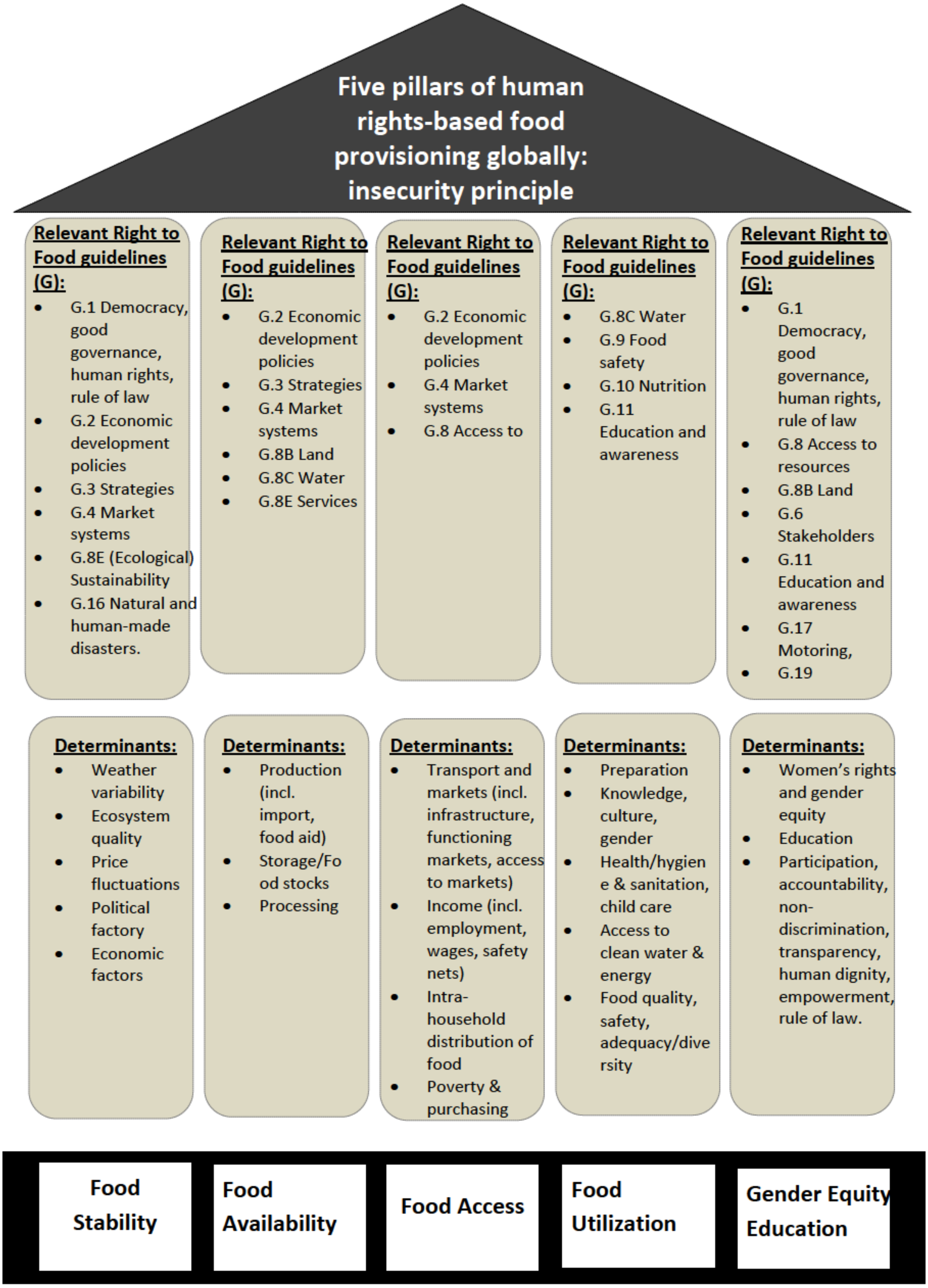

Figure 1.3: The Millennium Goals- A rights-based food security principle framework

Source: Mohr, Beuchelt, Schneider & Virchow, (2016) This framework, unlike many that only use four pillars, encompasses a cross-cutting fifth pillar which is gender-specific and builds on equity and education. The framework can also be utilized to address food insecurity and bio- sustainability standards. The relationship between food insecurity and bio-fuels will be discussed in more detail in Chapter 2.

The FAO Global Information and Early Warning System (GIEWS) classifies and regularly updates the list of countries requiring external assistance for food, dividing them into three categories according to predominant drivers: (1) Countries with an exceptional shortfall in aggregate food production and supplies; (2) countries with a widespread lack of access to food; and (3) countries with severe localized food insecurity (FSIN, 2017). According to the FAO (2015a), by 2010, around 24 countries had been experiencing food crises, with 19 countries consistently facing this challenge for over 8-10 years. The poor continue to be most affected and even though growth might be detected per country, it does not translate into effectively alleviating hunger and malnutrition. Food insecurity must therefore not be underestimated as it has detrimental consequences that will impact societies on a global scale and can have a more severe impact than the effects of war and mortality. When not addressed, food insecurity may progress to famine and, under this condition, death rates can exceed those caused by violence and war (FAO, 2017).

Globally, agriculture development is a key component in addressing food and nutrition insecurity. By focusing on smallholder farmers, food production can be enhanced and developed and food crop yields can be improved to feed nations. Smallholder farmers play a key role within the food supply chain and many have also contributed to poverty alleviation, as observed in certain countries in Africa and Asia (Conceição, Levine, Lipton & Warren-Rodríguez, 2016). Smallholder farmers can be defined as those farmers who manage farming land that ranges from less than one hectare to ten hectares in size (FAO, 2012; 2019). These farmers are predominantly family-focused as they need to ensure household food security, thus relying on family labour to produce crops while also using harvested produce to feed their families (FAO, 2012; 2019). Globally, smallholder farmers control over 90.0% of farms and 80.0% produce the world’s food, which are figures that highlight their active role in contributing to food and nutrition security (FAOa, International Fund for Agricultural Development [IFADa], World Food Programme [WFPa] & WFPb, 2015). This observation indicates the pivotal role that smallholder farmers play in providing food as well as income and employment as part of social protection, human development and food and nutrition security in developing countries. Moreover, smallholder farmers constitute the foundation on which the majority of the world's food-insecure population is dependent (FAO, 2019). However, South African smallholder farmers produce on 13.0% of agricultural land, whilst commercial farmers produce on 87.0% as result of historical patterns of land expropriation (Aliber & Hall, 2012).

The global food system is under threat and on a decline due to its inability to provide foods that are safe, nutritious and affordable to vulnerable groups in society. Regardless of increasing food production, humans across the globe are still facing food and nutrition insecurity against the tide of rising food costs (Nyantakyi-Frimpong *et al*., 2016a). According to the Global Food Policy Report (2016), an investigation into people's perceptions about food policy and food security globally revealed that about 60.0% of the global population is dissatisfied with food policies (International Food Policy Research Institute [IFRPI], 2016a). The IFPRI has also embarked on looking into other relational aspects between food security and soil health and the contribution of the latter to food availability and quality. The projected increase in the cost of processes for food sources such as grains is set to rise from 64.0% to 92.0% between 2010 to 2050 period, which suggests that food prices will soar concomitantly and that nutritious food will become even less affordable (Baldos & Hertel, 2016).

Food and nutrition security require the reformation of related institutions, as well as policy frameworks and infrastructure. Moreoever, it should be driven by agriculture and research into and the development of nutrition programmes that can impact control and manage synergies affecting sustainability (Fan & Brzeska, 2016). Moreover, there is no formal assurance that even if more food is produced, access to food will be improved for the poor, particularly in urban environments. The factors that need to be considered must address policy reform in escalating buying power and adjusting food prices through well-managed food distribution systems. The challenge of addressing food insecurity thus needs to be addressed as a matter of urgency by means of effective intervention mechanisms (Badami & Ramankutty, 2015). According to Borch and Kjærnes (2016), the literature has presented various discourses within the academic fraternity regarding food security and food insecurity.

Some of these discourses may be stronger than others and some even compete with discourses in the political arena, where leverage is often required for economic benefit. Moreover, there seems to be limited interest in Europe in funding food security studies, which is attributed to the assumption that Europeans are generally well fed and that food insecurity is not perceived as a major challenge on this continent (Borch *et al*., 2016).

The three pillars (access, availability and utilization) on which food security rests have evolved from production to consumption, as well as from supply to access, for decades. Another view of food security focuses on access as well as supply (Hadley & Crooks, 2012). The literature cited above on global food security perceptions suggests that global shifts are influencing food security trends and highlights that existing disparities may differ from region to region. There is thus a need for researchers as well as other key stakeholders to devise appropriate initiatives to ensure food and nutrition security that is region-specific. However, global agents should never lose sight of what is appropriate and relevant for each region in order to address their global mandate of nutritious food production. There is also increasing evidence of both food and nutrition insecurity, which can be addressed by adhering to the Sustainable Development Goals (FAO & WFP, 2019).

Studies conducted in the United States (US) have indicated a strong relationship between food insecurity and low income earning citizens, particularly in terms of the lack of affordability of more nutritious food for the poor. The lack of food affordability has direct implications for the status of food and nutrition, as this lack compromises nutrient intake. Secondly, the location of economically disadvantaged citizens occurs predominately in neighbourhoods where there are a limited number of food retailers. Against this backdrop, research in the US has shown that the Supplementation Nutrition Assistance Program (SNAP) has had benefits for a specific target, as government has provided a funding incentive to purchase food items and beverages, with a few exceptions (DeWeese *et al*., 2016). However, such initiatives do not exist in most developing countries where, according to the FAO (2015b), challenges associated with food insecurity are exacerbated by the diminishing state of natural resources such as water and soil. The eradication of hunger and poverty will require an estimated budget of US$267 billion per year globally, which will have to be a sustainable input until 2030.

International support to eradicate the challenge is provided mostly by the post-2015 Sustainable Development Goals, the 2014 Rome Declaration on Nutrition, the Zero Hunger Challenge and the 2015 Addis Ababa Action Agenda (FAO, 2015c). The 2030 Agenda for Sustainable Development Goals urges collaborative governance by the international community, highlighting that this should be a pivotal tool for addressing a comprehensive way forward towards food and nutrition security (FAO, 2017).

As was alluded to earlier, the phenomenon of food and nutrition insecurity is impacted by urbanization and global population shifts, particularly because already high food demands in urban societies are escalating. Moreover, the composition of the food that individuals are demanding is also diverse. This fact shapes and redefines demands for food and nutrition in cities across the globe. Taking into account that rapid urbanization is escalating in African and Asian cities (Padgham, Jabbour & Dietrich, 2015), one needs to appreciate that this poses a threat that may be difficult to stem if intervention strategies are not devised. Therefore, one can conclude that avaliable foods differ from country to country in terms of nutritious content, technological production, taste and many other factors. The need to shift from staple and ultra-processed foods to nutrient-rich foods in the developing world has also been identified. It is undeniable that a rapidly growing, increasingly affluent and urbanizing global population will transform food production systems by both increasing food demand and shifting the composition of the food required. It is envisaged that, by as early as 2020, around 75.0% of people living in urban areas in countries such as Latin America, Africa and Asia will live in cities. Urbanization increases poverty and food and nutrition insecurity within urban areas (Rezai *et al*., 2016). Consequently, a multi-faceted approach that will mainly focus on increasing employment and income streams for the poor in order to positively influence their buying power and food affordability will have to be devised as a matter of urgency.

According to Anderson and Strutt (2014), the Chinese government aims to address food insecurity by having a food security sector that focuses on investing in agricultural research to contribute to food production and economic growth, whilst also investing in other developing countries. The Korean government also wants to invest more in assessing the agricultural input and supply sector, as well as in food markets and household food security (FAO, IFAD & WFP, 2018). Both these initiatives are vital and should be adopted by other countries. The Chineses government also believes that there should be a continuous implementation of strategies to improve rural infrastructure and inequalities within rural and peri-urban settings through social investment. Various studies have focused on policy reviews in this country in an attempt to review food and nutrition security (Aliaga & Chaves-Dos-Santos, 2014; IFPRI, 2019). However, the latter studies highlight that there are FNS public policies in only 123 countries worldwide, and that only 139 countries had submitted review reports (Aliaga & Chaves-Dos-Santos, 2014; IFPRI, 2019).

1.3 Malnutrition: A Global Trend

Human development is adversely affected by poor nutrition (FAO, IFAD & WFP, 2018). This fact highlights the need to assist individuals in achieving their full potential and for countries to engage in development initiatives to ensure food and nutrition security. Optimal nutrition assists people in reaching their full potential and taking advantage of opportunities offered by education and development processes. Literature suggests that prices and rising costs play a key role in the accessibility of nutritious food (IFPRI, 2019). For example, many households in developing countries are both consumers and producers of food, meaning that food price increases can have diverse impacts on production and consumption decisions. It is a known fact that when food insecurity exists, it will increase the prevalence of malnutrition amongst poor communities (Borch & Kjærnes, 2016). Thus, 55 countries globally have joined forces in the surge to form part of the Scaling Up Nutrition (SUN) movement, which is in line with the UN Sustainable Development Goals (SDGs) to end malnutrition by 2030 (IFPRI, 2016b).

The majority of households in developing countries fall into these categories: ordinary consumers and food producers or farmers. This reality has a significant effect on the production of agricultural products and food consumption patterns, as well as on decisions associated with food security (Sibhatu, Krishna & Qaim, 2015). According to Jayne, Chamberlian and Headey (2014), the development of agriculture lies in the ability to facilitate favourable agricultural productivity, which in turn will result in favourable gains for rural development, household income and food entitlements. Moreover, these factors can alleviate pressures caused by environmental issues. One of these pressures is severe malnutrition that particularly impacts children, the poor and the elderly. For example, China and South Korea were observed as the only two countries that fell below the threshold for unhealthy conditions such as child stunting, overweight/obesity and anaemia in women. These countries stood out in an investigation of over 122 countries in a report compiled by the Global Nutrition Report in 2014 (IFPRI, 2014).

Table 1.1 depicts global undernourishment projections and trends over the past 13 years. There was an evident slow-down during 2012-2014, when a decline in rates and slower progress was noted. However, even though there has been a slight decline in malnourishment in certain regions (e.g. in Central Africa and South East Asia), other regions have remained unchanged (North America and Europe) (FAO, IFAD & WFP, 2018). This illustrates the point that the role of food security needs to be taken seriously as a global crisis.

Many factors for the shifts that have occurred in international markets and that pose a challenge for food governance are cited in the literature (IFPRI, 2014; IFPRI, 2016b). These trends and challenges include changes in consumption patterns and a greater demand for natural resources such as water, energy, land and civil unrests, which result in endless wars, for example in Syria (United Nations Office for the Coordination of Humanitarian Affairs [UNOCHA], 2016). These multifaceted challenges thus pose a threat to the world's ability to be food secure (IFPRI, 2019).

High prevalence rates of malnutrition globally highlight the need to review statistics that expose the magnitude of the malnutrition phenomenon. Micronutrient deficiency currently affects 2 billion people worldwide, whereas 1.9 billion people are overweight or obese. It has also been revealed that 1 in 12 adults has type 2 diabetes, which translates to approximately 794 million people suffering from this type of diabetes worldwide (FAO, 2015a; WHO, 2015a; IFPRI, 2016a). Issues such as gender inequality and climate change that cause increased flooding, storms and droughts have also been identified as factors that influence malnutrition globally (Intergovernmental Panel on Climate Change [IPCC], 2018).

Table 1.1: The prevalence of undernourishment in various countries of the World (2005–2017)

	Prevalence of undernourishment (%)					
	2005	2010	2012	2014	2016	2017[1]
WORLD	14.5	11.8	11.3	10.7	10.8	10.9
AFRICA	21.2	19.1	18.6	18.3	19.7	20.4
Northern Africa	6.2	5.0	8.3	8.1	8.5	8.5
Sub-Saharan Africa	24.3	21.7	21.0	20.7	22.3	23.2
Eastern Africa	34.3	31.3	30.9	30.2	31.6	31.4
Central Africa	32.4	27.8	26.0	24.2	25.7	26.1
Southern Africa	6.5	7.1	6.9	7.4	8.2	8.4
West Africa	12.3	10.4	10.4	10.7	12.8	15.1
ASIA	17.3	13.6	12.9	12.0	11.5	11.4
Central Asia	11.1	7.3	6.2	5.9	6.0	6.2
Eastern Asia	14.1	11.2	9.9	8.8	8.5	8.5
South Eastern Asia	18.1	12.3	10.6	9.7	9.9	9.8
South Asia	21.5	17.2	17.1	16.1	15.1	14.8
Western Asia	9.4	8.6	9.5	10.4	11.1	11.3
Central and Southern Asia	21.1	16.8	16.7	15.7	14.7	14.5
Eastern and South-Eastern Asia	15.2	11.5	10.1	9.0	8.9	8.9
Western and Northern Africa	8.0	7.1	8.9	9.3	9.9	10.0
LATIN AMERICA AND THE CARIBBEAN	9.1	6.8	6.4	6.2	6.1	6.1
The Caribbean	23.3	19.8	19.3	18.5	17.1	16.5
Latin America	8.1	5.9	5.4	5.3	5.3	5.4
Central America	8.4	7.2	7.2	6.8	6.3	6.2
South America	7.9	5.3	4.7	4.7	4.9	5.0
OCEANIA	5.5	5.2	5.4	5.9	6.6	7.0
NORTHERN AMERICA AND EUROPE	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5

[1] Projected values

Source: Adapted from the Food and Agriculture Organisation (FAO, IFAD & WFP), (2018)

1.3.1 Malnutrition dynamics on the African continent

According to the United Nations Programme Development [UNPD] (2012), some of the fastest growing economies of the world are found on the African continent. However, this reality has not yet manifested in bringing about food security in the region (UNPD, 2012). Undernourishment is significantly higher in East Africa than in the Southern regions. South Africa and Togo are the two countries that are expected to reach Millennium Development Goal 1c by 2020 if there is a constant trend, and South Africa is also expected to reach the World Food Summit goal (FAO, 2014a) of managing food security. In African countries such as Niger and Malawi, studies have linked food price volatility to malnutrition and have identified agriculture as a key player in addressing malnutrition (Conceição *et al.*, 2016). There is also a strong association between poverty and malnutrition across the continent. However, undernourishment is a very narrow way of examining malnutrition (Maitra & Rao, 2015). It is undeniable that other important factors leading to malnutrition in the Southern African region include poor infrastructure, limitations in accessing basic services, limited household income and a lack of political and social stability (Frayne & McCordic, 2015). However, there have been successful interventions in Africa where both GDP and malnutrition improved. For example, malnutrition (in Malawi) has been reduced by 10.3% and the country's GDP has subsequently improved (IFPRI, 2016a; World Bank, 2015c).

In order to address malnutrition and to devise effective interventions that will ensure food security in African countries, better linkages amongst agricultural enterprises and the incorporation of African farmers into agro-processing have been encouraged (FAO, 2014a). However, although these initiatives have resulted in adding value to some agricultural products from some African countries, they have to be fortified with improving post-harvest systems, high-quality storage facilities and effective distribution and logistical systems that are unfortunately still absent to a large extent in African countries (IFPRI, 2016a).

1.3.2 Association between health status and malnutrition in South Africa

The World Health Assembly meeting that was held in May 2013 proposed a resolution that non-communicable diseases (NCDs) should be reduced by 25.0% by the year 2025. The following targets were the main focus of the agenda: halting the rise of obesity and diabetes; reducing high blood pressure by 25.0%; reducing physical inactivity by 10.0%; reducing the harmful use of alcohol by 10.0%; reducing tobacco use by 30.0%; and reducing salt/sodium intake by 30.0% (Lobstein & Brinsden, 2014; WHO, 2013a). These goals clearly highlight the fact that ordinary people from regions across the globe are susceptible to health risks due to inappropriate diets and eating as well as lifestyle habits (WHO, 2015b).

In South Africa, diverse health problems that exist amongst older people can be attributed to malnutrition. Furthermore, both over-consumption and under-consumption of food play a significant role in the average health status of SA's people. During 2012, the South African National Health and Nutrition Survey (SANHANES) was conducted in all nine provinces (Sishana *et al.*, 2013). The findings were reported according to gender-based clinical examinations. The main observations were the following:

- In a study population of N=7 030, hypertension was most prevalent in the Free State (17.3%). Northwest (13.0%) and Gauteng (11.4%); while the lowest rate was in Limpopo (6.6%). In comparison to the South African Demographic and Health Survey (SADHS, 2016) highest prevelance was in the Western Cape with 51.6%.
- Hyperlipidaemia (total cholesterol) was highest in Indian women (45.3%), followed by Coloured women (40.6%), while African women had the lowest levels at 24.9% in a study population of N=3 478 women; and
- Food security was more prevalent in urban formal areas at 55.4% followed by rural formal areas at 50.9%. It was the lowest in rural informal areas at 30.2%.

These results suggest that a scenario of the high prevalence of malnutrition exists in this country in both areas as separately they are food insecure, hence a need for urban agriculture to focus on combating this growing trend (South African Human Research Council [HRSC] & the South African Medical Research Council [MRC], 2013).

Disorders are also an import health aspect in terms of the overall health of individuals, but sometimes the main emphasis is on diseases rather than on disorders. During the ageing process, many disorders are encountered which can hinder the functionality of the elderly, particularly elderly farmers. According to Correia *et al*. (2014), the next couple of decades will face increasing levels of neuro-degenerative diseases alongside natural ageing and environmental impacts. One can conclude that the nutritional status of many in this category will be compromised due to physical complications that will impact food selection and preparation. Hence, there is a clear link amongst health, malnutrition and food security (WHO, 2015a).

1.3.3 Food and nutrition security in Africa

In Africa, challenges associated with food security continue to affect millions of individuals and are attributed to a shortage of rainfall, high food prices, high fuel prices, drought, civil strife and the influx of refugees into receiving countries (United Nations Office for the Coordination of Humanitarian Affairs [UNOCHA], 2011). Other drivers of food insecurity in Africa include high poverty rates; external market dependence; prolonged droughts; poor rainfall; low levels of water in rivers; negative coping systems; localized food insecurity issues; death of livestock; reduced food production for consumption; and asset depletion that have all led to theft and the looting of resources (FAO, 2017). Sub-Saharan Africa faces various challenges associated with food insecurity. Refer to statistics in Table 1.2, which indicates the significant gap that this region needs to overcome these challanges. The projected global population of 9.73 billion by 2050 is a reality. Consequently, there is a great burden upon the earth and its peoples to produce 50.0% more food and biofuels, especially in sub-Saharan Africa and South Asia (FAO, 2017 & FAO; IFAD & WFP, 2015b).

The continent of Africa is well under way to adopting food and nutrition security-sensitive approaches (such as smallholder[1] farmer development). In countries like Ethiopia, this has been achieved by means of the Productive Safety Net Programme (PSNP) and in South Africa by the monitoring of food producers to ensure that the nutritional quality of food is not

[1] Terms smallholder or subsistence and elderly farmers will be used interchangeably throughout the study.

compromised at any level. In Tanzania, this was initiated by the Improved Supplementation Plan and the government's Nutrition Spending Programme (FAO, 2017).

Table 1.2: The Required increases in agricultural production to meet projected demands between 2005–2050

	2005/07	2050	2005/07	2013-2050
World	**%**	**%**	**%**	**%**
As projected for AT2050	**100.0**	**159.6**	**14.8**	**44.8**
With updated population projections (UN, 2015)	**100.0**	**163.4**	**48.6**	**14.8**
Sub-Saharan Africa and South Asia				
As projected for AT2050	**100.0**	**224.9**	**20.0**	**104.9**
With updated population projections (UN, 2015)	**100.0**	**232.4**	**20.0**	**112.4**
Rest of the world				
As projected for AT2050	**100.0**	**144.9**	**13.8**	**31.2**
With updated population projections (UN, 2015)	**100.0**	**147.9**	**13.8**	**34.2**

Source: FSIN (2017)

There is also evidence of leadership development in Africa through the African Nutrition Leadership Programme (ANLP) to ensure advocacy for nutrition- sensitive approaches in the region (IFPRI, 2016b). The sub-Saharan African region has the highest prevalence of undernourishment and hunger still persists within this region. It is estimated that one in every four people during the period of 2014−2016 were undernourished. This equated to almost 23.2% of the population (about 220 million people) and underscored the fact that effective ways to address hunger challenges in the sub-Saharan region were still required (FAO, IFAD & WFP, 2015b).

Food and nutrition security can never be achieved if there is limited economic transformation stunting better performance. Countries must prioritise food and nutrition security measures through vibrant policies that bring about economic growth. The global economy is under threat due to political, environmental and socio-economic challenges and these threats will continue to impact many nations globally within the next few decades (FAO, IFAD & WFP, 2015a). Global economic growth has a significant impact on the state of food and nutrition security at both national and household levels. Therefore, intervention programmes must take these factors into consideration (FAO, IFAD & WFP, 2015b).

Figure 1.4: Food security crisis in the Horn of Africa

Source: UNOCHA, (2011)

Figure 1.4 provides a visual representation of the food insecurity status in the region known as the Horn of Africa in 2011. There was political instability at the time, which led to the flight of numerous citizens to refugee camps. Currently, the situation has not improved much as thousands of individuals are highly stressed because the food insecurity crisis still exists and emergency assistance is required in terms of food aid, particularly in Mogadishu where famine is rife (UNOCHA, 2011). In other countries such as Syria, humanitarian aid is being obstructed, affecting millions of people (UNOCHA, 2016). The food insecurity situation in various countries in this region requires interventions that are particular to each region.

According to the Human Global Report by the UNDP (2018), chronic food insecurity in sub-Saharan Africa is associated with poor governance coupled with a lack of political will to eradicate the progressive nature of the food insecurity challenges in this region. This is also fuelled by growing disparities amongst the developing nations on the continent. However, the Human Development Index (HDI) has increased by half in some areas due to more recent good governance, particularly in Ethiopia (UNDP, 2018).

In West Africa, various factors have contributed to food and nutrition insecurity. For example, research has shown that food insecurity in Liberia is influenced primarily by the agricultural sector, which contributes 67.0% of the country's food intake and forms the basis of their livelihood. The basic activities that initiate access to food include trading for petty cash; street vending; food and cash crop trading; and hunting and gathering (or foraging) (Rutherford, Burke, Cheung & Field, 2016). The impact of poor harvests due to the recent harsh seasonal climate and minimal rainfall in the Southern African region has also contributed significantly to food and nutrition insecurity in many households in this region (FSIN, 2017).

Research conducted in Lagos, Nigeria, indicated that unaffordable food prices at both national and household levels could elevate poverty in the African continent (Agboola & Balcilar, 2012). This context has direct implications for creating the desired food security state on this continent through improved agriculture production. However, to achieve this aim, citizens should acquire various skills and obtain higher education qualifications (Rutherford *et al*., 2016). Skills to maintain healthy households, as well as work-related skills, will ensure higher per capita income rates. South Africa is no exception to the challenges citied above since food and nutrition insecurity is prevelance in over 50.0% of the households (SADHS, 2016; Statistics South Africa, 2019). These issues will be discussed in more detail in Chapter 2, as they form part of key variables that underpinned the intervention programme conducted during this study.

1.4 Persistent Challenges and Emerging Threats to Food Security: An Overview

Climate change, poor land quality, inefficient agricultural production systems, limited access to markets and escalating consumer needs are some of the threats that persistently impact food insecurity in most African countries. Natural disasters, climate change and a declining global economic climate have also exacerbated food insecurity on this continent (Wossen & Berger, 2015). Table 1.3 summarises the combination of trends and challenges that threaten food security on a large scale globally.

Table 1.3: Trends and challenges affecting food and nutrition security

TRENDS	*CHALLENGES*
Poverty, continuous sustainability of food and agricultural systems.	*These trends pose a series of challenges to agriculture and sustainable food production.*
Economic growth and economic structural changes: food systems are more capital intensive, vertically integrated and concentrated in a few hands.	*Eradicating extreme poverty and ensuring that vulnerable people who escape poverty do not fall back into it requires action to reduce inequalities.*
Climate change disproportionately affects food-insecure regions, jeopardizing crop and livestock production as well as fish stocks.	*Pro-poor growth must go beyond agriculture by involving both rural and urban areas and supporting job creation and income diversification.*
Hunger and extreme poverty have been reduced globally since the 1990s.	*A re-thinking of food systems and governance is essential for meeting current and future challenges.*
Critical parts of food systems are becoming more capital-intensive and vertically integrated and are concentrated in fewer hands.	*On the path to sustainable development, all countries are interdependent.*
Conflicts, crises and natural disasters are increasing in frequency and intensity.	*International bodies that intervene to resolve conflicts should be given more effective power.*

Source: Adapted from FAO, (2017)

Another major threat to food and nutrition security is international food price increases affecting countries that have huge deficits and that are also dependent on imports from wealthier nations to feed their citizens. On a micro level, consumers are also affected by high food prices, a challenge that mostly affects rural dwellers (International Work Group for Indigenous Affairs [IWGIA], 2014).

Water is an essential resource for attaining food security as 71.0% of water globally is mainly utilized for agricultural purposes. However, to feed the world, there has to be sufficient food production on a large scale and water is part of the high cost factor to the environment that directly affects food and nutrition security. Increasing tax revenues in developing countries also impacts food security negatively (World Bank, 2015a; 2019). The sustainable use of water as an undergirding limitation to food security and thus needs to be given urgent attention (Grafton, Williams & Jiang, 2015). There is a growing number of people living in stressful weather conditions that cause limited water supplies. These conditions are expected to increase and will affect 3–6 billion people by 2050. Other related factors to take into account in ensuring food and nutrition security are water storage systems, water rights and water management and supply systems (Mohr *et al.*, 2016). According to Help Age International (HAI) (2012), complex farming activities are also associated with water shortages that affect the reliability of crop cycles. Poor water management is a further factor that contributes to declining outputs in agriculture, compromising food production in areas where there are water shortages. The scarcity of water at both national and household levels also interferes with food processing and preparation processes as water often needs to be sourced from afar, especially in rural settings. Access to clean water is thus a defining factor in the food security chain (Boratyńska & Huseynov, 2016).

Poor transport infrastructure is another barrier to food security and availability, particularly in countries with a tropical climate where heavy rainfalls block access routes. Difficulties in transporting fresh produce compromise the ability of smallholder farmers to trade their produce, which directly influences food insecurity in many areas (Brown & Kshirsagar, 2015; World Bank, 2015b). Thus, such challenges have not yet been experienced. However, this could be a future threat and contingency plans thus need to be put in place, considering the changing weather patterns due to climate change (World Bank, 2019).

According to Ayuya *et al*. (2015), food security threats (such as food safety concerns) as well as diseases associated with food and a lack of emerging technologies that are not always accessible to more traditional farmers are linked to poor farming practices. Therefore, food safety standards can sometimes discourage the participation of smallholder farmers as providers in the food chain who might not comply with strigent protocols, required to access the formal market. Food safety can be attributed to environmental challenges associated with climate, water, soil and air are thus linked to food production challenges (Boratyńska & Huseynov, 2016).

Another factor that has affected increasing food prices over the years is countries' policies related to bio-fuels. The use of bio-fuels has impacted agriculture markets and the demand for bio-fuels seems to grow due to the promotion and use of tax credits; the application of mandates for their use; and trade restrictions as part of the policy that encourages the use of bio-fuels (Araujo Enciso, Fellmann, Pérez Dominguez & Santini, 2016).

The role of bio-fuels as a key economic driver is an essential factor that needs to be considered in food security initiatives because the co-products of these fuels are used for livestock feed, contributing to food price increases. It is inevitable that bio-fuels will impact future trends in food production as well as food prices, with particular emphasis on corn ethanol for bio-gas production (Baldos & Hertel, 2016). An example is West Africa, where an attempt has been made to investigate parklands where food and nutrition security threats were detected in the environment. Research done here advocates the need for the transformation of production options to improve diversified productivity in agriculture (Bayala, Sanou, Teklehaimanot, Kalinganire & Ouédraogo, 2014).

1.5 Poverty as a Social Barrier to Food Insecurity

South Africa has been catergorized as one of the unequalized societies, influenced by a historial past of apartheid. This has been one of the contributing factors towards the link between social status and food insecurity (Stats SA, 2017). Poverty is a multifaceted challenge that exists in both developed and underdeveloped economies. The instability of the global economy does not make it easy to address the existence of poverty in various nations across the globe. However, each country has to capitalize on building its own growing and sustainable economy to counteract pverty escalation. However, global economic growth is on the verge of decline and it has been predicted by the World Bank that this trend will continue between 2016−2030. It is with this threat in mind that the Millennium Development Goals were established (World Bank, 2016).

According to the FAO (2015c), the agricultural sector in the sub-Saharan region has a significant role to play in reducing poverty. However, it is argued that non-agricultural sectors can boost economic development eleven times more effectively if strong collaboration to reduce poverty exists among countries and industrial sectors. In developing nations, the people who are most vulnerable to hunger and poverty are located in rural areas. The profile of these people is also characterized by farming and, more particularly, smallholder agricultural activities. According to Kenny and Dykstra (2013), non-income goals (with particular reference to undernourishment, hunger and health) indicated shortfalls as opposed to income goals associated with the Millennium Development Goals. The World Bank (2016), highlights that high poverty levels occur particularly in sub-Saharan Africa and in South Asia. This condition persists and updated global poverty statistics show that the international poverty line is $1.90 a day. The new descriptors of global poverty are based on 2011 Purchasing Power Parity (PPP) prices. Even though reducing food insecurity is a fundamental development goal to uplift poor citizens, the collaborative focus of all these goals is to enhance sustainability for as many people as possible globally. The ability to improve poverty reduction thus requires policies that are customized for food and nutrition security (Babu, Gajanan & Sanyal, 2014).

1.6 Food Production, Utilization and Prices

The phenomenon of food shortages in various countries is premised on a number of factors that have become overwhelming due to internal and external conditions. When governments improve food production and provide the required resources for agricultural production through sustainable systems, they contribute to food availability, utilization and reasonable prices and ultimately improve the food and nutrition status of a country (FAO, 2015b).

However, the growing number of cities in Africa associated with urbanization has contributed to urban poverty as well as a shortage of food, which has ultimately re-calibrated the role of food production on this continent. Smart, Nel and Binns (2015) thus suggest that there is a need to further investigate the role of household food production and national food production in Africa in order to determine how they influence each other. Hadley and Crooks (2012) also highlight a shift from being production-focused towards a greater sensitivity towards food consumption at household level. In this researcher's view, this is an essential dialogue that should be encouraged. Producers and consumers of food thus have to find mutual ground to ensure sustainable food production for healthy consumption. Food wastage is another concern that addresses the issue of food utilization. Globally, over 30.0% of food goes to waste or is lost due to diverse stages within the food value chain. There is a clear gap in how to address this concern in order for food to be utilized efficiently across the globe (Béné *et al*., 2016).

The rise in food prices is currently affecting many consumers around the globe. Between 2010−2011, food price hikes affected over 850 to 963 million people. These figures followed a historical peak of 1.02 billion people who were undernourished in 2009 (World Bank, 2010). Another report indicates that international food prices escalated by US$44 million between 2010 –2011 (FAO, 2012). This challenge is gaining momentum as the food price index of 2019 showed a rise in food prices at an average of 172.4 points, which was up 1.2% from the previous year (FAO & WFP, 2019). However, in this regard increased food prices can improve farmer earnings. It is undeniable that a considerable drop in food prices will improve the living standards of farmers because lower prices will also increase agricultural production. If prices are lower, farmers will remain resilient against farming expenses, whereas lower prices will also allow poorer communities to obtain more food (Conceição *et al*., 2016). This could naturally also improve the health of poor communities as they will be able to afford more nutritional food. Another key aspect of integrating food production, utilization and pricing is through creating valuable trade platforms by means of local food markets. These markets encourage local production and flexible prices and offer various forms in which products can be utilized. They also create a social environment in communities where food is openly accessed and thus within the reach of even remote communities (McNeill & Hale, 2016).

A case in point in South Africa, is that the cost of legumes such as sugar beans has increased. According to the Pietermaritzburg Agency for Community Social Action (PACSA, 2017), the price of dry sugar beans increased by 30.0% between January 2016 (R84.32 – [about] US$6.5 per 5 kg) to January 2017 (R117.82 – [about] US$9 per 5 kg), whilst canned beans increased by 14.0% from January 2016 to January 2017. As the price of dry sugar beans increased more than that of canned beans, it is likely that consumers would be more inclined to buy the canned beans which can affect bean producing farmer's negetively.

1.7 The Evolution of Food Markets and the Impact on the Economy

Food markets are in a state of evolution as they adjust to global shifts. Communities are affected at grassroots level as they are required to adjust to changing markets whilst retaining their food patterns (World Bank, 2017). Even the cost of legumes in South Africa has increased, hence growing legumes has become a more desirable farming enterprise. The World Bank and the United Nations Conference on Trade and Development (UNCTAD) are key investors in promoting foreign direct investment in food production in order to transform markets to be more aligned to international standards (Mohr *et al*., 2016). There has been a global shift in food standards and the vertical integration of farmers within the supply chain. This shift is attributed to the evolution of consumer insights into food attributes, environmental issues, social derivatives from the agricultural production system, an escalation in organic food production and living standard improvements (Ayuya *et al*., 2015).

Against this backdrop, grain prices have recently dropped by 30.0% according to the 2016 World Bank International Index-WBII (World Bank, 2016). The Simplified International Model of Crop Prices and Land Use and the Environment (the SIMPLE model) also confirms this reduction by indicating a shortfall of 35.0%, which can be premised on historical growth rates of the population, agricultural outputs and income per capita (Baldos & Hertel, 2016). According to Koivunen *et al*. (2016), legume prices were volatile at the time in Europe (during 2009) and there was a need to maximize locally produced legume sources. This situation had not changed at the time of the current study, which prompted the investigation into the production of legumes by smallholder farmers in the study area, as will be explained in a subsequent section (in Chapter 3).

The fisheries industry is also in transition, which has affected the food and nutrition security status of poor citizens, especially in countries where fish is part of the local diet, which sometimes is less viable to access than legumes. Fish has essential nutrients such as protein, omega 3-fatty acids, iron etc and is thus a necessary source of nutrients in Asian and African countries where it is consumed at high rates (Goldblatt, 2013). The global transition has seen a shift from capture fisheries (which is a provider of culturally preferred fish) to aqua-culture fisheries (this industry includes fish and aquatic organisms as well as interventions to increase production). Aqua-culture has brought technological changes to the fishery industry, positively affecting fish prices due to improved technologies (Belton & Thilsted, 2014).

According to Popkin (2014), agricultural economists have discovered that fresh produce of animal and plant origin are governed by the retail system. The increasing strength of, retail business thus has implications for food security in low- and middle-income countries, whilst the emerging concept of ‘going green’ (or green growth) is taking shape in countries globally. According to the World Bank (2017), the definition of green growth is that "it aims to make economic growth processes resource efficient, cleaner and more resilient without necessarily slowing them down". These green strategies include the use of fertilizer, the usage of cleaner technologies and adherence to green growth policies. According to the World Economic Forum (2017), the International Development Intern (IDT) has ranked the South Africa economy 70th amongst developing nations, while it has the 19th highest GDP.

1.8 The Link between Agriculture and Food and Nutrition Security

The sustainable production of nutritious food requires a system that allows the end consumer to eat healthy food and be food secure with increasing population growth. The agricultural sector, the food industry and nutrition programmes and initiatives need to be integrated to speak the same language in this regard. It is essential that the nutrients required by the body are linked to soil quality and healthy food production and programmes to ensure that this requirement is addressed collaboratively. Nutrition security cannot be achieved outside of nutrition-sensitive agricultural systems. Hence, the rise in the consumption of processed products leaves consumers eating more product-based foods through primary agricultural processing and secondary processing, as opposed to fresh food directly from the soil to the table (Borch & Kjærnes, 2016). There is thus a growing need to adapt food production and processing systems, provided that these systems are sustainable, resilient and customized to address the food security needs of communities (Amjath-Babu, Krupnik, Kaechele, Aravindakshan & Sietz, 2016a).

The South African government declared the country a dry zone during 2015, with the KwaZulu-Natal province being declared a disaster area (Agri SA, 2016). As drought conditions are likely to remain, there is a need to focus on agricultural processing initiatives to ensure that communities have food in the future, to encourage value adding, and to enhance shelf-life extension (Al-Zahrani *et al*., 2019). Agro-processing refers to the processes that are followed to ensure food availability and safety. According to Farmlink (2015), agro-processing is categorized into primary and secondary stages and both these stages focus on different aspects of altering the original food that was produced naturally. Primary food agro-processing includes simple techniques such as washing, peeling, chopping, ageing, milling of cereal, etc. The secondary stage of agro-processing involves the conversion of primary processed products into more complex foods using extrusion, fortifying and fermentation processes, to name a few (Borch & Kjærnes, 2016).

There is a need to focus on the improvement of agricultural resources through productivity. This can be achieved through sustainable intensification, which increases food availability and improves food security and nutrition. As indicated earlier, food companies need to take into account the quality and safety of the end product that citizens will eventually consume as part of their daily dietary intake. According to the Food Review (2014), South African legislation has become stricter regarding the processes in food processing plants, food outlets, restuarants and food labelling issues. The food industry has been a major area of growth in recent years as a result of stricter legislation and a growing understanding of the risks posed by unsuitable labelling in food processing plants. The industry also needs to take all these factors into consideration (Heikkilä *et al*., 2016).

Adequate nutrition has vast benefits for individuals and families in countries across the globe. Nutrients are needed by the body to strengthen an individual and to render him/her healthy and productive. Productivity in turn leads to economic growth and success and ensures that all members of a household can enjoy a satisfying life (FAO & WFP, 2019). It was against this backdrop that the current study aimed to establish the synergetic relationship between nutrition and agriculture and to determine how health can be advanced through education, with specific focus on the consumption of legumes.

According to the United Nations Conference on Trade and Development (UNCTAD) (2008), organic agricultural methods and technologies can be applied favourably by poor and disadvantaged smallholder farmers in Africa. These benefits may be achieved by appropriate resources and input materials for high-quality product production. According to Silva *et al*. (2016), various studies have been undertaken to investigate the relationship between agriculture, food and nutrition security with comprehensive and multifaceted data having being elicited to support the interlinks between agriculture, food and nutrition security.

1.9 The Role of Food Policies and Food Value Chain Systems

The role of policies in food safety cannot be underestimated as these policies also affect the export and import of food, contribute to sustainability and underpin the ability of the poor to access food for their households. Policies also impact wage packages and income from domestic food markets and are instrumental in establishing food prices. In Europe, there is currently no common food policy that directly addresses food systems. According to the IFPRI (2016a), International Panel of Experts on Sustainable Food Systems (IPESFS) suggests that, there is a need to integrate trade, environmental protection, agriculture, rural development, food safety and economic and social challenges in order to address the issue of more favourable food policies that function holistically rather than exclusively. For example, a step in the right direction is the new US Act called the Global Food Security Act that was passed in support of the UN's Sustainable Development Goals (IFPRI, 2016a; IFPRI, 2017).

The ability of the poor (who are often food insecure) to procure nutritious food is shaped by various external realities that are enhanced by policies pertaining to export and import laws which apply to a farmer as a producer and as an ordinary consumer. These policies contribute to the determination of food prices, household income and systems that may operate within the domestic market (FAO, IFAD & WFP 2015b). For a food system to be sustainable and effective in addressing current and emerging demands for food, it needs to be administrated within the context of scarce natural resources. This can be achieved without over-utilizing resources and without jeopardizing the availability of scarce natural resources. Food systems create a channel between production and consumers. However, according to the Second International Congress of Nutrition Report of 2014, poorly functioning food systems exacerbate malnutrition and there is a correlation between them and increasing negative nutritional outcomes that are linked to the increase in nutrition-related non-communicable diseases and collapsing food systems (IFPRI, 2016b).

According to Pinstrup-Anderson (2015), in the 2006−2007 period, the impact of food prices became unstable due to various policy reforms. These reforms affected export restrictions; the removal of value added tax on food subsidies; cash transfers for food; and import levies. Thus, global food import rates fell during 2015 with a high impact on cereal-based foods as well as fruit and vegetables (IFPRI, 2016b). It is estimated that the production of meat products amounts to US$37 billion and this will have a great impact on developing nations. In South Africa, there is an urgent need to adjust food policies according to current global shifts in this sphere.

Research conducted in Asia on food security found a need to establish policies that enhance joint and collaborative research amongst researchers, government agencies and indigenous folk such as farmers. The current study embraced this proposal by encouraging older, more experienced farmers in a selected study area in KwaZulu-Natal to produce more legumes. Thus, focal issues such as crop diversity and soil fertility in food cultivation and security are key (IWGIA, 2014).

Various factors affect food systems and the food value chain, namely production rates, the pricing system and transition within the value chain. Such factors may affect the nutritious value of the food that is supplied to and demanded by consumers. Improving energy efficiency within food systems can also help stabilize food security (IFPRI, 2016b). According to the Global Food Security strategic plan (GFSSP) of 2013, developing a food system perspective in research themes aids in the identification of biophysical, social and economic interactions across a range of drivers. Such a model is presented graphically in Figure 1.5 below.

Figure 1.5: Model for food security drivers

Source: Global Food Security, (2013)

The model depicted above emphasises the key attributes of drivers within a food security system. Because all the identified components are key, research must be tailored to determine relationships amongst the components (Global Food Security, 2013). In relation to this model, the current study investigated attributes such as production, wellbeing, health, nutrition, processing and choice. Humphrey and Navas-Alema (2010) conducted review evaluations and issued a report on 30 value chain interventions. Their findings suggest that value chains have no substance unless they are playing a role in having a positive effect on poverty reduction. They found that the ‘Bringing Knowledge to Vegetable Farmers’ initiative in Rangpur, Bangladesh, was the only value chain within agriculture linkages that provided an impactful evaluation. According to Heikkilä *et al*. (2016), food value chains are also affected by consumers’ interpretation of food value, knowledge on how the food supply chain functions, as well as food waste. There is thus a need to look at the significant role that the food service sector can play in addressing food insecurity.

1.10 The Role of Elderly Farmers as Transformation Agents in the Food Security Context

In this study, 'older/elderly farmers' are defined as male and female smallholding farmers in the age group of 45 to 65 years who engaged in farming activities in the selected study area in KwaZulu-Natal. The terms 'older' and 'elderly' are used interchangeably. According to a United Nations Population Division (UNPD) report (2015), individuals or families manage more than 90.0% of the 570 million farms worldwide. This demanding job of engaging in agricultural activities requires customized interventions that must address nutritional and health needs and encourage improved methods of production. It is also a well-known fact that farmers are attached to their land and remain on it for many years, while members of the younger generation tend to flock to urban areas where they seek a new lifestyle (FAO, IFAD; WFP 2015b). Therefore, due to the increasing number of elderly people who remain on their farms and who may suffer chronic health conditions, comprehensive nutrition education may contribute to an improved lifestyle for them. By engaging in cultivating nutrient-rich crops and consuming a more nutritious diet, these farmers can become more effective and may transform into agents of change in agricultural settings.

Another factor that was taken into account in the decision to focus on older farmers' nutritional knowledge and needs, was the future impact of such a study on small-scale farming enterprises and practices. The prevalence of older persons in rural populations is expected to increase in the next 15 years (FAO, & WFP, 2019). The fastest growing regions will be Latin America and the Caribbean at 71.0%, followed by Asia (66.0%), Africa (64.0%), Oceania (47.0%), North America (41.0%) and Europe (23.0%) (FAO, 2017).

Poungchompu, Tsuneo and Poungchompu (2012), conducted a study in Japan sampling an ageing farming population and observed that older farmers had vast knowledge and experience in conservation and agriculture. They argued that these farmers' practices and experiences could be transferred to younger farmers but, on the down-side, they discovered that the older farmers were less open to investment in innovative agricultural practices. A projection about Japan with its ageing farmer population is that many older farmers will abjure their farms in the next 10 years. However, the Japanese government has a contingency plan for upscaling farmers under the age of 45 years (Jöhr, 2012).

In Africa, with particular focus on the sub-Saharan region, research has shown that the no-till farming system is linked to crop residues competing for usage, followed by limited skills in weed management amongst smallholder farmers (Fan & Brzeska, 2016). The number of smallholder farmers is also declining due to a lack of capital investment, which is a phenomenon that is exacerbated by a decrease in extension services and support. These factors limit farmers in their ability to produce sustainable and diverse food crops (FAO, 2014a). Moreover, older farmers sometimes face discrimination when they attempt to access financial support, training opportunities and income-generating resources. The degree of discrimination worsens when these farmers are older women. This discrimination becomes more prominent when other older rural people are competing for similar opportunities. It has also been suggested that older farmers often miss out on new agricultural technologies due to financial and literacy constraints (FAO, 2017).

According to Tsuchiya, Hara and Thaitakoo (2015), there is now food sustainability in cities due to the role of urban agriculture's role in improving the condition of buildings and lowering the intensity of negative environmental impacts. Green spaces are thus created in urban and surrounding environments. It may therefore be suggested that elderly farmers should be engaged in urban agriculture and they should receive training to adapt to the many possibilities that exist in urban areas. However, this may be difficult as older farmers are traditionally and emotionally attached to their land and it might be impossible to persuade them to move to urban areas (Tibesigwa & Visser, 2016). Instead, cooperativeness may be established in rural areas that are tailor-made to address the needs and skills of older farmers. However, should older farmers be present in urban settings, the many challenges associated with the municipal system in South Africa should be mitigated by enrolling them in training programmes, where their diverse knowledge and skills can be upscaled through partnerships with various role-players (FAO, 2017).

With the above information as a backdrop, this study focused on older farmers because of their significant prevalence as small-scale farmers and the key role they have played in agriculture due to years of experience and knowledge of farming practices (Reed *et al.*, 2014). According to Help Age International (HAI) (2012), older farmers are custodians of various knowledge systems, from the weather and climate trends to soil composition. They are also skilled in farming techniques based on their indigenous knowledge systems. Moreover, their land use knowledge can mitigate the challenges posed by climate and environmental impacts on agricultural output (FAO, 2017).

A particular focus was the role of women as small-scale farmers in the study setting. One of the challenges that older farming women face is the social responsibility they bear for family members. This is often a burden that increases stress and fatigue and impacts their health status. They are thus often prevented from contributing to social events and structures when they engage in farming for a living. Their male counterparts are generally more connected to social networks and support, while the women are burdened by limited assistance from these networks. Consequently, male-headed households are more likely to be food secure as opposed to the households of their female counterparts (Tibesigwa & Visser, 2016). Further investigation is needed within the South African context in order to determine how older farmers are participating in community structures and what agencies are available to them for support.

1.11 Is a Declining Agricultural Output Affecting Food Security?

One of the challenges related to agriculture can be attributed to older farmers as a human resource in this sphere. According to Asia Indigenous Peoples' Pact (AIPP) & IWIGA (2014) as temperatures continue to rise, crop assessment models indicate that there will be a decline in crop yields worldwide. According to the FAO (2017), farming land space has been diminished by 33.0% globally, leading to long-term challenges in terms of food and nutrition security. A global reality of great concern is that the expansion of land for agriculture is limited and most available land is not suitable for crop production.

Cereal crops are highly utilized for consumption globally, yet their total yields are declining in many parts of the world due to biotic factors (Midega *et al*., 2015). According to Amjath-Babu, Krupnik and Aravindakshan (2016b), this is exacerbated by a rise in baseline temperatures, as well as lowered precipitation levels in sub-Saharan Africa. The authors further project that these conditions will hinder development in dryland agricultural endeavours. Recommendations to address this phenomenon are improved adaptation measures, improved irrigation services and increased diverse income sources that are sustainable. Agriculture depends on rainfall that is often inconsistent and conditions such as flooding, and drought which affect subsistence farming negatively. Moreover, limited crops due to drought or floods also affect the food security of vulnerable groups, negatively. This is particularly challenging in sub-Saharan Africa, where an estimated 528 million people depend on subsistence agriculture (Choi *et al*., 2016). In South Africa the average farm size utilized varies from less than 1 hectare (ha) to 10 ha for small scale farmers (Wilk, Andersson, & Warburton, 2013).

According to Conceicao, Fuentes-Nieva and Levine (2012), interventions in Africa to make farming more efficient have not caused production rates to increase, as increases have been attributed to a focus on land expansion and not on the quality of the crops produced. Subsequently, there is a need to use more advanced knowledge and technologies to increase food production.

1.12 Aims and Objectives of the Study

1.12.1 Experimental Aim

In light of the above discourse, the overarching aim of this study was to initiate a comprehensive agricultural and nutrition programme that would address food security amongst the elderly study participants, who were all smallholder farmers. This programme comprised practical training and experimental sessions over a period of a year. Thus focused more specifically on the monitoring of the production and consumption of legumes in the diet of the study participants. In order to provide in-depth, progressive knowledge of the impact of farming practices on this agricultural product, such as the intercropping of legumes and other crops, legume variety germination and planting practices. It is undeniable that factors contributing to food security are broadly educational (Hayes, Contento & Weekly, 2018). The programme thus needed to take community dynamics into account. Therefore, challenges such as seasonal changes; land usage; attitudes towards legume consumption and growing; and community projects within the municipal environment of the study area were taken into account. The programme objectives were to promote the cultivation of legumes because this foodstuff would provide economic and dietary benefits to farmers and the wider community, should the yields be sufficient for marketing.

During the conceptualization phase of the study, it became clear that there was a need for a clearly outlined and defined framework that could be utilized as a guideline within academic curricula in tackling the multidisciplinary nature of food and nutrition insecurity. This study thus utilized such an academic curriculum that formed the basis of the training material administered to the study participants. It was pitched at a level that farmers could understand, and more practical applications were utilized to make it relevant. This part enlightened the researcher's knowledge on how academia can contribute to research, in conjunction with community engagement projects. Food producers, manufacturers, researchers, scholars, teachers, policy-makers and food scientists must be involved in a synchronized manner in the development of such a curriculum (Angelos, Arens, Johnson, Cadriel & Osburn, 2015). The definition of nutrition security supports and affirms food security, but places particular emphasis on the advocacy of individuals who should consume a healthy diet, with reference to the food-based dietary guidelines recommended in each country. However, it also embraces pivotal issues that affect life stages and people's development through life, social-economic inequalities, and malnutrition (Lobstein & Brinsden, 2014).

The study thus targeted registered smallholder farmers who were part of the EThekwini municipality Agricultural Hub Station Project and who were on the database of this initiative. To this day, these farmers attend general monthly meetings that are an effective platform from which to determine their nutritional status, agricultural activities and health and medical status. The database pool was a reliable platform from which to introduce legume production and consumption as an intervention strategy for better health. The selected study sample involved members of the project who were food producers and who were associated with the Agriculture Hub Station (AHS). Land was obtained from the AHS based in Mariannhill to conduct trials for the cultivation of various legumes so that the farmers could experiment and witness the results. Seeds were donated to the experimental farmers so that they could conduct field trials on their own/selected plots of land.

1.12.2 Overarching aim of the study

The overarching aim of the study was therefore to promote new agricultural practices for legume production and to improve the health status of elderly farmers within the eThekwini Municipal Project area before and after the experimental phase. Informed with a view to assessing the intervention programme in order to determine its applicability for legume production and the improvement of the health status of elderly farmers. The aim of the study was operationalised by developing and implementing the education programme mentioned to above, thereby improving the consumption of a nutrient-rich diet amongst elderly farmers and, ultimately, the communities they serve. The programme was thus designed to provide an educational platform for legume production, preparation and processing through building knowledge of the nutritional value and health benefits of legumes. This programme was designed as an intervention initiative to diversify the diet of older farmers in the study area. It was thus envisioned that these farmers would become agents who would address food security within their households. Consequently, this knowledge would inform the nutritional needs of this population group and, eventually, of the communities in which they lived in the Mariannhill area. The programme aimed to provide comprehensive food nutrition knowledge and thus enhance agricultural practices amongst older subsistence farmers in order to encourage them to improve their nutritional practices in the Mariannhill area. The programme was designed to address the issues of access to, availability of, and the utilisation of legumes as a key platform from which to promote food security amongst elderly small-scale farmers.

Legumes have been proven to have significant benefits for human health, particularly for the elderly, because the inclusion of this food in the diet provides essential nutrients that the body needs (this would be further discussed in the results session in Chapter 4). Moreover, legumes are relatively cheap and readily available for consumption. In summary, the study intended to enhance older farmers’ knowledge, expertise and skills and to improve their agricultural and dietary practices as well as their health status.

1.12.3 Objectives of the study

The specific objectives of the study were to:

- Determine the socio-demographic profile of the sample of older farmers by means of a socio-demographic questionnaire;
- Determine the health, medical and nutritional status of the participating older farmers through anthropometrics (i.e. the completion of a health questionnaire and determining their blood pressure[2]);
- Determine the dietary intake of the participating farmers by means of a 24-hour recall questionnaire;
- Conduct nutritional assessments by obtaining biochemical data by means of blood mineral value tests for blood glucose and cholesterol before and after the consumption of legumes;
- Determine the frequency of legume consumption by the participating farmers using the Food Frequency Questionnaire (FFQ);
- Determine the household food security status and food waste behavioural patterns of the participating farmers by using the Household Food Insecurity Access Scale (HFIAS);
- Determine the farmers' acceptability of legumes for cultivation and consumption by administering a feedback evaluation form;
- Determine the agricultural practices adopted by the farmers and their knowledge of storage mechanisms by administering an appropriate questionnaire;
- Determine the participants' eating habits and assess the nutritional quality of their diet before and after the intervention study by using blood tests; the 24-hour food recall questionnaire; obtaining food frequency information; and administering the health questionnaire as indicated earlier;
- Assess the participants' reported dietary and behavioural changes, as well as changes in their agricultural practices as a result of the intervention programme, by comparing the results of the pre- and post-measuring instruments;

[2] The health questionnaire was divided into Section A which recorded anthropometric measurements, blood pressure measurements and Section B recorded health related questions.

- Determine the experimental production rate of legumes by measuring the legume variety yields in two trials between 2015 and 2016 and later in 2016; and
- Develop and implement a two-year agriculture and nutrition intervention programme (including baseline pre- and post-interventions and follow-up survey intervals) as discussed in the experimental aim of the study.
- Conduct a follow-up survey to measure the impact of the training programme.
- Develop relevant recommendations for each project stakeholder.

As alluded to earlier, the need for the farmers to gain nutritional knowledge was an important part of the intervention programme. The agriculture and nutrition programmes ran concurrently and were based on the 2016 revised South African guidelines for healthy eating. The programme also covered practical planting training and food and nutrition training to ensure a holistic link between agriculture, food and nutrition security and maintaining a good health status. Experiments were conducted at the Agri-Hub station but were also rolled out to individual farming plots at household level. The training highlighted the health and nutritional benefits of legume consumption, especially during ageing, in a farming context where physical strength during agricultural activities is vital.

1.13 Study Area

The total Mariannhill area comprises 709 km^2 and has a basic infrastructure such, as limited running water in the peri-urban settings in this area. The area accommodates about 30.0% of the population of the EThekwini Metropolitan area. There are about 300 registered community gardens, some of which are privately owned, while others are on school or church premises. The vegetables produced in these gardens are used to feed families, terminally ill patients and school children, as well as being sold to the community. The objectives of the study were operationalised by means of investigations in the context described above.

1.14 Conceptual Framework of the Study

Figure 1.6 below presents the conceptual framework of the study and the chapter organisation.

Conceptual Framework: Continued

Conceptual Framework: Continued

Conceptual Framework: Continued

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Conceptual framework: Continued

*It is important to note that, although the design of the training material, the training programme, and the cultivation and the consumption of legumes occurred relatively interchangeably during the intervention phase, these processes are reported chronologically in this thesis for the sake of clarity and a logical flow of the discourse.

*It is also important to note that the use of 'participants' and 'respondents' occurs interchangeably in this thesis as the participants who were actively involved in the field work study (EG) also responded to the questionnaires.

1.15 Structure of the Dissertation

A summary of the chapters of this dissertation is presented below:

CHAPTER 1:	**Background and Problem Statement** The experimental and overarching aims of the study are explained with reference to the inclusion of elderly farmers from the EThekwini municipal Agric-Hub programme as the study sample.
CHAPTER 2:	**Literature Review** Academic articles and earlier studies are explored to gain in-depth insight into food and nutrition security and study and methodologies.
CHAPTER 3:	**Baseline Study** This chapter presents a discussion of the research methodologies that were adopted. The results of the baseline study are presented and discussed and conclusions are drawn. The limitations of the study are underscored.
CHAPTER 4:	**Pre-Intervention Survey, Intervention study, and Post-Intervention Survey** A discussion of the research methodologies and models that were adopted is presented. The results of the intervention programme are discussed and interpreted and concluding remarks are presented.
CHAPTER 5:	**Post-Intervention and Follow-up Surveys** The results are presented, compared and discussed.
CHAPTER 6:	**Conclusions and Recommendations** A broad summary of the study findings, the educational tools that were developed, and the implications of the findings is presented. Final conclusions are drawn and recommendations for future research are offered.

1.16 Conclusion

The aim of this chapter was to illuminate the background to the study and to discuss the prevailing challenges linked to food insecurity and malnutrition globally, and in Africa and South Africa in particular. These challenges constituted the main pillars on which the study was constructed. The chapter provided essential background information pertaining to food security and nutrition and highlighted the role of elderly farmers in the food production chain. This information was used to conceptualise the implementation of an experimental programme to enhance the diet, health and farming practices of elderly farmers in the study area. The aim of the study and the objectives were presented and brief descriptions of the project structure and the dissertation layout were provided.

The study aimed to link the chain of food production and the improvement of dietary patterns through diversity with the necessity for technical skills in food processing and knowledge of the food that one consumes. Achieving and sustaining a positive health status was highlighted as an overall responsibility of farmers, as they need to be equipped to continue providing food for their families and the communities in which they function as food providers. The objectives of the research project were summarised. It was explained that the study attempted to integrate agricultural activities (as a vital component of promoting food security) and dietary diversity with a practical educational platform to link theory and practical applications in food production and consumption by elderly farmers in the selected study area. The discussion thus focused on the need for food and nutrition security programmes to reach the broader community, yet for such programmes to be very specific in addressing various facets of the food insecurity problem. The selected community was an ideal platform to use as a springboard from which to explore the agricultural, nutritional and health aspects that older farmers faced. The knowledge elicited could be integrated with knowledge about global challenges in agriculture, with specific focus on smallholder farmers. The relevance of the study is its contribution to the body of knowledge on the challenges that elderly farmers face when they are confronted with issues such as malnutrition and poor health. The following chapter provides more in-depth information about the topic as gleaned from an extensive literature review. The discourse will also address the knowledge base on which the educational section of the study programme was built.

CHAPTER 2

LITERATURE REVIEW:

STRATEGIES TO ADDRESS FOOD AND NUTRITION INSECURITY

2.1 Introduction

This chapter provides a comprehensive review of current literature related to the key study objectives. Information gleaned from this review provided a scholarly framework and guidelines for the study and informed appropriate methods to ensure that the study objectives were addressed. The diversity of the literature sources consulted signifies the multidisciplinary nature of this study. Appropriate sub-headings are used to contextualise the focus areas and supporting evidence, ensuring that the discourse flows meaningfully.

2.2 Health and Wellbeing in the Twenty-First Century in Older Adults

Globally, human health and the overall wellbeing of people require a multidisciplinary approach to health and the engagement of all relevant stakeholders to ensure that the many challenges experienced in terms of health are addressed. It was against this background that the current study investigated the relational variables associated with human health in an effort to provide an interventional framework to improve the overall health and wellbeing of smallholder farmers in a selected study area. Addressing the health challenges that these farmers experienced as key role-players in ensuring food security within an environment of unstable population growth, was deemed urgent (Gomes, Abrantes, Banos, Rocha & Buxton, 2019). The selected study location was an essential platform from which these challenges could be addressed, as the farmers who were involved in the study played a critical role in creating a secure food environment within the value chain of the community in which they resided.

The increasing rate of non-communicable diseases, also referred to as non-transmissible chronic diseases, reportedly affects almost 49.5% of people worldwide, with cardiovascular disease being the most common amongst them. This has direct consequences for individuals' work, social life and overall wellbeing (Kim & Andrade, 2019). Although cardiovascular disease (CVD) is one of the most common non-communicable diseases affecting millions of people worldwide, obesity and diabetes are also lifestyle diseases that need to be addressed. According to Lim *et al.* (2015), people in both developed and developing countries face major morbidity and mortality challenges due to escalating levels of obesity and diabetes which are non-communicable diseases. Bhavani, Dangour and Shetty (2019) postulate that, no country has as yet been able to address escalating obesity trends successfully. Therefore, this phenomenon needs urgent attention. However, considering the seriousness of all the diseases mentioned above, interventions are needed to minimize the risks posed by all these health threats, globally (Kim & Andrade, 2019).

Risk factors that lead to cardiovascular disease include hypertension and stroke, which contribute to about 13.5% of deaths in both low- and middle-income countries (Ravi *et al*., 2016). The World Health Assembly Non-communicable Disease Global Monitoring Framework argues that there is a global concern regarding the escalation of diabetes and obesity. This body has therefore been monitoring and tracking various countries' progress in addressing these challenges (IFPRI, 2016a). Another significant challenge experienced by people in the latter parts of their lives is associated with bone disorders such as osteoporosis, menopause in women etc. which are associated with eating disorders (Dufour *et al.*, 2016). According to the NCD Alliance (2016), health policies should align agricultural and food policies for a more synergetic effect on health promotion. Physical exercise is an important avenue for alleviating non-communicable diseases. In South Africa, the Department of Health (DoH) (2016) recommends regular exercise in its guidelines for healthy eating under the slogan "Be Active". This initiative was launched during the National Nutrition Week of 9−15 October 2012. In the South African context, agricultural activity could form part of increasing physical activity. Canadian guidelines offer specific nutrient recommendations for elderly adults and urge that they engage in building the major muscle groups at least two days per week. This must be coupled with 150 minutes of moderate to vigorous aerobic activity. The Canadian guidelines correlate exercise with cardiovascular health, cognitive function, improved mental health, and social engagement (Canadian Society for Exercise and Physiology [CSEP], 2012). Another focus for older adults is on improving strength and mental functioning as opposed to improving cardiopulmonary fitness only. In the context of elderly farmers, the above arguments suggest that agricultural activity plays a vital role in elderly farmers' lives, as a form of physical exercise that can contribute positively to their health and overall wellbeing (Wan, 2014). Currently, non-communicable diseases pose global health challenges, and it is estimated that the global mortality rate due to various conditions will have escalated four times by 2030 (Joshi & Peiris, 2019). Addressing human wellbeing globally is thus driven by the promotion of healthy environments and ensuring that food suppliers produce safe food. The availability of healthy food environments ensures optimum nutrition, adds to the quality of life of consumers and establishes healthy behavioural patterns that are informed by sound policies from a micro to macro level (Cusatis & Garbarski, 2019). According to Angelos *et al.* (2015), societal health challenges require a health approach strategy that must take into account the distinctive role of experts working together rather than, distinctive fields that create a trans-boundary and cross-disciplinary effect.

2.2.1 Ageing and malnutrition

Ageing is a natural process that is part of human life. However, it is also associated with psychological, social, physiological and pathological challenges that affect elderly people (Kalaiselvi *et al.,* 2016). Amarya, Singh and Sabharwal (2015) argue that the consumption of nutrient-dense foods with bioactive compounds and phytochemicals can prevent age-related disorders. This argument suggests that educating the elderly on nutrient-dense foods is a vital component of addressing malnutrition among people of this age group in order to ensure adequate and appropriate treatment for health challenges. It is also vital to identify prevailing nutritional challenges amongst older people in order to provide adequate and appropriate treatment regimes, particularly where the quality of life of elderly people is susceptible to diverse health threats. Nutritional screening programmes are part of effective interventions and range from admission to hospitals and old age homes to doctors visits and treatment programmes at clinics (Hsu *et al*., 2018). Thus, educating and training elderly farmers to adhere to disciplined health regimes and to abide by regular health screening processes is vital in managing malnutrition during ageing. Moreover, elderly farmers need to be committed to the production of healthy food to ensure not only their own wellbeing, but also that of the consumers of the food they produce.

Expecting farmers to adhere to health screening can sometimes clash with their farming activities, especially during planting season, which can in turn compromise their nutritional status and lead to malnutrition. Kalaiselvi *et al.* (2016) suggest that there is a correlation between poor nutritional status and frailty. This has severe implications for older farmers with these conditions as it may affect their agricultural output and the quality of the fresh produce they sell to consumers. Moreover, poor health and frailty also suggest that such farmers will face the increased risk of declining agricultural outputs, which in turn will affect their incomes and livelihoods, negatively.

Previous studies have also identified a link between ageing and education. Some authors suggest that being educated early in life can lead to an enjoyable old age and offers more survival options for the elderly (Kye, Arenas, Teruel & Rubalcava, 2014; Jallinoja, Niva, & Latvala, 2016). Progressive initiatives in research have also revealed an association between health, education and mortality, and it has been shown that these links are more observable in first- world countries (Maeda, Ishida, Nonogaki & Mori, 2019). In general, however, the literature suggests that health challenges are more severe during the ageing process than at any other phase of human existence (Jallinoja, Niva & Latvala, 2016).

2.2.2 Health challenges amongst elderly farmers as a threat to food and nutrition security

People working in agriculture are often exposed to various hazards. For example, the use of pesticides can be harmful; they may be exposed to various poisonous chemicals, and the misuse of machinery can lead to accidents (Nguyen *et al*., 2018). It is thus essential that smallholder farmers, especially in rural areas, are trained to ensure that they avoid all these hazards as this has health implications which can affect their ability to farm and generate income (Al-Zahrani *et al*., 2019). Moreover, issues that may compromise their occupational health should be highly emphasized and monitored. If a smallholder farmer becomes disabled, it is not only he/she and the immediate family who are affected, but the community at large may also be deprived of easy access to food, which will in turn contribute to nutrition insecurity in the affected area (Din *et al*., 2014).

According to Cole *et al*. (2016), health services must improve the health of citizens and a constant review of their operations is vital in addressing health and nutrition-related problems which have direct implications among this population group. Effective programmes tailored for citizens must be multi-sectoral and should be sensitive to various cultures. Therefore, functional health systems and medical healthcare play a pivotal role in alleviating health burdens amongst older adults. This occurs particularly when food and nutrition security is assured (Gomes *et al.*, 2019).

2.2.3 Disorders and disabilities that impact elderly farmers

Disability amongst elderly adults is a public health issue that can impose a health challenge and limit functionality within this vulnerable group (Petri *et al*., 2016). According to Mack *et al.* (2015, p. 793), the term 'disability' refers to "limitations in performing socially defined roles and tasks expected within a social-cultural and physical environment such as family, work, recreation and self-care". Disability may also be more adversely linked to the decline of oestrogen levels amongst menopausal females as compared to their male counterparts (Lichtenberg, 2019).

Disability is also associated with diverse health defects that impact the overall wellbeing of people, which is often linked with institutionalization; the under-utilization of health resources, and non-communicable diseases such as cardiovascular disease and stroke (Shi *et al*., 2014; (Mohammadifard *et al.*, 2014a; De-Rosende Celeiro, Santos-Del-Riego & Muñiz García, 2017). According to Amarya *et al.* (2015), some age-related disorders can be minimized by incorporating certain nutrients and bioactive ingredients with phytochemicals into the diets of elderly people. Mental disorders in the elderly are also common and have been associated with increased risks of disability, whilst reducing the quality of life (Mack *et al*., 2015). For example, vestibular disorder is a form of dizziness that is common with increasing age and can even lead sufferers to fall regularly, resulting in frequent visits to emergency facilities and hospitals. There is also a correlation between disability and vestibular disorder (Petri *et al*., 2016). Research has shown that farmers with disabilities and disorders need special attention and assistance as they need to be healthy enough to address food production demands in order to maintain the overall health status of the communities that consume the food they produce (Mack *et al.*, 2015; Volaklis *et al.*, 2016).

2.2.4 Anaemia as a condition that compromises the health of elderly people

Anaemia is a condition that is diagnosed when haemoglobin (Hb) levels fall below 13 g/dl in men and 12 g/dl in women, and this condition can contribute to cardiovascular disease (Kaiafa *et al*., 2015). Anaemia affects 24.8% of the population, which amounts to 1.62 billion people globally. India has the highest rate of iron deficiency anaemia (IDA) which is attributed to dietary influences (Madhu *et al*., 2016). Parasitic infections, malaria and iron deficiency are factors that exacerbate anaemia, particularly amongst people in developing countries (Miller & Welch, 2013). According to Ferreira *et al*., (2018), anaemia has a particularly adverse effect on older persons who are frail.

There is evidence that the prevalence of anaemia is more common among older people and particularly amongst women living in poverty (Fan & Brzeska, 2014), which suggests that more studies should be conducted on anaemia among the elderly, including farmers in all the provinces of South Africa where populations and cultural dynamics are so diverse (DoH, 2013; SADHS, 2016). It is undeniable that anaemia can lead to a compromised health status in older persons. Thus great caution should be exercised by farming communities who are exposed to soil and who harvest and directly consume vegetables that can be contaminated with parasites as parasites can cause iron deficiency. In this section, only iron deficiency anemia has been discussed.

2.2.5 Eye health and functionality

In South Africa, there is a high prevalence of eye health challenges, with almost 5 000 in every million people being affected by cataracts, which can lead to blindness. Cataracts are linked to ageing, genetic predispositions, as well as ethnicity (DoH, 2013). However, modern technology can be used to remove cataracts and even replace affected lenses in the eyes, thus improving vision and the functionally of farmers who are affected (Torabi *et al*., 2019). Poor eyesight can affect an individual's ability to cook and eat food, making it difficult and strenuous to do these activities comfortably (Amarya *et al*., 2015). Therefore, the ageing population should be assisted to combat this challenge and to maximize available services that are provided virtually free of charge by the government for poor people. Farmers should also be more vigilant and take greater care of their eyes. For example, poor eyesight may be exacerbated by ignoring the dangers of pesticides and other hazardous chemicals. Moreover, inappropriate food and medication may be consumed as poor eyesight may limit the ability of a person to pay attention to warnings on labels. Such practices may lead to food and nutrition insecurity because of the lack of accessing information (Torabi *et al*., 2019).

2.2.6 The impact of frailty on health and nutrition

Frailty increases the risk of poorly managed daily activities, which in turn causes dependency on others and external health systems for functionality. Frailty can be triggered by a low socioeconomic status, non-communicable conditions, and a poor diet, indicating a significant association between frailty and malnutrition (Maeda *et al.*, 2019). Based on the findings of a study conducted in the United Kingdom, the researchers suggest that nutritional assessments must be accompanied by blood markers to further categorise health problems (Slee, Birch & Stokoe, 2016). Frailty is more common in women than in men, and there is also a link between obesity and frailty due to physical functional decline and inflammatory conditions (Castaneda-Gameros, Redwood & Thompson, 2017). In the context of frail smallholder farmers, there is a need to provide proper care and support to manage non-communicable diseases through community programmes, as this can capacitate affected farmers to deal with their frail condition (de van der Schueren *et al.*, 2016). Moreover, the early detection of conditions associated with frailty can prevent progressive malnutrition among older farmers, which may in turn address food and nutrition insecurity in the communities that they serve if interventions are provided early (Jyväkorpi *et al*., 2016).

2.2.7 Digestive disorders leading to nutritional problems

Digestive challenges in later life can be attributed to a decrease in gastric acid secretion which can then limit absorption, slow peristalsis and result in constipation (Amarya *et al*., 2015). Other disadvantages of gastric acid are excessive gas production and flatulence caused by the poor breaking down of food such as legumes. This condition is associated with carbohydrate complexity that is sometimes not broken down by digestive enzymes (Fabbri & Crosby, 2016). According to Lee *et al*. (2019), a decline in sensory functions and poor oral health coupled with digestive problems can alter dietary intake, particularly during old age. Research has shown a link between oral health and digestive problems such as decreased gastric acid and has highlighted the need for a focus on good digestion, absorption, transportation and excretion of nutrients (Dato, Bellizzi, Rose & Passarino, 2016). Effective processing of food can eliminate possible digestive problems associated with certain foods (Michaels, 2016), while digestive problems can result in inadequate food and liquid intake, which in turn will affect dietary patterns and eventually compromise a person's nutritional status (Rao, 2018). Other interventions of dealing with this challenge involves using medicinal plants as a remedy coupled with the use of indigenous knowledge can help address digestive disorders effectively (Rahman *et al*., 2016).

2.2.8 Menopause challenges that affect elderly women

According to Raman *et al.* (2015), menopause associated with a decline in sex hormones is one of the risk factors that increases the chances of a stroke. Moreover, menopause can lead to muscle dysfunction, as well as muscle and skeletal pain (Ogwumike, Adeniyi & Orogbemi, 2016). According to Santini, Andersson and Lamura (2016), menopause is a health risk factor that contributes to urinary incontinence in older adults. Menopause is also associated with the threat of functional disability caused by a decline in oestrogen levels (Velez *et al*., 2019). Menopause can also affect the overall distribution of adipose tissue, which renders women more susceptible to obesity-related disorders (Murphy, Moullec, & Santosa, 2017). However, regardless of extensive research on the impact of menopause, there is still a paucity of comprehensive programmes tailored to tackle menopause as a challenge for women in Africa (African Union, 2015).

2.3 Lifestyle Diseases and Their Associated Implications in Elderly Life

The literature discussed hitherto has detailed the role of non-communicable diseases and the impact they have on the health of the elderly, globally. The review presented in this section will further explore the implications and considerations of each disease. These diseases have formed the basis of the study's investigation and background information is provided to underpin their significance.

2.3.1 Overweight and obesity: A double burden

Over the past 50 years, obesity has been identified as a public health issue that has impacted the international community. For this reason, it is considered a double burden for people middle- and low-income countries (Hamann, 2017). Furthermore, its impacts on health risks, the quality of an individual's life, and national healthcare costs have been identified as major concerns in healthcare contexts (Centre for Disease Control (CDC), 2015 & 2017; World Health Organization (WHO), 2013b). According to the WHO (2015b & c), around 13.0% of the global adult population was obese at the time of the survey (which was 2015). This percentage amounted to more than 600 million people globally. These figures are alarming as they indicate that more than 10.0% of the world's population was afflicted with this condition only recently. This burden increased amongst older persons in the sub-Saharan region between 1980-2014 (Lartey *et al*., 2019). There is an urgent need for obesity management in order to prevent it from exploding any further to escalating worldwide. Medical costs associated with obesity will undeniably increase in the next 15 years (CDC, 2015 & 2017). The rise in medical costs is also associated with an increase in the body mass index (BMI) of people globally (Fu *et al*., 2016).

Moreover, obesity has been identified as the second largest expense that employers incur after depression (Bray *et al*., 2016). The complexity of obesity is associated with both internal and external factors that include energy imbalance and it has been argued that the reinforcement of certain food substitutions that are more nutritious can be a challenge for weight control interventions (McCullough, Guilkey & Stark, 2017). It is important to note that even though this term has been broadly discussed above however, there is a growing number of elderly people facing this challenge and fall within these statistics globally (Levy & Slade, 2019; Lim *et al*., 2015).

2.3.2 Central obesity and metabolic risk factors

Waist circumference is a measure for central obesity (CDC, 2015). According to Rohde *et al*. (2019), with increasing age, there is also an increase in central adiposity. This is associated with various risk factors such as diabetes as well as declining cognitive functioning, especially in women. There is a direct link between waist circumference and abdominal obesity. The measurement of waist circumference also forms part of a defining factor for metabolic syndrome risk (MetS), which includes pre-diabetes and dyslipidaemia (Okada *et al*., 2016). Visceral adipose tissue thickness is also associated with metabolic syndrome and is an acceptable method for conducting an intensive medical check-up (Kawada, Andou & Fukumitsu, 2016). According to Karatzi *et al.* (2016), there is an association between leptin levels and adiponectin levels in individuals with central obesity. Another association is the existence of Mets with obesity-related chronic inflammation and metabolic co-morbidities (Nimptsch, Konigorski & Pischon, 2019a).

2.3.3 Hypertension

Hypertension reportedly caused around 17.8 million deaths during 2017 worldwide, with the key risk factor being systolic blood pressure (SBP) due to a weakened elestacity of the arterial system. Hypertension is also a common denominator causing about 54.0% of strokes, and 47.0% accounts for coronary disease (Li *et* al., 2019a). The management of hypertension requires specific dietary approaches such as the dietary approach to stop hypertension, which is called the DASH diet. This diet is rich in fruit and vegetables and is low in salt, saturated fats and cholesterol and is known for lowering systolic and diastolic blood pressure in hypertensive patients (Tsioufis, 2018).

In a household food security study conducted in urban areas in Iran, hypertension was associated with the consumption of high-fat diets (Hosseini, Pakravan Charvadeh, Salami & Flora, 2017). Hypertension can be improved with phenolic compounds found in legumes and these compounds are utilized by various industries globally. This foodstuff provides significant therapeutic characteristics that can even be used in supplements (Šibul *et al*., 2016). The consumption of plant-based diets influences hypertension positively because such plants are more likely to contain fibre, micronutrients and polyunsaturated fats (Sobiecki, Appleby, Bradbury & Key, 2016). However, hypertension is no longer an adult problem alone, as evidence has shown its increasing prevalence amongst young people as well. There is thus a dire need for manageable lifestyle changes such as limited or no tobacco and alcohol use and healthy dietary interventions (Gadekar & Cariappa, 2017).

2.3.4 Diabetes

The prevalence of diabetes increased between during 2014 to 2016 globally, where 1.5 million deaths were attributed to this condition. A high death rate occurred, particularly amongst older persons (Supiyev *et al*., 2016) and it is predicted that deaths associated with diabetes will escalate in low- and middle-income countries by 20.0% between 2010-2030 (Liu *et al* ., 2018a; Lim *et al*., 2015). Diabetes is associated with the burden of ill-health and occurs primarily in the developing world, where more than 80.0% of the 1.5 million deaths occurred in low- and middle-income countries. Diabetic patients are at a disadvantage due to the inability of health systems to cope with the demanding care requirements for this condition. Other challenges include the limited availability of funds, poor service delivery, a lack of preventative measures and the limited experience of healthcare professionals (Prestes *et al*., 2017).

Type 2 diabetes is more prevalent than Type 1 diabetes. This increases the development of macro- and microvascular complications, leading to a negative impact on protein metabolism (Li *et al*., 2019b). According to Badran *et al.* (2016), the presence of trace elements in human tissue is vital in diagnosing and treating Type-2 diabetes. These elements are zinc, copper, chromium and manganese. The impacts of a low socioeconomic status, limited physical activity, being overweight, and the influence of urbanization (particularly as Westernized diets are consumed in urban areas) are increasingly evident in diabetic patients (Supiyev *et al*., 2016). When diabetes is well managed and controlled, it can lower cardiovascular risk.

However, an increasing mortality rate is influenced by prolonging diagnosis, as well as poor diabetic treatment and control (Prestes *et al*., 2017).

2.3.5 Cholesterol management

Cholesterol levels can be reduced by weight loss and by certain compounds called phytosterols that have been shown to have cholesterol lowering benefits. The use of non-soy legumes have been shown to lower cholesterol in long-term intervention trials ranging from 6 months to over 3 (Bazzano *et al*., 2011). However, poor cholesterol management can affect memory and frontal opercular cortex function amongst elderly patients (Kinno *et al*., 2019).

Diet has an effect on blood cholesterol because certain foods can affect the level of high-density lipoproteins (HDL), while some are rich in low-density lipoproteins (LDL) in the bloodstream. A prospective urban rural epidemiology (PURE) study conducted in 18 countries urges that governments should subsidise whole grains and vegetables so that these foods are affordable for consumers in order to lower cholesterol levels/fat intake. More particularly, legume intake improves cardiovascular health, which results in lower untimely mortality rates (Miller *et al*., 2017). According to Bain *et al.* (2015), cholesterol is modifiable through dietary intake interventions such as salt, alcohol, saturated fats and cholesterol level reduction. The risk of cardiovascular disease and stroke are some of the consequences related to poor cholesterol management (Kinno *et al*., 2019).

2.3.6 Cardiovascular disease (CVD)

According to Liu *et al*. (2018a), one of the most common non-communicable diseases globally is CVD, which impacts individuals as well as society at large. During 2017, it caused around 17.8 million deaths globally and adversely affected individuals' wellbeing and quality of life. Variables such as age, lifestyle, the prevalence of other diseases such as diabetes and economic factors contribute to the escalation of this disease (Liu *et al*., 2018b). Even though CVD is affected by increasing age (due to changes in the heart and in blood vessels), there are associations between handgrip strength and CVD (these associations include age, BMI etc.) (Yu *et al*., 2018). Weber and Grune (2016) argue that there will be a 3.5-fold increase of CVD globally within the next 30 years, with Brazil leading CVD mortality by 2040. Diets that are rich in fruit and vegetables have been known to reduce the risk of CVD (Hamirudin *et al.*, 2016) .

2.3.7 Cancer

In 2018, 18.1 million cancer cases were reported, while 9.6 million deaths occurred due to cancer. About 30.0% of cancers are linked to diet quality, particularly as some foods that are habitually consumed have carcinogenic effects (International Agency for Research on Cancer [IARC], 2018). These diets include excessive micro minerals and heavy metals (Akinyele & Shokunbi, 2015). One of the major factors contributing to cancer development is dysfunctional cells that are attributed to free radicals and reactive species (Żyżelewicz *et al.*, 2016). Diseases such as cancer can be lowered by regular legume consumption, as correlations between legume intake and cancer reduction have been found by various studies. This lower risk is attributed to polyphenols and antioxidant activity associated with legumes (Zhao, Du, Wang & Cai, 2014). Cancers such as those of the pancreas, kidney and thyroid associated with the prevalence of obesity are affecting a large number of people globally (Raftopoulou, 2017). Milk consumption over a long period can reduce bladder and colon cancer, but other dairy products such as butter and cheese do not have this effect (Vyncke *et al*., 2013). A study conducted in the United States of America highlights that a significant intake of folate curbed prostate cancer amongst older men (Rycyna, Bacich & O'Keefe, 2016). Colorectal cancer is linked to the consumption of red meat and processed meat products (Hoffman, 2017). However, Nikolić *et al.* (2012) suggests that colon cancer can be reduced by the consumption of legumes.

2.4 The Role of Nutrients in Blood Serum

Nutrients play an important role in the blood as they cause cell functionality and maintain bodily processes, since they also provide nutritive value of the food consumed (Dato *et al*., 2016). An absence of nutrients can lead to malnutrition and to various dysfunctionalities within the body, but drugs can be administered as an intervention when patients are experiencing challenges (Badran *et al*., 2016). The literature suggests that various nutrients are pivotal in the treatment of non-communicable diseases. The roles and impact of these nutrients and the manner in which they can be measured are discussed next.

2.4.1 Cholesterol (CH)

Cholesterol lipoprotein fractions as well as serum triglycerides can be measured and separated by ultra-centrifugation for assessment (Zaccardi *et al*., 2015). Cholesterol assessment can include serum total cholesterol and triglycerides by using enzymatic colourimetric assay, while HDL can be assessed by enzymatic precipitation with dextran magnesium (Rohde *et al*., 2019).

2.4.2 Magnesium (Mg)

The role of magnesium in the human body is to regulate cellular processes and various metabolic reactions required for the body to function optimally (Sales, Pedrosa, Lima, Lemos & Colli, 2011). According to Cunha *et al.* (2013), magnesium is an important intracellular tool that facilitates cardiovascular functions. Cherbuin (2016), states that studies have indicated that magnesium plays a vital role in the body as it acts as a natural calcium blocker; reduces coronary artery blockage through the accumulation of calcium salts; and enhances platelet coagulation. Magnesium also plays a pivotal role in homeostatic functions and allows membrane stability, fluidity within cells, as well as neuronal activity (Basheer *et al*., 2016).

Including magnesium in the diet has a number of advantages such as the modification of non-communicable diseases like stroke, high blood pressure and cholesterol (Bain e*t al*., 2015). Conversely, magnesium deficiency is linked with metabolic disorders and endocrine dysfunctionality, which occur predominantly in people who are diabetic (Ramadass, Basu & Srinivasan, 2015). A lack of magnesium has also been linked to hypertension and the risk of diabetes. A study conducted in the US showed that magnesium deficiency rates were associated with the onset of de novo hypertension and the worsening of pre-existing hypertension (Chrysant & Chrysant, 2019).

2.4.3 Calcium (Ca)

Insulin secretion is regulated by calcium and there is an association between higher serum calcium levels and the increased risk of Type-2 diabetes. However, conflicting results have been associated with glucose, as well as calcium interactions (Zaccardi *et al*., 2015). Calcium plays a significant role in the functionality of the body and thus innovations are increasingly introduced in the food industry to fortify products such as bread and cereals to improve calcium consumption (Shin, Choi, Kim & Song, 2016)**.** Calcium deficiency and poor absorption of Ca leads to poor bone quality, and therefore its deficiency in later life is a concern (Rana *et al*., 2016). The existence of coronary artery calcium (CAC) is a co-factor for coronary disease as it influences other conditions such as unhealthy calcium deposits (Nakanishi *et al*., 2015).

2.4.4 Iron (Fe)

Iron contributes to various biochemical reactions including oxidative phosphorylation, myelin synthesis, neurotransmitter production, and oxygen transportation. Iron deficiency is a result of depletion when a lack of iron can no longer be addressed by dietary intake (Drexler *et al*., 2019). About 70.0% of the body's iron is situated in the red blood cells, while the human brain stores iron reserves to maintain a healthy iron status. However, plateauing iron in the brain as age increases is associated with Alzheimer's disease (Peters, Connor & Meadowcroft, 2015). Anaemia is a common cause of iron deficiency and occurs in people in both developed and underdeveloped countries. It is a condition associated with various socio-economic challenges (Percy, Mansour, & Fraser, 2016). Two major factors leading to iron deficiency are insufficient intake due to poverty and poor bio-availability (Przybysz *et al*., 2016).

According to Kaur and Henry (2014), iron levels may fluctuate in diabetic patients, and test results have indicated a higher ferritin levels amongst diabetic patients as compared to non-diabetic patients. Increased iron levels are also associated with insulin resistance in Type 2 diabetes (Kaur & Henry, 2014). Obese individuals who consume a high-fat diet are more likely to experience iron deficiency due to poor iron absorption and circulation than people who are not obese (Sonnweber *et al*., 2012). Based on their findings, the latter authors suggest that the observed nutrient absorption could have been influenced by obesity levels because the majority of the individuals participating in their study were overweight or obese. Damage to the joints, the liver, the heart and the endocrine organs can be linked to iron overload (Camacho *et al*., 2016). Iron deficiency is a global nutritional disorder that poses severe challenges for human health (Chan *et al*., 2019).

2.5 Dietary Needs of the Elderly

Diet is a combination of food, nutrients and non-nutrient interactions that occur during the eating process. Consumed food contains various nutrients that are good for the body, but could also influence disease formation and progression. These afflictions may differ from individual to individual and even amongst communities and global populations (Nobbs *et al.*, 2016). Be that as it may, a healthy diet for older persons must be in line with the current need to curb non-communicable diseases and must address the physiological needs of ageing persons. Nutrients like protein and carbohydrates must be adequate for maintaining sufficient energy levels and ensure a good nutritional status (Tieland *et al.*, 2018).

In older life, dietary patterns can be used as an important tool to indicate relational dynamics between foods that are regularly consumed and disease prevalence. Various studies amongst diffrent population groupings have linked diet and diseases (Xu, Hall, Byles & Shi, 2015). The dietary needs of older adults are dependent upon various factors such as age, gender, body composition, weight and activity levels. In later life, people have lower energy requirements due to a reduced metabolic rate, and a reduction in physical activity as well as resting energy expenditure (Amarya *et al.*, 2015).

According to Hamirudin *et al.* (2016), several challenges are associated with older adults who are malnourished, namely delayed recovery ailements, a declining health status and compromised overall wellbeing. Other challenges are prolonged hospitalization and regular trips to health care institutions for medical attention. Therefore, timeous and regular nutritional screening is necessary to minimize health risks in older people and to counteract the many health challenges experienced by people in this age group (Bird *et al*., 2019).

Monitoring elderly people's dietary intake in the elderly is a fundamental tool in addressing some challenges related to disease and lifestyle choices. As indicated above (refer to section 2.3.1), the impact of obesity, metabolic risk and diabetes can be managed through diet. According to the FAO (2014b), "eating is also an ethical act" as eating involves diverse choices premised on cultural beliefs, traditions and social structures that impact the nutritional status of humans. Literature suggests that having access to a good quality diet in later life can help the elderly person deal with some disparities associated with food and nutrition insecurity. It was against this backdrop that the current study set out to promote a well-balanced, nutrient-dense diet by increasing legume consumption as the key to elderly farmers' wellbeing. Simultaneously, the farmers' in-depth knowledge of legume production and their health benefits to further underscore the importance of accessing legumes as a comprehensive food source, was a primary focus of the study.

2.5.1 Risk factors associated with malnutrition

The European Society for Clinical Nutrition and Metabolism (ESPEN) defines malnutrition as "a dual process which should first include risk identification through using a validated screening tool. The second assessment involves evidence of unintentional weight loss" (Rojer *et al.*, 2016, p. 759). Just like over-nutrition, under-nutrition or malnutrition has high risks for human health. This condition with its associated physiological changes that occur later in life exacerbates ill-health in elderly people (Din *et al*., 2014). Appetite loss, dental complications, a declining metabolic rate, lack of mobility and a lack of social support all have a direct influence on the health status of the elderly. The geographical setting of rural areas is (in many instances) also more prone to impact under-nutrition than urban settings (Kalaiselvi *et al*., 2016). Moreover, under-nutrition in older adults is frequently undiagnosed, which suggests that a more active role by carers is vital in providing nutritional education for and screening of the elderly (Amarya *et al*., 2015).

According to Harding *et al.* (2015), various malnutrition screening tools can be used to detect risk. These include biochemical and clinical indices, to determine mobility and cognitive status, while health and nutritional status could also be determined by biochemical indices that can provide objective measurements of elderly people's health status. In this study, the researcher tried to utilize the majority of the screening tools highlighted above. Simsek *et al.* (2013) conducted a study in the Balcova District of Izmir in Turkey to assess malnutrition amongst the elderly in a specific community. It was found that factors such as living alone, poverty, food insecurity, individuals' views of their socio-economic health status, chronic diseases and disability exacerbated malnutrition in this community. Other health challenges that can be linked to malnutrition include indicators such as the state of reduced immunity; risk of infection; weakened muscle strength; falls and fractures; and delayed wound healing, which can all worsen the condition of malnutrition in older adults (Amarya *et al*., 2015).

2.5.2 Micronutrient deficiency and nutrition insecurity

Micronutrient deficiency is one of the key indicators of household food and nutrition insecurity (Carletto, Zezza & Banerjee, 2013a). Micronutrient malnutrition occurs when intakes of bio-available micronutrients are too low to meet the body's requirements, which affects about a third to half of the world's population (Miller & Welch, 2013). Micronutrients have many biochemical properties that contribute to the homeostatic regulation of the human body. Prevention of this deficiency requires a holistic approach that focuses on increasing the energy, protein and micronutrient content in a diet. Micronutrient deficiency is also linked to obesity prevalence due to high intakes of macronutrients which are more energy dense (Poli *et al*., 2017). Frailty in older persons has been associated with micronutrient deficiency, which is a major concern that renders micronutrient adequacy a significant goal for the sustained good health status of elderly people (Castaneda-Gameros *et al.,* 2017).

According to Zahir-Aziz *et al*. (2018), about 75.0% of the world's population is affected by micronutrient deficiency and has caused increasing rates of morbidity and poor mental and physical health. Moreover, it ultimately affects productivity levels amongst older adults (Miller & Welch, 2013). An adequate intake of micronutrients plays a crucial role in improving the health profile of diabetic patients. This is achievable through glycaemic control, as is suggested by Kaur and Henry (2014) who conducted their study in Singapore on the associations between diabetes and micronutrient intake. Other essential nutrients during elderly life include Vitamin D, E, B as well as calcium, zinc and magnesium that must be consumed in sufficient amounts to address micronutrient deficiency (Hans & Jana, 2018).

Micro minerals, which are also defined as trace elements, are not highly consumed due to poor fruit and vegetable intake, yet they are a requirement in the diet of humans (Poli *et al*., 2017). The poor consumption of micronutrients has also been shown to contribute to about 30.0% of cancer cases as a lack of micronutrients triggers carcinogenic contaminants in the diet (Akinyele & Shokunbi, 2015). Vitamin C has been shown to have a significant impact on the provision of antioxidant protection and also in lowering atherosclerosis, cataract impact, degenerative diseases and some cancers, particularly in the elderly (Bolzetta *et al*., 2015).

2.5.3 Functional foods as a vital tool for improved nutrition

The term 'functional foods' is defined by Van der Zanden (2014, p. 17) as "a food that has exceptional health benefits beyond addressing hunger and general nutritional benefits associated with that particular food". In Japan, the functional food industry grew to 1.8 billion sales during 2018 because of regulations that promoted this industry as part of improving the nutritional status of its citizens (Iwatani & Yamamoto, 2019). However, there is growing concern about functional food claims and acceptance can sometimes be poor amongst certain population groups. It appears that older persons tend to prefer functional foods above others as they have a lower desire for taste and a greater need for the health benefits associated with the consumption of such foods (Van der Zanden *et al.*, 2014). Functional foods thus play an important role in the diet of elderly people due to their nutritional benefits and the health claims associated with them, which are features that most manufacturers use to their advantage (Verhagen & Van Loveren, 2016). According to Zhao *et al.* (2014), legumes are a good source of functional ingredients and can be utilized for various health applications.

The general perception is that functional foods are a healthy form of food in developing countries and that older persons in particular should consume such foods (Iwatani & Yamamoto, 2019). However, the downside from a consumer perspective is confusion about claims (due to a lack of nutritional knowledge), the uncommon taste of these foods and the cost associated with them (Van der Zanden *et al.*, 2014). For example, older people cannot fully understand the information on the food labels and the advertising and marketing propaganda used to drive these products is often confusing for them. However, there is a growing market for functional foods globally, which has been confirmed by legume silage usage that has resulted in improved lamb growth compared to other feeds (Przemysław *et al*., 2015). This suggests that the consumption of legumes as a primary functional food may be beneficial to both humans and animals in the long-term (Zhao *et al.*, 2014).

2.5.4 The role of dietary fibre

Sufficient intake of dietary fibre such as high fibre cereals and vegetables, is associated with benefits such as protection from cardiovascular diseases, oxidative stress, a desirable lipid profile and insulin resistance (Wang *et al*., 2019). Dietary fibre has a direct effect on satiety levels and on appetite (Koivunen *et al.*, 2016). A study in the United States on the impact of oatmeal as a good fibre source indicated an improved diet status, as well as positive physiological outcomes (Fulgoni, Chu, O'Shea, Slavin & DiRienzo, 2015). These results suggest that nutrition education should be used to provide guidance to the elderly in terms of various food sources with a high fibre content that should be incorporated into their diet.

Dietary fibre is also a vital energy source for colon epithelium and gel formation inside the body, particularly as soluble fibre can lower the risk of colon cancer and colitis. Its water-binding capacity also aids in producing a softer stool (Dodevska *et al.*, 2013). According to Koivunen *et al.* (2016), legumes are a good source of fibre and can improve gastrointestinal health through better digestion and a lack of constipation.

2.5.5 Sodium intake and the implications associated with its consumption

Research has warned against the danger of high sodium (salt) (also known as Na-sodium; Cl-chloride) intake as it is commonly associated with cardiovascular disease and increasing blood pressure levels (Becerra-Tomás *et al*., 2016). Apart from the direct intake of dietary sodium, other sources of sodium include bread, processed meats and various snacks. Traditional household recipes and cooking methods also encourage the use of high levels of sodium (Ravi *et al*., 2016). According to Borah *et al*. (2018), community-based interventions of salt reduction can be used successfully to reduce hypertension. This was evident in a study in India that examined the health status of tea garden workers, an initiative based on the knowledge that a high sodium intake exacerbates lifestyle diseases and can be life-threatening. It has therefore been suggested that the replacement of highly salted meat with legumes can improve levels of hypertension and metabolic risk syndrome (Becerra-Tomás *et al*., 2016).

2.6 The Consumption of Legumes as an Intervention to Address Food and Nutrition Insecurity

Based on information gleaned from the literature, the current study aimed to promote the consumption of legumes by elderly urban smallholder farmers as an intervention strategy to improve their health and food production capacity at the household level. Clearly, the literature illuminated the importance of improving food and nutrition security through multidimensional interaction. Hence the study addressed this challenge.

2.6.1 Why the consumption of legumes is a significant strategy for a healthier lifestyle

Legumes are an essential part of the human diet and have been consumed over many generations by various communities across the globe (Ruiz *et al*., 1996). Legumes are scientifically classified as follows:

- Beans: *Phaseolus vulgaris L*.
- Lentils: *Lens culinaris L.*
- Chickpeas: *Cicer arietinum L.*
- Peas: *Pisum sativum L.*

All these legumes are rich in plant proteins, starch, dietary fibre, minerals, vitamins and fatty acids (Caprioli *et al*., 2016; Ruiz *et al*., 1996).

According to Akibode and Maredia (2011), legumes have a kilojoule contribution of 30,0% in developing countries and they also have a 7.5% protein content. In South Africa, legume consumption contributes to 3.0% of the energy intake of the population (Ibid). The production of legumes occurs in more than a hundred countries worldwide, which translates into around 70 million hectares of harvested area. Regions with high legume production rates include Central America, certain parts of South America, West Africa, East Africa and South Asia. Unfortunately, South Africa is not a top producer of legumes due to restrictions such as land availability, market dynamics and food choices (Pradesh *et al.*, 2015; Alliance for Green Revolution in Africa [AGRA], 2017). The low production of legumes locally has cost implications, particularly in terms of their affordability amongst poorer communities (Bill & Melinda Gates Foundation, 2012). Grain legume cultivation is generally associated with women who are primarily involved in the cultivation, processing, food preparation and marketing of these harvests. Therefore, it is argued that women can improve food and nutrition security more readily than men can in countries within the Southern African region (Consultative Group on International Agricultural Research [CGIAR], 2012; 2013). The role of legumes in the economy is varied as these crops are used for livestock feed, medicinal benefits, green manure in industries and human consumption (Gutiérrez-Uribe, Guajardo-Flores & López-Barrios, 2016).

Clearly, there is a need to improve farmers' knowledge regarding the cultivation and application potential of legumes, particularly in terms of production, intercropping, processing, preparation and nutritional benefits. However, farmers' knowledge of pest control is also essential (Vanlauwe *et al*., 2019). Therefore, these knowledge platforms were explored in the current study. It is common knowledge that the cultivation of various types of grain is limited by the impact of pests (Van Kessel & Hartley, 2000). Therefore, agricultural practices and farmer behaviour when it comes to legume production need interventional strategies that are sustainable in terms of pest management (Abtew *et al*., 2016).

In recent years, interest has developed in utilizing legumes as a food source that will provide additional dietary benefits such as phytochemicals, nutraceuticals and functional properties. The role of phytochemicals in reducing various cancers, cardiovascular diseases, diabetes and chronic ailments and illnesses has been supported by clinical studies (Gutiérrez-Uribe *et al*., 2016 & Koivunen *et al.*, 2016). Such evidence underpinned the investigation undertaken in the current study to determine the relationship between the consumption of legumes and chronic diseases and blood mineral indices.

2.6.2 Rationale for the promotion of legumes in the diet

The term 'legume' originates from the Latin word 'legumen', which means 'seeds harvested in pods'. The term 'pulse' (from the Latin word 'pulse' meaning pottage) is used for legume seeds that contain small quantities of oils (Sathe, 2016). According to Michaels (2016), the *Leguminosae* family is very broad, with an estimated 16 000–19 000 species. Legumes in nature have various uses and can also differ in seed composition, which is the reason why they are sub-divided into various extending groups (Sibathu *et al.,* 2015).

The vast benefits of legumes include lowering the threat of some cancers, diabetes, chronic inflammation and cardiovascular diseases. Research has shown that legumes are consumed at a rate of about 19 g per person per day globally, which is relatively low (Gutiérrez-Uribe *et al.*, 2016). Legumes are known to be a source of isoflavones, phytochemicals and plant sterols while they are also a good source of magnesium, iron, calcium and potassium (Mohammadifard *et al*., 2014). As stated earlier, the consumption of legumes has been associated with the reduced risk of cancer, cardiovascular disease, diabetes, chronic inflammation, neural degeneration, and other chronic ailments and illnesses. Legumes are thus a good source of raw materials for the production of ingredients for nutraceuticals and functional foods (Gutiérrez-Uribe *et al*., 2016). It is undeniable that there is a need to promote the production and consumption of legumes on the African continent, as only 6,0% of the global consumption occurs in Africa, with West African leading (Bill & Mellinda Gates Foundation, 2012). Therefore, sub-Saharan regions also need to increase the consumption of legumes in the quest to ensure food and nutrition security amongst populations (CGIAR, 2013).

2.6.3 The role of legumes in modern diets

Legumes are rich in phenolic compounds such as isoflavonoids, phenylpropanoids, catechins, anthocyanins, tannins, lignans, coumarins, as well as anthraquinones and terpenoids. These phenolics have been linked to decreasing levels of certain cancers (Šibul *et al*., 2016). Dry beans have low levels of sodium and lipids and have no cholesterol as compared to sources of animal protein. They are also a good source of fibre, micronutrients and are relatively nutrient dense. Another important advantage is that they are a cost-effective protein substitution and also have long-term storage benefits because they are not perishable (Sathe, 2016).

According to Dodevska *et al.* (2013), legumes contain fibre and also fibre fractions that can positively improve dietary intake. Moreover, serum cholesterol and postprandial blood glucose can be reduced by the soluble fibre present in legumes. Since legumes are in demand as a food source for humans and animals, there is also a growing need for feed within feed industries. This scenario leads to increased production costs, which is a fact that reduces the drive for the daily consumption of legumes and thus poses a challenge (Li *et al*., 2016). In South Africa, the regular consumption of dry beans, peas, lentils and soy is encouraged, but limitations to the regular consumption of legumes are associated with cost and availability (Ronquest-Ross, Vink & Sigge, 2015). According to Sathe (2016), dry beans provide between 1 255–1 464 kilojoules (kJ) per 100 g of dry seeds, 15.0–25.0% protein and 50.0–75.0% carbohydrates.

2.6.4 Perceptions associated with legumes

According to Michaels (2016), legumes are generally consumed in areas where animal protein is scarce or not acceptable for religious reasons. Legumes are known to increase crop diversity and they also provide biological nitrogen fixation assistance in the agricultural sector. This benefits local agricultural systems, which include pulse crops that are suitable for cultivation in regional environments. However, even though the health benefits of legumes are well known, there is a declining trend in vegetable protein usage with a concomitant increase in meat-based diets. This trend is not only true for humans, as the feeding of animals with maize and grass plants instead of legume-based feeds is encouraged (Dequiedt & Moran, 2015). Literature suggests that individuals' perceptions of legumes are influenced by both internal and external factors and that both these factors need to be addressed separately (Becerra-Tomás *et al*., 2016).

2.6.5 Legume digestibility and absorption

According to Koivunen *et al.* (2016), legume cultivars must be evaluated to provide a clear nutritional evaluation and to determine their respective benefits. There is thus a need to evaluate the nutritive values of currently available legume cultivars for digestive benefits. Legumes are categorized into two groups: high-fat legumes and low-fat legumes. Regular legume intake may have a positive effect on excreting fat from the bloodstream through faeces and improving lipids in the body (Mohammadifard *et al*., 2014). The digestibility of legumes varies amongst cultivars due to the physiochemical structure of the legume (Liu *et al*., 2016). For example, a study in Finland indicated that when assessing the nutritional value of faba beans, a good digestibility score was achieved for this legume (Koivunen *et al*., 2016). A variety of legumes were used in this study to promote digestability among farmers since, each legume has various amounts of starch, oil, fibre and protein which contribute towards digestibility (Kumar & Pandey, 2020).

2.6.6 Legume preparation

According to Poelman *et al.* (2013a), regular consumption of legumes can be improved through flavour enhancement when cooking them. The selection of an appropriate cooking method improves the bio-availability of nutrients and factors such as length of cooking, the texture of the food, cost and flavour are important when choosing legumes. However, consumers need to be educated on the best ways of retaining the nutritional benefits when cooking legumes at home (Fabbri & Crosby, 2016). The processing of legumes such as the mung bean can improve both the nutritional and functional benefits of the actual legume processed (Chandrasiri, Liyanage & Vidanarachchi, 2016). Fermentation of legumes is a practice that has been used for decades and is associated with advantages such as improved nutritional benefits, improved digestibility of proteins, decreasing starch content and the bio-availability of micronutrients (Prakash, 2016).

2.6.7 Legume production and farming practices

In sub-Saharan Africa, legume production is key in addressing food and nutrition security and to ensure income generation (Vanlauwe *et al*., 2019). China is one of the world's largest producers of legumes as it has the major advantage of having minimized growth periods as well as biological nitrogen fixation (Li *et al.*, 2016). Tanzania has also been successful in legume production, with over 30 varieties produced by the National Bean Research Program and the activities of various research centres that aim to address food security (Bill & Mellinda Gates Foundation, 2012). According to Burridge *et al.* (2016), beans offer considerable genetic diversity for root architectural traits linked to growth in low producing and water- scarce environments.

However, even though legumes have many benefits associated with agricultural production, their cultivation is associated with many challenges. This explains why farmers often choose not to grow legumes. According to Reckling *et al.* (2016), these challenges include specialization in cereal crop production, low and unstable yields and low gross income margins that are attributed to various factors. Other limitations include unpredictable policy support and limited benefits associated with cropping systems. According to Burridge *et al.* (2016), legume residues that are incorporated in the soil can positively affect N_2O fluxes extracted from a legume. Guardia *et al.* (2016) argues that practices such as the latter are key in agricultural management and must be incorporated for desirable production. However, declining soil quality, shrinking land availability and a shift in production systems can lead to farmer depression due to unsuccessful outputs (Ernst, Kemanian, Mazzilli, Cadenazzi & Dogliotti, 2016). The above are common challenges that farmers have to deal with during planting and harvesting (Burridge *et al.,* 2016). There is no doubt that real challenges exist and that they pose a threat to the promotion of legume production, even by smallholder farmers. However, with efficient intervention strategies and concerted education initiatives, these challenges can be overcome to ensure stable yields, which was a focus of the current study.

2.6.8 Pest control in legume cultivation

Arthropod pests are a major interference for legume cultivation in Kenya. In South Africa among smallerholder farmers farming systems no single sustainable method can be used to produce desirable harvests due to the diversity of pests that attack legumes (Vanlauwe *et al*., 2019). It is important to note that when smallholder farmers have technical support and access to resources to maintain pest control over a long period of time, the cultivation of legumes will be sustainable (Abtew *et al*., 2016b)**.** Pest problems were a challenge in a climatic condictions such as this study area, further description of the climatic condiction will be outlined in chapter three under study area. The importance of inoculation and N2 fixation research was highlighted in 1952 when the first steps were taken by the Nitrogen Fixation in Tropical Agricultural Legumes (NifTAL) initiative to monitor legume growth. Other investigations included 228 standardized trials in over 20 countries, testing 19 legume species to determine the benefits of legume inoculation and how it can improve pest control (Van Kessel & Hartley, 2000)**.** According to Schreinemachers *et al.* (2015), viruses in plants are intensifying and spreading over time, which poses a threat to farmers as some of these viruses are difficult to detect because the genetic make-up of plants varies. Smallholder farmers should be educated to understand how viruses are transmitted and should be able to monitor the operation of the infection cycle, as they generally lack this knowledge (Vanlauwe *et al*., 2019).

2.7 The Importance of Agricultural Knowledge

The role of agricultural extension programmes is to provide support for farmers in developing their agricultural knowledge base to improve production and work ethics. In modern times, the use of the internet as an education tool has become invaluable in addressing current agricultural needs (Gunasekera *et al*., 2018). Various countries have launched unique extension services to support both emerging and commercial farmers. In productive communities, extension services must be adopted because they foster production *(*Sattaka *et al*., 2017).

2.7.1 The role of extension services and farmer training

In general, smallholder farmers lack sufficient in-depth knowledge of agronomic practices to produce legumes efficiently. This is key in enhancing good practices for a sustainable economy and achieving optimal nutrition. However, there is a gap in the establishment of extension programmes that are tailored for legume production. Such programmes should focus on practices such as pest control, seed usage, aflatoxin prevention and the role of inter-cropping (Bill & Melinda Gates Foundation, 2012).

When improving their farming systems, farmers should access favourable and reliable agricultural extension services that will help them to improve their production output at maximized levels (Al-Zahrani *et al*., 2019). Therefore, a comprehensive agricultural extension programme will include farmer training; officers visiting their fields to evaluate trials; meetings; the provision of learning materials; and informative radio programs (Sattaka *et al*., 2017). It was against this backdrop that the current study provided smallholder farmers with extension support to ensure that legume production was achievable.

A study in Nepal investigated the viability of conservation agriculture using the Analytic Hierarchy Process (AHP), which was a pivotal factor in providing motivation for new land conservation technologies (Reed *et al*., 2014). According to Kofi and Kwesi (2015), farmers' participation can assist in adopting more sensitive approaches to gender, engender pro-poor developmental strategies, and incorporate literacy programmes to form part of extension services.

2.7.2 Urban agriculture in a food insecure society

Urban agriculture is defined as "the involvement of an agricultural business that aims to grow, produce, process and distribute agricultural goods despite land size [for the procurement of] human capital in towns and cities" (Rezai *et al*., 2016, p. 39). The practice of urban agriculture (UA) is shaping society in both developed and developing nations worldwide. According to Piscopo (2016), more than 800 million people are engaging in urban agriculture globally. As the urban population escalates, so does the adoption of UA in cities and urban environments in various areas in sub-Saharan Africa (Tibesigwa & Visser, 2016). The benefits of UA include food and nutrition security, poverty reduction, improving livelihoods, income generation supplementation, seasonal access to food and food availability in urban contexts (Wielemaker *et al*., 2018).

The role of academics, policy-makers and government agencies is to develop further collaboration to encourage UA. Research conducted in Ghana has indicated that urban agriculture should form part of municipal plans, with reference to land tenure and municipal districts. Municipalities should expand irrigation projects and extend advisory services to fast-track UA (Nyantakyi-Frimpong *et al.*, 2016b). According to Tibesigwa *et al*. (2016), UA is a survival mechanism for people in the cities/towns of developing countries. Factors such as urbanization, climate change and food insecurity are contributing towards this phenomenon. In Southern Africa, rural agriculture has been the mainstream activity, but UA has become an acceptable alternative.

A study was conducted in Rome, Italy, to assess and map urban agriculture as part of the food and agriculture infrastructure. Observations indicated that an inclusive framework for sustainable agriculture within communities is essential. This framework should take into consideration the boundaries of urban areas, semi-urban areas, towns and rural areas when UA is implemented (Cavallo *et al*., 2016). In general, the literature suggests that more interventions need to be implemented by municipalities as they are key in the value chain that supports emerging markets to supply food to citizens in urbanized areas and cities (Wielemaker *et al*., 2018). It was against this background that the current study was supported by the eThekwini Municipality as part of an urban agriculture initiative to assist farmers and markets in the urbanized study area.

2.7.3 Addressing household food insecurity

In South Africa, food security is well addressed at a national level. However, approximately 20.0% of households are still food insecure and a large number of households struggle to have sufficient food for all their members (Chakona & Shackleton, 2019). The definition of food security encompasses five dimensions: sufficiency, nutritional quality, acceptability, safety, and stability (Coates, 2013). Food security indicators are therefore essential in measuring, monitoring and evaluating food security levels globally. However, there is still a gap in the ability to identify indicators for the standardization of survey tools around the world (Carletto *et al*., 2013). A food security study conducted in Mexico found that foodsecure households purchased more healthy food than unhealthy food.

The same households had a bigger food expenditure compared to households that were food insecure (Silva *et al*., 2016). Another study conducted in the Southern African region amongst poor households used key measuring instruments, namely the Household Food Insecurity Access Scale (HFIAS) and the Adequate Household Food Provisioning (AHFP) instrument. The results indicated that a strong influencer of household food security is social and physical infrastructure (Frayne & McCordic, 2015). A South African study conducted to measure the perceptions of food secure and insecure households indicated that food insecure households wanted more support from the government. This suggests that the government has to play a key role in social discourse to alleviate food insecurity burdens. However, food secure households stated that it was a personal responsibility to exist in a particular state (Grobler, 2016).

2.7.4 The importance of nutrition education

Nutrition education is pivotal in advocating correct consumption patterns and shaping perceptions when empowering people for various reasons. Such education can occur directly or indirectly (Hayes, Contento & Weekly, 2018). Nutrition education can advocate practical learning; improved dietary knowledge; healthier eating behaviours; a greater interest in cooking; and is essential for community building and entrepreneurial initiatives (Piscopo, 2016). Nutrition education can also be utilised as a tool to create awareness of the nutritional value of indigenous plants. These foods are easily accessible by smallholder farmers and may be used as a food source to improve food security in the region where they reside (Schindler *et al*., 2016). However, nutrition education as an intervention strategy requires an effective food system to be in place in order to allow people to be more effective in accessing adequate and nutritious foods, as was proposed at the Ministerial Meeting on Food Security and Climate Adaptation in Small Island Developing States in Milan, Italy, on 14-16 October 2015

Session 5 (UNDP, 2015). According to Fanzo (2015), nutrition education requires multi-sectoral involvement that should include governments, the private sector, local and international communities, as well as civil society. National policies of countries can contribute to implementing nutrition education that can improve the knowledge and perceptions of consumers (Lyson, 2016). For example, a study conducted in South Africa on the bio-fortification of sweet potato to address food and nutrition insecurity amongst small-scale farmers recommends nutrition education as an important intervention to address food insecurity (Laurie, Faber, Adebola & Belete, 2015).

2.8 Behavioural Change Theories that address Food and Nutrition Security

Behavioural change theories are important as drivers of intervention studies. In the current study, a behavioural change theory underpinned the investigation to ensure that the educational programme instituted provided farmers with a holistic and transformative platform from which to operate. The core pillars of the behavioural change theory are motivation, opportunity and ability. These pillars were also adopted in a similar study that had uniquely designed interventions at household level for food and nutrition security (Thondhlana & Kua, 2016). The current study adopted the Social Cognitive Theory (SGT) to influence behaviour towards legume acceptability. Food behaviour has been linked to the theory of planned behaviour, which is primarily premised on attitudinal and behavioural change being mutually exclusive (Stancu *et al*., 2015). This theory addresses the changing behaviour of people who wish to attain a healthier lifestyle and acquire knowledge on lifestyle diseases. This requires a detailed assessment of participants' understanding of perceived risks and knowledge testing (Imes, Novosel & Burke, 2016). The current study assessed elderly farmers' agricultural knowledge as well as their knowledge of legumes, the SGT was used to link internal and external factors within the learning enviroment of the study. The social behaviour theory focuses on the learning process with three distinct areas of influence, namely the environment, behaviour and personal factors (Brocas & Carillo, 2014).

Nutrition education programmes may fail if key pillar of food security (access, availability, utilization and stability) are not holistically addressed when improving behaviour among communities (Hunter-Adams, Battersby & Oni, 2019; Wenhold & Faber, 2008).

Community interventions must not have a top down approach and must take into account the characteristics of the group, study content and appropriate timing during the intervention (Vollmer, Adamsons & Mobley, 2019). Hence the researcher based the study on the premise that existed on poor diverse legume production and consumption (refer to section 3.1 in Chapter 3).

2.9 Intervention Programmes to Integrate Agriculture and Nutrition Education

In Africa, intervention initiatives that target states, farmers, households and individuals have been adopted and tailored for specific regions. For example, Grow Africa is an organisation that provides support to farmers through links with farmer organizations and agribusiness sectors. This organization provides support to members of the West African Farmers' Association (Grow Africa, 2014a & b). During 2015 and beyond, Grow Africa has been committed to providing support to smallholder farmers through smallholder business development models. Countries like Mozambique, Tanzania, Nigeria, Senegal and Ghana are part of this initiative (Grow Africa, 2017). Another initiative is the Food and Nutrition Programme initiated by the US Department of Agriculture (USDA). This organization targets 50 states around the world to promote legume consumption as an alternative protein source. According to Guenther and Luick (2015), food production, food preparation skills, storage, safety and sanitation are initiatives that provide a more health-sensitive approach to food and nutrition security programmes. Other skills that are deemed essential for this purpose include food production, storage and safety and sanitation, which are all critical factors for overall good diet quality. An urban agricultural project in Rome called 'Orti Solidali' is a solidarity garden project that was initiated in 2009. This project was designed to fill the gap between consumers and producers for sustainable food production and healthy food consumption. The project used garden plots that were allocated to a family or individual and participants were required to pay a yearly subscription fee. Specified vegetable portions were also supplied to school canteens. This UA project was regarded as 'a quality revolution' for public service (Cavallo *et al.*, 2016). The World Food Programme also initiated an intervention programme entitled 'Purchase for Progress', which was rolled out in over 20 countries. The programmes in these diverse countries focused on linking smallholder farmers within a formal market structure to create a more favourable trading environment. Participating countries in

Africa such as Ethiopia and Tanzania showed statistically significant results in terms of yield, business improvement, key household attributes and food consumption (Rutherford *et al*., 2016).

2.10 Functionality of Dietary Reference Intakes (DRIs) and other Dietary Requirements

Various people in the field of nutrition have developed instruments and standards that define nutrients, energy, dietary and physical activity requirements and that provide guidelines for their consumption. This initiative is referred to as Dietary Reference Intakes (DRIs) and is an initiative that established a set of nutrient recommended values. These included the Recommended Nutrient Intake (RNI), which is a nutrient value needed by a high number (97.5%) of a group (British Nutrition Foundation [BNF], 2019). The establishment of DRIs is evidence of collaborative mechanisms linking various countries. These guidelines set standards for micronutrients, macronutrients, electrolytes and water (Trumbo *et al*., 2013, p. 657). DRIs are a collective of four nutrient-based reference values and each type of DRI is considered to be the recommended average daily nutrient intake. Any deviation from an average value is possible (Institue of Medicine [IOM, 2003]; Nutrition Information Centre University of Stellenboch- NICUS, 2003). In the current study, the consumption of legumes was regarded as a process of nutrient as well as energy intake by a particular individual or group. Food and nutrition security status (or insecurity status) can be determined by referring to these dietary standards.

The DRI[3] structure comprises the following categories:

2.10.1 Estimated average requirement (EAR)

This category intends to target 50.0% of the population to meet the requirements of individuals with a good health status. This also incorporates adjusting perceptions of the bio-

[3] Specific nutrients were reported on in chapters (3,4,5) for the purpose of this study.

availability of nutrients (Rolfes *et al*., 2015, p. 18). Other studies have added alternative values where nutrient diversity was prevalent for EARs (IOM, 2003).

2.10.2 Recommended dietary allowance (RDA)

This value is usually set within ranges of an overall population's estimated daily requirements to facilitate meeting the needs of the majority of the population (IOM, 2003). These can be targeted above the EAR meeting by reaching at least 98.0% of the population (Rolfes *et al*, 2015, p. 18). RDAs for young people are sometimes similar to those of older persons in terms of specific nutrients. This can be attributed to physiological challenges during the ageing process, which can lead to limited interpretation (Bolzetta *et al*., 2015).

2.10.3 Adequate intake (AI)

The AI reflects an average value of a particular nutrient that healthy individuals consume and utilise when RDA values are not determinable (IOM, 2003). Scientific opinion is recommended when AI levels are interpreted due to limited evidence. There is a tentativeness of values as opposed to those of RDA (Rolfes *et al*., 2015, p. 19). There is also a possibility of a lack of actual percentage data associated with the AI (Wallace, 2012, p. 234).

2.10.4 Tolerable upper intake level (UL)

This value is the maximum nutrient intake that should not be exceeded by an individual as high doses can be toxic and may cause adverse health effects (IOM, 2003; NICUS, 2003). It is important to carefully consider these upper levels in addressing over-consumption, particularly in cases where individuals are consuming higher doses of dietary supplementation or fortified products (Rolfes *et al*., 2015, p. 19).

2.10.5 Estimated energy requirement (EER)

The EER is defined as the average dietary energy intake per day in a healthy individual who engages in some level of physical activity. Balance is an important factor to consider and it is also important to determine the food source that provides functionality (IOM, 2003). There are no upper energy level values determined in this category (Rolfes *et al*., 2015, p. 19). According to Statistics South Africa (Stats SA, 2015), 2 261 kilojoules is the average intake per person per day.

2.11 Conclusion

The literature reviewed provided a comprehensive overview of factors contributing to both food and nutrition security and insecurity. Clearly, there are complex and multifaceted challenges that impact food and nutrition security in countries across the globe, and in South Africa in particular. The literature provided an in-depth insight into global initiatives to address food insecurity in both developed and developing countries. However, specific attention was given to food security challenges in developing countries where links exist between a low socio-economic status, poor nutrition, ill-health and low agricultural production. The discourse underscored the importance of understanding various variables and tools that should be considered and utilized as part of the food security system. The literature review highlighted that the role of food production by smallholder farmers cannot be underestimated as it has a massive impact on the health of individuals and the community at large. Such farmers need to gain knowledge of sound food production practices and the nutritious value of the food they produce, so that they can improve their own as well as the livelihoods and nutritional status of the people they feed. Particular emphasis was placed on the need for farmers to gain knowledge on how to produce and utilize legumes for consumption. The role of legumes as an essential food that can be incorporated regularly into a food system for improved nutritional intake at household level, was shown to be critical. It was established that food and nutrition programmes must connect all the necessary dots in community-based studies to comprehensively underscore why legumes are beneficial for the survival of smallholder farmers and the health of the community that consumes the produce they cultivate. In closure, the diverse literature sources that were consulted provided a comprehensive overview of the factors that would impact the multidisciplinary nature of the study.

CHAPTER 3

BASELINE SURVEY

3.1 Introduction

The study aimed to develop a comprehensive nutritional and agricultural education programme involving elderly farmers, with the overarching aim of linking the entire value chain of legume production and consumption. The baseline survey was conducted to address the concerns raised by the Manager of the Agricultural Hub Station[4] who identified increasing health challenges and poor dietary practices amongst smallholder farmers in the eThekwini Agricultural Hub Station (AHS) area in KwaZulu-Natal, South Africa. Members of this Hub were registered farmers who participated actively in the municipal programme to improve urban agriculture. The baseline survey that was conducted aimed to perform a situational analysis to determine, inter alia, the rates of legume intake and production by farmers. The study was premised on the assumption that legumes are a source of protein that farmers could grow and also consume to improve their food and nutrition security status. Data were elicited to understand the patterns, relationships and opportunities that would be used to develop an effective agricultural and nutrition programme involving these farmers.

The conceptual framework for this study was outlined in Chapter 1. This chapter is an excerpt to elucidate the methodology and processes of Phase One as presented in the conceptual framework diagram in Figure 3.1. The baseline survey was the first phase of the study, which was rolled out over three phases.

[4] The Agricultural Hub Station was a municipal site where farmers gathered to expand their knowledge base as part of a municipal food security programme.

Figure 3.1: Phase One- Baseline component of the conceptual framework of the study

Food insecurity was reported to be high in the area by the Hub manager. To this day, the role of this station is to provide farmers with appropriate tools and skills to ensure that food security is achieved in the area. It was against this backdrop that knowledge transfer as a tool was used to ensure that the participating farmers played an active role in addressing the food insecurity and nutrition challenges that were related to their production levels, health status, and nutritional habits. The results reported in this chapter were used as the foundation on which to develop an intervention strategy for improving the cultivation and consumption of legumes and they served as a foundation for a subsequent intervention phase that will be discussed in Chapter 4. The results were obtained due to effective data collection processes and established an effective platform from which the training programme could be developed. Participating farmers understood the link between legume production and consumption, as well as their impact on the nutritional and health status of people who consume this food.

At the time of the study, there were about 120 registered community garden farmers in the study area, but only 100 of these members regularly attended meetings held at the so-called Agri-Hub station. The researcher was informed of this organization by the senior horticulture Hub manager who also urged that the dietary patterns of farmers be addressed through nutrition and agriculture interventions, in order to capacitate them to produce healthy produce and to mitigate the health challenges in the area. The Hub manager worked with the researcher to formulate a strategy to reach out to all farmers in the identified municipal area who felt discouraged by the challenges they faced. The key player was the Chairman who facilitated the recruitment of the participants for the study. Monthly registers were kept and those farmers who had a poor attendance for meetings before the survey, were motivated through presentations to understand the importance of the study. Due to these initiatives, 110 farmers were recruited and they committed themselves to full participation in the study.

3.2 Methodology

It was necessary to ensure that appropriate and reliable methods were adopted to meet the study objectives. The careful selection of an appropriate sampling method, study procedures and research practices were informed by established research guidelines and regulations in the literature, and various criteria were established to ensure adherence to ethical issues. The following had to be taken into consideration in order to meet the research objectives and to accommodate the context and dynamics of the population within the environment in which the study was conducted:

- A clear baseline survey of the farmers' situational realities was conducted and the findings were analysed in line with the objectives of the study.
- The extent of the farmers' interest in cultivating legumes as a nutritious alternative protein food source was determined, as well as whether prevailing negative perceptions of food and food consumption habits could be changed.
- The Agriculture Hub station was promoted as a secure, accessible facility for farmers at all times and it was advocated that it could be used as a learning centre. It was also accessible for field data collection purposes.
- Farmers were urged to understand the importance of arriving on time on data collection days and for training sessions so that sufficient data could be captured.
- Dates and venues other than the monthly meetings, for conducting the research had to be established so that the participating farmers' practices could be observed.
- It was necessary to build trust and rapport with the farmers to ensure that the administration of the project was continuous and that progress was not hampered.
- It was important to empower the farmers with knowledge when they attended the monthly meetings without interfering unnecessarily with the meeting procedures. The farmers were thus addressed on various related issues on a monthly basis in order to capacitate them with know-how and skills (during each study phase).
- It was important to ensure that all the research procedures pertaining to the field work were clearly spelt out and that procedures were complied with. Confidentiality and ethical considerations were also rigorously adhered to.
- Every effort was made to ensure that safe, reliable procedures for data collection (refer to section 3.12.1) were followed and that the equipment utilized to obtain the farmers' medical and anthropometric data functioned optimally.
- Baseline survey indicators were determined. Thus data were obtained for blood indices, health status, dietary intake, socio-economic status, acceptability of legumes as an alternative nutrient source and household food security levels.
- By building trust, blood samples could be collected reliably at set intervals. The study participants were continuously informed of the factors that were investigated when their blood samples were taken and they were informed of the results.
- The attendance register of the meetings was regularly monitored and a meticulous record was kept of all the blood samples taken.

3.3 Ethical Considerations and Participants' Informed Consent

Ethical considerations were adhered to in order to ensure the anonymity of the participants and the protection of the information pertaining to individuals. The Durban University of Technology's (DUT) Research Ethics Committee approved the study (clearance number IREC 026/15; Annexure A). A letter was also submitted to the municipality on behalf of the researcher by the Municipal Agricultural Site Manager (i.e. the Chief Horticulturalist) for permission to conduct the study in the selected municipal area (Annexure B). The letter stated the objectives of the study, the need to occupy agricultural land and the utilization of resources for the project. Permission was granted by the eThekwini Municipality Parks, Recreation and Culture Unit to conduct interviews and to initiate training and agricultural trials on site (Annexure B1). The study protocol was submitted to (DUT) in accordance with the Medical Research Council guidelines for medical research. The researcher rigorously adhered to the ethical guidelines of the Human Sciences Research Council (HSRC) for research on human beings throughout the study.

3.4 Geographical Setting of the Study

The baseline survey that was conducted was necessary to determine the health status of the farmers to develop intervention strategies to improve their agricultural practices and ultimately their nutritional status. The Agricultural Hub station had land space that was utilized for the farming project. It was fenced and had a constant water supply. Organic methods were used for crop production. It also had a training venue, kitchen facilities and a drying room that was used for practical demonstrations. The training initiative that was launched through this study project formed part of the eThekwini Municipality's Mile Institute of Learning (MILE) project that is aimed at improving urban agriculture. The researcher conducted meetings with farmers and the Chairman who managed the farmer network. This network was used, inter alia, to determine if the farmers would deem the project relevant to their needs. During the consultation process, the farmers indicated that they faced diverse health and farming challenges. The information obtained during this phase became the foundation for the formulation of the actual project and the interventions that were designed.

The support of some farmers, and especially of the Chairman, instilled the confidence in the researcher to also recruit disgruntled farmers who had been poor in their attendance. The researcher could obtain data during the monthly meetings when most farmers were available for interviews and informal discussions. A map of the study area is presented in Figure 3.2.

Figure 3.2: Bio-resource map of Mariannhill[5]

Source: Camp, (1997)

The Agricultural Hub Station is a trial demonstration site administered by the eThekwini Municipality in the Province of KwaZulu-Natal in South Africa. This experimental site is located at Latitude 29° 52' 03" S and Longitude 30° 49' 48" E at an altitude ranging from about 220 m to 240 m above sea level. The land is characterised as a bio-resource group (BRG), which is defined as 'a moist coast forest' as well as a 'thorn and palm veld'. The area has a mean annual rainfall of 842 mm and a mean annual temperature of 19.1°C (Camp, 1997). The study site is dominated by well-drained soils with clay content ranging from 10.0% to 20.0%, which means that the soil is mostly loamy sand (Camp, 1997).

[5] Researcher formulated the map using Bio-resource.

Figure 3.3: Map of Mariannhill and its surrounding areas

Source: eThekwini Municipality, (2016)

Mariannhill forms part of the eThekwini Metro and is situated near Pinetown (Figure 3.3). The Agricultural Hub site that was accessed for this study is located within this area. Farmers in the study area live in areas surrounding Mariannhill in townships such as KwaNdengezi, Thornwood and Dassenhoek. At the time of the study (which was 2016), the total population in KwaZulu-Natal province was estimated at 10 267 300, with the general population age ranging from newly born to 85 years. The eThekwini Municipality had a population of 3 442 360, while the Mariannhill area, excluding surrounding areas, had a population of 40 898 (Stats SA, 2016).

3.5 Empirical Study Design

The study employed a cross-sectional survey design because observations and the examination of variable relationships were necessary before the development of an intervention programme could commence. The study was also descriptive in nature. Mixed methods were used to collect data for the analysis of the relationships and trends amongst the variables. Quanitative data were collected by means of biomedical data collected from blood samples that were analyses as well as from the trial experiments involving legume production. The questionnaire focusing on agricultural practices combined both qualitative and quantitative data (for knowledge). The quantitative data were used to determine the health status, dietary habits, socioeconomic status, food security, agricultural patterns and knowledge of the participating farmers. However, legume knowledge (refer to Annexure J) and agricultural pattern questionnaires (refer to Annexure K) both also recorded qualitative data. As part of the medical data, anthropometric data were collected in terms of the weight, height, waist circumference (WC) and waist-to-height ratio (WHtR). Blood pressure was also measured as part of the medical data that were collected for each participating farmer. These data were recorded on scheduled days during the data collection stage of the study. The findings pertaining to the qualitative and quantitative data were integrated and analysed for evaluation and reporting. The monthly meetings at which data were collected were conducted every last Wednesday of the month. Special arrangements were also made for other days to cover all fieldwork sessions of the project. All necessary transportation, the fieldworkers, the phlebotomists and the required equipment had to be ready on these allocated Wednesday mornings.

The collection of the data was a long process as the farmers first had to hold their meeting in the morning and the researcher could then continue with the research session afterwards. The interviews took about one hour each for both the quantitative and qualitative data collection processes using all the measuring instruments referred to earlier. The long hours caused frustration amongst the farmers as they needed to return to their fields to continue their agricultural activities. Another challenge was individuals' medication schedules as the more elderly farmers had to adhere to medication regimes, which meant that their medication generally had to be taken after a meal. The collection of blood was scheduled early in the morning upon the arrival of the farmers. This meant that no refreshments could be consumed as it would impact their blood glucose levels. However, a light lunch was provided after the questionnaires had been completed, and thus farmers who needed to take midday medication were accommodated. Transport was arranged by the researcher for the farmers to ensure their timeous arrival in order to complete the data collection programme each day. All the participants were transported back to the areas where they resided, which meant that they had to wait the whole day for others to also complete their sessions. The farmers were thus frustrated by such time constraints, but after a while, they adjusted and began to own the project.

3.6 Outline of the Roll-Out Phases of the Study

The study commenced with a baseline survey (Phase 1) that started with a pilot study to investigate the knowledge status and the trends and patterns of farmers' dietary and farming practices. This phase of the study also provided a crucial and comprehensive information base that could be used as a starting point for the intervention programme. All the measuring instruments used will be discussed in later sections. The baseline survey provided quantitative and qualitative data pertaining to certain variables that the study aimed to investigate, and the results were a benchmark for the subsequent intervention programme. The variables measured were gender, age, employment and health status, anthropometrics, blood pressure, dietary intake, food security status, blood nutrient profile, blood glucose and cholesterol levels. The agricultural knowledge of the farmers; their legume acceptability levels; and their perceptions of legumes as a nutritious foodsource were also measured. Other variables such as legume seed varieties, soil quality and climate were also assessed using appropriate qualitative or quantitative methods. The other phases of the study (see Chapter 4 and Chapter 5) consisted of a pre-intervention survey, the intervention project, a post-intervention survey and a follow-up survey six months after the cessation of the intervention project.

3.7 Sequential Flow of the Study

Stage 1: Municipal briefing and identification of problems experienced by farmers (1–10 September 2014)

Stage 1 involved visiting farmers accompanied by the Agricultural Hub Station (AHS) manager and asking the farmers brief questions about legume production and their consumption levels of this food. This provided an insightful background and highlighted potential gaps that the study could fill.

Stage 2: Presentation of the appropriate study objectives during arranged meetings (1−16 February 2015)

Stage 2 involved clarifying the study objectives. The Chairman of the Hub supported these presentations and encouraged the farmers to participate in the study. The farmers were initially highly demotivated because of government and municipal policies. They also understood that they would not be given any incentives (particularly in the form of financial compensation) for their participation. Moreover, during this stage, the most convenient ways for proceeding with the project without interfering with the farmers' agricultural activities, were discussed (Annexure C).

Stage 3: Requesting permission from the overseeing municipal Parks Unit (1−16 March 2015)

The AHS manager submitted a letter to request permission to conduct the study. This was done on the researcher's behalf as the manager was adamant that such a study would benefit the farmers in the area, particularly the targeted elderly farmers. Permission was granted (Annexure B1). The potential participant database was established and the date for the next meeting was set to roll out the baseline survey.

Stage 4: Planning the baseline survey roll-out (29 April─5 August 2015)

- Ethical clearance from DUT was requested and it was granted.
- All the participants signed informed consent forms.
- The pilot study was conducted to pre-test the baseline measuring instruments.
- Focus group discussions were planned. The discussions were utilised to determine possible ways of rolling out projects so that they would be convenient for the farmers and thus encourage full attendance.

Stage 5: Baseline survey (29 April−5 August 2015)

During this stage, all the field investigations were conducted using the measuring instruments as identified in Chapter 2.

Stage 6: Baseline results and interpretations (1 September–30 November 2015)

- Reporting the results and analysing trends;

- Presentation of baseline results to the participants; and
- Formulation of pre- and post-intervention plans.

The following stages were a pre-intervention survey, the intervention study, a post-intervention survey and a survey six months after the intervention study. These stages are discussed in later chapters.

3.8 Participant Selection and Sampling Methods

The participant selection process was conducted based on AHS attendance. A potential sample of 120 participants (registered farmers) was identified.

3.8.1 Inclusion criteria: Screening and recruitment

Since the researcher was allowed to access an existing municipal project, it was easy to identify the sample. As the majority of the farmers were above 50 years of age (defined as 'older persons'), the following inclusion criteria were applied:

- The participating farmers had to be 50 years or older;
- They had to be registered participants in the municipal farming/gardening project;
- Any farmer belonging to a registered co-operative or independent farming organisation could take part;
- Farmers with physical or mental disabilities were excluded;
- The farmer's had to be available and willing to undergo continuous training and blood sampling;
- They had to be committed to all field work sessions, with a particular interest in legumes;
- The farmers had to be self-motivated and have an agenda for participation, with an interest in legume production and consumption.

3.8.2 Possible threats

- Farmers who visited the area on an ad-hoc basis to attend a training session in the Agricultural Hub Station were identified and excluded;
- Family members standing in at meetings for absent members were not allowed to participate;
- The rotation of cooperative members attending meetings posed a threat and care was taken that such members did not participate;
- There was limited opportunity for sharing of information with other cooperative members in terms of legume production;
- Guests invited by the farmers to join the programme had to be excluded;
- Some farmers used public transport which delayed arrivals, and some had to walk long distances to the venue, which also caused their late arrival; and
- Land on which to practically conduct the field demonstrations was initially not available.

3.8.3 Management of threats

- Visiting farmers were excluded because they had no long-term interest in attending a programme. Some only came because they had been informed about access to seeds.
- Family members were given seeds only if they stood in for absent participants on seed collection dates, but they were excluded from participating in the data collection processes.
- Only the participants who were involved in all the assessments were retained and their data were used for the analyses.
- Members were encouraged to plant the seeds they had been given on a certain plot of land and to make special arrangements to see the project to completion.
- Guests who randomly arrived never took part in the study project, but benefited from the programme peripherally.
- The researcher provided transport to collect the farmers from their areas. The farmers then arranged and organized this means of transport themselves, which created a sense of community involvement.

- Due to the limited plots of land at the AHS, the researcher requested the utilization of a municipal venue and land for conducting practical demonstrations. This request was granted by the municipality and the project proceeded.

3.9 Sampling

Purposive sampling was used on the basis of the characteristics of the population; i.e. smallholder farmers living in the Mariannhill region, who were already part of a municipal programme. Purposive sampling ensured that the selection of the sample achieved the specific objectives of the study (Palys, 2008). In this context, limited legume production and the need for improved nutritional and dietary intake, were identified as challenges in the study area by the Hub Station manager. Of the 120 registered farmers initially identified, 112 farmers were recruited and given a code number to be utilized in the first data collection phase. For the selection to be successful, intensive recruitment, commitment and the ability to adjust an established mindset were needed. Meticulous records of the data obtained during the baseline study were kept to ensure control and the sustainability of the experimental group.

3.10 Management to Ensure Survey Compliance

The researcher made presentations to the farmers during monthly training meetings and the farmers grasped the importance of this programme. They understood that addressing food and nutrition insecurity and improving dietary diversity through the production and consumption of legumes were viable options for a better lifestyle (this was observed during discussions after presentations were made and when feedback was given by farmers). The Hub committee provided support by communicating with the farmers and encouraging them to attend. A focus group discussion was conducted with the farmers in order to identify possible challenges and for rolling out the survey. Ten farmers were recruited for the focus group discussion to pre-test and validate the measuring instruments that would be used in the study.

Participation was entirely voluntary and each participant signed a voluntary consent form after they had been briefed about the study. This form clearly stated their rights (Annexure D). An information letter was also discussed and then distributed to the participants by trained fieldworkers to provide clarity about the project. These letters were translated from English into IsiZulu so that those who were not proficient in English also clearly understood the requirements (Annexure C). Each farmer was assigned a participant number (code) which was used instead of their names for reporting purposes. This was done to ensure their confidentiality and anonymity, particularly in the data reporting phase of the study. All the participants' names and codes were recorded and their attendance was meticulously monitored to ensure consistency during the programme. The municipality provided support in the form of a training venue and plots of land.

3.11 Data Enumerators

The researcher, recruited and trained 22 third-year students from the Mangosuthu University of Technology (MUT) in the Department of Community Extension as fieldworkers (Annexure D1). Bachelor of Technology students (who were three) in the Food and Nutrition Consumer Science Department at the Durban University of Technology were also part of the team. Data enumerators were requested to sign a confidentially agreement form to ensure the privacy of the participants' information (Annexure A1). The fieldworkers had to arrive on time each morning to prepare the venues, divide the participants into groups and ensure that the records of the participant's number were correct after the blood samples had been taken. English was the language of instruction for the training session of the fieldworkers and the training manual was also in English (Annexure DD). All the fieldworkers were able to speak the local language (IsiZulu) in order to avoid any language barriers between them and the participants. The questionnaires were presented in IsiZulu and the responses were translated into English by a proficient translator. The fieldworkers were trained to administer the questionnaires and to take measurements such as blood pressure, height and weight (however, blood pressure measurements and blood collection were strictly done by the professional nurses). The researcher cross-checked the translactions for accuracy and all measurements taken.

The fieldworkers were expected to show respect, friendliness and patience when they dealt with the study participants. In an African setting, older people are traditionally treated with great respect and they are easily offended if younger people ask them personal questions that may seem intrusive. Punctuality and reliability were also key factors in ensuring successful fieldwork sessions. The participants were therefore treated with the utmost respect and their time was honoured as a key feature in ensuring that all the objectives of the data collection processes were met. The fieldworkers thus exercised patience, particularly when the farmers became impatient during the long procedures of data collection. Only the three phlebotomists were hired for the collection of blood serum, taking of blood pressure, and gathering anthropometric data. These health professionals were responsible for making the farmers feel calm and safe and to inform them of the non-threatening nature of the blood collection procedure. The farmers also received immediate feedback regarding the blood pressure results in order to gain their support and to keep them informed of their blood pressure status.

3.12 Measuring Instruments for the Baseline Survey

Diverse tools were used for data collection and the researcher made sure that these tools would meet the study objectives through consulation. Moreover, the variables associated with each instrument were taken into account. The questionnaire that was administered elicited data regarding the participants' socio-demographic and biomedical data; their health status; their dietary and household food security status; the level of their legume acceptability; and their agricultural knowledge. Each instrument will be discussed in more detail below.

The survey questionnaires had been used and tested in previous studies. They were scrutinised by a working group of experts who were part of the consultative process for designing the educational programme (refer to Chapter 4). References pertaining to those studies are provided in the questionnaires. During the consultation processes involving the farmers, the questionnaires were presented to a small group who did not participate in the study. Face validity was used which is a common method for empirical community-centered observations in government initiated projects. This was appropriate as this project formed part of a municipal food security programme (Gaber & Gaber, 2010). In this manner, the farmers attained clarity and understanding of the overall project objectives and the relevance of this study.

3.12.1 Socio-demographic questionnaire

The socio-demographic questionnaire was compiled in English and translated into IsiZulu. It was also pre-tested and validated (Mkhize, Napier, & Oldewage-Theron, 2013). Its purpose was to measure the socio-economic status of the participants under the following main categories: personal information, accommodation, family composition, work and economic status, highest education level, language and household assets. This survey was thus used to elucidate the social characteristics of each participant and included variables such as age, gender, family size, marital status, household income and resource allocation (Annexure E). The questionnaire was extensive and time-consuming to complete as it took approximately 15−25 minutes or more. Each socio-demographic questionnaire was completed in an interview situation by the trained fieldworkers. The data obtained from these completed questionnaires were captured by the researcher using an Excel® 2010 spreadsheet and analysed using the IBM Statistical Package for the Social Sciences® (SPSS) software for Windows Version 25.0. Descriptive statistics were determined with the assistance of a statistician to indicate frequencies for the different variables. The data are presented in this report in frequency and percentage units in tables and graphs. Analyses were conducted for a total of 112 farmers.

3.12.2 Anthropometric data

Anthropometric data are nutrition aligned indicators used in nutrition studies. The data can be analysed to provide information on nutritional outcomes. Measurements of individuals or groups categorically classify malnutrition, which is interpreted as under-nutrition or over-nutrition (Carletto *et al*., 2013). This anthropometric survey comprised of Section A and a Section B contained anthropometric, medical and health survey data. The questionnaire that was used had been validated and tested by Mkhize *et al*. (2013) and was compiled in English and IsiZulu. The medical and health survey data were recorded in separate sections. Section

A included data on weight, height, and waist circumference (WC) (Annexure F). Weight, height, the Body Mass Index (BMI), fat percentage and waist circumference are anthropometric variables that can be used simultaneously to determine risk factors that might impact nutritional status (Rocha, Milagres, de Novaes & do Carmo Castro Franceschini, 2016). Anthropometric assessments were conducted using procedures as discussed below. These assessments were conducted by trained nurses. The data from the completed questionnaires were captured on an Excel® 2010 spreadsheet by the researcher and analysed using the IBM Statistical Package for the Social Sciences® (SPSS) software Windows Version 25.0. Descriptive statistics were determined with the assistance of a statistician to indicate the frequencies of the different variables. The data are presented in this report in frequency and percentage units in tables and graphs. Analyses were conducted for a total of 112 farmers. According to the WHO (2004), global guidelines have been established to ensure that accurate readings of weight and height are taken. It is important to note that self-reported values (for height and weight) were not accepted because such information can be inaccurate. The following procedures were followed for anthropometric data collection:

3.12.2.1 Weight measurement

Weight was determined to the nearest kilogram using a good quality, electronic standardised beam balanced scale (MDW-250L Digital Physicians Scale). The participants had to be dressed in light clothing and had to remove their shoes prior to being weighed, as heavy clothing would have interfered with the accuracy of the measurement. Various items such as jewellery, socks and heavy jackets had to be removed. Two qualified nurses/phlebotomists were responsible for taking all the anthropometric measurements to ensure the accuracy and validity of the measurements. Standardized and universal procedures were followed.
The scale was placed on an uncarpeted area and was levelled with the spirit level indicator in the middle. The scale was switched on. When the zero indication (0.0) and the stable indicator appeared, the following considerations applied for weight assessments:

- For consistency, the participants were weighed at the same time of the day each time and the same clothing weight had to be worn as far as possible (Rolfes *et al*., 2015, p. 551-566).

- Weight measurement required accurate scales that were carefully maintained, calibrated and checked for accuracy at regular intervals. The scales used were electronic medical scales that are generally regarded as the most accurate. Such scales can be utilized for bedridden patients.
- The participants had to wear light clothing and shoes had to be removed before weighing.
- The participant had to step on the scale, standing upright, facing straight ahead, with arms at the sides. The feet had to be flat on the scale, with legs slightly parted. The subject had to stand still until the measurement had been taken.
- An average of two readings was taken and weight was recorded to the nearest 0.1 kilograms (Rolfes *et al*., 2015, p. 551-566).
- After the measurement had been completed, the participant stepped down from the scale and the nurse waited for a zero recording to appear on the digital display before weighing the next person.

3.12.2.2 Height

Height was taken immediately after the weight measurements had been completed. The participants were measured on the stadiometer attached to the medical scale (MDW-250L Digital Physicians Scale) for the determination of height. Two readings were taken to the nearest 0.5 cm using the stadiometer. Readings were monitored and care was taken that they did not to vary by more than 5 mm. The following considerations were taken into account during the measurement procedure (using Frankfort horizontal plane):

- The participant had to face the nurse, looking straight ahead under the stadiometer headpiece.
- All excess clothing items had already been removed for the weight measurement.
- Arms were held relaxed at the sides and legs were straight with knees together, feet flat, heels touching.
- The head had to face forward, shoulders had to be relaxed, buttocks and heels touching the wall.

- Measurements were recorded in meters (m) and height value was recorded to the nearest 0.1 centimetre on the health questionnaire form.
- An average of two readings was taken (Rolfes *et al*., 2015:551-566).

By combining the two assessments of weight and height, BMI calculations could be conducted for each participant.

3.12.2.3 Body mass index (BMI)

BMI is a recognised calculated index of weight and height variables put together to determine various scorings from underweight to obesity class III. The individual can be placed at the appropriate score based on the calculation outcome. Body composition in relation to height is determined (Marqueta de Salas *et al*., 2016). The BMI calculations were done according to the following formula:

Metric Formula: BMI = Weight (kg) ÷ Height (m^2).

The BMI cut-off points applicable to this study were as follows: Underweight (BMI <18.5kg/m^2); Normal weight (BMI = 18.5 - 24.9 kg/m^2); Overweight (BMI = 25 - 29.9kg/m^2); Obese 1 (BMI = >30kg/m^2); Obese 2 (BMI = >35kg/m^2); and Obese 3 (BMI = >40kg/m^2) (WHO, 2004).

3.12.2.4 Waist circumference measurement

Waist circumference is an indicator of central obesity and was used to validate the body mass index (BMI) results. These measurements were taken as follows:

- A non-stretchable measuring tape was held firmly, ensuring its horizontal position when used around the participant's waist circumference area.
- The tape had to be held in such a manner that it allowed the observer to place one finger between the tape and the participant's body.
- The placement of the tape had to be at a level between the lower rib and the iliac crest, with the tape around the body in a horizontal position.
- The participants had to stand with their feet fairly close together (about 12 - 15 cm apart) and with their weight equally distributed on each leg.

- The participants were asked to breathe normally and the measurement was then taken at the end of exhaling. This prevented the participant from contracting the abdominal muscles or from holding their breath.
- Heavy clothing had to be removed and a tape measure was wrapped around the waist.
- The procedure was repeated twice.
- The measurement was rounded off to the nearest 0.1 cm.

The cut-off point for women was ≤88 cm and for men it was ≤102 cm. The Waist to Height Ratio (WHtR) should be ≤0.5 for men and women (Lee & Nieman, 2010). The readings were recorded on the health questionnaire.

3.12.2.5 Waist-to-height ratio

Waist-to-height ratio (WHtR) is another anthropometric measurement commonly used to determine visceral fat in conjunction with other assessments such as BMI. It is believed that visceral fat is associated with cardiovascular disease and metabolic syndrome risk. According to the WHO (2004), the WHtR cut-off point is ≥0.5. This is a reliable assessment method that has been used in various obesity studies to determine metabolic risk. Metabolic risk is closely associated with waist circumference scores and is part of abnormal obesity (Okada *et al*., 2016). Calculations for WHtR must be categorised as ≤0.5 and ≥0.5 in order to determine risk (Tyrovolas *et al*., 2015). According to Kawada *et al*. (2016), WHtR is a more favourable assessment tool than the visceral adipose tissue measurement to determine metabolic syndrome since fat distribution in this area is more dangerous. The measurements of height and waist circumference were taken according to the procedures indicated above for each measurement. After the initial recordings, the waist circumference value was divided by the height as both were measured in the same units (cm). The data recorded in the questionnaire forms were captured on an Excel® 2010 spreadsheet and analyzed using the IBM Statistical Package for the Social Sciences® (SPSS) software for Windows Version 25.0. Descriptive statistics were determined with the assistance of a statistician to indicate frequencies for the different variables. The data are presented in frequency and percentage units in the form of tables and graphs.

3.12.3 Blood pressure (clinical) measurement

A reliable blood pressure monitor (Tensiometro Automatico Superior) was used to measure clinical data by a trained phlebotomist to measure the blood pressure of each participant as follows:

- The blood pressure strap was wrapped around the middle part of the arm, a reading was reflected and an electronic reading was captured.
- The values for systolic and diastolic blood pressure (BP) were measured and recorded on the health questionnaire.
- Prior to taking the reading, the participant had to sit down in a relaxed manner to normalise the blood pressure.
- Readings were taken twice.

The South African guidelines for hypertension cut-off points were used for the analysis of blood pressure (Seedat *et al.*, 2014). Blood pressure measurement categories were as illustrated in Table 3.1 below.

Table 3.1: South African Hypertension cut-off points

Source: adapted from Seedat *et al*., (2014)

3.12.4 Medical and health data

Section B of the questionnaire focused on assessing each participant's health condition and the health challenges within the community as they perceived them. The key variables were evidence of any illness, usage of medication, smoking tobacco, level of physical activity, disability, type of health-care system utilized and possible conditions that could pose a threat to conduct daily activities and consume food which were pre-tested in another study conducted at Umlazi township in Durban (Mkhize *et al*., 2013).

Health surveys are generally dependent on self-reported data and it is therefore very important that such data are valid and reliable (Lin *et al*., 2017). The health questionnaire focused on the health conditions, disorders and possible communicable and non-communicable lifestyle diseases that these participants experienced. A general screening of the nature and severity of health conditions was also conducted. Thus, information pertaining to the use of alcohol, traditional medicines, type of health-care service used and level of physical activity was obtained. For the purpose of this study, qualified phlebotomists (there were three per data collecting session) were used to collect all the health-related data (Annexure F). Section A obtained anthropometric information such as blood pressure measurements [clinical information] and Section B elicited health and medical data. Descriptive statistics were determined with the assistance of a statistician to indicate the frequencies of the different variables. The data are presented in frequency and percentage units in the form of graphs and tables (refer to section 3.13.2). Analyses were conducted for a total of 112 farmers.

3.12.5 Nutrition assessment: Dietary intake instruments

3.12.5.1 24-hour recall questionnaire

The 24-hour recall questionnaire elicits information pertaining to the food and beverages that a person consumed previous 24 hours (during the week). It is highly relevant in populations where there are low literacy levels as well as limited computation skills (Barroso *et al.,* 2016). Energy intake information, as well as estimated portion sizes for each group and nutrient, is obtained by means of the administration of the 24-hour recall questionnaire (Huang, Wahlqvist & Lee, 2014). According to Castaneda-Gameros *et al*. (2017), the administration of a 24-hour recall survey over three days captures information of food consumed at home or away from home, whilst indicating types and quantities of food consumed. Estimations of the nutrients consumed with reference to each reported dish are made. Portion sizes of the food consumed can be estimated using standard household measuring cups, spoons and ladles (Ravi *et al*., 2016).

Food and beverage intake, eating patterns, times and quantities consumed over a 24-hour period were recorded. This process was repeated on three non-consecutive days and the results were recorded by fieldworkers. Food models were used to determine portion sizes and to explain food items to quantify portion sizes**.** The participants were asked for 3 days x 24-hour recalls: one weekend day and two weekdays to measure eating patterns. The quality of the information obtained using the 24-hour recall questionnaire depends mainly on the work of the interviewer (ability to assist the respondent recall and quantify food intake) and this person's interrogation techniques (Jiménez-Contreras *et al*., 2006). The food consumption data obtained in this manner were analyzed using the Food Finder® version 3 computer programme developed by the South African Medical Research Council (SAMRC) and the data were captured manually. Information included the intake of enriched maize flour and bread, which do not appear in the program (SAMRC, 2002; Institute of Medicine [IoM], 2003). The results were compared to the dietary reference intake (DRI) for people aged 51-70 years (IoM, 2003, 2005, 2006, 2010; NICUS, 2003) these were EAR, Al, IU for various nutrients to be compared.

Data collected for the period of 3 days were then averaged to be presented in descriptive statistics for nutrient data, which is normally distributed when means and standard deviation frequencies were established. The data are then presented in the form of tables (in section 3.13.4). The top-20 most consumed foods were also determined, ranked and presented in ascending order by per capita intake. Analyses were conducted on a total of 112 farmers. This tool (refer to Annexure G) was pre-tested in a previous study (Mkhize *et al*., 2013). Fruit and vegetable intake (in grams) was determined according to the individual dietary intake 24hr recall survey. The survey collects data over 3 days that are then averaged per group by gender seperately and compared against the WHO (2003), guidelines for the daily consumption of fruit and vegetables as per recommendations.

The estimated energy requirement (EER) for an active adult's daily physical activity levels were calculated using the Harris Benedict Revised Formula as follows:
The Basal Metabolic Rate (BMR) for men (metric): BMR = 88.362 + (13.397 x weight in kg) + (4.799 x height in cm) - (5.677 x age in years).
The Basal Metabolic Rate (BMR) for women (metric): BMR = 447.593 + (9.247 x weight in kg) + (3.098 x height in cm) - (4.330 x age in years) (Roza & Shizgal, 1984).

3.12.5.2 Food frequency questionnaire (FFQ)

The FFQ aims to evaluate the variety of foods consumed over a week and is a good indicator of the dietary diversity consumed by a person. However, care should be taken that the seasonal availability of certain food items does not affect food intake results (Rolfes *et al*., 2015, p. 551-566). This questionnaire was used to determine how often certain foods were consumed over a period of seven days and to identify the food groups that were predominantly consumed to measure dietary diversity and frequency.

Dietary diversity scores (DDS) are calculated as an aggregate of food groups consumed over 7 days (as a measure of a given time) and each food group also has to be aggregated (Habte & Krawinkel, 2016). The formulation used is logical syntax, which categorises all the foods selected by an individual (by a simple count of each food item) per food group frequency, then summing up all food groups (as a variety score of the groups selected) to arrive at the dietary diversity score (Hatløy *et al.*, 1998; Hatløy *et al.*, 2000; Kennedy *et al.*, 2010).

Nine food groups were selected in this study as measurement for DDS as this was a more relevant and suitable standard for the nature of the study. A South African national study supported the use of nine food groups as these food groups are commonly consumed in the South African context (Matla, 2008; Steyn & Ochse, 2013). These were also ranked according to the following levels: 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. The results are presented in percentages, as proposed by Matla (2008). The recommendation by Kennedy *et al.* (2010) to use 12 food groups (DDS) as suggested by an FAO report in 2010 was not adopted. The current study required that factors such as a specific focus of dietary patterns and age be considered. It was also decided to limit the food groups to nine, as suggested by a previous South African study (Steyn *et al.,* 2013). However, in the future, consideration of this age group should be given to adopt the 12 food groups due to dietary shifts, and thus to measure a wider food group range.

The questionnaire was developed with the assistance of a small group of elderly farmers from the community during the consultation process. It was then updated and administered to the study participants (refer to Annexure H). This instrument was also used to validate the 24-hour recall questionnaire information by Mkhize *et al*. (2013), who conducted a study in Umlazi near Durban in KwaZulu-Natal. The data obtained from the FFQ were captured on a Microsoft Excel® spreadsheet and analyzed using SPSS version 25.0 software programme to determine the food variety scores (FVS), food group diversity (FGDS) scores, the DDS for mean scores and frequencies of consumption of each food group. All these calculations formed part of the FFQ results. Descriptive statistics that reflected the means, standard deviations and frequencies were established and the data are presented in the form of tables and graphs. Analyses were conducted for a total of 112 elderly farmers.

3.12.5.3 The household food insecurity access scale **(HFIAS)**

The HFIAS is a monitoring tool that is utilized worldwide in food in/security studies and originates from the United States. It is cost-effective and easy to utilize. However, it has to be validated from country to country (Carletto *et al*., 2013). The tool provides comprehensive information on food insecurity status and therefore must be correlated with other measurable variables relating to poverty and food consumption patterns. The interpretation of the HFSSQ can be based on the observation of response indicators such as 'never' in relation to all sub-domains (Kabunga, Dubois & Qaim, 2014). The interpretation of the information elicited by this questionnaire is based on food consumed over the four weeks (30 days) prior to the survey. Each score has a variable, which is calculated by various codes of each frequency, as well as occurrence (Kabunga *et al*., 2014) and focuses on the access, availability, quantities and duration of shortage levels of food at household level (Coates *et al*., 2013). For the purposes of this study, the questionnaire was adapted to include definitions of food security as well as to determine food waste patterns in the households represented by the participants (Annexure I). The questionnaire was pre-tested in various food security studies globally (Coates *et al.*, 2013). The data was captured on an Excel® 2010 spreadsheet and analyzed using the IBM Statistical Package for Social Sciences® (SPSS) software for Windows Version 25.0. Descriptive statistics were determined with the assistance of a statistician to indicate frequencies for the different variables. The data are presented in frequency and percentage units in the form of tables and graphs (refer to section 3.13.6). Analyses were conducted for a total of 112 farmer.

3.12.5.4 Legume knowledge acceptability evaluation feedback questionnaire (LKAEFQ)

The purpose of the LKAEFQ was to assess the knowledge and acceptability levels of the participants of various legumes that were not commonly consumed by them. The legumes that were going to be introduced in the education programme needed to be socially and culturally acceptable for regular consumption. The questions included information regarding the farmers' levels of resistance for legume intake in their diet (Annexure J).

Various statements and acceptance scores can be used to measure food acceptability within a community or by individuals. A similar study conducted in Malaysia investigated urban agriculture and addressed food and nutrition security acceptance levels as well (Rezai *et al.*, 2016). Acceptability is determined by scoring responses to a combination of questions and these scores are then calculated as a total score percentage with a maximum scoring level for each variable (Rusinamhodzi *et al.*, 2012). Data were captured on an Excel® 2010 spreadsheet by the researcher and analyzed using the IBM Statistical Package for the Social Sciences® (SPSS) software for Windows Version 25.0. Descriptive statistics were determined with the assistance of a statistician to indicate frequencies for the different variables. The data are presented in frequency and percentage units in the form of tables and graphs. Analyses were conducted for a total of 112 farmers.

3.12.6 Biomedical indices and blood analyses

Biochemical indices are reported in two categories: serum (for cholesterol) and plasma (for blood glucose). Various factors influence blood results such as fluid imbalance, various infections, or an individual might have an inflammation. Physiological factors play an important role in the determination of vitamin and mineral scores. Validation with other sources is required to strengthen the validity of the results of these tests (Rolfes *et al*., 2015, p. 565). Biochemical data obtained in malnutrition studies can provide objective results. However, fluctuations due to inflammation can affect serum results in ill patients (Harding *et al*., 2015). It has also been cautioned that biochemical data can change due to the prevalence of Parkinson's disease, as such patients will have low haemoglobin levels (Deng *et al*., 2017). In the current study, the reliability of the data was ensured by using trained laboratory technicians staff members who ensured that calibrated equipment and machinery were used. The Biolis 15i Chemistry analyser was calibrated according to the manufacturer's instructions (Tokyo Boeki Medical Biosystems). The results were printed by the analyser, captured on a spreadsheet, and then compared against the range values (Randox Laboratories, 2015). These range values indicated if a respondent was below or above the required values for each test (Randox Laboratories, 2015). The following ranges were used as indicators of above or below the normal serum values for biomedical data:

- Cholesterol: ≤ 5.17 mmol/l reflected desirable for blood cholesterol; 5.17-6.18 mmol/l reflected borderline high; and ≥ 6.20 mmol/l reflected high blood cholesterol;
- Glucose: low (<5 mmol); normal (5-6 mmol); high (>6 mmol) (Randox Laboratories, 2015).

None of the participants were fasting during the blood assessment tests (Randox Laboratories, 2015; Tietz, 1990). Participants did not fast due to the time at when research was conducted, they had to engage with farming activities in the morning, then came to the AHS during mid-morning for data collection.

3.12.6.1 Blood collection procedure

The participants received their files on arrival with all questionnaires and a coded blood tube pack with the numbers corresponding on the blood tube pack and the file (containing all questionnaries). Two types of tubes were placed in a clear plastic bag and labelled.

- The participants had to sit down on a chair in front of the phlebotomist.
- All heavy clothing was removed.
- The participant relaxed and opened and closed the fist to allow blood circulation.
- Three phlebotomists took the blood samples. Wearing gloves, they applied sterile swabs to the vein around the wrist area before inserting the needle.
- Items used were gauze pads, adhesive bandages, skin antiseptic solution, isopropyl alcohol, and disposable gloves.
- A vacutainer needle using a needle holder was inserted to draw blood for the grey tube (7 ml) which was used for the blood glucose and cholesterol analysis. A second sample of blood was drawn for the yellow tube (7 ml) for the analysis of all mineral values.
- After withdrawal, the needle was removed and cotton wool was adhered using clear tape to cover the vein area.
- The needles (sharps) were then disposed of in a leak-proof and puncture resistant sharps container bin brought to the venue by the phlebotomists (WHO, 2010). This waste was taken away by municipal workers in two leak-proof non-infectious waste bags to be disposed of according to regulations.
- All blood samples were immediately placed in a cooler box and transported to the biomedical laboratory at MUT for analysis. The blood tests were measured in serum levels for cholesterol and in plasma for glucose and the results are reported in these values in this dissertation.

3.12.6.2 Blood analysis procedure

The analyses were conducted at the Biomedical Chempath Laboratory at MUT. The blood samples were placed on ice in a cooler box by the medical technologist at the Biomed laboratory. Serum separator tubes (yellow top) and matching glucose (grey top) tubes were received. All the batches were treated in the same manner. The samples were sorted by the unique numbers allocated to them on site. They were also given a unique lab number by the medical technologist.

The samples were centrifuged for 5 minutes at 2000 rpm. For the glucose tubes, plasma was separated from the cells and stored at -200°C for 24 hours. The contents of the other tubes (strictly for blood mineral analysis) were not separated because a separator that automatically separated serum from cells was available. These samples were also stored at 200°C for 24 hours. The analyser was programmed to run these tests. The Biolis 15i Chemistry analyser was then calibrated according to the manufacturer's instructions (Tokyo Boeki Medical Biosystems). Controls were run to validate the calibration and to ensure the reliability of the results. Controls were run with each batch for each test.

Once the calibrators had been passed and the controls had been read and fell within acceptable control ranges, the actual samples were then analysed on the analyser for plasma glucose and serum cholesterol results. Calibration was done and controls were analysed at every reagent change. The data were captured on an Excel® 2010 spreadsheet by the researcher and analyzed using the IBM Statistical Package for the Social Sciences® (SPSS) software for Windows Version 25.0. Descriptive statistics were determined with the assistance of a statistician to indicate frequencies for the different variables. Data are presented in frequency and percentage units in the form of tables and graphs. P-test values, significant levels and comparisons were conducted using the Mann-Whitney U and Wilcoxon W tests.

The Mann-Whitney U test is one that compares differences between two independent groups as the dependent variable which can neither be continuous nor ordinally distributed. This test was used to determine the significance values for blood glucose, cholesterol and anthropometrics in the male and female participants. This test can also be applied in non-parametric alternatives for independent t-tests. Another important factor is that the t-test using SPSS statistics also allows various conclusions to be drawn (Laerd Statistics, 2013). There were 112 respondents whose blood samples were analysed.

3.12.7 Instrument measuring agricultural production output

The Traditional Agricultural Practices Questionnaire (TAPQ) was used for gathering agricultural data. The TAPQ gathers information about the agricultural practices within a farming environment. It assesses issues about water, crops commonly cultivated, types of equipment used, land use, and usage of computer models. This questionnaire (Annexure K) was used during the baseline survey to determine the agricultural situation in the study area, with particular reference to the practices of elderly farmers. The questionnaire was pre-tested in a previous study (Mothepu, Napier & Duffy, 2016). Trained fieldworks who were able to assist the farmers in providing the necessary information were utilised. The questionnaire took 15 - 20 minutes to complete. The data that were generated were captured on an Excel® 2010 spreadsheet by the researcher and analysed using the IBM Statistical Package for the Social Sciences® (SPSS) software for Windows Version 25.0. Descriptive statistics were determined with the assistance of a statistician to indicate frequencies for the different variables. The data are presented in frequency and percentage units in the form of tables and graphs. Analyses were conducted for a total of 112 farmers.

3.13 Results and Discussion: Baseline Survey

The results obtained for the baseline study are presented and discussed in this section. The information is presented in tables and graphs and correlations are drawn for different variables. The results that are presented were elicited by means of the measuring instruments as discussed in the preceding methodology section. Each instrument elicited information pertaining to the prevailing trends and the challenges that the farmers encountered.

3.13.1 Results of the socio-demographic survey

Figure 3.4 indicates that the majority of the farmers participating in the study were women (79.5%; n=89), while the men were the minority (20.5%; n=23). The mean age was 63.3 years (SD± 8.2).

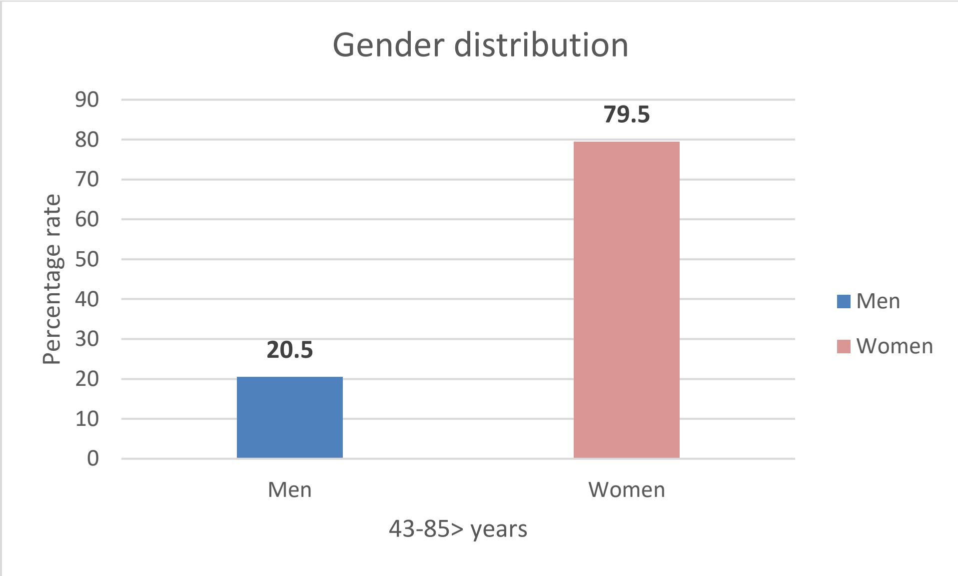

Figure 3.4: Gender distribution of the farmers participating in the baseline study (n=112)

In terms of affiliation, Figure 3.5 indicates that the majority of the farmers' affiliation structure of choice was the eThekwini Municipality (82.2%; n=92). Other affiliations were co-operatives (8.0%; n=9) the Department of Agriculture (6.3%; n=7), small businesses (1.8%; n=2) and private associations (1.8%; n=2). This result suggests that the municipality is integral to assisting the farming community and that, by extension, it should provide educational services and support as well as agricultural resources to the farmers of this community.

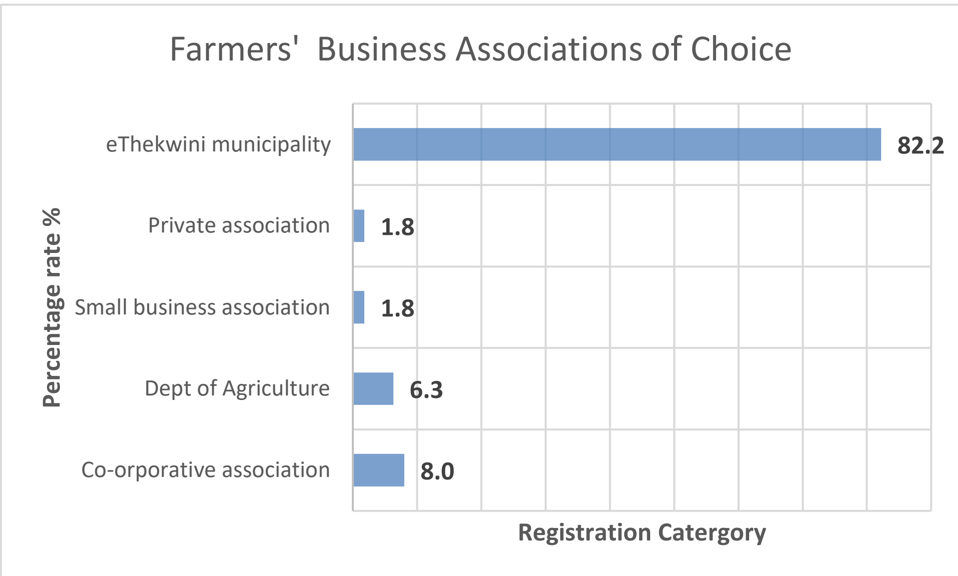

Figure 3.5: Farmers' business registration options (n=112)

In terms of housing and household arrangements, the data presented in Table 3.2 indicate that the majority of farmers had other members of their families living with them (93.0%; n=104). Most of these people lived with the participants on a permanent basis (95.5%; n=107). The mean number of people living with the farmers was 3.3 excluding the farmer. The type of housing that the majority stayed in was brick houses (93.7%; n=109), followed by clay (1.8%; n=2) and grass (0.9%; n=1) dwellings. A higher number (46.4%; n=52) of rooms per household was >4 rooms, followed by 3-4 rooms (42.9%; n=48) and <2 rooms (10.7%; n=12). The majority had resources such as water dispensed by a tap inside their homes (75.0%; n=84), whereas some only had a tap outside the house (21.4%; n=24) or a borehole (3.6%; n=4). Water as a primary resource was available to all the farmers, which was an advantage if these farmers grew home crops such as vegetables. The availability of water also meant that the majority of households used flush toilets (79.5%; n=89), whereas some still had to use pit latrines (13.4%; n=15) or a bucket system (5.4%; n=6). A small number indicated that they did not have access to a toilet (1.8%; n=2). A waste removal service was available to the majority (90.2%; n=101) of the households. Good infrastructure such as tarred roads leading to the dwellings (85.7%; n=96) was also prevalent in the area. The most common pest infestations experienced were rats (41.1%; n=46), cockroaches (29.5%; n=33) and ants (13.4%; n=15). Other pests referred to were flies, mosquitoes, and geckos (16.1%; n=18).

Table 3.2: Housing, family composition, household resources and pest infestation rates

Variable	**Number (n=112)** **Yes**	**Percentage** **(%)**
Family Composition:		
Living with other people	Yes 104	93.0 100.0
Total number of people living per household	Mean 3.3 SD±3.2	
Permanent members	Yes 107	95.5 100.0
Accommodation		
Type of house:		
Brick	109	97.3

Table 3.2: Continued

Clay	2	1.8
Grass	1	0.9
Total		100.0
No. of rooms per household:		
≤ 2 rooms	12	10.7
3-4 rooms	48	42.9
≥ 4 rooms	52	46.4
Total		100.0
Water facilities available per home:		
Tap inside the house	84	75
Tap outside house	24	21.4
Borehole	4	3.6
Total		100.0
Toilet facilities available per home:		
None	2	1.8
Pit latrine	15	13.4
Flush/water-borne sewerage	89	79.5
Bucket system	6	5.4
Total		100.0
Operational waste removal system:		
Yes	101	90.2
Total		100.0
Tarred road access outside the house:		
Yes	96	85.7
Total		100.0
Pest infestation challenges:		
Rats/Mice	46	41.1
Cockroaches	33	29.5
Ants	15	13.4
Others (flies, mosquitos. geckos)	18	16.1
Total		100.0

In terms of employment status, Table 3.3 indicates that the majority (83.3% [n=98]) of the farmers were engaged full-time in farming activities and were not otherwise employed. The rest (11.3% [n=12]) were working whilst farming. The majority (79.0% [n=89]) did not seek other employment. Half of the farmers (50.0% [n=56]) spent all their working hours in the field, while the other 50.0% (n=56) spent part of their time in the field. Social support was provided to 67.0% (n=75) of the farmers, whereas 33.0% (n=37) did not receive any social support. Quite a large number (73.0%; n=84) did not have spouses, while 11.0% (n=12) had spouses who were retired; 8.9% (n=10) of the spouses were unemployed, 2.6% (n=3) were employed full-time; 1.7% (n=2) had temporary work; and 0.8% (n=1) were employed part-time. The monthly household income ranged between R1 000 - R2 000 in 36.6% (n=41) of the households, followed by R2 000 - R3 000 in 28.5% (n=32), >R3 000 - R4 000 in 10.7% (n=12), R4 000 - R6 000 in 9.8% (n=11), >R6 000 in 7.1% (n=8) and <R10 000 in 7.1% (n=8) of the households.

The results suggest that most of these households had to survive on a limited budget, but additional social support was received by a larger number, which could compensate for a tight financial environment. The farmers indicated that they experienced minimal food shortages, as 33.0% (n=37) never had any food shortages, some (24.1% [n=27}) had food shortages, a few sometimes (19.6% [n=22]) had food shortages; some often (17.0% [n=19]) experienced food shortages; and a few (6.3% [n=7]) always lacked food. Food purchases were conducted mostly once a month by 87.5% (n=98) of the participants, followed by once a week (8.9% [n=10]), every day (1.8% [n=2]) and others (1.8% [n=2]). The monthly food budget of the majority (60.7% [n=68]) of the households was between >R500 - R1 500, followed by those who had a budget of <R500 (21.4% [n=24]). Only a small number (17.9% [n=20]) had a food expenditure budget of >R1 500.

Table 3.3: Employment and income status of the participating farmers

Variable	Number (n=112)	Percentage (%)
Currently employed:		
Yes	12	11.7
		100.0
Seeking Full-time Employment:		
Yes	23	21.0
No	89	79.0 100.0
Type of employment:		
Full-time, permanent	56	50.0
Part-time, permanent	56	50.0 100.0
Farmers receiving social support:		
Yes	75	67.0
No	37	33.0 100.0
Spouse employment status:		
Yes, full-time, permanent	3	2.6
Yes, part-time. permanent (< 25 hours p w)	1	0.8
Yes, temporary	2	1.7
No, unemployed	10	8.9
No, retired	12	11.0
No, single. no spouse	84	75,0 100.0
Household income status per month		
< R1000 (<±US$58 [6])	8	7.1
≥R1 000-R2 000 (>±US$58 - ± US$116)	41	36.6
≥R2 001-R3 000 (>±US$116 - ± US$174)	32	28.5
≥R3 001-R4 000 (>±US$174 - ± US$232)	12	10.7
≥R4 001- R6 000 (>±US232 - US$345)	11	9.8
≥ R6 001 (>US$348)	8	7.1

[6] $ Exchange rate was 17.24 (US dollar) to the South African rand during the time of the study.

Table 3.3: Continued

		100.0
Variable	Number (n=112)	Percentage (%)
Limited money to purchase food:		
Always	7	6.3
Often	19	17.0
Sometimes	22	19.6
Seldom	27	24.1
Never	37	33.0 100.0
Frequency of food purchases:		
Every day	2	1.8
Once a week	10	8.9
Once a month	98	87.5
Other	2	1.8 100.0
Food expenditure budget per month:		
<R500	24	21.4
>R500- R1 500	68	60.7
>R1 500	20	17.9 100.0

Table 3.4 indicates that a large number (90.2% [n=101]) of the participants had electric stoves. A gas stove was used by 36.6% (n=41) of the households, which suggests that some used both gas and electricity. Of the 112 participants, 42.0% (n=65) owned a paraffin stove. Electricity was obviously available as 72.3% (n= 81) of participants owned a microwave. Hot plate stoves were owned by 44.6% (n=50) of the sample. A radio was owned by 74.1% (n=83), while a television was owned by 89.3% (n=100). A refrigerator was owned by 87.5% (n=98) and a household freezer was owned by (51.8% [n=58]). Resources such a bed with a mattress were owned by 86.6% (n=97) of the participants, while 58.0% (n=65) had a lounge suite and 66.1% (n=74) owned a dining room suite. Appliances such as an iron (88.4% [n=99]) and a kettle (89.3% [n=100]) were owned by the majority of the participants.

Table 3.4: Household assets and appliances

Variable (asset type)	Number (n=112)	Percentage % (Yes)
Electric stove	101	90.2 100.0
Gas stove	41	36.6 100.0
Paraffin stove	47	42.0 100.0
Microwave	81	72.3 100.0
Hot plate stove	50	44.6 100.0
Radio	83	74.1 100.0
Television	100	89.3 100.0
Refrigerator	98	87.5 100.0
Freezer	58	51.8 100.0
Bed & mattress	97	86.6 100.0
Lounge suite	65	58.0 100.0
Dining room suite	74	66.1 100.0
Appliances: **Electric iron**	99	88.4 100.0
Kettle	100	89.3 100.0

3.13.2 Anthropometric, clinical medical and health survey

This survey was completed by all 112 participants. Table 3.5 indicates that 56.5% (n=13) of the male participants were above the threshold of normal weight as they were mostly overweight (BMI >25- 29.99 kg/m^2) or obese (BMI >30->40 kg/m^2). Seven (30.4%) participants were within the normal BMI range (BMI 18.5-24.99 kg/m^2), while 13.0% (n=3) were underweight (BMI<18.5 kg/m^2).

Table 3.5: Body mass index (BMI) classification for men (n=23)

BMI(kg/m^2)	Indicator	Number = 23	%	Mean	± SD
Underweight	(<18.5)	3	13.0	15	11.72
Normal	18.5-24.99	7	30.4	21	7.77
Overweight	25-29.99	6	26.1	27	7.79
Obese 1	30-34.99	4	17.4	31	7.68
Obese 2	35-39.99	2	8.7	37	6.99
Obese 3	40+	1	4.3	41	0.00
	TOTAL	**23**	**100.0**		

The majority (88.7% [n=79]) of the female farmers were overweight or obese (BMI >25 or >40 kg/m^2). The participants who were within the normal BMI range (BMI 18.5-24.99 kg/m^2) comprised 7.9% (n=7) of the sample, while 3.4% (n=3) were underweight (BMI <18.5 kg/m^2). These outcomes suggest that the women were more over- nourished than their male counterparts (Table 3.5).

Table 3.6: Body mass index (BMI) classification for women (n=89)

BMI (kg/m^2)	Indicator	Number	%	MEAN	± SD
Underweight	(<18.5)	3	3.4	15	8.65
Normal	18.5-24.99	7	7.9	21	7.92
Overweight	25-29.99	16	18.0	26	7.61
Obese 1	30-34.99	23	25.8	32	7.55
Obese 2	35-39.99	25	28.1	37	7.75
Obese 3	40+	15	16.8	43	7.70
	TOTAL	**89**	**100.0**		

Source (BMI calculations): WHO, (2004)

The results indicate that 60.9% (n= 14) of the men were within the recommended cut-off point (≤102 cm) with regard to WC, while 39.1% (n=9) were above the cut-off point (>102cm). This suggests that obesity was a higher risk (Table 4.5) as compared to central obesity in the men (refer to Chapter 2 where the risk factors of obesity are discussed).

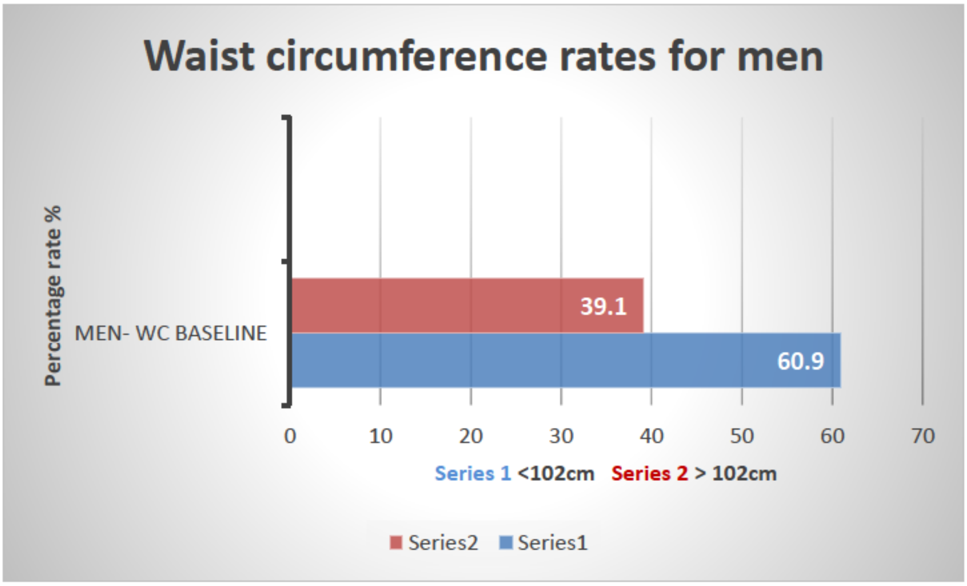

Figure 3.6: Waist circumference (WC) rates for men (n=23)

Source: WHO, (2004)

The WC results for the women (Figure 3.7) indicate that the majority (84.3% [n=75]) exceeded the cut-off point for waist circumference (>88cm), while only 15.7% (n=14) were within the recommended range (≤88 cm). These results correlate with the findings pertaining to the BMI results, suggesting that obesity was a serious threat amongst the female participants (see Table 3.5). Central obesity was found to be more prevalent than standard obesity (which is a BMI classification) in the female participants.

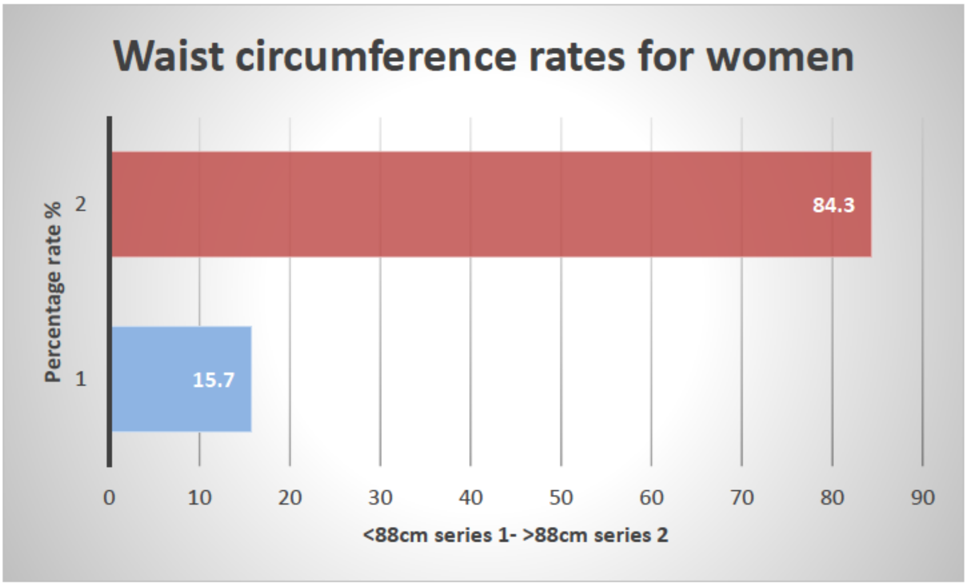

Figure 3.7: Waist circumference (WC) rates for women (n=89)

Source: WHO, (2004)

Figure 3.8 indicates that 88.8% (n=79) of the women exceeded the WHtR (≥0.5) range, while 11.2% (n=10) were within the recommended range of <0.5. However, the majority (65.2% [n=15) of the men exceeded the recommended range of ≥0.5, while the minority (34.8% [n=8]) fell within the recommended range of <0.5. These results suggest that many men and women were at risk of metabolic syndrome as well as other diseases related with this risk (also refer to table 3.5 and 3.6). The results thus imply that metabolic risk was evident in this sample of farmers, and possibly occurred in the entire farming community. The predetermination of metabolic risk is an effective preventative measure in reducing the impact of various diseases and disorders to impact people (Okada *et al*., 2016).

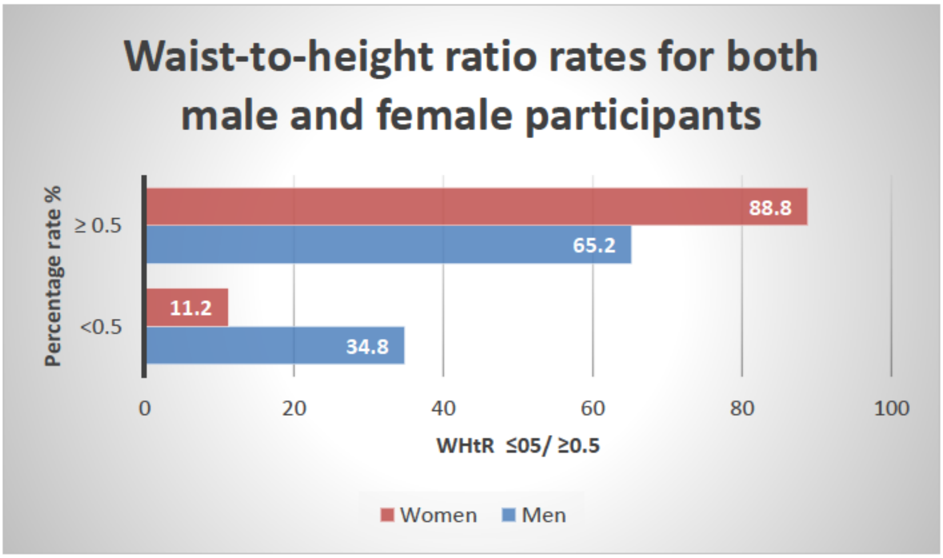

Figure 3.8: Waist-to-height ratio rates (WHtR) (n=112)

Source: WHO, (2004)

In terms of health challenges and diseases, Table 3.7 indicates that the following threats were present amongst the participants: A small percentage (16.0% [n=18]) of the sample had skin problems, while a large number (57.1% [n=64]) had skeletal problems. Of these, 43.8% (n=49) were farmers who felt that the challenges identified above affected their agricultural activities. Eye problems were prevalent in 56.2% (n=63) of the participants, while a few (16.9% [n=19]) indicated that they had not undergone any cataract surgery to improve their sight, which is a critical procedure for this age group. The results suggest that the participants might face serious eye problems in the future as untreated cataracts can lead to blindness if not attended to (DoH, 2013). Dental problems were a challenge for 43.8% (n=49) of the participants and 25.0% (n=28) wore dentures. Dental problems can cause elderly people to be more selective in their food choices and they may choose softer foods to avoid applying pressure to the gums when chewing. The session to educate the farmers on legume preparation and consumption was therefore significant because legumes are softer in texture than most meats. These elderly farmers could thus improve their protein intake by consuming a more palatable form of protein such as legumes.

Ear and nose problems were encountered by 24.1% (n=27) of the participants. Circulatory challenges were prevalent in 25.0% (n= 28) and chest and respiratory problems were self reported by 20.5% (n=23). Since pesticides can contribute to respiratory problems, pesticide usage was measured and it was found that 35.7% (n=40) indicated usage. Precautions may be necessary for those who used pesticides as well as had respiratory problems in order to avoid any impact of pesticides usage on their health. Digestive problems were experienced by 42.8% (n=48) of the participants, whereas nervous system problems occurred in only a few (7.1%; n=8). Surprisingly, headaches were prevalent in only 35.7% (n=40) of the participants. Other health conditions that seemed to affect the participants were constipation (29.5% [n=33]); diarrhoea (12.5% [n=14]); ulcers (20.5% [n=23]); irritable bowel syndrome (IBS) (4.5% [n=5]); and heartburn (22.3% [n=25]). Poor appetite was experienced by 26.8% (n=28), while 30.3% (n=34) had a large appetite. Lack of sleep affected the majority (61.6% [n=69]) of the participants, while memory loss was experienced by 60.7% (n=68) and weakness of the wrists by 26.8% (n=30).

Table 3.7: Disease prevalence rates as reported by the study participants (n=112)

Variables (status)	Number (n=108)	Percentage % (yes)
Skin disease	18	16.0
Skeletal/joint problems	64	57.1
Affecting agricultural activity	49	43.8
Eye problems	63	56.2
Cataract surgery	19	16.9

Table 3.7: Continued

Dental problems	49	43.8
Difficulty eating	31	27.8
Dentures	28	25.0
Ear & Nose problems	27	24.1
Health and circulatory challenges	28	25.0
Chest and respiratory problems	23	20.5
Pesticide usage	40	35.7
Digestive problems	48	42.8
Urinary and genital problems	22	19.6
Nervous system/mental problems	8	7.1
Frequent headaches	40	35.7
Health conditions: Constipation	33	29.5
Diarrhoea	14	12.5
Ulcers	23	20.5
Irritable Bowel Syndrome	5	4.5
Heartburn	25	22.3
Poor appetite	30	26.8
Large/big appetite	34	30.3
Lack of sleep	69	61.6
Loss of memory	68	60.7
Weakness of the wrists	30	26.8

The physical activity results indicated that 40.2% (n=45) of participants were involved in heavy physical activity, followed by 31.8% (n=36) who engaged in moderate physical activity, 15.9% (n=13) who did no physical activity; and 12.1% (n=18) who engaged in light physical activity. These results indicate that the majority of the farmer participants were physically active (refer to figure 3.9). However, even though physical activity was evident, the anthropometric results indicated high levels of obesity, which suggests that factors such as inappropriate diet, type of exercise (e.g. not placing emphasis on resistance training) and a declining metabolic rate in later life, could have impacted weight gain. Further investigations are necessary to determine exactly which factors impacted this group. Epidemiological studies have advocated that muscular strength is an indicator of physical fitness (Raynor & Champagne, 2016). Therefore, more research should investigate the role of muscular strength amongst older farmers.

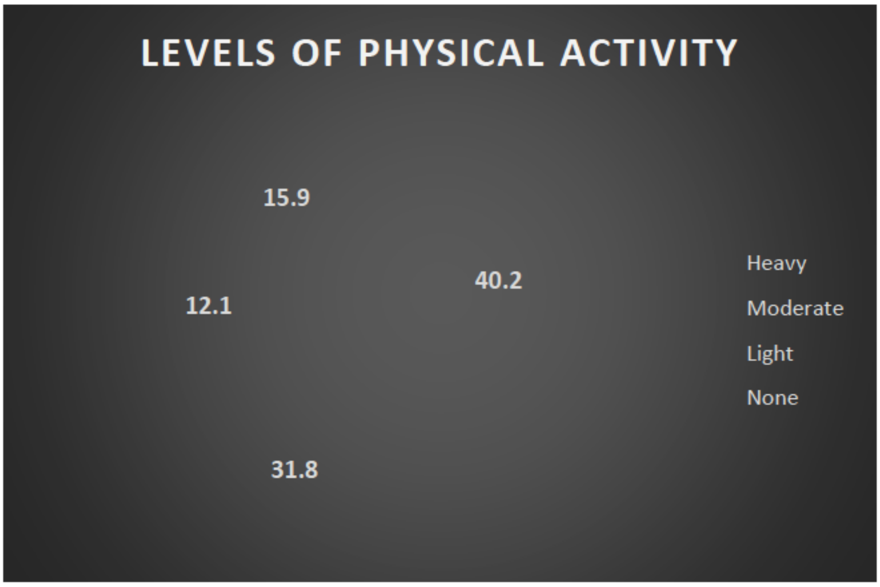

Figure 3.9: Physical activity levels of farmers (n=112)

The smoking status of the participants was assessed and the results indicated that 70.5% (n=78) never smoked; 15.2% (n=16) had stopped smoking; and only 14.3% (n=15) were smoking at the time of the study (refer to figure 3.10 below).

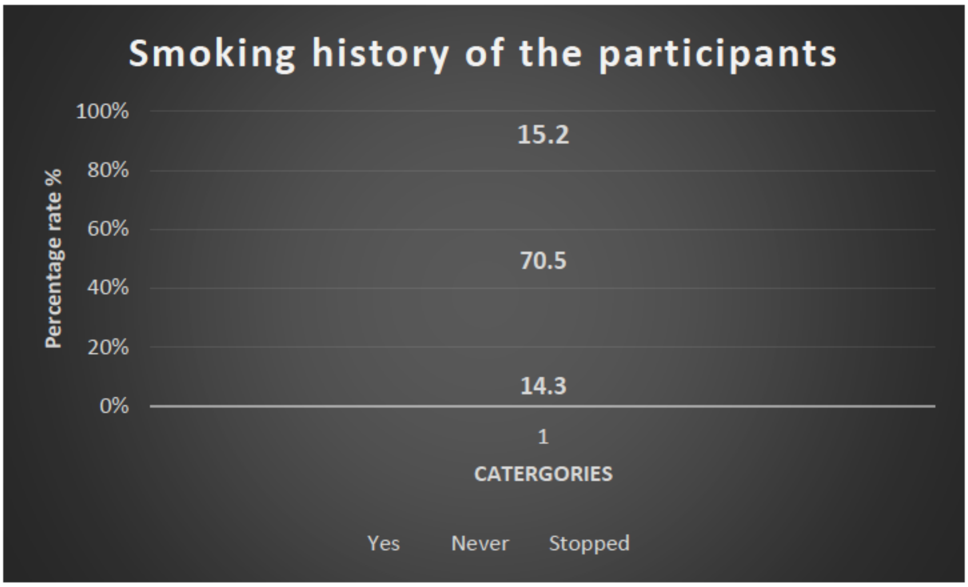

Figure 3.10: Smoking history of the respondents (n=112)

The majority (67.0% [n=76]) of participants were on chronic medication (Figure 3.11), which suggests that the health status of these farmers was under threat as the majority could face long-term health challenges if they did not access proper healthcare. One way of addressing this challenge was to assist them in adopting appropriate, healthy and easily accessible foods.

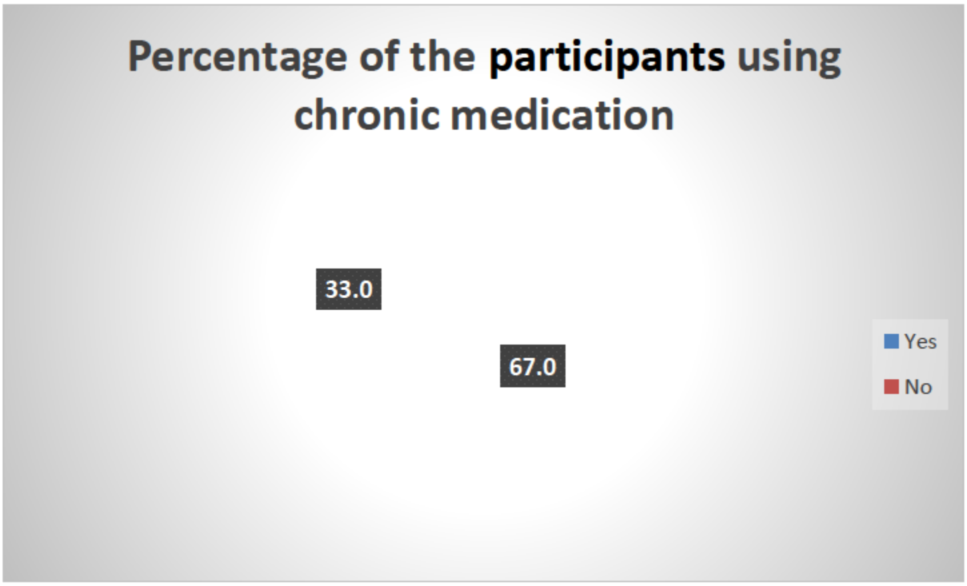

Figure 3.11: Percentage of participants on chronic medication (n=112)

A relatively large percentage (68.8% [n=77]) of the participants visited a clinic for health-care support, followed by those who visited private doctors (16.0% [n=18]), hospitals (13.4% [n=15]) and traditional healers (1.8% [n=2]) (Refer to figure 3.12).

These figures suggest that the members of this community generally accessed primary healthcare facilities. It was thus deduced that chronic medication was mostly sourced from local clinics, which are pivotal in managing chronic illnesses as well as other health conditions (refer to figure 3.13).

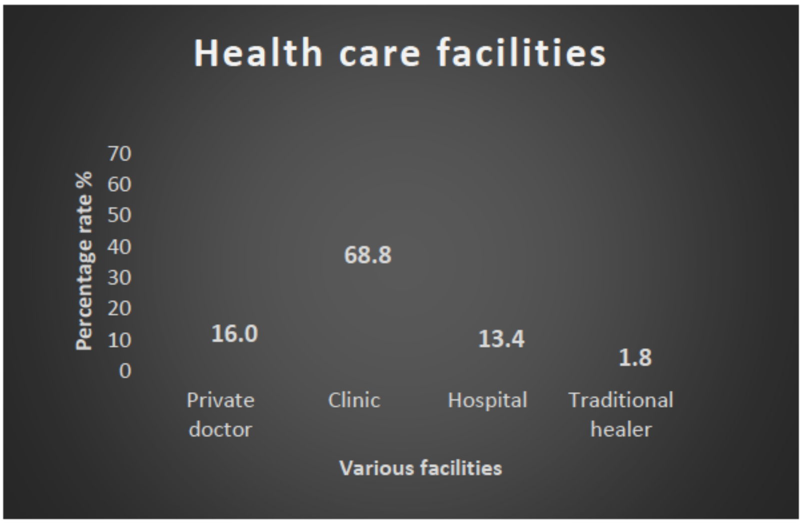

Figure 3.12: Healthcare facilities utilized by the participants (n=112)

The majority 58.0% (n=65) of the participants used a taxi as their main form of transport, followed by walking 35.7% (n=40), own transport 4.5% (n=5) and using a bus 1.8% (n=2). These figures suggest that a clinic was within reach of the majority of the participating farmers.

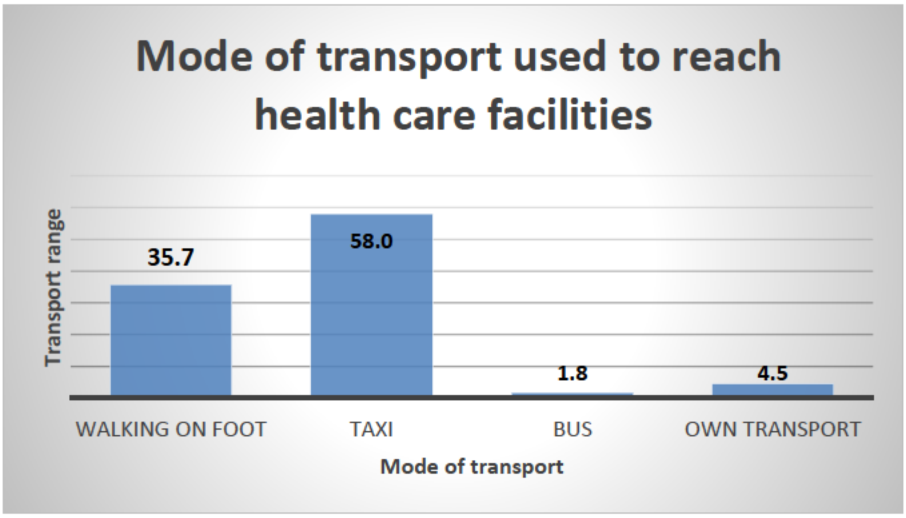

Figure 3.13: Transport mode utilized to access health facility (n=112)

Figure 3.14 indicates that 35.7% (n=40) of the participants had a normal diastolic blood pressure (<80 mmHg), followed by those who were rated at the optimal level (33.0% [n=37]: 80-84 mmHg). High normal (85-89 mm Hg) occurred in 10.0% (n= 11), while evidence of hypertension stages grade 1-3 occurred in 21.3% (n=24) of the participants in the cut-off range of >90 - >110 mmHg.

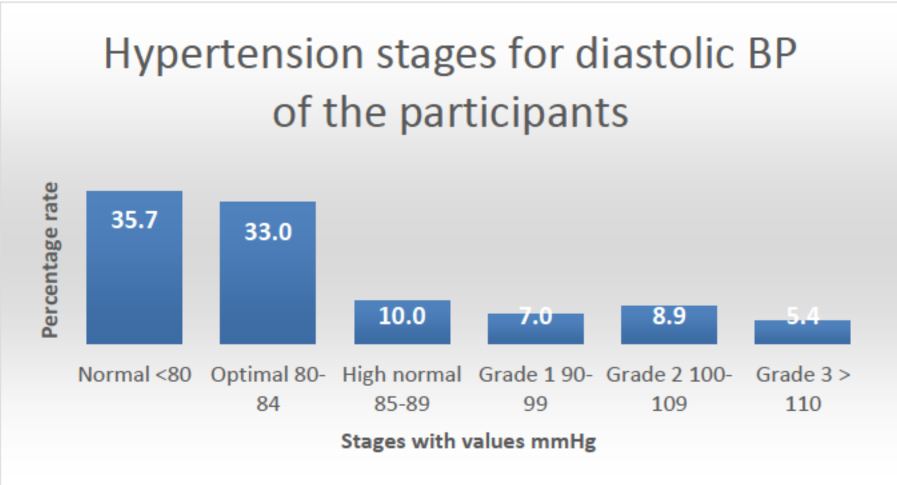

Figure 3.14: Hypertension diastolic blood pressure results for both genders (n=112)

Source for measurement: Seedat *et al.*, (2014)

Figure 3.15 presents the data for the systolic BP range (some could have already been on treatment, refer to figure 3.11). The findings indicate that 32.1% (n=36) of the participants were within the optimal stage (120-129 mmHg), while 26.0 % (n=29) was at the high normal stage (130- 139 mmHg). There was also evidence of hypertension (>140->180 mm Hg) from grade 1-3 in 33.8% (n=38) of the sample. Normal values (<120 mmHg) were indicated for only 8.0% (n=9). Systolic pressure elicited values that were the most disconcerting for hypertension as such values are linked to a high risk for cardiovascular diseases and metabolic syndrome, which are increasing trends as age increases (Okada *et al.*, 2016). The results confirmed the hypothesis that the participants' health status might be at risk and that interventions would be required to assist them in leading a healthier lifestyle. It must be noted that when high risk values (grade 1- 3 indicates an emergency) were recorded, such participants were instantly referred to a hospital for assessment and possible treatment.

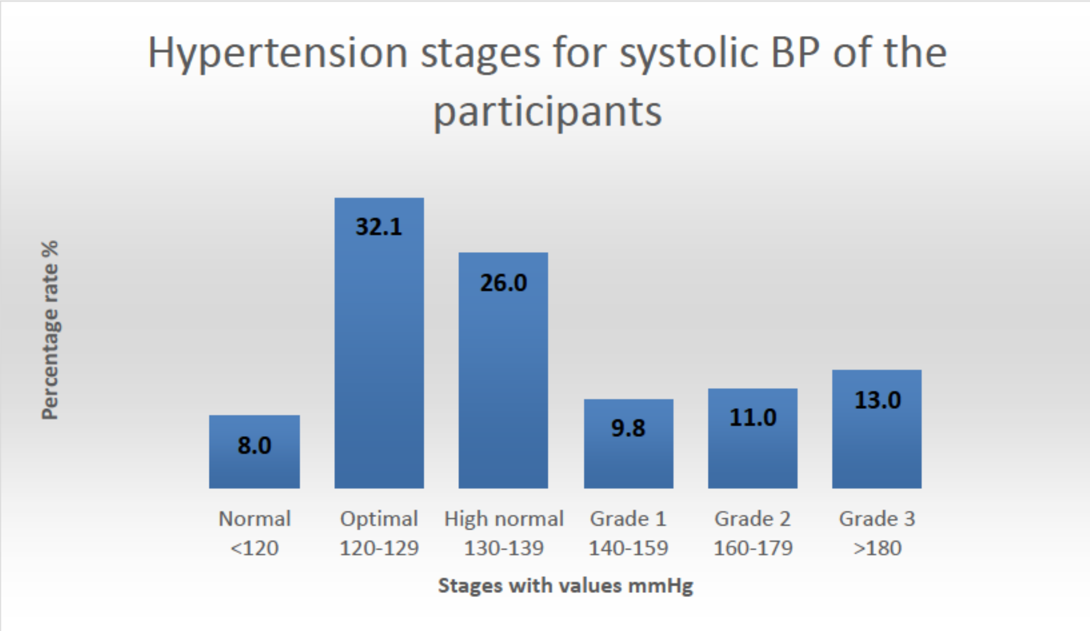

Figure 3.15: Systolic blood pressure results for both genders (n=112)

Source for measurements: Seedat *et al.*, (2014)

The hypertension results presented in Figure 3.16 indicate that the majority (71.5%) of farmers were hypertensive.

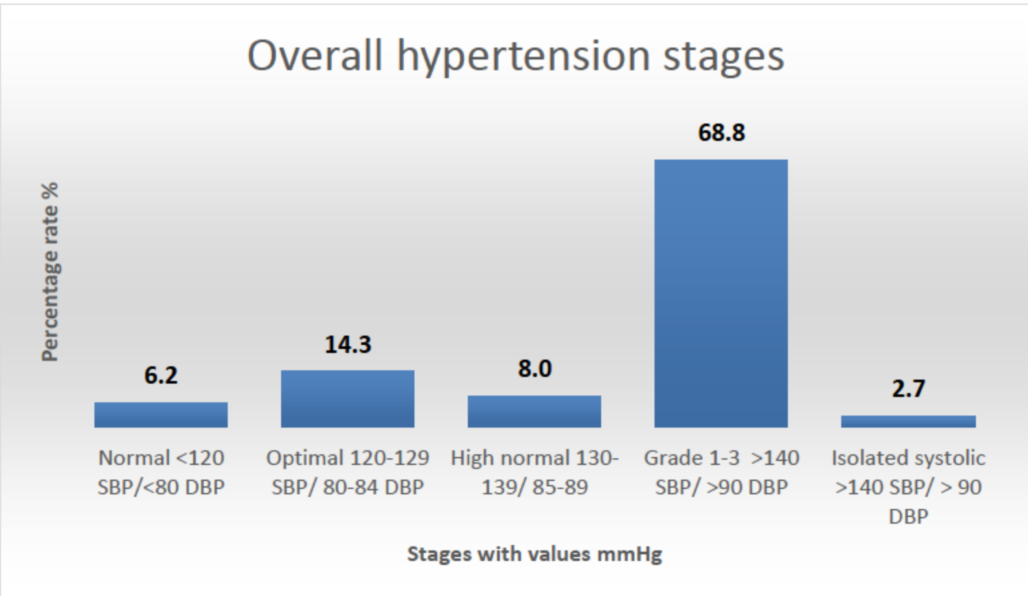

Figure 3.16: Systolic blood pressure results for both genders (n=112)

Source for measurements: Seedat *et al.*, (2014)

3.13.3 Baseline biochemical measurement results

This section reports on the biochemical results for glucose (plasma) and cholesterol (serum). The findings were measured against acknowledged reference ranges and controls for biomedical indices.

Figure 3.17 indicates that 42.0% (n=40) of the participants were within the normal blood glucose range (5-6 mmol), while 42.0% (n=40) were hyperglycaemic. Only a small percentage (16.0% [n=16]) had hypoglycaemic levels (<5 mmol) which is low blood glucose.

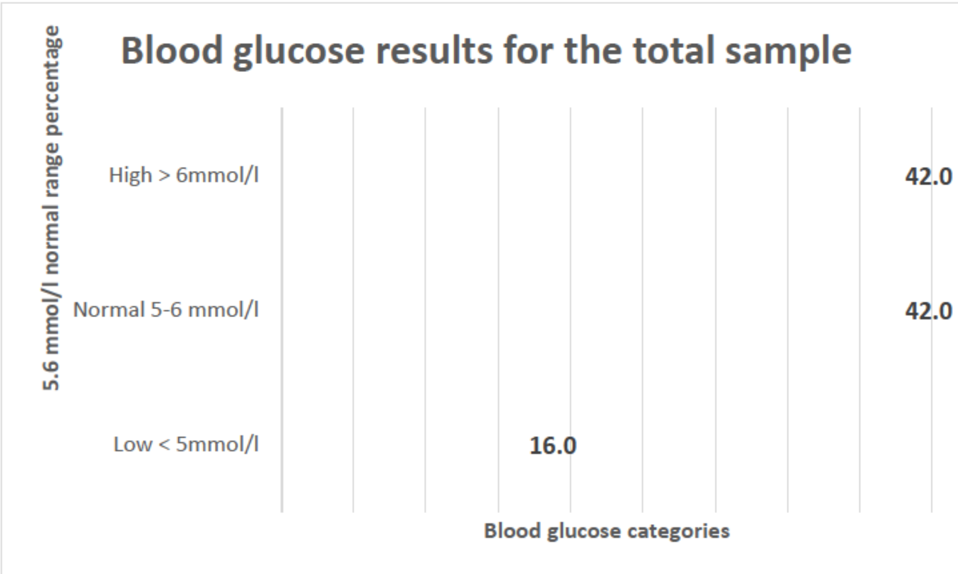

Figure 3.17: Plasma glucose levels for the total sample (n=112)

Source for measurements: Randox Laboratories Limited, (2015)

Figure 3.18 indicates that the majority (61.0% [n=59]) of the participants were within the normal range (<5.17 mmol/l or 200 mg/dl) for cholesterol levels, followed by 21.0% (n=20) at high levels (≥6.20 mmol/l or 240 mg/dl) and 18.0% (n=17) at the borderline (5.17 - 6.18 mmol/l – 200 or 239 mg/dl). Total cholesterol (TC) is a composite of different measurements, including high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein (LDL- C) and triglycerides (TRGs). Although high TC levels could indicate cardiovascular risk, TC should be considered in conjunction with the other known risk factors (i.e. physical activity, smoking, being overweight and diet) to determine risk.

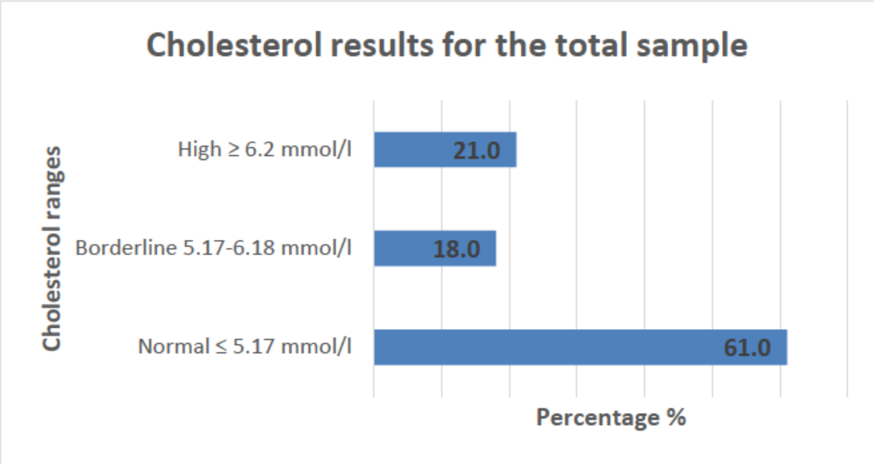

Figure 3.18: Serum cholesterol levels (n=112)

Source for measurements: Randox Laboratories Limited, (2015)

Table 3.8 depicts the statistical data that were calculated to determine the statistical differences between men and women for the following variables: BMI, WHtR, WC, SBP, DBP, cholesterol and glucose. A Mann-Whitney U test confirmed that there was no significant value by gender for the compared variables. Statistical significance was determined at $p< 0.05$.

Table 3.8: Mann-Whitney U analyses: Comparison of significant values for the total sample

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)	Exact Sig. [2*(1-tailed Sig.)]	Men	Women
Age	39.500	45.500	-0.069	0.945	0.948	66.00	66.41
Baseline BMI	31.000	37.000	-0.659	0.510	0.554	30.33	31.78
Baseline WC	34.500	412.500	-0.415	0.678	0.695	105.33	103.67
Baseline WHtR	27.500	405.500	-0.949	0.342	0.387	0.70	0.65
Baseline SBP	33.500	411.500	-0.484	0.628	0.647	155.00	150.67
Baseline DBP	19.000	25.000	-1.489	0.136	0.155	71.67	84.48
Baseline Cholesterol	36.500	42.500	-0.277	0.782	0.795	4.53	5.27
Baseline Glucose	39.500	417.500	-0.069	0.945	0.948	7.57	7.92

3.13.4 Dietary intake indicators

The data were obtained by calculating the average intake for each of the nutrients from the three 24-hour recall food intake questionnaires. The average energy intake (kJ) by men was 5514.63 ± 1573.01 kJ compared to the required ranges [5291.50 ±1629.35 EER]. The average intake by women was 4857.02 ± 1907.44 kJ [required range of 6355.40 ± 1118.25 EER] (Roza *et al*., 1984). The results indicate that the dietary intake in terms of energy requirements was higher for the men, while the women had lower energy intakes (Table 3.9).

The protein intake was also below the estimated average requirement (EAR) levels (i.e., 56 g for men and 46 g for women) as the majority of men (61.0% [n=14]) had a mean ±SD daily protein intake of 51.21 g ± 17.1, while 74.1% (n=66) of the women had a mean ±SD intake of 41.01 g ± 18.3. High carbohydrate intakes were observed for both genders as reflected by the mean CHO intake. However, 4.3% (n=1) of the men and 8.9% (n=8) of the women had low carbohydrate intakes. Dietary fibre (AI) intake was low for the majority of the participants with 91.3% (n=21) of the men recording an intake of less than 30 g and 80.8% (n=80) of the women recording an intake of less than 21 g.

All the respondents (100.0%) had inadequate calcium, magnesium, and Vitamin D intakes, whereas 100.0% of the men also had an indaquate intake of selenium. In addition, more than 67.0% of the women had inadequate intakes of all the micronutrients, except for phosphorus, zinc, selenium, and vitamins B1, B3 and B6. A similar trend was observed for the men, with 67.0% having inadequate intakes of iodine, and vitamins B2, C, E, K, and biotin. It is noteworthy that although the mean dietary intakes were adequate for iron, zinc, vitamins B6, B12 and K in the women, large percentages of women had low intakes of these micronutrients (96.6%, 37.0%, 55.0%, 22.4%, 16.8% and 70.7% respectively). A smiliar trend was observed for iron, vitamins A, B6, B12, folate and panthothenate intakes.

Table 3.9: Intake of nutrients (%) by participants below DRI values (sourced from an average of three 24-hour food recall questionnares). Data are presented for men and women separately (IoM, 2001, 2003, 2005, 2006; 2010, NICUS 2003)

Nutrients /day	Men (n=23) Mean ± SD	Men NARs[7] Mean % of the DRIs	Men consuming <100% of DRIs	% Women (n=89) Mean ± SD	Women NARs Mean % of the DRIs	Women consuming <100% of DRIs	DRIs ♂men ♀women
Energy (kJ) EER	5514.63 ± 1573.01	104.21	0.0%	4857.02 ± 1907.44	91.8	32.6%	♂ 5291.50 kJ EER ♀ 6355.40 kJ EER
Total protein (g)	51.21± 17.13	92.4	61.0%	41.01 ± 18.30	73.3	74.1%	♂56 RDA ♀46 RDA
Carbohydrates (g)	174.07 ± 49.90	174.0	4.3%	165.71 ± 60.51	165.7	8.9%	♂100 EAR ♀100 EAR
Total dietary fibre (g)	16.83 ± 7.70	56.1	91.3%	1393.49± 6.70	66.3	80.8%	♂30 AI ♀21 AI
Minerals and Vitamins							
Calcium (mg)	196.57 ± 113.00	16.3	100.0%	196.15 ± 124.57	16.3	100.0%	♂1200 AI ♀1200 AI
Iron (mg)	10.70 ± 3.07	178.3	4.3%	10.31 ± 3.90	171.8	96.6%	♂6.0 EAR ♀5.0 EAR
Magnesium (mg)	178.15 ± 54.75	42.2	100.0%	153.48 ± 57.22	36.5	100.0%	♂420 EAR ♀320 EAR
Phosphorus (mg)	112.51 ± 33.77	19.3	100.0%	571.52 ± 250.38	98.5	58.4%	♂580 EAR ♀580 EAR
Zinc (mg)	9.28 ± 2.73	98.7	60.8%	8.24 ± 3.54	121.1	37.0%	♂9.4 EAR ♀6.8 EAR
Selenium (µg)	19.18 ± 11.21	42.6	100.0%	14.53 ± 10.81	32.2	2.2%	♂45 EAR ♀45 EAR
Iodine (µg)	35.06 ± 35.05	36.9	95.6%	21.00 ± 17.95	22.1	98.8%	♂95 EAR ♀95 EAR
Sodium (mg)	1134.09 ± 604.27	564.0	0.0%	782.93± 412.52	391.4	2.2%	♂200 EAR ♀200 EAR
Vitamin A (µg)	651.80 ± 830.57	104.2	73.9%	483.77 ± 526.19	96.7	70.7%	♂625 EAR ♀500 EAR
Thiamine (mg)	0.99 ± 0.31	99.0	60.8%	0.94 ± 0.35	104.4	55.0%	♂1.0 EAR ♀0.9 EAR
Riboflavin (mg)	0.70 ± 0.34	63.6	91.3%	0.61 ± 0.35	67.7	88.7%	♂1.1 EAR ♀0.9 EAR
Niacin (mg)	19.74 ± 7.77	162.2	8.6%	16.37 ± 7.27	148.8	22.4%	♂12 EAR ♀11 EAR
Vitamin B6 (mg)	2.49± 1.00	177.8	4.3%	2.24± 1.08	172.3	16.8%	♂1.4 EAR ♀1.3 EAR
Folate (µg)	320.74 ± 137.09	100.2	56.2%	293.80 ± 118.79	91.8	57.0%	♂320 EAR ♀320 EAR
Vitamin B12 (µg)	3.30 ± 7.80	165.0	60.8%	2.40 ± 4.68	120	75.2%	♂2.0 EAR ♀2.0 EAR

[7] NARs and DRIs used IOM 2001, 2003 as the original reference throughout the study however, supported by other references given in the table heading.

Table 3.9: Continued

Pantothenate (mg)	5.50 ± 3,86	110.0	60.8%	4.16± 3.28	83.2	74.1%	♂5.0 AI ♀5.0 AI
Biotin (µg)	25.69 ± 17.64	85.6	78.2%	22.23 ± 12.06	74.1	80.8%	♂30 AI ♀30 AI
Vitamin C (mg)	28.24 ± 17.29	37.6	95.6%	32.51 ± 23.15	54.1	91.0%	♂75 EAR ♀60 EAR
Vitamin D (IU)	64.80 ± 52.3	16.2	100.0%	72.80± 79.60	18.2	100.0%	♂♀ 400 IU
Vitamin E (mg)	8.37 ± 4.15	69.7	73.9%	7.46 ± 4.77	62.1	93.2%	♂12 EAR ♀12 EAR
Vitamin K (µg)	97.11± 180.97	80.9	82.6%	121.46 ± 192.78	134.9	70.7%	♂120 AI ♀90 AI

Sources for recommendations: Institute of Medicine, (2003)

EER (estimated energy requirements), AI (adequate intake) is used where EAR (estimated average requirement) is not available. RDA: Recommended dietary allowance. NARs (Nutrient Adequacy Ratios)

3.13.4.1 Top-20 foods that were consumed by participants

The foods that were predominantly consumed by the 112 participants (89 women and 23 men) were measured using the 24-hour recall data questionnaire (portion size x number of participants). The results are ranked and presented by per mean capita.

Intake of food by women

Table 3.10 illustrates that maize meal was a highly consumed carbohydrate by the women participants, with a mean per capita intake of 216.04 g ± 2.40 g ranked 1st on the top 20 list, followed by white rice (75.86 g ± 1.21 g), bread (67.17 g ± 2.01 g), steamed bread (19.40 g ± 1.59 g) and lastly sugar (13.16 g ± 0.27 g). The results indicate that the top three food items consumed were refined carbohydrates as ranked by per capita intake. Tea was within the five top food items (182. 66 g ± 2.48 g).

Food items following in ranking were protein-rich food such as chicken curry (60.13 g ± 2.96 g) at number five, followed by milk (26.29 g ± 3.14 g), beef curry (15.02 g ± 5.30 g), eggs (9.91 g ± 0.02 g) and sugar beans (7.32 g ± 2.32 g). In terms of fruit and vegetable intake, cabbage was at number eight (17.88 g ± 1.14 g), followed by potato (13.67 g ± 1.69 g), tomato and onion stew (10.09 g ± 0.43 g), spinach (8.18 g ± 1.77 g), mixed vegetables (5.84 g ± 0.69 g), vegetable curry (5.36 g ± 0.69 g) and onions in a gravy (1.89 g ± 0.26 g). The lowest ranked items included gravy soup powder (3.31 g ± 0.54 g) and margarine (3.30 g ± 0.14 g).

Table 3.10: Women's baseline top-20 food items consumed and measured using three 24-hour recall questionnaires and ranked by per capita intake (n=89)						
No	**Item**	**Mean *frequency (number of times consumed) (n)**	**Total group intake over 3 days (g)**	**Mean total intake over 3 days (g±SD)**	**Mean intake per frequency (g±SD)**	**Mean per capita intake per day (g±SD)[8]**
1	Maize meal porridge	79	57684.00	19228.00±213.29	241.69±7.72	216.04±2.40
2	Tea	65	48770.00	16256.67±220.51	250.04±3.48	182.66±2.48
3	White rice	54	20255.00	6751.67±107.55	125.12±4.78	75.86±1.21
4	Brown bread (fortified)	59	17935.00	5978.33±179.28	100.10±2.72	67.17±2.01
5	Chicken stew or curry	34	16055.00	5351.67±263.75	157.69±3.33	60.13±2.96
6	Full cream milk	32	7020.00	2340.00±279.50	71.38±14.08	26.29±3.14
7	Steamed bread	12	5180.00	1726.67±141.68	145.53±35.58	19.40±1.59
8	Cabbage stew or curry	14	4775.00	1591.67±101.33	116.68±52.68	17.88±1.14
9	Beef curry	19	4010.00	1336.67±472.00	178.89±25.24	15.02±5.30
10	Potato curry	16	3650.00	1216.67±150.11	76.48±12.78	13.67±1.69
11	Brown sugar	91	3515.00	1171.67±24.04	12.82±0.43	13.16±0.27
12	Tomato and onion stewed (no sugar)	13	2695.00	898.33±38.45	68.05±9.54	10.09±0.43
13	Egg fried	9	2645.00	881.67±55.01	99.95±11.92	9.91±0.62
14	Spinach sautéed	8	2185.00	728.33±157.18	85.28±18.15	8.18±1.77
15	Sugar bean curry	13	1955.00	651.67±206.74	21.72±54.98	7.32±2.32
16	Mixed vegetables	15	1560.00	520.00±61.19	34.94±5.02	5.84±0.69
17	Vegetable curry	14	1430.00	476.67±85.87	34.96±2.89	5.36±0.96
18	Gravy made with soup powder	7	885.00	295.00±48.42	37.90±3.32	3.31±0.54
19	Margarine	28	880.00	293.33±12.06	10.52±1.92	3.30±0.14
20	Onion in a gravy	7	505.00	168.33±22.75	23.80±1.25	1.89±0.26

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable.

[8] Mean intake per capita intake per values were calculated based on [mean total intake ÷ total number of participants] and will be reported on throughout the study.

Intake of food by men

Table 3.11 illustrates that tea was highly consumed by the male participants with a mean intake per capita of 196.67 g ± 6.19 g, followed by maize (172.90 g ± 5.27 g) which ranked ^{2nd} on the top-20 list. Next was white rice (85.43 g ± 3.84 g), bread (72.90 g ± 2.46 g), samp and beans (50.43 g ± 9.94 g), steamed bread (24.28 g ± 4.84 g), diluted squash drink (35.14 g ±3.38 g) and lastly sugar (12.25 g ± 0.32 g) which was ranked 12th.

The results indicate that the top three food items consumed per capita were refined carbohydrates. Food items following in ranking were protein-rich food such as chicken curry (60.13g ± 2.96 g) at number three, followed by milk (13.84 g ± 0.42 g), beef curry (12.17 g ± 2.12 g) and peanut butter (2.57 g ± 0.18 g). In terms of fruit and vegetable intake, tomato and onion (14.86 g ± 0.47 g) ranked 9^{th} , followed by potato (13.67 g ± 1.69 g), carrot (6.81 g ±2.23 g), vegetable curry (5.36 g ± 0.96 g), onions in a gravy (3.55 g ± 0.96 g) and margarine (4.35 g ± 0.13 g) and salt (0.49 g ±0.08 g).

Table 3.11: Men's baseline top-20 food items consumed as measured by three 24-hour recall questionnaires and ranked by per capita intake (n=23)						
No	Item	Mean *frequency (number of times consumed (n)	Total group intake (g)	Mean total intake over 3 days (g±SD)	Mean intake per frequency (g±SD)	Mean per capita intake per day (g)
1	Tea	52	13570.00	4523.33±1.67	260.96±1.93	196.67±6.19
2	Maize meal porridge	51	11930.00	3976.67±8.80	233.92±2.35	172.90±5.27
3	Chicken stew or curry	41	5895.00	1965.00±30.73	147.38±3.09	85.43±3.84
4	White rice	36	5365.00	1788.33±6.26	149.03±5.69	77.75±3.21
5	Brown bread (fortified)	50	5030.00	1676.67±5.79	104.79±1.67	72.90±2.46
6	Samp and Beans	10	3480.00	1160.00±174.66	348.00±18.87	50.43±9.94
7	Diluted cold squash drink	10	2425.00	808.33±30.05	242.50±13.68	35.14±3.38
8	Steamed bread	11	1675.00	558.33±72.55	152.27±27.34	24.28±4.84
9	Tomato and onion. Stewed (no Sugar)	11	1025.00	341.67±42.72	93.18±10.88	14.86±0.47
10	Full cream milk	23	955.00	318.33±14.85	41.52±1.15	13.84±0.42
11	Potato stew or curry or boiled	16	945.00	315.00±12.28	59.06±5.65	13.70±1.01
12	Brown sugar	63	845.00	281.67±0.64	13.41±0.09	12.25±0.32
13	Beef curry	10	840.00	280.00±9.20	93.33±43.69	12.17±2.12
14	Carrot, boiled	9	470.00	156.67±35.38	52.22±22.40	6.81±2.23
15	Mixed vegetable	13	465.00	155.00±19.84	35.77±5.05	6.74±0.22
16	Vegetable curry	9	390.00	130.00±51.68	43.33±64.73	5.65±2.64
17	Margarine	27	300.00	100.00±3.96	11.11±0.69	4.35±0.13
18	Onion in gravy	9	245.00	81.67±14.81	27.22±25.35	3.55±0.96
19	Peanut butter	9	177.00	59.00±6.80	19.67±1.44	2.57±0.18
20	Salt	11	34.00	11.33±0.73	3.09±0.39	0.49±0.08

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable.

3.13.4.2 Fruit and vegetable intake by men and women separately

The fruit and vegetable intake (Refer to table 3.12) as the mean per capita intake and percentage of the requirement was measured using the average of three 24-hour food recall questionnaire data. The results indicated that men and women were significantly below the recommendation of the WHO of >400 g daily consumption (WHO, 2003). The mean per capita intake per day was higher for men and the frequency and portion size intake were also lower for women (99.1 g) than for men (104.3 g). This was determined as an average intake per day of the total fruit and vegetable from the three composite meals by gender seperately (refer to section 3.1.5.1). The total fruit and vegetable intake was <30.0% of the daily requirement (>400 g per day) for both women and men. These findings suggest that innovative approaches to increase fruit and vegetable intake to reach recommended portion sizes are necessary as the current intake was clearly not adequate, even though some of these foods appeared in the top-20 food list of the participants (refer to table 3.12).

Table 3.12: Mean baseline fruit and vegetable intake per person (both genders) using the 24-hour food recall questionnaire (n=112)

Fruit and Vegetable intake	Men (n=23)	Women (n=89)
Mean per capita per day	104.3	99.1
Percentage contribution of 400 g	26.7%	24.7%

Source of measurements: WHO, (2003)

The acceptable macronutrient distribution range (AMDR) as recommended by the WHO (2003) was used to compare the nutrient intake results that are presented in Table 3.13. It was found that protein contributed 15.8% to the men's total energy intake, while it was 14.4% for women. The protein contribution to total energy by the men (15.8%) was slightly higher than the recommended range for them (10-15%), while the women's intake was within the recommended range. Fat and carbohdrates were in the normal ranges for both genders (refer to Table 3.13).

Table 3.13: Comparison of energy distribution of macronutrient intake (n=112)

Men (n=23)			
Protein (g)	**51.21±17.13**	**15.8**	10 - 15 %
Fat (g)	**37.81±14.98**	**25.4**	15 - 30 %
Carbohydrate & fibre (g)	**190.91±57.60**	**58.8**	55 - 75 %
Women (n=89)			
Protein (g)	**41.01±18.03**	**14.4**	10 - 15 %
Fat (g)	**29.11±16.32**	**22.2**	15 - 30 %
Carbohydrate & fibre (g)	**181.37±67.21**	**63.4**	55 - 75 %

Source: Acceptable Macronutrient Distribution Range (AMDR), (WHO, 2003)

3.13.5. Dietary diversity scores and nutrient adequacy

The total number of individual food items consumed over the seven days prior to the survey was 90. The mean FVS amongst all the food groups over a period of seven days was 47.3 (± 17.27), indicating medium food variety (30-60 food items) (Matla, 2008), A higher number (72,3% n=81) of respondents fell within the medium food variety score (medium = 30 - 60 individual items (Matla, 2008; Kennedy *et al.* 2010). Only 5.3% (n=6) of the respondents had a high FVS (>60 food items) (refer to Table 3.14).

Table 3.14: Food group diversity consumed over a period of one week (n=112) (men and women)

Meat Group n=2	Egg Group n=1	Dairy Group n=9	Cereal Group n=5	Legume Group n=11	Vitamin A Rich Group n=7	Fruit Group n=18	Vegetable Group n=16	Fat Group n=5	Total individual food items consumed by both groups n=90
0=00	0=50	0=04	0=00	0=01	0=00	0=00	0=00	1=01	< 30=25
1=72	1=62	1=72	1=30	1=90	1=20	1=15	1=40	2=80	>30-60 =81
2=40		2=05	2=55	2=08	2=20	2=03	2=27	3=28	> 60-90 = 6
		3=03	3=01	3=00	3=39	3=05	3=10	4=03	
		4=04	4=25	4=04	4=30	4=04	4=00	5=00	
		5=06	5=01	5=02	5=01	5=18	5=00		
		6=07		6-01	6=02	6=01	6=00		
		7=04		7=00	7=00	7=03	7=00		
		8=04		8=00		8=10	8 =25		
		9=03		9=01		9=05	9=03		
				10=01		10=01	10=00		
				11=04		11=11	11=00		
						13=00	12=01		
						14=00	13=01		
						15=00	14=00		
						16=00	15=01		
						17=01	16=04		
						18=35			

Low = < 30 individual foods. Medium = 30-60 individual foods. High >60 individual foods (Matla, 2008)

Source: researcher

The cereal group had the highest mean±SD food group diversity score (FGDS) of 10.6 (±3.31), followed by the vegetable group (8.1±2.98), the meat group (7.0±2.19), other fruits (6.6 ± 2.90), vitamin A-rich fruit and vegetables (4.9±1.52) and the legume group (3.5±1.7).

Table 3.15: Summary of food group diversity scores (FGDS) (n=112)

Food Group	Mean	±SD	Range
Meat	7.0	2.19	1 - 02
Eggs	1.0	0.00	0 - 01
Dairy	3.2	1.62	0 - 09
Cereals	10.6	3.31	1 - 05
Legumes	3.5	1.70	0 - 11
Vitamin A-rich fruit & Vegetables	4.9	1.52	1 - 07
Other Fruits	6.6	2.90	1 - 18
Other Vegetables	8.1	2.98	1 - 16
Fat and Oils	2,4	1.05	1 - 05
FGDS	**47.30**	**±17.27**	**10 – 74**
Mean DDS	**8.15**	**±1.05**	**913**

The dietary diversity score (DDS) results presented in Table 3.16 indicate that 94.7% (n=106) of the participants consumed seven to nine food groups, thus indicating a high food group diversity score (high = 6 - 9 food groups). Four (3.6%) and two (1.8%) of the participants had a medium and low food group diversity score, respectively (Matla, 2008). The results showed a mean ±SD DDS of 8.15 ± 1.05, indicating high diversity. A statistically significant difference (p=0.00) in DDS between the men (7.86 ± 1.60) and the women (8.61 ± 0.74) was observed, with the women consuming a more diverse diet.

Table 3.16: Summary of the dietary diversity score (DDS) for the total group (n=112)

Number of food groups consumed (n=9)	Frequency	Percentage
2	1	0.9
3	1	0.9
5	4	3.6
6	2	1.8
7	26	23.2
8	29	25.9
9	49	43.8
TOTAL	112	100.0

Table 3.17 indicates the statistical differences for the DDS between men and women, with a significance value of $p<0.05$.

Table 3.17: Mann-Whitney U analyses: Comparison of DDS between men and women separately

GROUP	MEN MEAN VALUE ± SD	WOMEN MEAN VALUE ± SD	Signficance *p- value*
BASELINE	7.86 ± 1.60	8.61 ± 0.74	0.00

3.13.6 Establishment of household food security/insecurity (HFIAS)

Table 3.18 indicates that 42.0% (n=47) of the participants were concerned about not having enough food in their households in the four weeks prior to the survey. Restrictions due to a lack of resources to access certain types of foods for consumption by other household members was found in 33.0% (n=37) of the households. A minority (38.4% [n=43]) of the participants indicated that they had limited food choices, which means that they consumed food that was not a desired choice. Eating food that the farmers and their households really did not want to eat was evident in 41.0% (n=46) of the sample. Small meal portions were consumed by 43.8% (n=49) because they did not have enough food. The participants who had no food to eat due to a lack of resources comprised 41.0% (n=46) of the sample, whereas going to bed hungry because of a lack of food was reported by 13.4% (n=15) of the participants. The majority (59.0% [n=66]) did not understand the term 'vulnerable group' (these farmers are considered a vulnerable group as people who were diagnosed with a disease not necessarily elderly people). It was found that food wastage was well managed because a minority (9.8% [n=11]) of the participants threw away consumable food. Legumes were perceived as an important food group by 94.6% (n=106) and legume health benefits were familiar to 71.4% (n=80) of the participants. These results suggest that knowledge of nutritional benefits associated with a particular food doesn't always translate into individuals consuming that food. Access, and not only knowledge, is therefore a critical mechanism in improving healthy food consumption.

Table 3.18: Household food security levels four weeks prior to the survey (n=112)

Variable status	Number of respondents (n=112)	Positive answers (yes) Percentage (%)
Worried that the household would not have enough food	**47**	**42.0**
Household members were not able to eat the kinds of food they preferred because of a lack of resources	37	33.0
Household members had to eat a limited variety of food due to a lack of resources	43	38.4
Farmer or any household member had to eat some foods that they really did not want to eat because of a lack of resources to obtain other types of food	46	41.0
Farmer or any household member had to eat a smaller meal than desired because there was not enough food	49	43.8
No food to eat in the household because of a lack of resources to procure food	46	41.0
Farmer or any household member had to go to bed at night hungry because there was not enough food	15	13.4
Farmer or household members went an entire day and night without eating anything because there was not enough food	15	13.4
Understanding what the term 'vulnerable group' means	66	59.0
Is any consumable food thrown away?	11	9.8
Do you think the legume food group is important?	106	94.6
Are you aware of the benefits associated with legumes in a diet?	80	71.4

Various mechanisms to improve farmers' access to food were suggested (Figure 3.19). Most indicated that finding a job (29.2% [n=33]) and the employment of their children (23.0% [n=26]) would add value to their lives. The group who thought that producing their own food would be the best option comprised 16.9% (n=18), followed by those who regarded having a business (15.9% [n=18]) as the best alternative. Social support was perceived as an option by only 15.0% (n=17) of the participants. The results suggest that the farmers were considering various options to sustain their households.

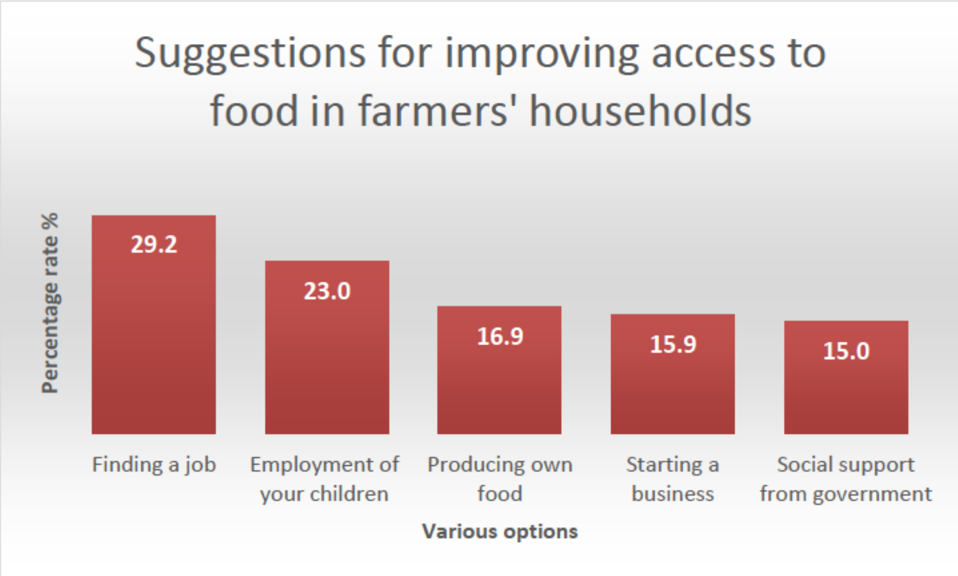

Figure 3.19: Options to improve access to food in farmers' households (n=112)

3.13.6.1 Most desirable food groups

The results reported in Figure 3.20 indicate that the meat group was the most preferred (29.2% [n=33]) food group that the respondents would have bought and consumed if cash had been available. This was followed by carbohydrates (27.4% [n=31]); fruit and vegetables (23.0% [n=26]); and legumes (18.6% [n=21]). The least preferred group was fats and oils (1.8% [n=2]).

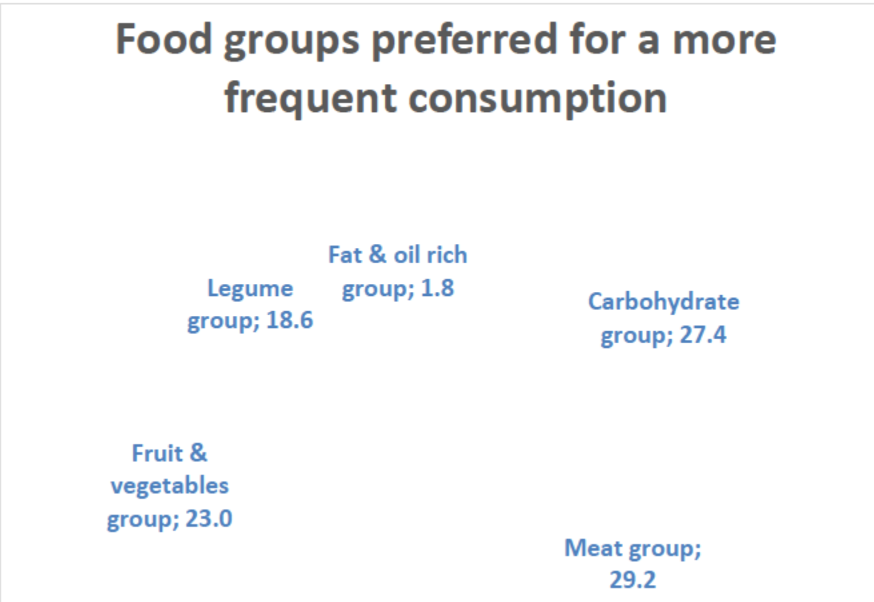

Figure 3.20: The most preferred foods that would have been bought and consumed if financial resources had been available (n=112)

3.13.6.2 Results indicating the acceptability levels of various legumes

Sugar beans was the most preferred of the legume food group, as 90.2% (n=101) of the farmers indicated that they preferred to consume these beans. The sugar bean group was also the only legume that appeared on the top-20 food items of the women's list (see Table 3.10). The rest of the most commonly preferred legumes were peanuts (45.5% [n=51]), fresh green beans (41.1% [n=46]), jugo beans (36.6% [n=41]), broad kidney beans (35.7% [n=40]) and lentils (32.1% [n=36]). The legumes that were preferred the least were soy beans (17.9% [n=20]), followed by cow peas (8.9% [n=10]), chick peas (3.6% [n=4]), and green mung beans (1.8% [n=2]) refer to table 3.19. The results suggest that the promotion of various legume varieties has become a necessity if the dietary intake of elderly farmers and their households is to be improved.

Table 3.19: Acceptability levels of legume, oil seed and nut varieties (n=112)

Legume Type►	Sugar Bean 1	Green mung bean 2	Jugo Bean 3	Broad Kidney Bean 4	Soy Bean 5	Fresh Green Beans 6	Cow Peas 7	Chick Peas 8	Peanuts 9	Lentils 10
Choice Frequency	101	2	41	40	20	46	10	4	51	36
% AC*	90.2 **100**	1.8 **100**	36.6 **100**	35.7 **100**	17.9 **100**	41.1 **100**	8.9 **100**	3.6 **100**	45.5 **100**	32.1 **100**

*AC = Accept

3.13.6.3 Challenges associated with legume production and consumption

A number of challenges that impacted the farmers' choice of legumes as a food option were identified (Figure 3.21). For example, 28.6% (n=32) indicated that a variety of issues impacted their households' preferences and that these challenges limited their production/consumption of legumes. One challenge was the extended cooking time associated with legumes (18.8% [n=21]). Only 15.2% (n=17) of the participants experienced no limitations, whereas some (14.2% [n=16]) did not know how to prepare or cook legumes. Some stated that their family members did not like legumes (14.2% [n=16]), whereas others blamed bloating (6.3% [n=7]) and a lack of knowledge of the nutritional benefits associated with legumes (2.7% [n=3]) for not consuming them. Table 3.4 (socio-economic status) indicates that the majority of the participants used electricity as a fuel source. Thus, the high cost of electricity, combined with the long cooking time of legumes, could have been a major factor in the argument that cooking time was a challenge.

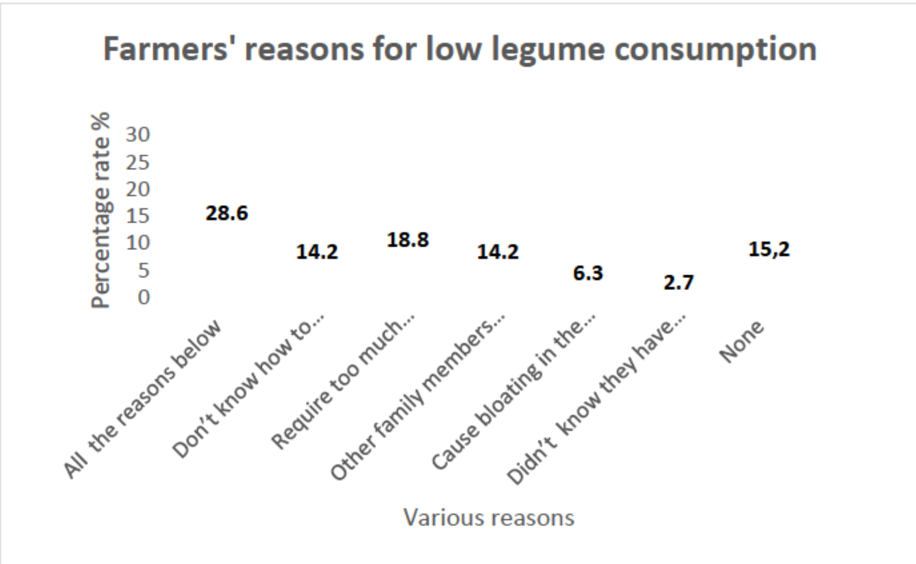

Figure 3.21: Reasons for low legume consumption (n=112)

Sugar beans were the most preferred legume as 86.6% (n=97) indicated that they consumed this food. The choice of this variety was followed by red kidney beans (31.2% [n=35]), peanuts (29.0% [n=32]), green mung beans (22.3% [n=25]), jugo beans (19.6% [n=22]), soy beans (17.0% [n=19]), broad kidney beans (16.0% [n=18]), cow peas (8.9% [n=10]), chick peas (7.1% [n=8]), and finally lentils (5.4% [n=6]) refer to table 3.20. The results suggest that sugar beans were the most preferred legume for consumption and production by members of the community under study. It may be concluded that this preference was based on the farmers' familiarity with this legume variety. However, dietary diversification requires a change in perceptions based on knowledge as well as regular access to various food groups and varieties.

Table 3.20: Acceptability levels of legume (oil seed and nut) varieties for cultivation (n=112)

Legume Type▶	Sugar Beans 1	Green Mung Beans 2	Jugo Beans 3	Broad Kidney Beans 4	Soy Beans 5	Red Kidney Beans 6	Cow Peas 7	Chick Peas 8	Peanuts 9	Lentils 10
Number	97	25	22	18	19	35	10	8	32	6
% AC*	86.6	22.3	19.6	16.0	17.0	31.2	8.9	7.1	29.0	5.4
	100	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

*AC = Accept

Figure 3.22 indicates that 92.0% (n=103) of the farmers were willing to consume various legumes, whereas only 8.0% (n=9) did not want to consume new varieties. The farmers who indicated interest in planting new legume varieties comprised 85.7% (n=96), whereas only 14.3% (n=16) indicated no interest. Consumption as a variable indicated a higher acceptability than production.

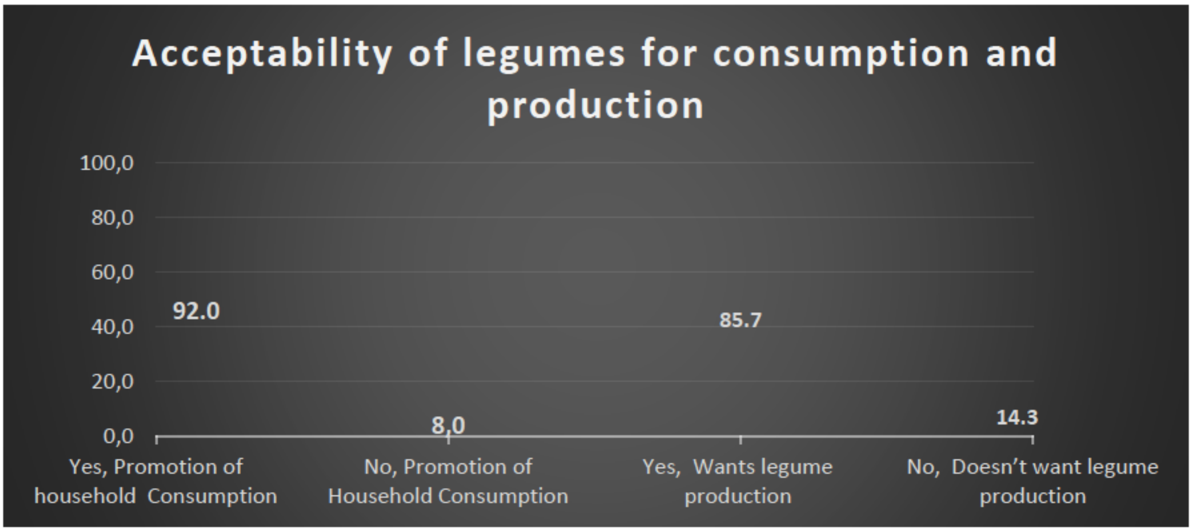

Figure 3.22: Acceptability levels of legume production and consumption (n=112)

3.13.7 Survey results pertaining to agricultural practices

3.13.7.1 General training

The survey elicited data pertaining to farming conditions and farmers' practices. This part of the survey also involved the total sample of 112 farmers. Of this sample, 64.3% (n=72) had undergone agricultural training of some sort, whereas 35.7% (n=40) had not been exposed to any training at all (refer to figure 3.23). The results suggest that the upscaling of farmers with limited training should be considered a matter of urgency (refer to Table 4.32 in the next chapter).

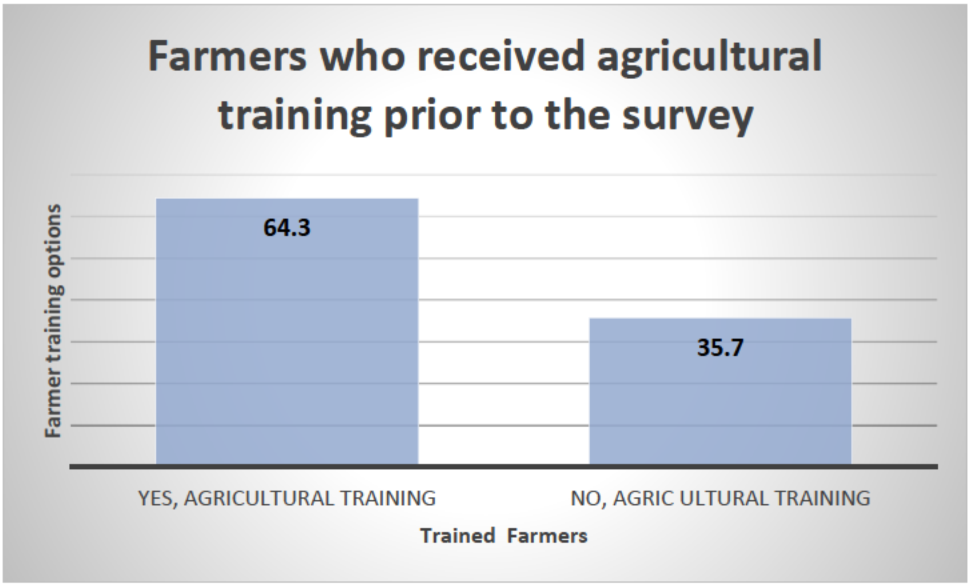

Figure 3.23: Exposure to agricultural training (n=112)

3.13.7.2 Challenges associated with irrigation and access to water

Figure 3.24 indicates that the majority (72.3% [n=81]) of the farmers experienced irrigation challenges, while a mere 27.7% (n=31) did not encounter any such challenges.

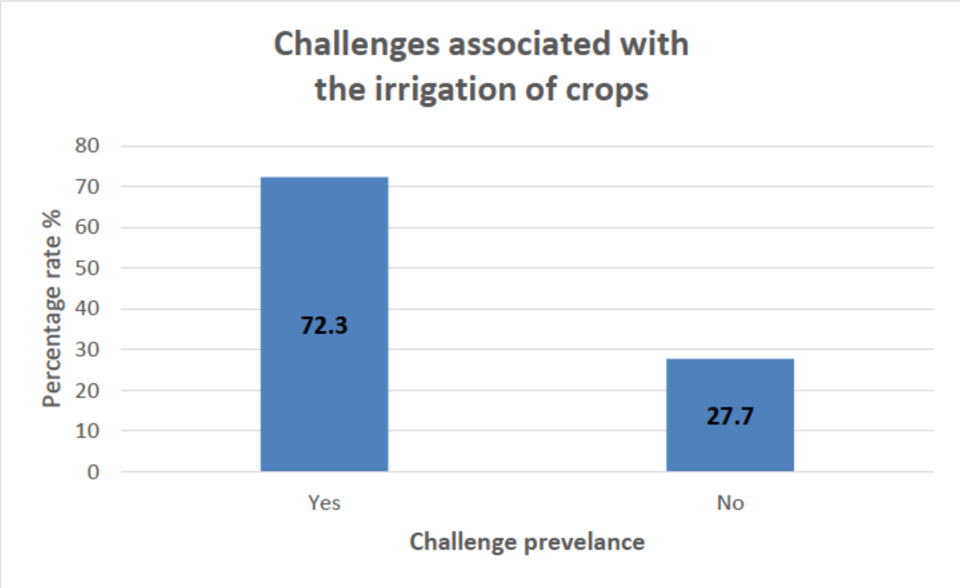

Figure 3.24: Challenges experienced with irrigation (n=112)

Figure 3.25 illustrates that 44.6% (n=50) of the participants indicated that water was expensive, and that access was a main challenge. Some (34.8% [n=39]) stated that a water shortage in the area was a challenge, limited irrigating equipment (15.2% [n=17]) was a problem, and that a combination of all these factors was experienced (5.4% [n=6]). The results indicate that a wide range of factors needs to be taken into consideration when these challenges are addressed. For example, the majority of the participants had access to a tap with potable water outside their homes. However, having access to water infrastructure (see Table 3.2) does not necessarily translate into regular access and affordability to utilise large quantities for irrigation purposes.

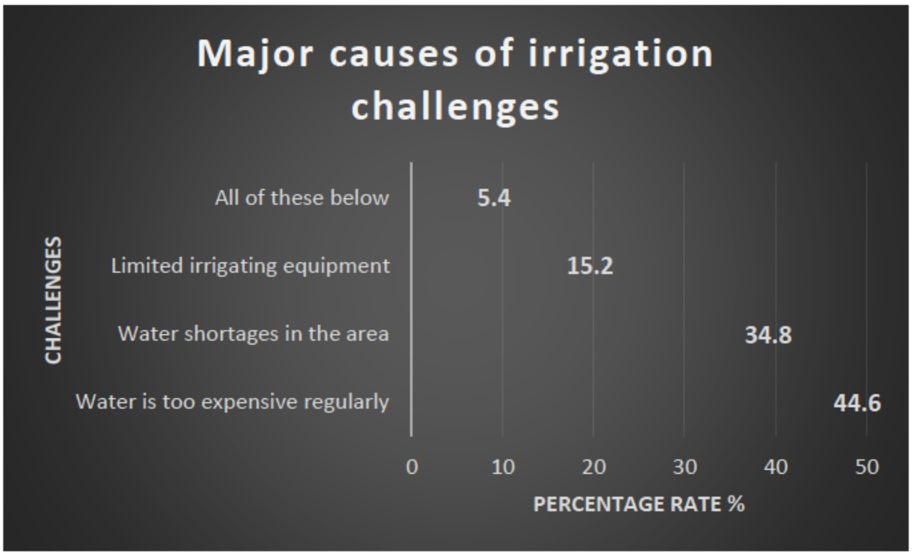

Figure 3.25: Causes of challenges associated with irrigation (n=112)

3.13.7.3 Land ownership

Figure 3.26 indicates that the majority (47.3% [n=53]) of land used for farming was privately owned, followed by communal land (schools, crèches) (44.6% [n=50]), privately rented (7.1% [n=8]) and other (e.g., borrowed land) (0.9% [n=1]).

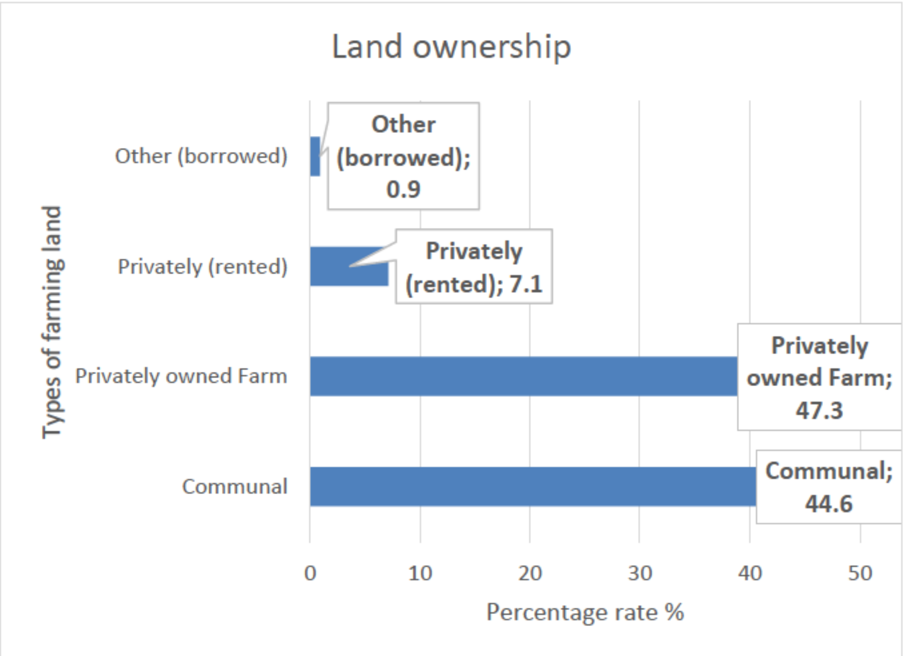

Figure 3.26: Land ownership (n=112)

3.13.7.4 Crops planted and harvested

Table 3.21 ranks the production of vegetables from the highest to the lowest. Green, leafy vegetables were the most preferred crops (95.0% [n=106]), followed by the tuber group (94.0% [n=105]), maize (73.2% [n=82]), tomatoes (54.5% [n=61]), wild herbs (49.1% [n=55]), onions (47.3% [n=53]) and potatoes (43.8% [n=49]). Legumes were the least preferred crops at 18.8% (n=21). In light of their nutritional value, it is argued that the promotion of legume production amongst farmers could enhance their agricultural production output, as well as their health status.

Table 3.21: Crops most frequently planted in the study area (n=112)

Crop varieties	*Number of farmers*	*Percentage (%)*
Green, leafy vegetables (spinach, cabbage)	106	95.0 100.0
Tubers (carrots, beetroot)	105	94.0 100.0
Maize (green)	82	73.2 100.0
Tomatoes	61	54.5 100.0
Wild herbs	55	49.1 100.0
Onions	53	47.3 100.0
Potatoes	49	43.8 100.0
Legumes	21	18.8 100.0

Table 3.22 underscores that in the farming environment under study (refer to Chapter One for a description of the study area), the consumption of a variety of legumes was not common. Moreover, farmers rely on their knowledge of indigenous farming systems for food production. However, the AHB is a facility for knowledge exchange and is a critical platform where farmers gain insight and promote legume production and consumption.

Table 3.22: Summary of agricultural practices (n=112)

Questions	Farmers' Responses
What are the reasons why legumes are not commonly grown?	*"We are used to growing common crops (particularly Vitamin A rich food) such as spinach, carrot, cabbage, beetroot and lettuce"* *"We don't consume too much legumes within our households (even our children don't like them) therefore the demand is less to grow them"* *"We are accustomed to the taste of sugar beans and canned beans because it's the legume we commonly eat"*

Table 3.22: Continued

	"We have limited access to seeds and usually buy what is cheaper and what we are subsidised with by the municipality" *"We share planting space within our co-operatives, so we all have to agree to plant them"* *"We do not have customers who want legumes in the community and also don't donate them to nearby schools and crèches when we have too much harvest"*
What do you use for land preparation?	*"We use our own hands for land preparation"* *"We don't have any modern equipment to help us to do land preparation* *"We sometimes get assistance from the municipality with their tractor"*
What guides your decision about the climate?	*"We us our Indigenous knowledge passed down to us about the climate so we can plant our crops"* *"We share knowledge at our monthly meetings about climate concerns to see how to plan for planting times when we received inputs"*
What guides your decision-making about crop management?	*"We are guided by our our knowledge of indigenous farming methods for each crop we are planting"* *"With new crops we receive guidance from the municipality at our monthly trainings"* *"We share knowledge with each other about crop treatments and challenges"*

3.14 Baseline Survey: Summary and Discussion of Findings

At the conception of this study, nutrition insecurity amongst the farmers in the intended study area was a concern because the literature had indicated that micronutrient intake needed improvement. Legumes as a source of plant protein was thus an essential foodsource needed by these farmers (refer to Chapter Two for supporting literature). The subsequent survey findings indicated that the risk of obesity (men: 56.5%; n=13 and women: 56.5%; n=13) amongst the participating elderly farmers and the high rates of central obesity amongst both the female (88.8%; n=79) and male (65.2%; n=15) participants, exceeded the WHtR (≥0.5) recommendation. Foods frequently consumed over a week indicated that even though there were diverse fruit (6.6 ± 2.90) and vegetable (8.1 ± 2.98) varieties, the legume group was less frequently consumed, with a mean ±SD FGDS of 3.5 ± 1.70.

In light of the focus on legume production and consumption that this project intended to enhance, it was found that sugar beans were the most commonly consumed legume amongst the study group and, by extension, probably amongst the members of this community. Dietary fibre intake was evident, but this can be improved by legume consumption. Legumes high in dietary fibre such as cooked peas and kidney beans (see the Serbian diet, as advocated by Dodevska *et al.*, 2013), can improve the dietary fibre intake of elderly farmers. This was recommended because legume intake (samp and beans) was already observed in both the male and female farmers.

Health risks were observed amongst the participants as hyperglycaemia was observed in 42.0% (n=40) and hypoglycaemia in 16.0% (n=16). The risk for diabetes was identified even though further tests would be needed. Hypertension and obesity were also prevalent and identified as metabolic risk for factors within the sample. These three risk factors are indicative of potential major health implications that should be explored in more depth. A similar study found that women were mainly affected by these conditions and needed to lose weight and that waist circumference adipose tissue reduction would assist in managing these challenges (Nimptsch *et al.*, 2019). A European study on ageing highlights relational similarities amongst central obesity, diabetes and hypertension which suggests that there is need to address central obesity as a core factor in order to manage diabetes prevalence is prevalent (Tyrovolas *et al*., 2015). The cholesterol levels detected ranged from 21.0% (n=20) at high levels (≥ 6.20 µmol/l - 240 µg/dl) and 18.0% (n=17) to borderline (5.17 - 6.18 µmol/l to 200 - 239 µg/dl). Such levels suggest that this population could benefit from intervention programmes to address these health risks. It was found that sources of calcium such as full cream milk were amongst the top-20 food items that the participants consumed. However, the intake of calcium-rich sources was low. This finding was considered in the intervention strategy that was designed to assist the elderly farmers through the introduction of a legume-rich diet which is lower in saturated fats, rich in fibre and micronutrients (calcium, magnesium, iron) and low in sodium. These are positive contributions in addressing the detected risk rate of non-communicable diseases, like cardiovascular disease and the risk of diabetes (refer to Chapter Two section 2.3).

The HFIAS revealed evidence of household food insecurity amongst respondents. Therefore, poor nutrition and inadequate micronutrient content in the diets of the study participants are influenced by household food insecurity status (Pinstrup-Anderson, 2015). Nutrition insecurity was also evident, according to the dietary and biomedical data that were obtained and reported earlier. In the African culture, going to bed without having been fed is taboo and no one will honestly confess to this experience, which is a limitation in food security studies (Chakona & Shack, 2019; Babu *et al*., 2014).

According to the United States Department of Agriculture (USDA), there are four categories of food security (Barroso *et al*., 2016; Hadley & Crooks, 2012). Category 1: high food security with zero food access problems; Category 2: marginal food insecurity with some anxiety over food sufficiency, with no changes in diets or food intake; Category 3: low food security with reduced food quality and a limited variety of food, but without many changes in food intake; and Category 4: very low food security with disrupted eating patterns and reduced food intake. Against this backdrop, the study population could be placed in the marginal food security category as they could be defined as 'people with some anxiety over food sufficiency (this imposes a sense of worry during food shortages), with no changes in diet or food intake'. However, further assesments are needed to explore and confirm this observation for the current study population.

High food insecurity is “having no access to food at all” (Barroso *et al*., 2016). Evidence of anxiety due to the lack of access to food was highlighted. It was demonstrated that there were limited food budgets as these budgets ranged between >R1 000 - R2 000 per month in 36.6% (n=41) of the households. Food purchases occurred mostly once a month in 87.5% (n=98) of the households. The results further indicated that the food budget consumed almost ± 75.0% of the total household budget of the majority of the participants. A study in Liberia addressed a similar challenge and recommended the instigation of agricultural value chain programmes to alleviate household food insecurity and to enhance agricultural productivity amongst smallholder farmers (Rutherford *et al*., 2016).

Willingness to plant legume crops and to consume this food type differed according to legume preferences. However, legume preference in the diet was generally limited. Various factors influence what farmers plant and what they consume at household level. According to the Bill and Melinda Gates Foundation, (2012), there has historically been limited emphasis on legume production, which has had a minimal impact on stakeholders to encourage the cultivation of legumes in the food chain. This has significantly influenced small-scale farmers who could otherwise have benefited from legume production. For example, legumes are an advantage when polycropping them with various cereal crops (Burridge *et al.*, 2016).

It was peripherally mentioned that legume consumption and production would be dually addressed through an education platform to promote their use and sustainable production. Sugar beans is a common legume variety that is consumed in South Africa, but the purpose of this study was to introduce a more diverse legume base so that farmers would cultivate and consume legumes in order to improve their nutrition and enhance their food security status. The findings suggest that aspects that need to be addressed are access to land and effective irrigation systems, as each type of land ownership impacts the type of irrigation system a farmer has access to.

Although it was indicated that legumes were the least preferred crop cultivated by the farmers, the nature and scope of this survey seemed to encourage them to want to cultivate legumes. It was thus necessary to expand their knowledge and desire to cultivate various legume varieties, and not just sugar beans. In this context, access to water and irrigation facilities were major factors in ensuring a food secure environment. A study conducted in Yemen indicated that water insecurity can result in declining agricultural growth and activity (Breisinger & Ecker, 2014).

Since legume cultivation was not common among the elderly farmers who participated in this study, there was a need to devise strategies that would enhance their desire to grow legumes, particularly in the context of their status as developing or upcoming farmers. In general, the stereotypical perceptions associated with the production and consumption of legumes thus needed to be eradicated and the major focus on the consumption of more animal-based foods as a symbol of affluence needed to be addressed (Michaels, 2016). Clearly, the participating farmers had low acceptability rates for jugo beans (36.6% [n=41]), broad kidney beans (35.7% [n=40]), cow peas (8.9% [n=10]), chick peas (3.6% [n=4]) and green mung beans (1.8% [n=2]), which indicated that these legume cultivars were not commonly consumed. Against this background, the introduction of a legume development programme was deemed necessary to contribute to introducing diverse protein sources in the targeted people's diets, improve nutrition and food security and enhance crop diversification, which in turn would enhance agricultural production.

3.15 Findings that Informed the Proposed Intervention Project

- Findings pertaining to the socio-economic status of the farmers indicated that they were full-time farmers, had limited food budgets and limited access to water and infrastructure. These challenges created a platform for the engagement of farmers in an intensive intervention programme in order to enhance the production and consumption of legumes.
- Health data and observations indicated that the farmers encountered various challenges and some had hypertensive disorders, obesity trends and metabolic risk that needed to be addressed by improving their dietary intake. It was envisaged that the intervention programme to be conducted as part of the study would address some of their health challenges through providing an educational platform that would capacitate these farmers with knowledge and skills to take ownership of their improved health and lifestyles.

- The biomedical data indicated that some farmers were borderline in terms of hypoglycaemia and some had high cholesterol levels. The impact of these results on human health were discussed in Chapter 2. It was thus envisaged that these farmers could benefit from an educational programme that would encourage the cultivation and consumption of legumes as a primary objective. However, the promotion of the consumption of fruit and vegetable intake was also part of the nutrition education programme detailed in Chapter 4. The scope of the study was ultimately limited and thus further screening tests should be conducted to specifically investigate the status of other blood minerals.
- The relationship between dietary intake and the use of traditional medicines (which was not investigated in this study but could have been a considerable factor - refer to Figure 3.12) in combination with legumes, should be investigated as this was beyond the scope of the current study.
- Household food insecurity was detected as some farmers experienced food shortages and consumed a limited variety of foods. This could have impacted their health. It was envisaged that improved access to legumes, significant yields and marketing this food group would result in higher income levels, which in turn would have been an opportunity to address food insecurity amongst the study participants. These farmers initially showed little motivation to use cash to improve their dietary intake during the baseline survey. It was envisaged that the intervention programme would clarify the significance of legume consumption and thus motivate the production of this food group.
- Based on the legume acceptability assessment, it was concluded that the farmers had been motivated to regard legumes as a vital food group for consumption and as part of improving nutrition and income insecurity status. By educating these farmers, the researcher intended to develop their nutritional, agricultural and health knowledge and to improve their skills and resources. The participating farmers would thus be equipped and capacitated with relevant and precise information, tailored specifically for legume production.

3.16 Conclusion

The baseline survey was necessary to provide a broad overview of the various factors that impacted the farmers who would participate in the intervention programme that would form the major component of this study. Major challenges such as health, nutrient deficiency, food insecurity and poor agricultural production were identified. The measuring instruments utilized in this phase of the study effectively captured the required and useful data and the findings assisted the researcher in creating a profile of the farmers living in this community. Based on the results, it was confirmed that intervention was necessary to educate these farmers on the importance of good nutrition, health and agricultural practices. The findings and recommendations of this phase of the study informed the objectives for and planning of the intervention study that will be discussed in the next chapter.

CHAPTER 4

RESULTS AND DISCUSSION OF THE INTERVENTION STUDY WITH SPECIFIC FOCUS ON THE PRE- AND POST-INTERVENTION SURVEYS

4.1 Introduction

The intervention initiative aimed to improve the participating farmers' health through a nutrition education programme and trials that were designed to encourage them to utilise practical legume growth applications based on various topics that had been identified during the baseline study. Legume production and preparation, agro-processing skills and the nutritional benefits of the consumption of legumes were components of the curriculum that was offered. The baseline study identified various health problems in the farmers, such as micronutrient deficiencies (calcium, magnesium, vitamin D, C, E, K refer table 3.9) and a lack of diversity in their diet. It was also revealed that limited quantities of legumes were consumed by these farmers. The intervention programme was thus a strategy to fill some dietary and lifestyle gaps that the farmers experienced. The project placed emphasis on legume production and utilised blood test results as a point of departure to improve dietary diversity and the consumption of legumes. Two study groups were utilised: an experimental group (EG) and a control group (CG). As an introduction to the intervention project, an overview of the differences between the experimental and control groups is provided. The study was conducted in three phases comprising a pre-intervention, intervention and post-intervention phase. During each phase, the participants were monitored and the progression of the groups was evaluated over time as the project was rolled out over a period of two years. The following terms will be used frequently in the discourse: experimental group (EG) experimental group before legumes (EG-BL) and control group (CG).

4.2 Empirical Study Design

The research design was experimental in nature. A controlled case study methodology was followed in order to obtain data that could be analysed for pre- and post-intervention information. The research was based on independent variable management. Units/tasks were randomly allocated to the designated groups and nuisance variables (unwanted variables that could influence the study results) were continuously assessed, as proposed by Welman, Kruger and Mitchel (2005). The study design incorporated two groups (i.e., two cases); one group was actively involved in an intervention programme, while the other was not. The purpose of utilising these two groups was to provide estimate frequencies of significant legume production and consumption during and following an educational programme. The control group played an important role as it was not exposed to the intervention and educational programmes, but the data was utilised to highlight selected variables.

The intervention project utilised variables that were necessary to improve the participants' knowledge of legume production and consumption. The same qualitative and quantitative methods were used as those described for the baseline survey. The administered questionnaires were also the same for the experimental group (EG) and the control group (CG). However, strict regulations for legume production and consumption had to be followed by the experimental group. Blood collection intervals were within set time frames to measure possible improvement. Study procedures were set out and followed according to the baseline survey methods, but non-legume consumption and production were two factors that distinguished the EG from the CG. The characteristics of each group are discussed later in more detail.

4.3 Methodology

According to Wisdom and Creswell (2013), a mixed methods research approach is ideal for complex intervention studies. Such an approach enriches the data, as well as the analysis processes. A mixed methods approach was utilised in this study as both qualitative and quantitative data were obtained. This chapter reports on the qualitative and quantitative data that were obtained by means of various measuring tools and statistical analyses (similar insturuments were repeated refer to section 3.5). Intervention studies are essential in assessing developing communities while, they also provide such communities with resources that can result in self-reliance (Welman *et al*., 2005). For the assessment of the intervention project, a combination of quantitative and qualitative methods was used. These processes were the same as those used in the baseline survey (See Chapter 3).

The following had to be taken into consideration as pressure areas during the pre- and post-intervention phases:

- There was a need to reach consensus (to ensure non-discriminatory measures) with the farmers in terms of their division into an experimental and a control group (through random selection) for the intervention project. This was necessary to increase partnership relationships and to ensure that the research results would not be comprised by peevish attitudes.
- A partnership relationship with the municipality was maintained and the agriculture site that it provided was used for the field trials. In this process, the effective use of land and water and the methods that were adopted for organic production had to be considered on a continuous basis.
- The municipality was approached to assist the researcher in supplying manure to the experimental group of farmers.
- Legume seeds had to be sourced and donated to the participating farmers.
- The appropriate season for planting and seed varieties that would be suitable for the soil fertility in the experimental area had to be considered.
- Flexibility always had to be considered as the farmers had minimal land space. Plots for the experimental project had to be selected or allocated, as adding new crops to existing fields would not have resulted in successful crop cultivation or better profit margins for the farmers should they be able to market their products.
- The quantities of legumes to be used for production and consumption during the project and the recipients of these legumes had to be strictly monitored.

- The farmers had to be empowered with knowledge when they attended monthly meetings, without interfering with standing procedures. This had implications in terms of time management and participant satisfaction.
- Additional dates and venues had to be determined as not all the research activities could be conducted during the monthly meetings. For example, the farmers' legume production had to be viewed on-site once their legume crops had started to grow.
- A major challenge was to create interest in legumes as a nutritious food for production and consumption and to ensure acceptability and confidence amongst the farmers in the face of prevailing perceptions, dietary habits and traditional influences.
- Trust and confidence had to be built between these farmers and the managers of the study. They had to understand that the nature of the research was multi-dimensional as it required administrative, continuous and progressive skills, as well as long-term commitment.
- Trust had to be built so that the farmers understood that the blood samples collected at various intervals would be for their benefit. Thus, various factors that may have influence their blood sample results and had to be avoided had to be explained on a continuous basis.
- The farmers had to be educated in order to capacitate them to embrace new farming technologies and to diversify from their traditional practices.
- It was necessary to guide the farmers to adhere to set time frames. For example, they had to understand when planting season had arrived and when planting the legumes would be best.
- They also needed to be informed of the need to fast before their blood samples were taken in order to ensure reliability and the effective analysis of the blood samples (however, most farmers reported they did not fast).
- A primary focus was the creation of an environment that was conducive to learning and experimenting. It was also necessary to continuously encourage the farmers to attend meetings and not to withdraw along the way.

4.4 Ethical Considerations and Informed Consent

Ethical clearance to conduct this phase of the study was obtained from the relevant gatekeepers. Approval was sought and obtained from the Research Ethics Committee of the Durban University of Technology (clearance number IREC 026/15 − Annexure A). The same group of farmers that was used for the baseline survey was then divided into a control group and an experimental group. Both groups consented in writing to continue with the study. The same ethical principles that applied to the baseline survey were adhered to for the duration of the intervention project.

4.5 Geographical Setting

The geographical setting where the intervention phase of the study was conducted was also in Mariannhill (see Chapter 3 for the geographical mapping and landscape explanation). The farmers identified their own plots of arable land (which is defined as land used for crop production and ploughing). Some plots were identified at schools, crèches and clinics. However, challenges were experienced because of a lack of access to water, theft and animal and pest invasions in some instances, as these factors could impact the trials that were conducted.

4.6 Position of the Intervention Project within the Conceptual Framework of the Study

With reference to the conceptual framework of the study, the position of the pre-intervention, intervention and post-intervention phases are illustrated in Figure 4.1. Each phase significantly contributed to the progression of the entire intervention project, which was informed by the baseline survey findings and recommendations. The intervention project was divided into six main phases, which were in turn separated into different parts, as illustrated in Figure 4.1 below.

Conceptual framework: Continued

Conceptual framework: Continued

Figure 4.1: Flow diagram summarising the intervention phase of the study (Chapter 4)

Summary of the Framework above:

The EG was requested to consume legumes for three months (refer to section 4.7.4.4) and the results of the CG and EG groups were compared at intervals. The EG benefited from training, whereas the CG did not receive any training at all. The former group was also given seeds to grow and they were required to consume legumes to determine their biochemical indices and to assess any improvement in the nutrient profile of their blood. These profiles were compared with those of the CG. The CG had also been exposed to training in the production and consumption of legumes in the baseline study, but these farmers were not given legume seeds and were not expected to produce and consume legumes. However, blood samples were taken from them for analysis on the same days as samples were taken from the EG.

4.7 Roll-Out of the Intervention Project

Figure 4.1 illustrates the phases according to which this project was conducted. This involved six phases that are categorised into the pre-intervention stage (Phase 1, Phase 2 and Phase 3); the intervention stage (Phase 4 and Phase 5); and the post-intervention phase (Phase 6 only). The sequential administration of these phases ensured that the study could adequately measure and attain all the objectives for intervention and evaluation.

4.7.1 Pre-Intervention Phase 1 Part 1: Selection Criteria and Sampling- EG and CG

Purposive sampling was used to ensure that the data obtained would address the research objectives. The original cohort of farmers was randomly divided into an EG and CG. An important inclusion criterion for the farmers who would participate in the EG was that they had to appear regularly and purposefully on the attendance register of meetings. Farmers who had not attended regularly were included in the CG. The original number of 112 participants declined to 103 due to non-attendance at meetings and a lack of sustained interest in the project. This was determined by checking the attendance register from the commencement of the study and for the duration of the baseline phase.

4.7.1.1 Exclusion criteria for both groups:

- Farmers who lived in the area but who were not part of the municipal project;
- Walk-ins who wanted to participate in the training sessions and who wanted seeds;
- Visitors who accompanied the selected participants;
- Farmers who participated in the baseline assessment study, but who never returned for selection into any of the two groups;
- Farmers who did not collect seeds during the planting season;
- Members of the control group who wanted to be moved into the experimental group, and vice versa;
- Farmers who were regularly absent and who persisted in not complying with specific deadlines for the production and consumption of legumes;
- Experimental group members who failed to complete the 12-week (3 month) legume administration experiment and who did not arrive for blood sample analysis;
- Experimental group members who only wanted to conduct blood tests without completing all the other qualitative data, and vice versa; and
- Drop-outs from the baseline study who came back only to collect the sponsored legumes.

4.7.1.2 Inclusion criteria for the EG:

- Demonstrated commitment and willingness to participate in all stages of the project as discussed and explained;
- Regular attendance at meetings;
- Willingness to cultivate and consume legumes;
- Adherence to dietary guidelines and the consumption of quantities of legumes as required, with adequate and credible demonstration of adherence;
- Active engagement in farming activities and access to land for planting the legume seeds that were donated; and
- Willingness to apply new germination techniques before planting.

4.7.1.3 Inclusion criteria for the CG:

- All of the above requirements as for the EG applied, except that they were not required to participate in any legume training for the production and consumption for the duration of the study.
- Addressing any interest in legume education that these farmers may have had was reserved for the end of the project.

4.7.1.4 Possible threats identified prior to recruitment

- Members wanting to drop out due to continuous education sessions;
- Limited access to water for legume cultivation;
- High cost of electricity to prepare legume dishes;
- Limited space for the cultivation of legumes;
- The need to use public transport that might delay arrival at meetings, and walking long distances to the meeting venue causing late arrivals;
- Some visiting farmers had no long-term interest in attending the programme and some only came because they had been informed about access to seeds/beans; and
- Family or other co-operative members who were given permission to collect seeds on behalf of absent participants on seed collection dates.

4.7.1.5 Management of threats

- Farmers who resided close to one another were designated as support groups. This was done so that they would liaise and motivate one another to attend meetings. Most met at central venues for transport to pick them up on the days that they had to attend meetings and training sessions.
- The municipality was contacted to ensure that farmers received a regular water supply during the planting season.
- Food preparation techniques were demonstrated during the education programme to encourage farmers to preserve legumes by freezing them and/or making pastes that

could be refrigerated. These processes could be used to store legumes for extended periods instead of cooking them every second day.

- Only the participants who had been involved in the earlier assessments for the study were retained and recommended for the next phase.
- Members of the EG were encouraged to use their own farming plots for planting and to make special provision for the project.
- The researcher provided transport to collect the farmers and to transport them to and from the meeting venue. This ensured the kindling of a community spirit.
- A working partnership was established with the municipality for the use of a municipal venue and to motivate municipal officials to visit farmers and to provide support. In some cases water was distributed to the farmers who experienced challenges with water supply.
- Continuous motivation of both the experimental and control groups was needed on a regular basis to ensure that both felt a valuable part of the study.

4.7.2 Pre-Intervention Phase Part 2: Data collection

In Part 2 of the pre-intervention phase (which was six months after the baseline survey), all the measuring instruments utilized in the baseline study, except the agriculture survey, were repeated. The entire sample (EG and CG) was asked to again complete the socio-demographic survey, the health and medical survey, the 24-hour recall questionnaire, the FFQ, the household food security scale, the legume knowledge and acceptability survey, and to agree to providing blood samples. Legume acceptability patterns had been identified during the baseline study. Thus, this pre-intervention investigation was conducted to provide more updated data on the farmers' lifestyle habits and health conditions.

Various measuring instruments were again used in the pre-intervention phase (Part 2). Farmers had been divided into the two groups before these measurements were taken and before training was conducted. During the field intervention phase (the planting and consumption of legumes), no measurements were conducted. During the post-intervention phase after training, planting and consumption, certain measuring instruments were again utilised, as will be explained later.

The measuring instruments used in this part of the pre-intervention phase were similar to those that had been utilized in the baseline study. These methods will not be explained again in this section as they were outlined in detail in Chapter 3.

In this part of Phase 1 (pre-intervention phase), 53 farmers in the EG and 50 farmers in the CP were again surveyed. All the questionnaires were administered by the same field workers who had been part of the baseline survey. It should be mentioned here that, for the post-intervention survey, 18 of the EG farmers dropped out for various reasons, whereas only six farmers dropped out of the CG. This will be explained in more detail in the relevant section. For the purpose of clarity, the survey instruments that were used are briefly reiterated.

4.7.2.1 Socio-demographic questionnaire

The administration of this questionnaire was similar to the manner in which it was conducted, as explained in Chapter 3. This questionnaire was administered to both the CG (n=50) and the EG (n=53), but it was not administered in the post-intervention phase of the study.

4.7.2.2 Anthropometric and clinical measurements

This nutritional assessment survey was similar to the one that had been administered in the baseline study (Chapter 3). The measurements were again recorded according to the health questionnaire for both the CG (n=50) and EG (n=53) groups. The same methods for collecting weight, height, waist circumference, waist-to-height ratio as well as blood pressure were thus used in this phase, as those used in the baseline survey.

4.7.2.3 Medical and health data

The description, reliability, validity and analysis methods used for this nutritional assessment was similar to that reported in Chapter 3. The measurements were recorded based on the health questionnaire for both the CG (n=50) and EG (n=53). The anthropometric and blood pressure measurements were the only medical assessments used to measure health status in the EG and CG in the post-intervention phase.

4.7.2.4 Nutritional assessment: Dietary intake instruments

The administration of this dietary assessment survey and its descriptive, reliability, validity and analysis methods were similar to those reported in Chapter 3. The measurements were recorded based on the dietary questionnaire for both the control (n=50) and experimental (n=53) groups. This questionnaire was also administered in the post-intervention phase of the study to the EG (n=35) and the CG (n=47). The questionnaire survey included the 24-hour recall questionnaire (three per farmer) and the food frequency questionnaire (one per farmer). The EERs and BMR requirements for an active adult's daily physical activity levels according to the Harris Benedict Revised Formula for the calcualtion for both men and women were similary repeated as was described in Chapter 3 (Roza *et al*., 1984). Furthermore, the same methodology for determining FFQ data on FVS, FGDS and DDS was repeated as was described Chapter 3.

4.7.2.5 Household Food Insecurity Access Scale (HFIAS)

The same questioannaire (Coates *et al.*, 2013) was used, as decribed in Chapter 3. The measurements were recorded for both the CG (n=50) and the EG (n=53). This questionnaire was only administered in the baseline survey and in the pre-intervention phases.

4.7.2.6 Legume Knowledge Acceptability Evaluation Feedback Questionnaire (LKAEFQ)

The administration of this nutrition assessment survey and its descriptive, reliability, validity and analysis features, were similar to those reported in Chapter 3. The measurements were recorded for both the EG (n=53) and the CG (n=50) during this pre-intervention phase. This questionnaire was also administered in the post-intervention phase.

4.7.2.7 Biomedical indices and blood analyses

The survey of the biomedical indices of the farmers was reported in Chapter 3. These blood indices were collected and completed for the pre-intervention phase (EG n=53 and CG n=50) and also for the post-intervention phase (EG n=35 and CG n=47) of the study. Comparisons were conducted using the Mann-Whitney U and Wilcoxon W tests. Blood tests (for serum cholesterol and plasma glucose) were conducted for the EG. The first blood test was done in the baseline study and repeated 12 weeks (± 120 days) after the intervention programme had commenced. The results were compared with blood tests taken before the planting of the legumes. A similar study provided information on the daily consumption of two soy beverages over a 6-12 week period and the effect they had on the blood profile of older American men, who were cancer patients in the University of Alabama Hospital (Urban *et al*., 2001). Other similar studies tested the frequency of legume consumption over a 12-week period (3 months) to improve the risk factors of cardiovascular disease through the comparison of dietary intake and blood profile (blood glucose levels, serum cholesterol, hypertension blood pressure, as well as BMI). This formed part of a First National Health and Nutrition Examination Survey Epidemiologic follow-up study (NHEFS) in the United States of America (Bazzano, Jiang & Ogden, 2001). Both studies showed a relationship among these variables.

4.7.3 Intervention Phase Part 1: Education and Training

This section will report on the education and training activities that were conducted during the intervention phase of the study.

4.7.3.1 Roll-out of education and training activities

It was deemed vital to educate and train the farmers who would participate in the EG as knowledge was important for efficient legume production and consumption. The curriculum that was devised particularly for this purpose included the following activities (refer to Table 4.1 and Figure 4.2):

Activity 1: Adoption of the Social Cognitive Theory as part of nutrition education
Activity 2: Education on legume varieties, sensory analysis and preparation techniques
Activity 3: Training on legume storage options
Activity 4: Legume consumption intervention trial with legume dish tasting by farmers
Activity 5: Feedback sessions on legume utilization
Activity 6: Monitoring farming and consumption practices

Activity 7: Arranging dates for specific trials and specific monitoring and collection dates

Activity 8: Post-analysis of education programme focusing on legume production and consumption

4.7.3.2 Legume production considerations captured in the curriculum

- The farmers had to be knowledgeable about the appropriate planting season and seed varieties that would be suitable for the experimental areas.
- They had to understand the importance of seed germination, planting time and spacing of the seeds.
- It was important to ensure that resource information and dissemination were well managed by the field technician at the Agricultural Hub Station.
- Farmers had to be encouraged to embrace new farming technologies and to diversify their crop range. They also had to be encouraged to consume legumes, which was a food item they were not used to.
- There was a need to encourage the farmers to adhere to the education programme schedule and to understand the importance of adapting their farming practices to the planting season.

In summary, the education programme had two key pillars: agriculture education (which included conducting legume cultivation experiments) and nutrition education (which included food demonstrations and knowledge exchange). These programmes were not offered in a haphazard manner, curricula was informed by information garnered from the literature survey were administered.

4.7.3.3 Mariannhill food security: Agriculture and nutrition education programme curricula

The education programme was designed by the research team and two educational platforms were taken into account, namely agriculture and nutrition. Various sources (such as experts in various fields) were consulted in the development of the content of the training material that was presented during the training programme. A working group was established that consisted of a panel of experts to ensure the validity of the educational content. The development process also involved a consultation process with the municipality, an agronomist, a horticulturalist, an agriculture extension officer, a nutritionist and a biomedical technologist in order to ensure content reliability. These processes were facilitated by the researcher, who ensured that the training programmes were embedded in knowledge gained from diverse sources and that various teaching methodologies were employed.

The main teaching and learning strategies that were adopted involved 'active learning' processes; i.e., all theoretical information was practically applied on the farming plots to ensure effective legume cultivation and consumption practices, as well as nutrition status management (based on knowledge provided which was to be used) at home. Key themes in the programme to support legume cultivation were elicited from reputable agricultural scholars such as Smith (2006); Amirzadeh Iranagh, Motalebi & Mohammadi (2018); Ferdous, Datta, Anal, Anwar & Khan (2016); and Bayyurt & Yılmaz (2012). Information regarding the nutritional value of legumes was informed by specialists such as Charlton, Ferreira & du Plessis (2008); Luesse & Contento (2019); and Lee, Contento & Koch (2013). Themes of the programme are outlined in Table 4.1.

Table 4.1: Training programme to develop awareness of agricultural and nutritional skills

Agriculture Programme	Food and Nutrition Programme
▪ **Soil analysis and nutrients** ▪ **Legume varieties** ▪ **Planting methods and bean seed germination information** ▪ **Conservation: agricultural methods** ▪ **Extension: Indigenous methods** ▪ **Inter-cropping of beans and maize**	▪ SA guidelines for healthy eating with emphasis on legumes ▪ Nutritional value of beans ▪ Food diversity ▪ Lifestyle diseases and diet ▪ Legume preparation, processing and recipe development ▪ Legume uses and storage ▪ Recipe reading and portion control ▪ Importance of maintaining a good nutritional status, understanding chronic diseases and the management, and treatment of chronic diseases

Source: Researchers compilation

All the training sessions were conducted in the IsiZulu language at the AHS and also at the field trial plots. Presentations were done on various topics as indicated in Table 4.1 and discussions were held after each topic had been presented. The farmers were also free to propose other issues that they wanted to know more about. Links were also created with the Extension and Advisory Services of the KZN Department of Agriculture. Legume growth trials at the AHS were open for other farmers to observe for the duration of the project. The field training sessions on legume production were conducted at the AHS, while nutrition training (e.g., discussions, lectures and food demonstrations) was conducted in the training room at the AHS. Refer to figure 4.2 for the sequencial outline of the training sessions conducted during the programme.

Figure 4.2: Mariannhill education programme activity roll-out schedule

The programme consisted of two streams, namely agricultural training and food and nutrition training. The programme started in the morning and lasted until the afternoon. It started with legume production and nutrition for the duration of October 2015 to June 2016.

4.7.3.4 *Social Cognitive Theory reinforcement*

As indicated in Chapter 2, it was deemed important to adopt this theory in support of the education programme. Pertaining to this theory, Table 4.2 illustrates how various factors (personal, behavioural and environmental) shaped the information imparted to the study participants and how they also shaped the environment (de Almeida, Recine & Fagundes, 2020; Stancu *et al*., 2015). The principles that underpin the Social Cognitive Theory (SGT) include reciprocal determination, which is a construct that argues that people are influenced by the environment and that they also influence the environment. Thus, human behaviour can influence and be influenced. Another encompassing principle is that observational learning can impact people (Imes *et al*., 2016). Table 4.2 has been split according to the 3 factors that were invesitigated.

Table 4.2: Summary of the Social Cognitive Theory demonstrating the application of this construct in the intervention phase of the study formulated by the researcher

Moreover, self-efficacy is vested in an individual's willpower to implement certain actions when dealing with a situation (Stancu *et al*., 2015). It was important to adopt the SGT as an educational environment was constructed and the participants interchangeably demonstrated their influence and how they were influenced through the various activities in which they participated (refer to Figure 4.2).

4.7.3.5 Methodology to train farmers in legume production

Changing the mind-set of the farmers was an important challenge when food and dietary diversity in both the production and consumption spheres was introduced. Thus, education in agriculture extension and nutrition adaptation was required to ensure the commitment of the members of the EG. This phase of the intervention programme was thus tailored to facilitate change, particularly in terms of legume production in an area where these smallholder farmers were engaged in the eThekwini research initiative to impact urban agriculture. The baseline survey revealed that the sugar bean legume was most commonly consumed by the farmers. However, the intervention project aimed to introduce an additional five legume varieties to the farmers that were not commonly consumed and planted by them. The training thus incorporated visual presentations of these varieties to the participants, coupled with discussions on the diversity of these legume cultivars. The EG was also subjected to an evaluation of the acceptability levels of the five legume varieties by means of the LKAEFQ. The training programme had a practical focus (which was hands on) and was conducted in the following manner:

(a) Field experiment design and plot layout for demonstrations

A demonstration plot was prepared to illustrate to the farmers how legume cultivation should be conducted. This was done after the new legume cultivars had been introduced by the AHS manager who highlighted that farmers had learnt to plant only one legume variety. The baseline study results indicated that the farmers were interested in new legume cultivars. This demonstration plot was deemed an 'outdoor laboratory', where the farmers could view various demonstrations of methods that they could apply to their respective plots once they started their own cultivation practices. The plot was laid out in a randomised complete block design (RCBD) with three replications (see Figure 4.3). The experiment involved monocrops and the intercropping of maize (*Zea mays L.* cv SC701 [white maize]) and four legume cultivars. The benefits of intercropping have already been discussed in the literature review in Chapter 2 (section 2.6.7). The main raised bed plot size was 6 m x 1 m divided into four sub-plots of 1.5 m x 1 m for each treatment (intercrop or monocrop). The legumes that were planted and assessed were *Phaseolus vulgaris L* (red kidney beans), *Cicer arietinum* (chick peas), *Phaseolus vulgaris* (white broad beans) and *Vigna radiate* (green mung/ moong beans). These legumes were intercropped with maize cultivar SC701. The experimental treatment combinations were as follows[9]:

- Intercrops: maize + white broad beans; maize + chick peas; maize + green mung beans; and maize + red kidney beans.
- Monocrops: white broad beans, chick peas, green mung beans, red kidney beans and maize.

Figure 4.3: Randomised complete experimental design for legumes

[9] It is important to note that demonstration plots provided hands on training and observational learning based on agricultural research and education.

(b) Land preparation and planting

The plots were ploughed during the second week of August 2015 using garden forks. This process was followed by the application of horse manure that was thoroughly mixed with the soil. Maize was planted at an inter-row spacing of 30 cm and intra-row spacing of 20 cm. The inter-row spacing for legumes was 30 cm, with an intra-row spacing of 15 cm. This resulted in three rows of legumes, each alternating with one row of maize in the intercropped plots. Two seeds of maize were planted per hole to ensure germination. Thinning was done when both maize seeds germinated. Bean seeds were planted first in seedling trays. Then the legume seedlings were transplanted into the rows of the plot (Figure 4.4 and Figure 4.5). Maize seeds were planted at the same time as the legume seedlings as it was a familiar planting practice for the local farmers.

Figure 4.4: Image of the experimental plot with legumes only

Figure 4.5: Image of the experimental plot with intercropped maize and legume seedlings

(c) Weed and pest control

Weeding occurred two weeks after planting and subsequently every time weeds were noticed in the plots in order to avoid interspecific competition. However, there was a problem as insects such as snails damaged the bean leaves. Organic sprays were used to kill any pests.

(d) Harvesting

At harvesting, maize cobs were weighed to assess the average yield. The cob length of three cobs per row was measured using cobs from both the intercropped plots and the plots containing maize only. A ruler was used to measure the cobs. Legumes were also harvested by hand. Harvesting of legume beans was done when all the pods had turned yellow, but before the pods became so dry that they would begin to shatter. The bean plants in each plot were pulled by hand early in the morning before the dew had evaporated to prevent shattering as this would have resulted in bean grain yield loss. The bean plants from each plot were put in rough fabric sacks. This was then followed by threshing which was done by hand. The sacks were beaten with a stick to separate bean and grain seeds from the pods. The bean seeds were then further separated from the chaff by using the wind to achieve a complete separation of beans from any foreign plant matter. The bean seeds were then weighed using a balancer weighing scale device and bean yields were recorded accordingly.

(e) Field day and demonstrations

The farmers visited the field where certain agronomic practices and the performance of the legumes and maize under various cropping strategies (intercropping and sole cropping) were demonstrated. This practical experience created further awareness and stimulated the farmers' interest in the various legume cultivars and in maize-legume intercropping.

4.7.4 Intervention Phase Part 2: Farmers' endeavours to plant and cultivate legumes

4.7.4.1 Legume seed administration and distribution

Intensive administration and planning had to be conducted to ensure that the legumes were disseminated to the farmers in a fair and equitable manner. Technicians working at the AHS were invaluable in this process. The legume seeds were pre-packed per weight and these packets were disseminated to the participating EG farmers at the AHS (Figure 4.6). The CG was not given any legumes for planting (for twelve months). All the experimental group members received legumes for 8-12 weeks (3 months).

Legumes were distributed for planting (250 g per pack for each variety during the two planting trials). All the absent participants were requested by phone and text messages to collect the legumes themselves or to send family/co-operative representatives to the AHS to collect the legumes from the designated technician (Figure 4.6 and Figure 4.7). This was done to ensure that all the farmers began planting at the beginning of the planting season. The municipal tractor also visited the farmers to supply horse manure and to drop off seeds for those who did not collect them. Before the distribution of the next packet the following month, feedback sessions were conducted to assess how far those who had received seeds had progressed with the cultivation of the legumes and to establish any challenges they experienced. This feedback was used to identify areas for improvement and to provide relevant advice.

Figure 4.6: Image of weighed legume seed varieties

Figure 4.7: AHS manager and researcher distributing packs of legumes

4.7.4.2 Field experiments

In these experiments, a completely randomized design (CRD) was used as the legumes were assigned in a random fashion to each experimental plot. This was done to ensure that each legume variety had a fair chance of receiving any treatment the farmers would use. The trials were repeated the following year. The farmers were given the opportunity to plant the same legume cultivars as those that had been used in the demonstration trial. This was done to evaluate the performance of these legumes when planted in the farmers' own plots of land. This was also done to familiarise these farmers with these legumes in terms of planting and cultivating techniques. The project also involved visiting the farmers' plots to assess progress.

(a) Field visits

Field visits were conducted by the municipal technician every six weeks to support farmers and to ensure that water supplies were sufficient. The researcher also visited these sites (Figure 4.8) after the municipal technicians had provided reports on progress, as well as when the farmers themselves indicated that the legumes were ready to be harvested. Visits by the researcher were conducted twice for both trials (2015-2016 and 2016-2017).

Figure 4.8: Researcher (left) visiting a female farmer's plot after the training programme

(b) Soil preparation and planting

The allocated plots were ploughed during the second week of November 2015 using garden forks. This process was followed by the application of horse manure (available at the AHS for farmers to collect/be delivered by a municipal vehicle) that was thoroughly mixed with the soil. The ratio of horse manure to soil was 1:1, which was the ratio used by the municipality for all organic production. This ratio was suggested by Dr Mike Leech, a senior horticulturalist and manager with 45 years' experience, who was available at the AHS as a member of the consultative process (Leech, 2015). This manure was freely available and was medication and hormone-free.

The inter-row spacing for legumes was 30 cm, with intra-row spacing divided according to each treatment (mono-cropping or intercropping). The researcher and the AHS manager discussed the nutritional benefits of the legume cultivars and selected specific legumes for their nutrient profile. The legumes issued to the farmers were *Phaseolus vulgaris L* (red kidney beans), *Cicer arietinum* (chick peas), *Phaseolus vulgaris* (white broad beans), *Vigna radiate* (green mung beans) and *Vigna subterranean* (jugo beans). Legume cultivar germination varied with an average of about 12 days per legume variety. The legume seeds were planted in the seedling trays first and were than transplanted into the plots for cultivation.

(c) Weed and pest control

Weeding occurred two weeks after planting and subsequently every time weeds were noticed in the plots in order to avoid interspecific competition. However, the farmers also reported that insects such as snails damaged the bean leaves and that caterpillars damaged the leaves and stems. The farmers used natural repellents such as a moringa tree spray, which they had learnt to produce at the AHS as a conservation method.

(d) Harvesting

All harvested legumes were weighed in kilograms to get measurements per plot, and they were stored in dry places to ensure food safety. All the measurements were recorded on a post-harvest legume harvest questionnaire, which was a secondary part of the agriculture survey (Annexure K).

Figure 4.9: Harvested legumes (red kidney beans)

Samples to demonstrate the quality of the harvest were brought to the AHS. These viewings informed the learning outcomes of the experimental phase (Figure 4.9).

4.7.4.3 Methodology to educate farmers on the nutritional value of legumes for Consumption

The study adopted the behavioural model of the SGT in order to define, implement and adjust the behaviour of the farmers and to effectively engage them in accepting legumes as a food that can be regularly consumed for good health. Behavioural change required the implementation of new knowledge through the education programme to address self-efficacy (which could have been hindered by negative attitudes, perceptions, fears and barriers that had existed amongst members of this community for a very long time) (Thondhlana & Kua*,* 2016). For example, the baseline study revealed that legume varieties were not regularly consumed and limited attempts had been made by farmers to grow and consume them prior to the intervention programme. The education initiatives of this study thus provided a platform to transform farmers' perceptions and behaviour by encouraging them to embrace the role that legumes could play in assisting them with addressing food and nutrition insecurity. The nutrition education programme was necessary to change their behaviour and perceptions and to encourage their understanding of healthy eating practices, the nutritional value of legumes and easy ways of preparing delicious and healthy legume dishes.

The education of the farmers in terms of nutrition included key themes as indicated in Table 4.2. These themes were informed by scholars in the field as well as South Africa's Guidelines for Healthy Eating (DoH, 2016) (refer to Annexure N for content of nutrition education). Due to the limitation of illiteracy, no handouts were prepared. Practical demonstrations were done as part of the active learning process. All the educational talks were presented in IsiZulu to ensure that the message of good nutritional practices was communicated in a language that the farmers understood. To ensure consistency of legume consumption, the farmers were given recipes to promote various ways of preparing nutritious legume dishes (refer to Annexure M).

It must be reiterated at this point that cognisance was taken of the SGT (Table 4.2) when the nutrition education programme was designed and implemented, because knowledge dissemination is influenced by personal, behavioural and environmental factors (refer to table 4.1 and figure 4.2). The theory argues that various behavioural shifts are aligned with new knowledge, which was a primary consideration when the nutrition programme was introduced to the farmers. Thus, personal, behavioural and environmental factors had to change when the farmers shifted their behaviour towards the consumption of legumes as a regular food source in their diet (DoH, 2016).

The nutrition programme (conducted by the researcher) commenced after the first harvesting attempts had failed. This was deemed an advantage as the nutrition programme could commence at a time when all the farmers were given the same quantity and varieties of legumes to consume. The education programme commenced fluently (measured by good attendance) and involved imparting information to all the farmers equally as none felt that they had been disadvantaged by a smaller harvest than the others. This programme was deemed part of the intervention project and not part of the pre-intervention phase of the project.

Legume preparation demonstrations were presented (by the researcher assisted by students) in an effort to expand the knowledge of the farmers and to encourage their use of legumes (refer to figure 4.10). Easy recipes were provided, demonstrated and for a tasting experience of newly developed recipes in order to identify what farmers preferred. This is a common method used for increasing perceptions and acceptability of specific food group catergories amongst a certain group of people (Gomez & Spielmann, 2019). The dissemination of legume recipes was also done to promote a higher consumption of legumes during the intervention phase of three months. This was done when they first collected the legumes for consumption. During the three months of consumption, more recipe ideas where discussed and challenges of legume preparation experiences were shared in the group so that the maximum consumption could occur within the three months. Farmers had to be shown innovative ways to prepare legumes for a three-month period as part of expanding their knowledge and skills to increase legume consumption (Refer to 4.11 for acceptable dishes). After the intervention period, biomedical data were collected from blood samples in the post-intervention phase in order to assess whether the changed diets of the farmers impacted their health positively.

Figure 4.10: Legume preparation, processing and food tasting session

Figure 4.11 a and b: Samples of legume dishes and spreads

Figure 4 11a - Picture Left: Far back left: jugo and cow pea breyani; Far back: cow pea spread; Middle right: butter bean and pasta dish; Middle: five-bean stew; Front: Mixed bean spread (all five varieties)

Figure 4b -Picture Right: A variety of spreads using processed legumes

Food demonstrations were conducted and farmer participation in food applications was encouraged for four weeks until various recipes had been tested and accepted. This was done to give farmers wide options in terms of their meal choices (Annexure M). Legume acceptability was determined by using the dishes that had been prepared based on the recipes (demonstrated) that were later distributed (Figure 4.10 and Figure 4.11). The farmers were requested to make recommendations based on their sensory experiences and to share ideas on how they would apply legumes/beans in their diets. The distributed recipes were standardised to meet the individual serving requirements per person per day.

(a) Demonstrations of legume preparation and processing

Demonstrations for legume preparation and processing were conducted in the AHS which has a kitchen facility. Based on dietary intake requirements, the focus group provided guidance in terms of the formulation of simple recipes that could be used during weekdays and weekends. Additional ingredients were bought and distributed in line with recipe specifications. These were incorporated into the legume dishes that were standardised to serve 4-6 people. Knowledgeable field workers assisted in all the demonstrations and ensured that the farmers understood the practical requirements during each session.

(b) Presentation and knowledge of nutrition

Knowledge was imparted and shared during various presentations of about one hour each, during which the topics as listed in Table 4.1 were discussed. Farmers were made aware of the role of legumes in a healthy diet and the importance of healthy eating in the later years of a person's life was emphasised.

4.7.4.4 Contingency measures to enhance legume consumption

Due to poor soil quality in some areas, there was a lack of good yields in time for the consumption period, which was a major component of the study. However, due to very low legume yields, the farmers were given additional legumes for consumption so that they could all start their consumption regime at the same time. Another delaying factor was that some farmers did not grow their legumes in the planting season. As a contingency plan, the participants were then all given the same legume varieties they had been given to grow (*Phaseolus vulgaris L* [red kidney beans]; *Cicer arietinum* [chick peas]; *Phaseolus vulgaris* [white broad beans]; *Vigna radiate* [green mung beans], and *Vigna subterranean* [jugo beans]). They were requested to consume these while the growing phase continued, which ensured a smooth continuation of the project. Moreover, in this manner, the recommended daily intake portion sizes would be met (guided by Annexure N).

Figure 4.12: Farmers receiving packs of legume seeds (note the variety in each pack)

A register was kept to record the variety and quantity of beans received by each participant. Each farmer was then issued an additional five varieties of legumes (i.e., 1 kg per variety: broad beans, red kidney beans, jugo beans, cow peas and chick peas). Each farmer thus received a 5 kg pack of beans for 12 weeks (3 months), to be consumed at least four or five times a week.

The participants were requested to consume 125 g (or half a cup) of beans at least four or five week, which was in line with the South African Food Based Dietary Guidelines (DoH, 2016). However, consideration was given to family consumption needs as well and additional legumes were issued. The left-over legumes could be distributed to other family members. The bulk of 5 kg was more than sufficient for the monthly recommended consumption per person, with a little extra as well. The consumption of legumes within an established period of time before blood testing was critical as non-consumption could have influenced the blood results. Plans were therefore in place to ensure that all the farmers in the experimental group were given their beans on time. Absent farmers could also access the beans as soon as possible after each meeting. Compliance was measured by ensuring that all recipes handed out were standardized to ensure correct servings per person (feedback on adherence to recipe standards were discussed). During the discussions and follow-up meetings, serving size was reinforced to ensure compliance with the research objectives (even though this was done, shortcomings could have occurred from participants at a household level).

4.8 Results and Discussion: Pre- and Post-Intervention Phases

The results that will be discussed in this section pertain to the following variables: socio-economic status, health status, blood profile, dietary intake, household food security status, legume knowledge, and legume acceptability level of the farmers participating in the pre-intervention phase.

4.8.1 Attrition

In the post-intervention phase it was found that some farmers who had participated during the pre-intervention phase, had dropped out of the study and could thus not participate in the next phase (refer to table 4.3 below).

Table 4.3: Pre-and post-intervention measures to determine the impact of respondents who had dropped out of the study

Variable	Normal range	EG n=53 Pre-intervention Mean	Standard Deviation	EG drop-outs n=18 Post-intervention Mean	Standard Deviation	Significance *p-value*
Glucose	5-6 mmol	5.30	2.86	6.66	2.84	0.085
Cholesterol	(< 5.17 mmol/l 200 mg/dl	4.39	1.42	4.88	1.18	0.193
		CG n=50 Pre-intervention Mean	**Standard Deviation**	**CG drop-outs n=6 Post-intervention Mean**	**Standard Deviation**	**Significance *p-* value**
Glucose	5-6 mmol	6.94	4.49	6.73	4.50	0.194
Cholesterol	(< 5.17 mmol/l 200 mg/dl	6.23	2.77	6.30	2.88	0.954
SIGINFICANCE OF DROPUTS						
EG DROP OUT **CG DROP OUT**	Hartley test for equal variance: F = 1.01					0.511
	Hartley test for equal variance F= 1.00					0.433

They could therefore not be evaluated for legume consumption effects over the 3-month period (Table 4.3). In the EG, 18 respondents dropped out (33.9%; n=18), which means that this group now totalled 34, whereas 12.0% (n=6) from the CG had dropped out. The purpose of the study was to measure the impact of legume consumption on the biomedical data (cholesterol and blood glucose) of the participants. The pre- and post-intervention results of both drop-out groups were thus compared to ensure that the blood results for the study were not affected by the absence of their results in the post-intervention phase. It was found that there was no significant difference (p=<0.05) between the loss of these participants and participants who completed the pre- and post-intervention in the EG (p=0.511) and CG (p=0.433). It was therefore concluded that the loss of these participants would not impact the study results significantly, leaving this group with 44 members. In both groups, the farmers who had dropped out had failed to consume legumes according to the guidelines (and were excluded) as outlined for the study (refer to sampling and selection criteria).

4.8.2 Socio-demographic survey results: Pre-intervention and intervention phases of the study

The socio-demographic results highlighted the variables that were key to the objectives of the study. All these will be comparatively and descriptively reported on in the sections below. Only one of the two population groups were given legumes to consume (EG n=53), while the control group (n=50) did not specifically consume legumes but continued with their customary diets. The socio-economic status of the participants in both groups is discussed in the next section.

Figure 4.13 indicates that the majority of the participants in the EG group were women, at 73.6% (n=39). This was also the case in the CG, where 66.0% (n=33) were women. In both groups, men were in the minority at 26.4% (n=14) in the EG and at 34.0% (n=17) in the CG. In the EG, the mean age was 63.3 (SD ± 6.3) years and in the CG it was 67.9 (SD ± 8.5) years. In the post-intervention phase, women were still the majority at 68.6% (n=24) and 63.0% (n=29) in the EG and CG respectively, while in the EG and CG men remained in the minority at 31.4% (n=11) and 37.0% (n=17), respectively. The mean age in years of the men was 67.2 (SD ± 6.7) and 64.2 (6.4 ± SD) in the EG and CG, respectively.

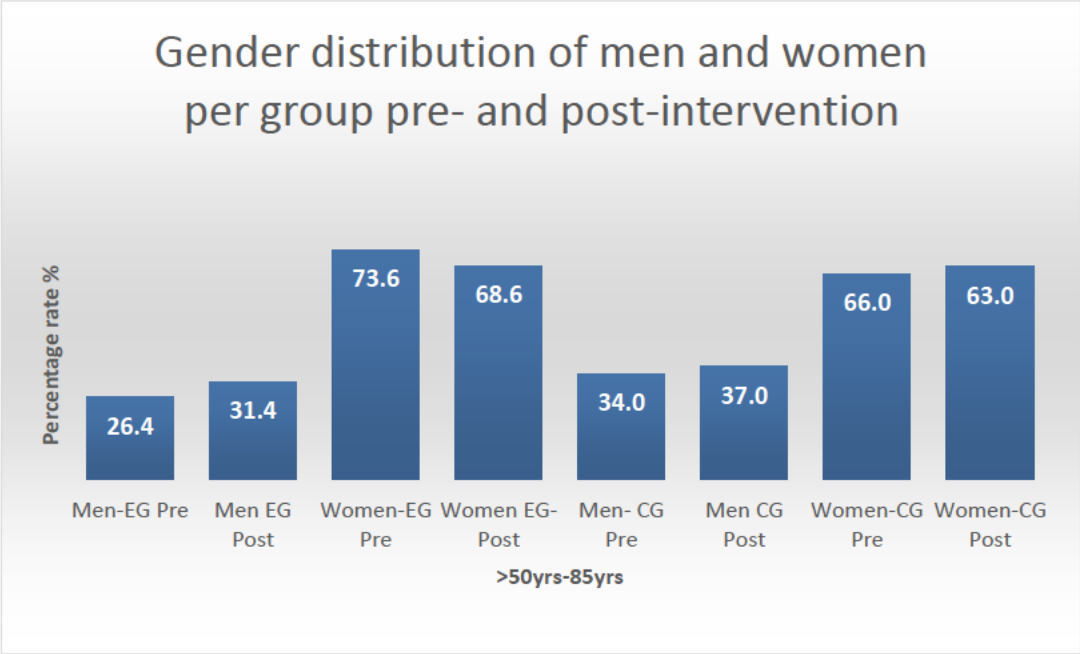

Figure 4.13: Gender distribution (pre-intervention EG n=53; CG=50; post-intervention EG n=35; CG n=44)

The only affiliation of the EG (100.0% [n=53]) and CG (100.0% [n=50]) was the eThekwini Municipality (Figure 4.14), which was thus a key role-player in terms of farmers' development, training and access to agricultural resources.

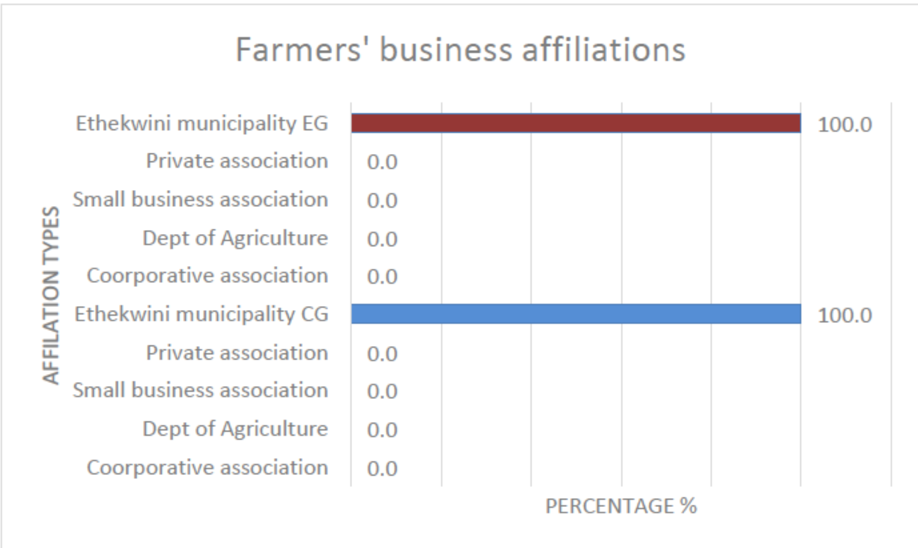

Figure 4.14: Farmers' business affiliations (EG n=53; CG n=50)

The results in terms of the living conditions of the two group are depicted in Table 4.4. These results indicate that the majority of the farmers did not live alone as 94.3% (n=50) in the EG and 94.0% (n=47) in the CG were cohabiting. Futhermore, 92.5% (n=49) of the EG and 94.0%

(n=47) of the CG lived permanently in the household. The mean number of people living with the farmers was 3.1, excluding the farmer. The type of housing that the majority of the EG lived in was brick houses (98.1% [n=52]), while 100.0% (n=50) of the CG lived in brick houses. Some (1.9% [n=1]) in the EG lived in clay dwellings.

The dwellings generally comprised >4 rooms (EG: 73.6% [n=39] and CG: 54.0% [n=27]), followed by 3-4 rooms (EG: 22.6% [n=12] and CG: 32.0% [n=16]) and <2 rooms (EG: 3.8% [n=2] and CG: 14.0% [n=7]). The majority of both groups had water dispensed from a tap inside their houses (EG: 81.1% [n=43] and CG: 84.0% [n=42]), whereas some had a tap only outside the house (EG: 15.1% [n=8] and CG: 12.0% [n=6]) or a borehole (EG: 3.8% [n=2] and CG: 4.0% [n=2]). The results indicate that a primary resource such as water was available which could be an advantage for farmers if their farming activities occurred within a home garden setting. The type of toilet facilities used per household was mostly a flush toilet (EG: 90.6% [n=48] and CG: 82.0% [n=41]), followed by a pit latrine (EG: 7.5% [n=4] and CG: 10.0% [n=5]) and a bucket system (EG: 1.9 [n=1] and CG: 8.0% [n=4]). A waste removal service was available for the majority of both groups (EG: 86.8% [n=46] and CG: 90.0% [n=46]). A tarred road outside the houses was also available for the majority of the EG (88.7% [n= 47]) and the CG (78.0% [n= 39]). Common pest infestations in households were rats (EG: 32.1% [n=17] and CG: 38.0% [n=19]); cockroaches (EG: 18.9% [n=10] and CG: 24.0% [n=12]); others (EG: 30.1% [n=16] and CG: 22.0% [n=11]); and ants (EG: 18.9% [n=10] and CG: 16.0% [n=8]).

Table 4.4: Accommodation, family composition, household resources and challenges (EG n=53; CG n=50)

Variable	EG Number (n= 53)	Percentage (%)	CG Number (n=50)	Percentage (%)
Family Composition				
Living with other people	Yes 50 No 3	94.3 5.7 100.0	Yes 47 No 3	94.0 6.0 100.0
Total number of people living per household	Mean 3.1		Mean 3.1	
Are residents' permanent members?	Yes 49 No 4	92.5 7.5 100.0	Yes 47 No 3	94.0 6.0 100.0
Accommodation				
Type of house:				
Brick	52	98.1	50	100

Table 4.4: Continued

Clay	1	1.9	0	0
Total		100.0		100.0
No of rooms per household:				
≤ 2 rooms	2	3.8	7	14.0
3-4 rooms	12	22.6	16	32.0
≥ 4 rooms	39	71.7	27	54.0
Total		100.0		100.0
Water facilities available per home:				
Tap inside the house	43	81.1	42	84.0
Tap outside house	8	15.1	6	12.0
Borehole	2	3.8	2	4.0
Total		100.0		100.0
Toilet facilities available per home				
None	0	0	0	0.0
Pit latrine	4	7.5	5	10.0
Flush/sewerage	48	90.6	41	82.0
Bucket system	1	1.9	4	8.0
Total		100.0		100.0
Operational waste removal system:				
Yes	46	86.8	46	92.0
No	7	13.2	4	8.0
Total		100.0		100.0
Road access outside the house:				
Yes	47	88.7	39	78.0
No	6	11.3	11	22.0
Total		100.0		100.0
PEST INFASTATION CHALLENGES				
Rats/Mice	17	32.1	19	38.0
Cockroaches	10	18.9	12	24.0
Ants	10	18.9	8	16.0
Others (flies. mosquitos. geckos)	16	30.1	11	22.0
		100.0		100.0

The results in Table 4.5 indicate that a few farmers were also working elsewhere while farming (EG: 13.2% [n=7] and CG: 8.0% [n=4]). A minority sought some form of employment (EG: 34.0% [n=18] and CG: 22.0% [n=11]). Most farmers were full-time in the field (EG: 94.3% [n=50] and CG: 88.0% [n=44]), while only 5.7% (n=3) of the EG and 12.0% (n=6) of the CG were part-time in the field.

Social support was provided to the majority of the EG farmers (50.9% [n=27]) and it was higher for the CG farmers (72.0% [n=36]). A higher percentage of the CG farmers (74.0% [n=37]) did not have a spouse (EG: 58.5% [n=31]), although some respondents had spouses who were unemployed (EG: 18.9% [n=10] and CG: 14.0% [n=7]). Some respondents had temporary work (EG: 16.9% [n=9] and CG: 4.0% [n=2]), were part-time employed (EG: 3.8% [n=2] and CG: 2.0% [n=1]) or had retired (EG: 1.9% [n=1] and CG: 2.0% [n=1]).

The household income status ranged from <R1 000 (EG: 5.7% [n=3], CG: 4.0% [n=2]) to >R1 000-R2 000 (EG: 52.8% [n=28], CG: 50.0% [n=25]); followed by R2 000-R3 000 (EG: 13.2% [n=7], CG: 32.0% [n=16]); >R3 000-R4 000 (EG: 13.2% [n=7], CG: 6.0% [n=3]); R4 000-R6 000 (EG: 9.4% [n=5], CG: 4.0% [n=2]); and >R6 000 (EG: 5.7% [n=3], CG: 4.0% [n=2]) per month.

A few farmers indicated that they sometimes had food shortages (EG: 28.3% [n=15], CG: 32.0% [n=16]), while those who never had shortages were 24.5% (n=13) for the EG and 26.0% (n=13) for the CG. Those who seldom had shortages were 18.9% (n=10) for the EG and 8.0% (n=4) for the CG; often (EG: 15.1% [n=8], CG: 28.0% [n=14]); and always (EG: 13.2% [n=7], CG: 6.0% [n=3]). Both groups purchased food mostly once a month (EG: 88.7% [n=47] and CG: 86.0% [n=43]), other (occasions) (EG: 7.5% [n=4] and CG: 10.0% [n=4) and lastly once a week (EG: 3.8% [n=2] and CG: 4.0% [n=2]).

EG respondents indicated a monthly food budget spent of around >R1 500 (100.0%; n=53), whilst 92.0% (n=46) of the CG was within that range. In the CG, only 8.0% (n=4) spent between R500-R1 500 on food a month. The CG indicated a greater need for more social support than the EG, but the household income status was similar for both groups, as was the food expenditure budget. The results highlight that the CG received higher rates of social support and had a higher household income status. The EG had more living space due to a higher number of people living in homes with ≥4 rooms.

Table 4.5: Work and income status (EG n=53; CG n=50)

Variable	Number EG (n=53)	Percentage (%)	Number CG (n=50)	Percentage (%)
Currently employed:				
Yes	7	13.2	4	8.0
No	46	86.8	46	92.0
Seeking Fulltime Employment:	n=53		n=50	
Yes	18	34.0	11	22.0
No	35	66.0	39	78.0
Type of employment:				
Fulltime, permanent	3	5.7	6	12.0
Part time, permanent	50	94.3	44	88.0
Social Support Access				
Yes	27	50.9	36	72.0
No	26	49.1	14	28.0
Spouse employment status				
Yes, full time, permanent	2	3.8	2	4.0
Yes, part-time, permanent (< 25 hours p w)	0	0.0	1	2.0
Yes, temporary	9	16.9	2	4.0
No, unemployed	10	18.9	7	14.0
No, retired	1	1.9	1	2.0
No, single no spouse	31	58.5	37	74.0
Household Income Status				
< R1000 *(< ± US$58)*	3	5.7	2	4.0
>R1000-R2000 *(>±US$58 - ± US$116)*	28	52.8	25	50.0
>R2000-R3000 *(>±US$116- ± 174)*	7	13.2	16	32.0
>R3000-R4000 *(>± 174 US$ - ± 232 US$)*	7	13.2	3	6.0
>R4000- R6000 *(>± 232 US$- ± 345 US$)*	5	9.4	2	4.0
>R60000 *(>± 348 US$)*	3	5.7	2	4.0
Food buying shortages:				
Always	7	13.2	3	6.0
Often	8	15.1	14	28.0
Sometimes	15	28.3	16	32.0
Seldom	10	18.9	4	8.0
Never	13	24.5	13	26.0
Frequency of food purchases:				

Table 4.5: Continued

Everyday	0	0.0	0	0.0
Once a week	2	3.8	2	4.0
Once a month	47	88.7	43	86.0
Other (occasions)	4	7.5	5	10.0
Food expenditure budget per month:				
<R1500	0	0.0	4	8.0
>R1500	53	100.0	46	92.0

Regarding the prevalence of assets and appliances in the farmers' households, Table 4.6 indicates that the majority owned electric stoves (EG: 94.3% [n=50], CG: 92.0% [n=46]), while fewer had gas stoves (EG: 43.4% [n=23], CG: 32.0% [n=16]) and paraffin stoves (EG: 26.4% [n=14]. CG: 40.0% [n=20]). Microwaves were also owned by the majority (EG: 75.5% [n=40]. CG: 88.0% [n=44]), followed by those who owned a hot plate stove (EG: 39.6% [n=21], CG: 22.0% [n=11]). A radio was owned by the majority of both groups (EG: 74.1% [n=40], CG: 76.0% [n=38]) and so was a television (EG: 96.2% [n=51], CG: 92.0% [n=46]), a refrigerator (EG: 96.0% [n=51], CG: 94.0% [n=47]) and a household freezer (EG: 62.3% [n=33]; CG: 52.0% [n=26]). Beds with mattresses were also owned by the majority (EG: 98.1% [n=52], CG: 98.0% [n=49]), followed by a lounge suite (EG: 86.8% [n=46], CG: 92.0% [n= 46]) and a dining room suite (EG: 73.6% [n=39], CG: 78.0% [n=39]). Appliances such as an iron (EG: 98.1% [n=52], CG: 94.0% [n=47]) and a kettle (EG: 100.0% [n=53], CG: 86.0% [n=43) were owned by the majority.

Table 4.6: Household assets and appliances (EG n=53 and CG n=50)[10]

Variable (Asset type)	Number EG (n=53)	Percentage %	Number CG (n=50)	Percentage %
Electric stove	50 3	94.3Y 5.7 N	46 4	92.0 Y 8.0 N
Gas stove	23 30	43.4 56.6	16 34	32.0 68.0
Paraffin stove	14 39	26.4 73.6	20 30	40.0 60.0
Microwave	40 13	75.5 24.5	44 6	88.0 12.0
Hot plate stove	21	39.6	11	22.0

[10] Y-yes to having access.
N- no to not having access.

Table 4.6: Continued

	32	60.4	39	78.0
Radio	40 13	74.1 25.9	38 12	76.0 24.0
Television	51 2	96.2 3.8	46 4	92.0 8.0
Refrigerator	51 2	96.0 4.0	47 3	94.0 6.0
Freezer	33 20	62.3 37.7	26 24	52.0 48.0
Bed mattress	23 30	43.4 56.6	49 1	98.0 2.0
Lounge suite	46 7	86.8 13.2	46 4	92.0 8.0
Dining room	39 14	73.6 26.4	39 11	78.0 22.0
Appliances: **Electric iron**	52 1	98.1 1.9	47 3	94.0 6.0
Kettle	53 0	100.0 0	43 7	86.0 14.0

4.8.3 Anthropometric, medical and health survey

The health survey results are presented for anthropometrics and blood pressure. These medical and health status results are presented comparatively and descriptively. This section will present a clear view of the health status of both the EG and the CG.

4.8.3.1 Anthropometric and clinical results

Table 4.7 indicates that the majority of the men in EG were overweight (BMI 18.5-24.99 kg/m^2) and even obese (BMI 30->40 kg/m^2), with 42.8% (n=6) falling within the obese classification level. This group was followed by the normal BMI range (BMI 18.5-24.99) at 21.4% (n=3) and the underweight group (BMI <18.5 kg/m^2) at 21.4% (n=3). Overweight (BMI 18.5-24.99 kg/m^2) occurred in 14.3% (n=2) of the respondents of this group. The results suggest that almost 60.0% (57.1%; n=8) of the EG was over-nourished. In comparison, above half (52.9%; n=9) of the CG was overweight (BMI 25.00-29.99 kg/m^2). This group was followed by those who were obese (BMI 30->40 kg/m^2) at 29.5% (n=5). The respondents who were within the normal BMI range (BMI 18.5-24.99 kg/m^2) in the CG comprised 17.6% (n=3), while none was underweight (BMI <18.5 kg/m^2). Overweight and obesity levels were much higher for the CG than for the EG.

During the post-intervention phase, the majority (63.7% [n=7]) of the respondents in the EG were obese (BMI 30->40 kg/m^2), followed by those who were overweight (BMI 18.5-24.99 kg/m^2) at 27.2% (n=3). This suggests that almost 90.9% (n=10) of this sample was over-nourished. Those with normal BMI (BMI 18.5-24.99 kg/m^2) represented 9.1% (n=1) and nobody was underweight (BMI <18.5). In comparison, the CG in this phase had overweight levels (BMI 25.00- 29.99 kg/m^2) at 47.1% (n=8), followed by those who were obese (BMI 30->40 kg/m^2) at 29.0% (n= 5), with only 23.5% (n=4) who had a normal weight (BMI 18.5-24.99 kg/m^2). No one was underweight (BMI <18.5 kg/m^2). In the CG 76.4% (n=13) were over-nourished. It was observed that overweight and obesity levels increased during the post-intervention phase in both groups. This indicates that further dietary modifications might have addressed the issue of body weight management in the study group, but such measures were beyond the scope of the study.

Table 4.7: Body Mass Index (BMI) classification for men (pre-intervention: EG n=14 and CG n=17; post-intervention: EG n=11 and CG n=17)

PRE-INTERVENTION BMI kg/m^2	Men	Number EG n=14	%	MEAN	±SD	Number CG n=17	%	MEAN	±SD
Underweight	(<18.5)	3	21.4	16	0.00	0	0.0	0	10.16
NORMAL	18.5-24.99	3	21.4	22	8.68	3	17.6	22	8.86
Overweight	25-29.99	2	14.3	26	8.12	9	52.9	27	9.13
Obese 1	30-34.99	4	28.6	33	7.73	3	17.7	31	8.32
Obese 2	35-39.99	1	7.1	36	8.97	2	11.8	36	0.00
Obese 3	40+	1	7.1	41	0.00	0	0.00	0	0.00
Significance *p*=0.63	**TOTAL**	**14**	**100.0**			**17**	**100.0**		
POST- INTERVENTION BMI kg/m^2	**Men**	**Number EG n=11**	**%**	**MEAN**	**±SD**	**Number CG n= 17**	**%**	**MEAN**	**±SD**
Underweight	<18.5	0	0.0	0	0.00	0	0.0	0	0.00
NORMAL	18.5-24.99	1	9.1	22	0.00	4	23.5	22	8.75
Overweight	25-29.99	3	27.2	25	6.05	8	47.1	27	8.18
Obese 1	30-34.99	2	18.2	34	4.19	3	17.6	31	7.89
Obese 2	35-39.99	4	36.4	36	5.57	2	11.7	36	8.84
Obese 3	40+	1	9.1	41	0.00	0	0.0	0	0.00
Significance *p*= 0.70	**TOTAL**	**11**	**100.0**			**17**	**100.0**		

Source for measurement: WHO, (2004)

The p-values for the total group BMI for Pre-intervention EG and CG was p=0.63 and Pre CG was p=0.70, indicating no statistical significance. Refer to Table 4.7 for correlations of BMI the between groups.

Table 4.8 presents the BMI results for the women in both groups. The pre-intervention results for the EG indicated that the majority (66.7% [n=26]) was above the threshold for obesity (BMI >30->40 kg/m^2), followed by those who were overweight (BMI 25-29.99 kg/m^2) at 20.5% (n=8). This suggests that 87.2% (n=34) of the group was over-nourished. Those who were within the normal BMI range (BMI 18.5-24.99 kg/m^2) were 7.7% (n=3), while only 5.1% (n=2) fell within the underweight (BMI <18.5 kg/m^2) catergory. The outcomes suggest that women were more over-nourished than their male counterparts. In the pre-intervention phase, the majority of women 72.7% (n=24) in the CG were above the threshold of normal BMI (BMI >30->40 kg/m^2) and were thus obese. This group was followed by those who were overweight (BMI 25-29.99 kg/m^2) at 15.2%; (n=5), which suggests that almost 87.9% (n=29) of the women in this group were over-nourished.

Respondents who were within the normal BMI category (BMI 18.5-24.99 kg/m^2) comprised 9.1% (n=3), while only 3.0% (n=1) were underweight (<18.5 kg/m^2). These outcomes suggest that the women were more prone to overnutrition than their male counterparts. Overweight and obesity levels were similar for the women of both groups, suggesting that weight management was important in ensuring the wellbeing of these participants. The post-intervention results indicated that no significant changes has occurred in the BMI. Table 4.8 below highlights BMI results for women.

Table 4.8: EG Body Mass Index (BMI) classification for women (Pre-intervention: EG n=39 and CG n=33; Post-intervention: EG=24 and CG=29)

BMI kg/m²	Women	Number EG n=39	%	MEAN	±SD	Number CG n=33	%	MEAN	±SD
Underweight	<18.5	2	5.1	17	9.64	1	3.0	17	0.00
Normal	18.5-24.99	3	7.7	22	9.55	3	9.1	22	8.95
Overweight	25-29.99	8	20.5	28	8.50	5	15.2	27	7.50
Obese 1	30-34.99	15	38.5	32	8.49	11	33.3	32	7.34
Obese 2	35-39.99	5	12.8	37	8.62	8	24.2	37	7.45
Obese 3	40+	6	15.4	47	9.24				
	TOTAL	**39**	**100.0**			**33**	**100.0**		
Significance *p*= 0.21									
BMI kg/m²	**Women**	**Number EG n=24**	**%**	**MEAN**	**±SD**	**Number CG n=29**	**%**	**MEAN**	**±SD**
Underweight	<18.5	0	0.0	0	0.00	1	3.4	17	0.00
Normal	18.5-24.99	1	4.2	21	0.00	3	10.3	22	8.26
Overweight	25-29.99	6	25.0	27	5.75	5	17.2	27	7.42
Obese 1	30-34.99	9	37.5	31	5.42	7	24.1	32	7.27
Obese 2	35-39.99	2	8.3	37	5.78	8	27.6	37	7.42
Obese 3	40+	6	25.0	41	6.71	5	17.2	46	9.83
	TOTAL	**24**	**100.0**			**29**	**100.0**		
Significance *p*= 0.78									

Source for measurements: WHO, (2004)

The *p*-value for the total group BMI for Pre-intervention EG and CG was $p=0.21$. For post-intervention the EG and CG the *p*-value of $p=0.78$ indicated no statistical significanct difference of comparisons. Refer to Table 4.8 for correlations between groups.

In terms of waist circumference (Figure 4.15), the pre-intervention results for the EG indicated that 57.1% (n=8) of the men were within the recommended cut-off point (≤ 102 cm). The results for the CG indicated that the majority (70.6% [n=12]) of the men were above the cut-off point (≥ 102 cm). The post-intervention results indicated that no significant changes had occurred in the WC for either group after the intervention phase.

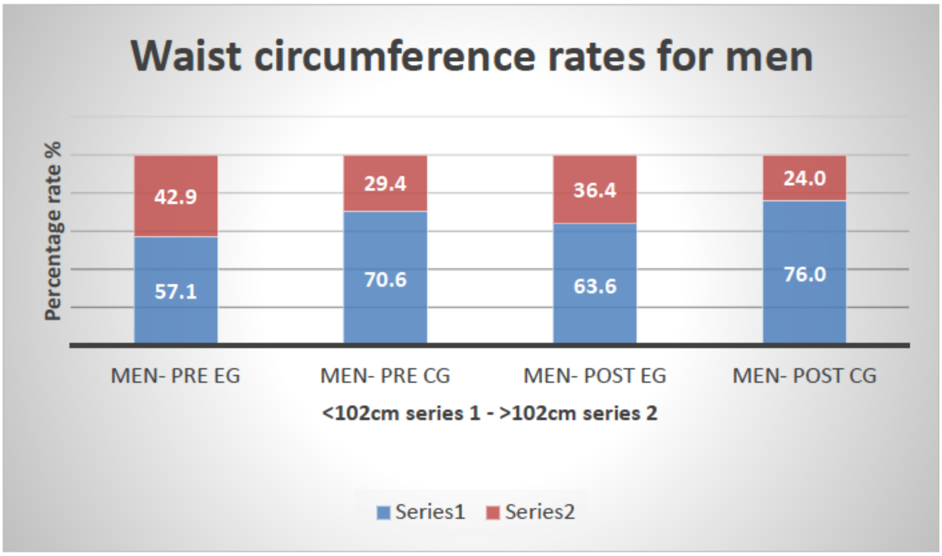

Figure 4.15: Waist circumference (WC) rates for men (Pre-intervention: EG n=14 and CG n=17; Post-intervention: EG n=11 and CG n=17)

Source for measurements: WHO, (2004)

Figure 4.16 indicates that the majority of EG women (84.6%; n=33) exceeded the cut-off point for waist circumference (>88cm). In the CG, the majority of women (87.9% [n=29]) exceeded the cut-off point for waist circumference (>88cm). Both groups had higher waist circumference scores than required for a healthy lifestyle. The post-intervention results indicated that no significant changes had occurred in WC in either group after the intervention phase.

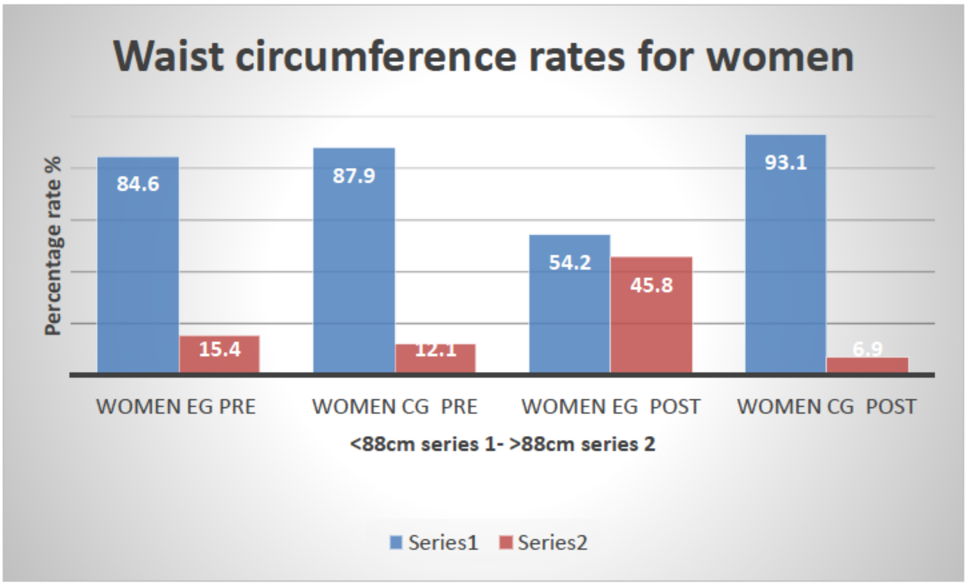

Figure 4.16: Waist circumference (WC) scores for women (Pre-intervention: EG n=39 and CG n=33; Post-intervention: EG n= 24 and CG n=29)

Source for measurements: WHO, (2004)

Figure 4.17 indicates the waist-to-height ratios for the EG. The majority of women (94.9% [n=37]) exceeded the WHtR (≥0.5). A large number (78.6% [n=11]) of men also exceeded the recommended ratio (≥0.5). The results suggest that both men and women were at high risk of metabolic syndrome.

For the CG, the results indicated that the majority women (90.9% [n=30]) exceeded the WHtR (≥0.5) as did the majority of the men (88.2% [n=15]). The WHtR (≥0.5) scores were still high for both groups, indicating the prevalence of the same health risks (hypertension and diabetes) that were revealed by the post-intervention results.

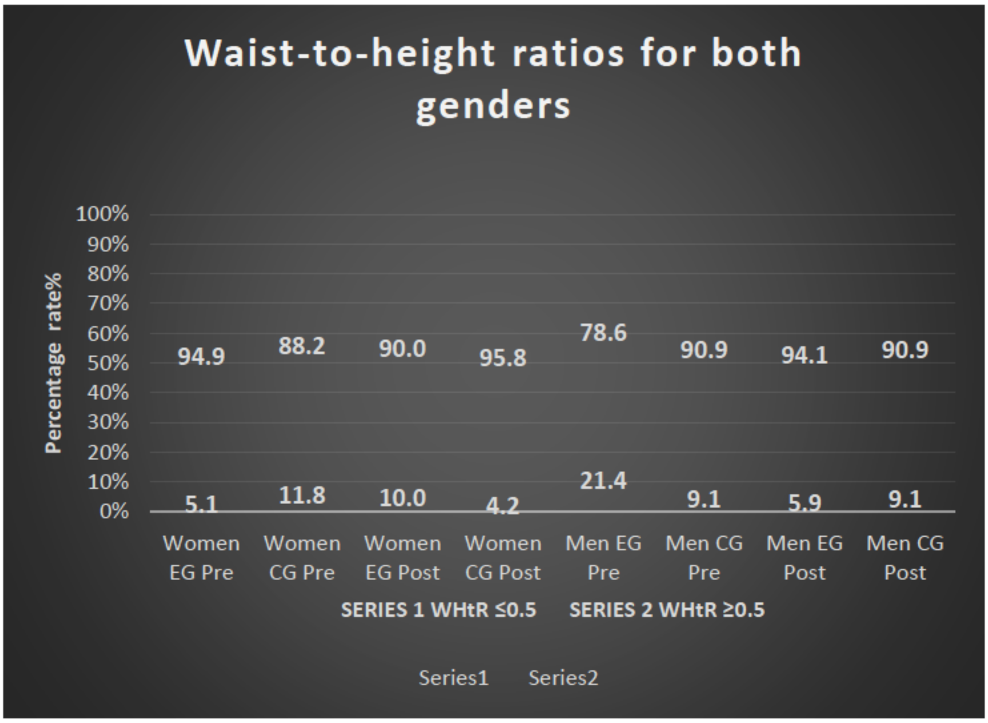

Figure 4.17: Waist-to-height ratio (WHtR) results (Pre-intervention: EG n=53 and CG n=50; Post-intervention: EG n=35 and CG n=44) (WHO, 2004)

In terms of diastolic blood pressure, Figure 4.18 indicates that in the EG in the pre-intervention phase, 36.0% (n=19) of the respondents had a normal diastolic blood pressure (<80 mmHg), followed by those who were in the optimal stage (80-84 mmHg) at 30.1% (n=10), high normal (85-89 mmHg) at 11.3% (n=6) and those who indicated hypertension grade 1-3 (>90 mmHg) at 33.9% (n=18).

For the CG, the results indicated that those in the optimal stage (≥80-84 mmHg) and (85-89 mmHg) were at 20.0% (n=14). There was evidence of hypertension grades 1-3 (>90 mmHg) at 32.0% (n=16). Only 28.0% (n=20) of the respondents had a normal diastolic blood pressure (≤80 mmHg) (refer to figure 4.18). The post-intervention results indicated statistical significance for the EG, but not for the CG (refer to Table 4.9 for the correlations).

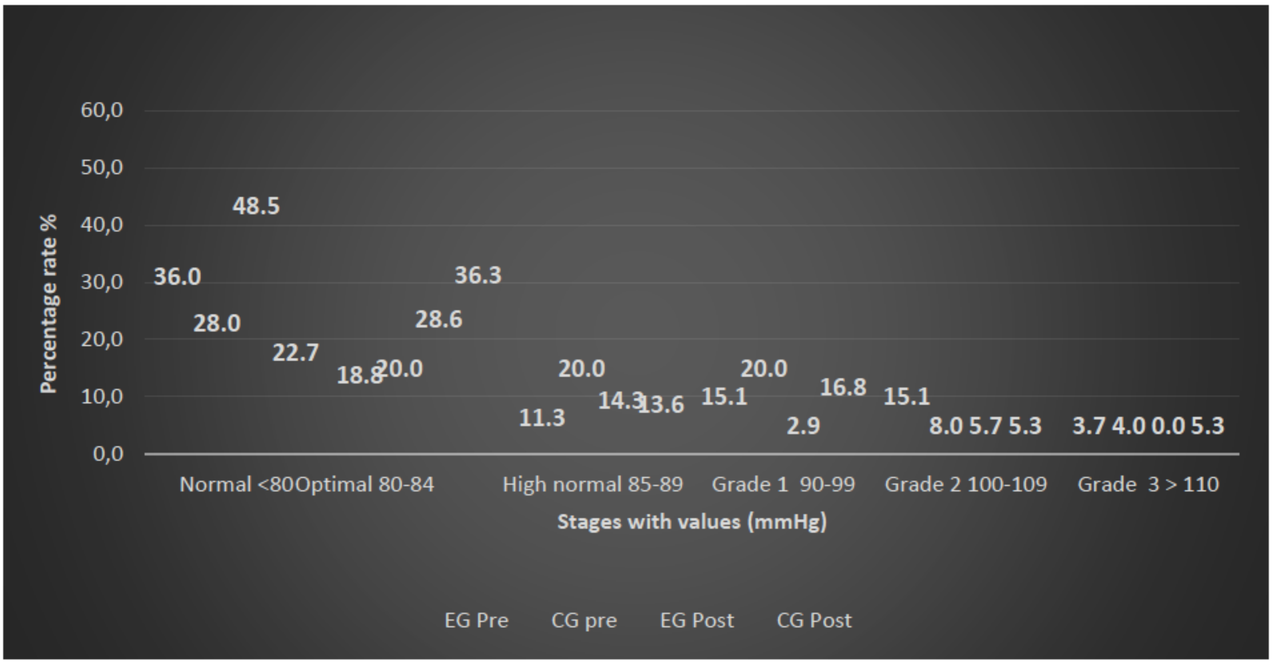

Figure 4.18: Diastolic blood pressure results for both genders (Pre-intervention: EG n=53 and CG n=50; Post-intervention: EG n=35 and CG n=44)

Source for BP rates: Seedat *et al.*, (2014)

The systolic blood pressure results for the EG indicated that, during the pre-intervention phase, 34.0% (n=18) were within the normal range (<120 mmHg) for hypertension. Those in the optimal stage (>120-129 mmHg) were at 11.4 % (n=6), whilst 9.4% (n=5) were in the high normal range (130-139 mmHg). The majority (45.2%; n=24) were in the hypertensive grade ranges 1-3 (140-180 mmHg). In comparison, in the CG 16.0% (n=8) of the respondents was in the optimal stage (>120- 139 mmHg), while 68.0% (n=34) were in the hypertensive range grade 1-3 (140- ≥ 180 mmHg). Those in the high normal range (130-139 mmHg) comprised 10.0% (n=5). Normal values (≤120 mmHg) were indicated for only 6.0% (n=3). The post-intervention results indicated no statistical significance for DBP either group during the intervention phase.

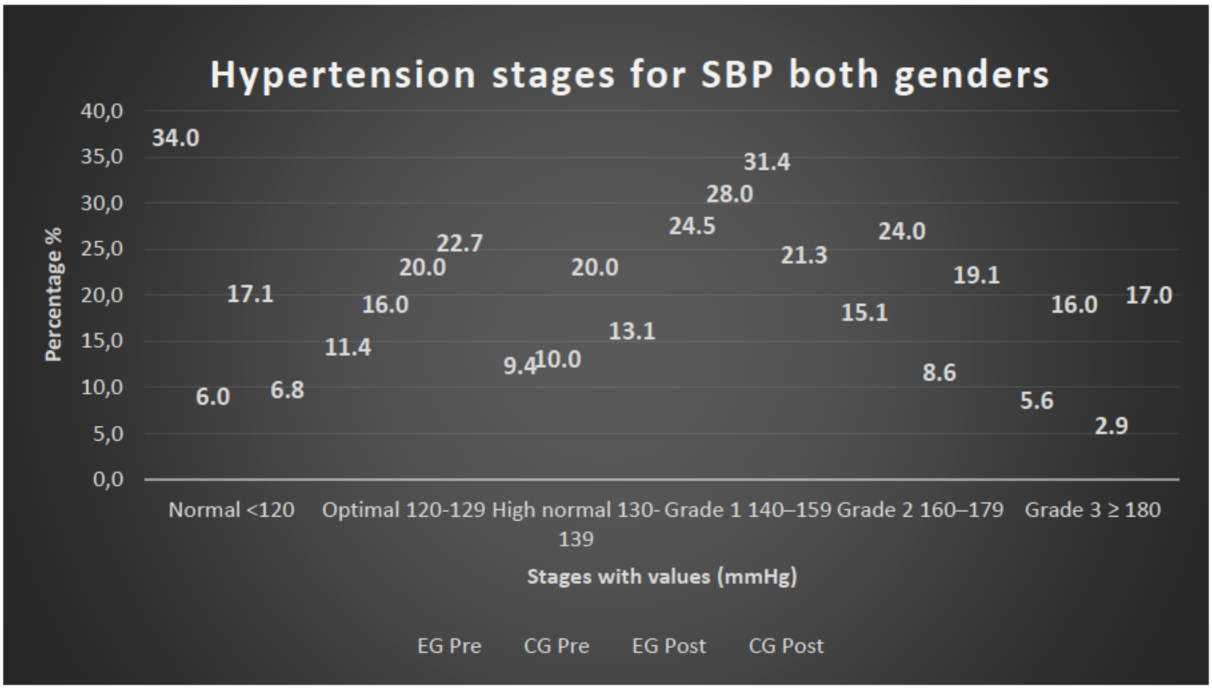

Figure 4.19: Systolic blood pressure results for both genders (Pre-intervention: EG n=53 and CG n=50; Post-intervention: EG n=35 and CG n=44)

Source for BP rates: Seedat *et al.*, (2014)

Figure 4.18 and Figure 4.19 indicate that when comparing both diastolic and systolic readings, hypertension trends fluctuated during the intervention phase. However, both groups (EG and CG) were hypertensive overall. The results suggest that hypertension management needs to be addressed. The respondents' inability to adapt their habits regardless of new knowledge about the disease and the implementation of the DASH principles (which were aspects of the education programme that were also communicated to them by local health authorities) was disconcerting (Kim & Andrade, 2019). Figure 4.20 supports the overall results of hypertensive prevelance for both groups (CG pre-intervention 70.0% [n=35], EG post-interventioon 65.8% [n=23] and CG post-intervention 71.7% [n=33]).

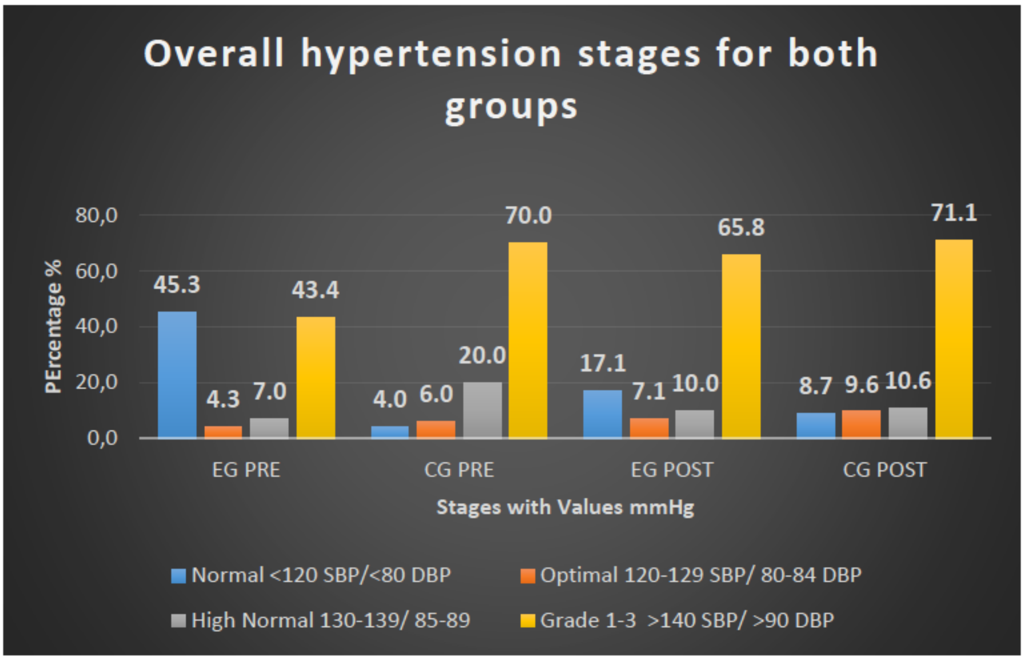

Figure 4.20: Overall blood pressure results for both genders (Pre-intervention: EG n=53 and CG n=50; Post-intervention: EG n=35 and CG n=44)

Source for BP rates: Seedat *et al*., (2014)

Table 4.9 presents the total reported variables (BMI, WC, WHtR, SBP and DBP) for each group with a significance per interval (pre-intervention vs post-intervention) comparison. No significant changes were observed for either the EG or the CG after the intervention phase, except for DBP that was significantly lower (p=0.02) for the EG after this phase.

Various diseases and health challenges were prevalent amongst the EG and CG respondents during the pre-intervention phase (Table 4.10). Problems that were encountered affected the skin (EG 24.5% [n=13]; CG 34.0% [n=17]) and many had skeletal problems (EG 58.5% [n=31], CG 50.0% [n=25]). The impact of skeletal problems affected 34.0% (n=18) of the EG and 38.0% (n=19) of the CG when they were engaged in agricultural activities. Both groups indicated eye problems (EG 64.2% [n=34], CG 74.0% [n=37]), while a few respondents (EG 18.1% [n=10], CG 26.0% [n=13]) indicated that they had not received any cataract surgery as part of improving their eyesight.

Table 4.9: Mann-Whitney U analyses for BMI, WC, WHtR and BP: Comparison of significant values for the same group pre- and post-intervention

	Pre EG Mean ± SD	Post EG Mean ± SD	*Signficance p-value*	Pre CG Mean values ± SD	Post CG Mean values *± SD*	*Significance p-value*
BMI kg/m²	31.07 ± 8.62	32.35 ± 6.29	0.451	31.42 ± 7.13	31.28 ± 7.32	0.161
WC (cm)	99.99 ± 12.41	105.02 ± 18.59	0.249	100.98 ± 13.85	101.26 ± 14.35	0.092
WHtR cm/ m²	0.60 ± 0.10	0.65 ± 0.11	0.080	0.619 ± 0.09	0.61 ± 0.09	0.066
SBP (mmHg)	138.02 ± 28.41	129.58 ± 32.76	0.147	155.54 ± 28.65	155.52 ± 29.51	0.070
DBP (mmHg)	84.86 ± 14.12	78.41 ± 11.53	**0.022**	85.50 ± 12.37	85.06 ± 12.55	0.191

*The first *p*-value represents the mean value comparison of the EG pre- and post-intervention (column 3). The second *p*-value represents the mean value comparison of the CG pre- and post-intervention (column 6).

Dental problems were higher in the CG (58.0% [n=29]) than in the EG (37.7% [n=20]), while eating problems occurred in only 20.8% (n=11) of the EG and 34.0% (n=17) of the CG. In the EG, 22.6% (n=12) had dentures, while 26.0% (n=13) of the CG had dentures. Ear and nose problems were encountered by 20.8% (n=9) of the EG, while 24.0% (n=12) in the CG encountered such problems. In the EG, health and circulatory challenges were evident in 17.0% (n=9) and in 18.0% (n=9) of the CG, while chest and respiratory problems occurred in 3.8% (n=2) of the EG and in 12.0% (n=6) of the CG. Since pesticides usage can contribute to respiratory problems, pesticide usage by farmers was 22.6% (n=12) for the EG and in 24.0% (n=12) of the CG. Digestive problems were experienced by 50.9% (n=27) of the EG and by 48.0% (n=24) of the CG.

Few urinary and genital challenges (EG: 5.7% [n=3], CG: 14.0% [n=7]) and nervous system problems (EG: 11.3% [n=6], CG: 14.0% [n=7]) occurred. Headaches were experienced by 39.6% (n=21) of the EG and by 42.0% (n=21) of the CG. Both groups indicated that none (EG 100.0% [n=53] and CG 100.0% [n=50]) were physically disabled. Other self reported health conditions that seemed to affect both groups were constipation (EG: 24.5% [n=13], CG: 26.0% [n=13]); diarrhoea (EG: 17.0% [n=9]; CG: 18.0% [n=9]), ulcers (EG: 13.2% [n=7], CG: 14.0% [n=7]), irritable bowel syndrome (IBS) (EG: 1.9% [n=1], CG: 2.0% [n=1]); and heartburn (EG: 15.1% [n=8], CG: 16.0% [n=8]). Other problems experienced included poor appetite (EG: 24.5% [n=13] and CG: 28.0% [n=14]), while large/big appetite affected 32.1% (n=17) of the EG and 34.0% (n=17) of the CG. Lack of sleep was reported by 47.2% (n=25) of the EG and by 38.0% (n=19) of the CG. Memory loss occurred in 35.8% (n=19) of the EG and in 50.0% (n=25) of the CG, while weakness of the wrists was reported by 30.2% (n=16) of the EG and 32.0% (n=16) of the CG. Table 4.10 indicates that most concerns were raised by the CG, with a higher number of eye and teeth problems that needed attention than the EG (even though there was no age difference).

Table 4.10: Disease profiles of both male and female participants (EG n=53; CG n=50)

Variable (status)	Number EG (n=53)	Percentage %	Number CG (n=50)	Percentage %
Skin disease	24 29	45.3 Y 54.7 N	17 33	34.0 Y 66 N
Skeletal/ joint problems	31 22	58.5 41.5	25 25	50.0 50.0
Affecting agricultural activity	18 35	34.0 66.0	19 31	38.0 62,0
Eye problems	34 19	64.2 35.8	37 13	74.0 26.0
Cataract surgery conducted	10 43	18.9 81.1	13 37	26.0 74.0
Dental problems	20 33	37.7 62.3	29 21	58.0 42.0
Difficulty eating	11 42	20.8 79.2	17 33	34.0 66.0
Dentures	12 41	22.6 77.4	13 37	26.0 74.0
Ear & Nose problems	11 42	20.8 79.2	12 38	24.0 76.0
Health and circulatory challenges	9 44	17.0 83.0	9 41	18.0 82.0
Chest and respiratory problems	2 51	3.8 96.2	6 44	12.0 88.0

Table 4.10: Continued

Pesticide usage	12 41	22.6 77.4	12 38	24.0 76.0
Digestive problems	27 26	50.9 49.1	24 26	48.0 52.0
Urinary and genital problems	3 50	5.7 94.3	9 41	18.0 82.0
Nervous/ mental problem	6 47	11.3 88.7	7 43	14.0 86.0
Frequent headaches	21 32	39.6 60.4	21 32	42.0 58.0
Physical disability:	0 53	0.0 100.0	1 49	2.0 98.0
Health conditions:				
Constipation	13 40	24.5 75.5	13 27	26.0 74.0
Diarrhoea	9 44	17.0 83.0	9 41	18.0 82.0
Ulcers	7 46	13.2 86.8	7 43	14.0 86.0
Irritable Bowel Syndrome	1 52	1.9 98.1	1 49	2.0 98.0
Heartburn	8 45	15.1 84.9	8 42	16.0 84.0
Poor appetite	13 40	24.5 75.5	14 36	28.0 72.0
Large/big appetite	17 36	32.1 67.9	17 33	34.0 66.0
Lack of sleep	25 28	47.2 52.8	19 31	38.0 62.0
Loss of memory	19 34	35.8 64.2	25 25	50.0 50.0
Weakness of wrist	16 37	30.2 69.8	16 34	32.0 68.0

Results for the EG (Figure 4.21) indicated that 62.3% (n=33) of the respondents were involved in heavy physical activity, followed by those who engaged in moderate physical activity (24.5% [n=13]), no physical activity (7.5% [n=4]) and light physical activity (5.7% [n=3]). In the CG, 50.0% (n=25) was involved in heavy physical activity, 28.0% (n=14) engaged in moderate physical activity, 14.0% (n=7) did no physical activity, and light activities were done by 8.0% (n=4). The EG was revealed as the more physically active group as compared to the CG.

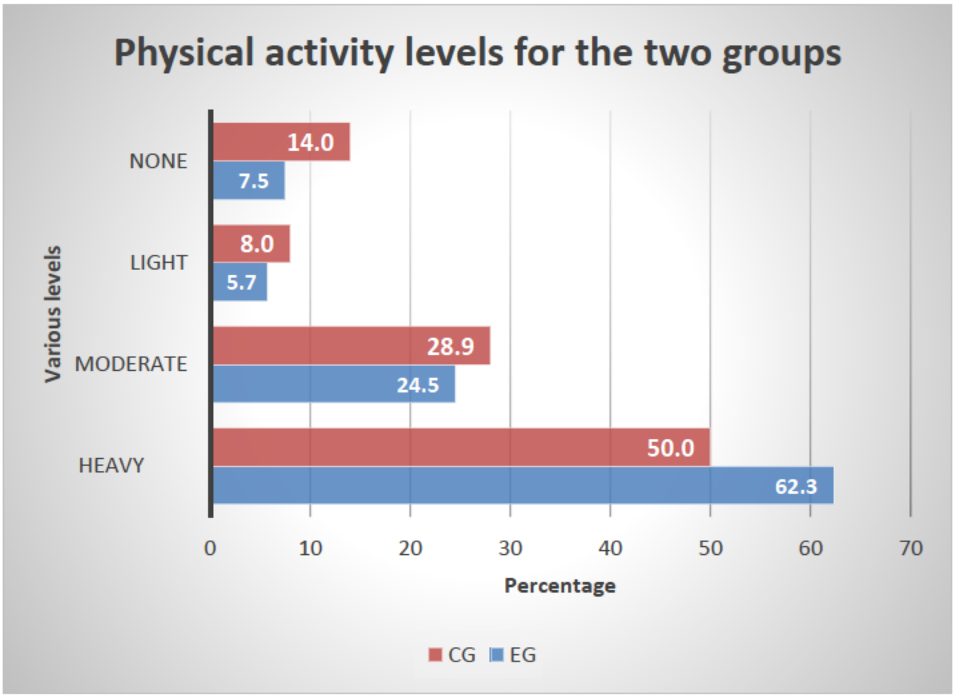

Figure 4.21: Physical activity levels (EG n=53; CG n=50)

In the EG, 69.8% (n=37) never smoked while 84.0% (n=42) in the CG never smoked. In the EG, 18.9% (n=10) and in the CG 10.0% (n=5) had stopped smoking. Only 11.3% (n=7), members of the EG were currently smoking at the time of the study, while 6.0% (n=3) of the CG smoked refer to figure 4.22.

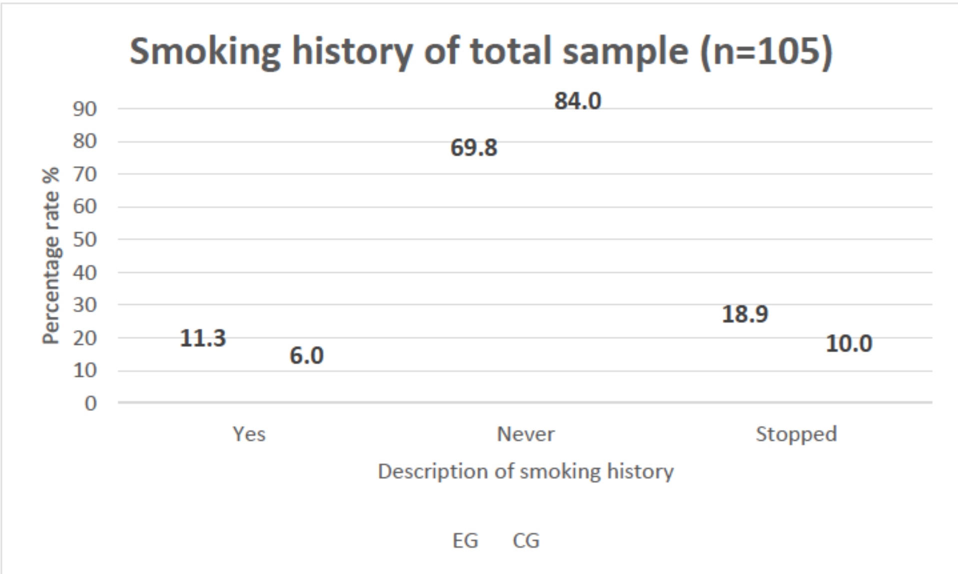

Figure 4.22: The smoking history of the total sample (EG n=53; CG n=50)

In the EG, 57.0% (n=30) were on chronic medication, while 60.0% (n=30) of the CG were on chronic medication. Less than 50.0% (43.0% [n=23]) of the EG and 40.0% (n=30) of the CG were not on chronic medication (refer to figure 4.23).

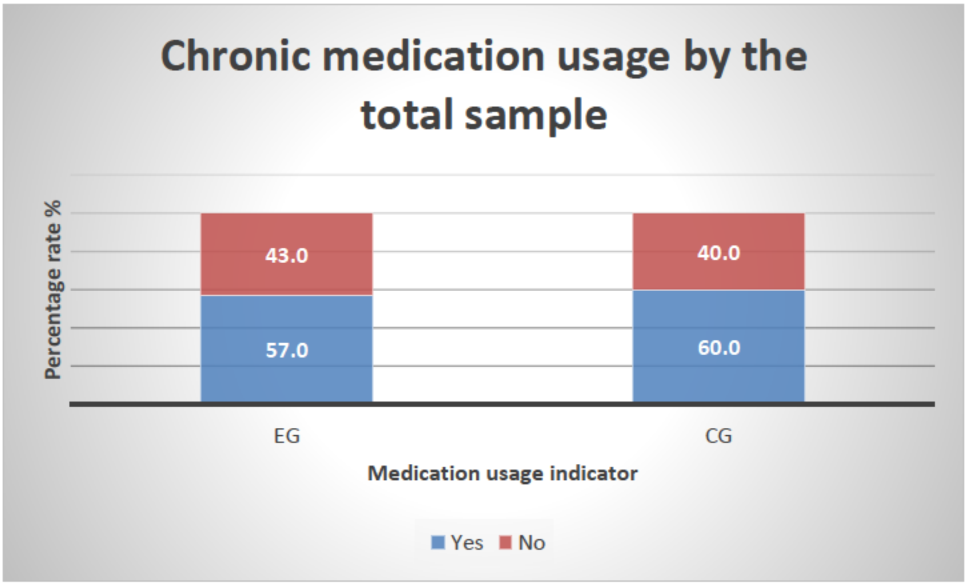

Figure 4.23: Farmers on chronic medication (EG n=53 and CG n=50)

Primary healthcare was accessed by 73.6% (n=39) of the EG respondents, and 52.0% (n=26) of the CG. This was followed by visits to public hospitals (13.2% [n=7] by the EG) and 32.0% (n=16) by the CG. Private doctors were visited by 13.2% (n=7) of the EG and by 16.0% (n=8) of the CG, while no one from either group reported visting traditional healers. This data suggests that primary healthcare (particularly clinics), was the predominant health system used by the participants.

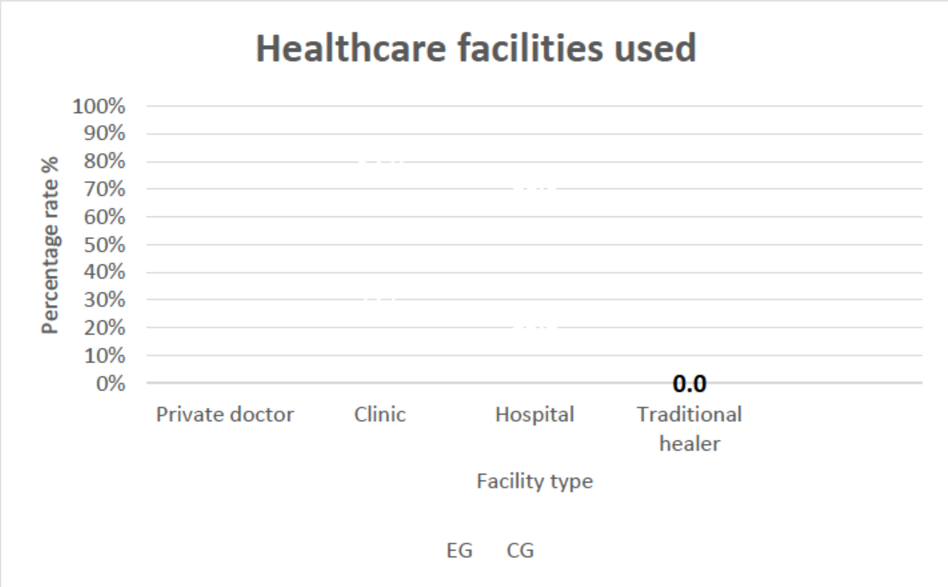

Figure 4.24: Healthcare facilities used (EG n=53; CG n=50)

In the EG, 45.3% (n=24) used taxis for transport, (to access health services refer to figure 4.25) while 48.0% (n=24) in the CG used taxis. Walking (on foot) was used by 43.4% (n=23) in the EG and 42.0% (n=21) in the CG. Another mode of transport was using a bus (EG: 9.4% [n=5], CG: 2.0% [n=1]). Own transport was used by 1.9% (n=1) of the EG and 8.0% (n=4) of the CG. Transport was very important in ensuring that farmers go to and access servces they needed which were necessary in enabling them to manage their health status and general well-being.

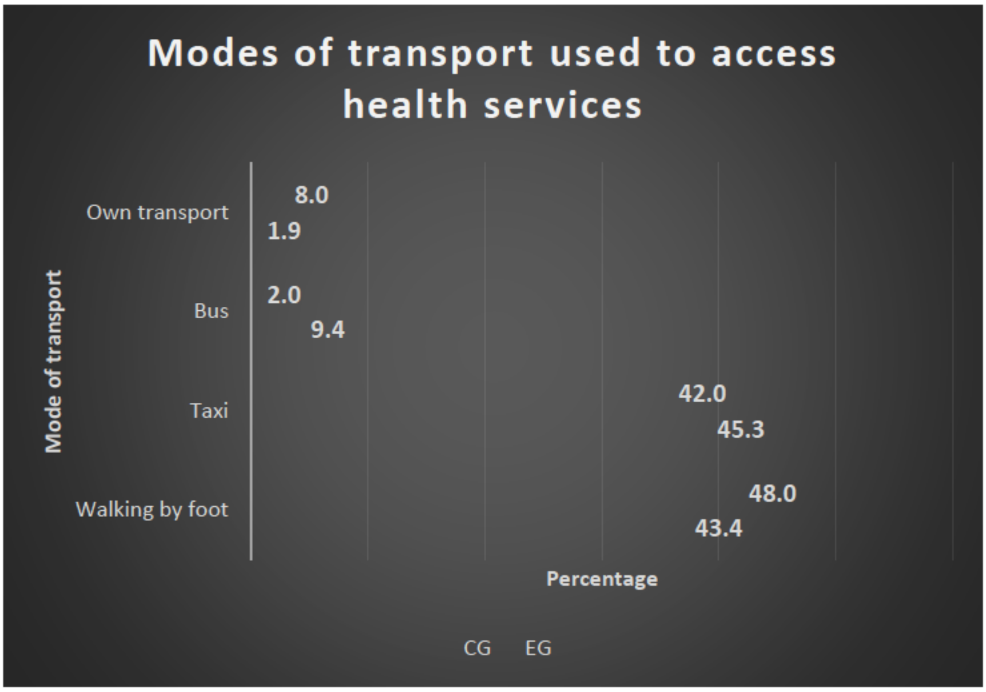

Figure 4.25: Modes of transport to access health facilities (EG n=53 and CG n=50)

4.9 Biomedical Indices and Blood Sample analyses

This section presents the data that were elicited by the blood samples taken to measure the participants' cholesterol (serum) and blood glucose (plasma) levels. These biomedical indices were measured for the EG before and after they consumed legumes and for the CG who were not required to consume legumes, other than what they would have consumed in their normal, habitual diets. The results were analysed at various intervals during the pre- and post-intervention phases of the study, thus before and after the consumption of legumes by the EG. The results for the pre-intervention phase are reported first, starting with the EG and comparing their results with those of the CG. These results are then compared with those obtained for the post-intervention phase, starting with the results for the EG and comparing them with those of the CG. The results for the men and women are reported separately.

4.9.1 Blood analysis results pre- and post-intervention

In terms of blood glucose levels, Figure 4.26 indicates that 47.0% (n=21) of the EG and 36.0% (n=18) of the CG were within the normal blood glucose range (5-6 mmol/l). The EG respondents who had hypoglycaemic levels (≤ 5 mmol/l) comprised 33.0% (n=15) of the EG, while those in the CG comprised 2.0% (n=1). The participants with hyperglycaemic levels (≥ 6 mmol/) comprised 20.0% (n=9) of the EG and 62.0% (n=31) of the CG group.

The results indicated that more respondents had normal glucose levels and no high glucose levels in the EG after the intervention phase, compared to the CG that showed a higher prevalence of high glucose levels (refer to Table 4.12). The EG thus showed improved glucose levels after the intervention programme (for a short-term indicator of blood glucose levels). Remedial action was therefore recommended for the control group and the stabilisation of these participants' blood sugar levels during the study was recommended. However, any follow-up measures were outside the scope of the study. It was important to measure the glucose levels of both groups at different intervals because further tests might have been required to assess their proneness to diabetes and to eliminate further risk. It is reiterated that at-risk participants were advised to attend a clinic or visit a doctor, but any medical treatments were beyond the scope of the study.

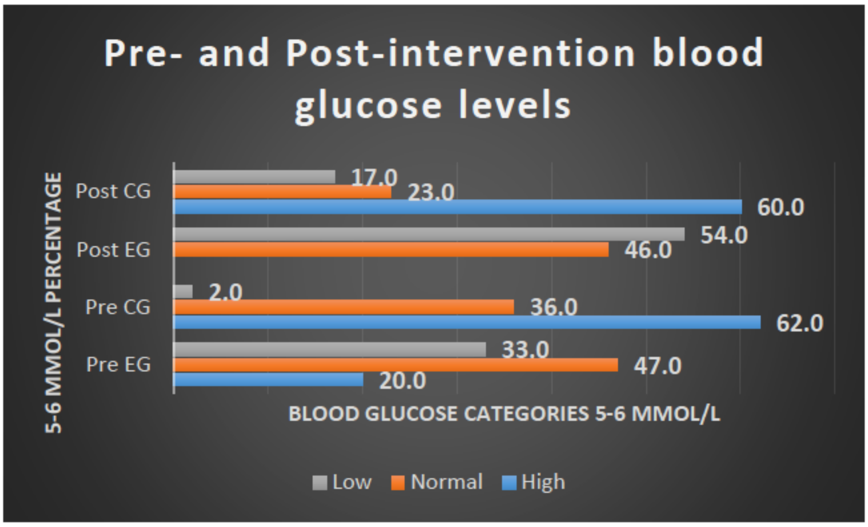

Figure 4.26: Blood glucose levels (Pre-intervention: EG n=53; CG n=50; Post-intervention: EG n=35; CG n=44)

Source for measurement levels: Randox Laboratories Limited, (2015)

4.9.2 Cholesterol levels

The pre-intervention results for the EG showed the blood cholesterol range consistently (Figure 4.27) indicated that 67.0% (n=30) of these respondents was within the normal (<5.17 mmol/l or 200mg/dl) cholesterol range and 38.0% (n=18) of the CG was within this range. This was followed by 22.0% (n=10) of the EG and 27.0% (n=13) of the CG who were in the borderline range (5.17- 6.18 mmol/l or 200-239 mg/dl). High cholesterol levels (≥ 6.20 mmol/l or 240mg/dl) were detected in 11.0% (n=5) of the EG and in 35.0% (n=17) of the CG. These results highlighted the fact that correct food choice and legume consumption interventions were necessary for the borderline and high cholesterol level groups because of the nutritional benefits (associated with lowering cholesterol) cited in the literature (Chapter 2 in section 2.6.3). Consuming legume dishes could thus have benefited at-risk participants (for non-communicable dieases). Although high cholesterol levels were detected particularly in members of the CG, such levels were less prevalent than the risk of developing diabetes (Figure 4.26) in the selected members of this sample of the farming population in the study area. The improved levels of cholesterol in participants from both groups (pre-intervention and post-intervention) indicated more normal levels cholesterol levels (which could be an association between lower cholesterol and reduced hyperglycaemia). For significance values, refer to Table 4.11.

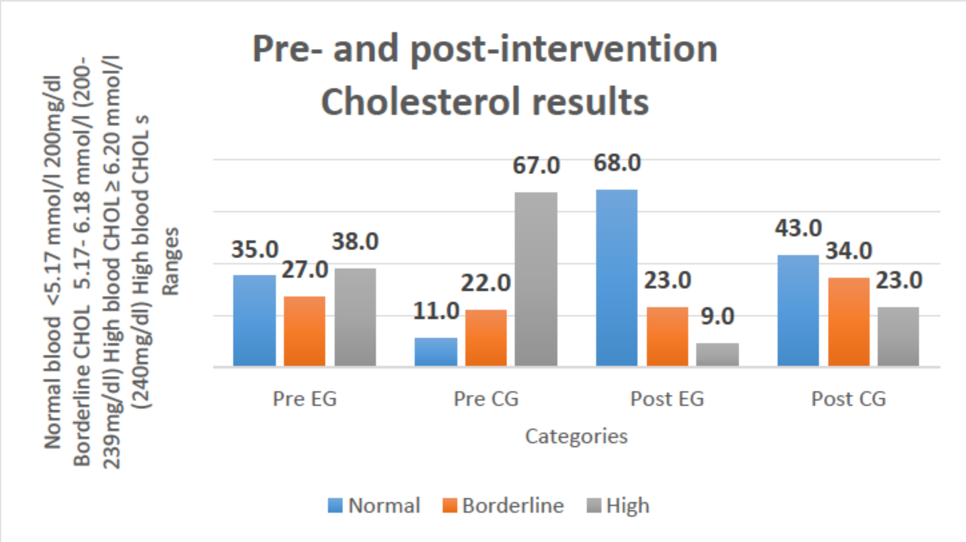

Figure 4.27: Cholesterol results (Pre-intervention: EG n=53 and CG n=50; Post-intervention: EG n=35 and CG n=44)

Source for measurement levels: Randox Laboratories Limited, (2015)

4.9.3 Comparison of variables by group

The results showed a statistically significant (p=0.004) lower mean total cholesterol level in the EG after the intervention programme. This was confirmed by the indication that hyperglycemia had been reduced from 38.0% to 9.0% after the intervention programme in the EG. No significant difference in TC was observed for the CG. The mean glucose levels were significantly (p=0.038) lower after the intervention programme for the EG.

Table 4.11: Mann-Whitney U analysis: Comparison between the EG and the CG for the pre- and post-intervention phases

Group	Pre-Intervention Mean ± SD	Post-Intervention Mean ± SD	*Significance p-value*
GLUCOSE CG **mmol/l**	6.73 ± 4.50	6.94 ± 4.49	0.818
GLUCOSE EG mmol/l	6.66 ± 2.84	5.30 ± 2.86	0.038
CHOLESTEROL CG *mmol/l -200mg/dl*	6.23 ± 2.77	6.30 ± 2.88	0.906
CHOLESTEROL EG *mmol/l- 200mg/dl*	4.39 ± 1.42	2.20 ± 0.48	0.004

*The *p*-value represents the mean value comparison of each group (EG and CG) pre- and post-intervention

4.10 Dietary Intake and Food Consumption Pattern Indicators

The EG sample comprised 39 women (n=39) and 14 men (n=14) pre-intervention and 24 (n=24) women and 11 (n=11) men post-intervention. The CG sample comprised 33 women (n=33) and 17 men (n=17) pre-intervention and 17 women (n=17) and 29 men (n=29) post-intervention. All the data in the discussion below can be verified by referring to Table 4.15 (pre-intervention) and Table 4.16 (post-intervention).

4.10.1 Pre-intervention data for men (EG and CG)

The total energy intake by both the EG and CG men was low at pre-intervention (4729.46 ± 1290.86 kJ and 2860.31 ± 1373.39 kJ respectively) (Roza *et al.*, 1984).

The protein EAR was below the EAR (56 g) for the majority of the men, with a mean intake of 38.2 g (± 16.7) for the EG and 20.4 g (± 0.9) for the CG, indicating that lower protein intake occurred in the CG than in the EG. Carbohydrate intakes for the EG men (100.0% [n=14]) was at 170.0 g ± 53.5 g, which further underscored a high macronutrient intake pattern amongst the EG respondents. All the men in both groups had a low dietary fibre (30 g AI) intake (EG 14.4 g ± 5.7 g and CG 7.73 g ± 4.5 g).

Overall, the men in both groups had poor micronutrient intakes as 100.0% did not meet the EARs for Ca, Mg, Se, Iron, Vitamin A, biotin, and Vitamin D before the intervention programme. In addition, the majority of the men in both groups had inadequate intakes for all the other micronutrients, except for dietary iron, Vitamin B3 and Vitmain B6 in the EG (Table 4.12).

Table 4.12: Pre-intervention data for the EG and the CG: Results of nutrient adequacy ratios (NARs) and % of respondents below the DRI values (sourced from the average of three 24-hour food recall surveys for men). The two groups are reported separately (EG n=14; CG n=17) (IoM, 2003, 2001, 2003, 2005, 2006; 2010, NICUS 2003)

Nutrients /day	EG Men (n=14) Mean ± SD	EG Men NARs Mean % of the DRIs	EG % Men consuming <100% of the DRIs	CG Men (n=17) Mean ± SD	CG Men NARs Mean % of the DRIs	CG % Men consuming <100% of DRIs	DRI for ♂men
Energy (kJ) EER	4729.46 ± 1290.86	98.2	35.7 %	2860.31 ± 1373.39	59.4	70.5%	♂4815.55 ± 1545.68 kJ
Total protein (g)	38.29 ± 16.78	68.3	92.9%	20.45 ± 9.01	35.5	100.0%	♂56 RDA
Carbohydrates (g)	170.07 ± 53.58	170.7	0.0%	102.79 ± 49.20	102.7	52.9%	♂100 EAR
Total dietary fibre (g)	14.44 ± 5.798	48.1	100.0%	7.73 ± 4.532	25.7	100.0%	♂30 AI
Minerals and Vitamins							
Calcium (mg)	188.81 ± 125.16	15.7	100.0%	109.17 ± 85.56	9.1	100.0%	♂1200 AI
Iron (mg)	10.28 ± 3.00	171.3	14.3%	5.39 ± 2.95	89.8	64.7%	♂6.0 EAR
Magnesium (mg)	145.25 ± 44.20	41.5	100.0%	76.47 ± 36.078	21.8	100.0%	♂350 EAR
Phosphorus	540.07 ±	93.11	57.1 %	296.85 ±	51.1	94.1%	♂580 EAR

Table 4.12: Continued

(mg)	173.757			143.77			♀580 EAR
Zinc (mg)	8.39 ± 3.08	89.2	64.3%	3.96 ± 1.98	42.1	100.0%	♂9.4 EAR
Selenium (µg)	12.14 ± 7.69	26.9	100.0%	5.51 ± 4.36	12.2	100.0%	♂45 EAR
Iodine (µg)	6.73 ± 6.26	14.9	100.0%	5.51 ± 4.36	12.2	100.0%	♂45 EAR
Sodium (mg)	844.72 ± 319.26	422.6	100.%	383.31 ± 233.46	191.6	23.5%	♂200 EAR
Vitamin A (µg)	268.76 ± 94.65	43	100.0%	182.36 ± 133.23	29.1	100.0%	♂625 EAR
Thiamine (mg) (Vit B1)	1.00 ± 0.317	100	64.3%	0.49 ± 0.280	49.0	94.1%	♂1.0 EAR
Riboflavin (mg)	0.64 ± 0.306	58.1	92.9%	0.28 ± 0.144	25.4	100.0%	♂1.1 EAR
Niacin (mg) (Vit B3)	15.89 ± 5.788	132.4	35.7%	7.55 ± 3.884	62.9	88.2%	♂12 EAR
Vitamin B6 (mg)	2.47 ± 0.934	176.2	0.0%	0.93 ± 0.667	66.4	70.5%	♂1.4 EAR
Folate (µg)	311.04 ± 96.60	97.2	57.1%	157.93 ± 94.78	49.3	94.1%	♂320 EAR
Vitamin B12 (µg)	1.37 ± 1.55	68.5	78.6%	0.99 ± 1.68	49.5	82.4%	♂2.0 EAR
Pantothenate (mg)	3.03 ± 1.45	60.6	85.7%	1.77± 1.10	35.4	100.0%	♂5.0 AI

Table 4.12: Continued

Biotin (µg)	17.83 ± 6.01	59.4	100.0%	8.12 ± 4.48	27.1	100.0%	♂30 AI
Vitamin C (mg)	22.95 ± 14.53	30 6	100.0%	31.49 ± 40.81	41.9	88.2%	♂75 EAR
Vitamin D (IU)	64.80 ± 53.2	16 2	100.0%	39.60 ± 54.00	9.9	100.0%	♂♀ 400 IU
Vitamin E (mg)	5.69 ± 2.39	47.4	100.0%	4.00 ± 4.15	33.3	100.0%	♂12 EAR
Vitamin K (µg)	21.40 ± 36.16	17.8	92.9%	66.49 ± 99.68	55.4	76.5%	♂120 AI

EER: Estimated Energy Requirement (Institute of Medicine. 2003)

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

EAR: Estimated Average Requirement

RDA: Recommended Dietary Allowance

NAR: Nutrient Adequacy Ratio

Estimated Energy Requirement (EER) and Basal Metabolic Rate (BMR) calculations ♂ Men

4.10.2 Post-intervention data for men (EG and CG) after the consumption of legumes

Intake for the EG men was 5255.45 ± 1954.55 kJ, while it was 6942.03 ± 1398.65 kJ for the CG. This was within the required EER (5188.34 ± 1452.19 kJ) (Roza *et al*., 1984). Both groups of men, particularly the CG, had higher energy intakes during the post-intervention as compared to the pre-intervention phase.

These findings suggest that the male farmers continued to ingest food with high total energy values (kJ) even in the post-intervention period. The mean protein intake increased in both groups, but was lower for the EG (48.0 g ± 20.5 g) than the CG (52.7 g ± 15.0 g) post-intervention. A similar trend was observed for dietary fibre. A consistently high CHO intake was observed for both groups post-intervention.

Consistently low micronutrient intakes were observed in both groups after the intervention programme. However, those micronutrients for which inadequate intakes were observed by all the men were only Ca, Mg, Vitamin B12, Biotin and Vitmain D for the EG, compared to Ca, Mg and Iron for the CG. Although a high dietary iron intake was observed for the EG pre- and post- intervention, a larger percentage of these men (36.4%) showed inadequate iron intake post- intervention as compared to pre-intervention (14.3%). The opposite was observed for the CG in terms of dietary iron intake.

Table 4.13: Post-intervention data for the EG and CG after legume consumption: Dietary intake, nutrient adequacy ratios (NARs) and % of respondents below the DRI values (sourced from the average of three 24-hour food recall surveys for men). The two groups are reported separately (EG n=11; CG n=17) (IoM, 2001, 2003, 2005, 2006; 2010, NICUS 2003)

Nutrients /day	EG Men (n=11) Mean ± SD	EG Men NARs Mean % of the DRI	EG % Men consuming <100% of the DRI	CG Men (n=17) Mean ± SD	CG Men NARs Mean % of the DRI	CG % Men consuming <100% of the DRI	DRI ♂men
Energy (kJ) EER	5255.45 ± 1954.55	101.2	45.5%	6942.03 ± 1398.65	133.0	17.6%	♂ 5188.34 ± 1452.19
Total protein (g)	48.09 ± 20.56	85.8	72.2%	52.73 ± 15.00	68.3	94.1%	♂56 RDA
Total fat (g)	33.67 ± 16.08	33.6	50.0%	37.39 ± 14.76	25.5	17.6%	♂100 EAR
Carbohydrates (g)	167.91 ± 63.54	167.9	18.2%	251.58 ± 44.95	170.7	0.0%	♂100 EAR
Total dietary fibre (g)	19.93 ± 8.38	66.4	36.3%	22.70 ± 6.58	48.1	17.6%	♂30 AI
Minerals and Vitamins							
Calcium (mg)	260.72± 130.36	21.7	100.0%	340.47 ± 170.55	15.7	100.0%	♂1200 AI
Iron (mg)	11.91 ± 5.68	198.5	36.4%	14.05 ± 3.24	171.3	47.0%	♂6.0 EAR
Magnesium (mg)	188.51 ± 82.65	53.8	100.0%	213.97 ± 46.38	41.5	100.0%	♂350 EAR
Phosphorus (mg)	665.26 ± 220.43	114.7	45.4%	839.85 ± 230.44	93.11	5.8 %	♂580 EAR

Table 4.13: Continued

Zinc (mg)	7.92 ± 3.15	84.2	72.7%	10.14 ± 2.53	89.2	70.0%	♂9.4 EAR
Selenium (µg)	19.11 ± 14.08	42.4	90.9%	21.42 ± 16.79	26.9	90.0%	♂45 EAR
Iodine (µg)	51.18 ± 40.63	53.8	81.8%	6.93 ± 6.36	9.1	100.0%	♂95 EAR
Sodium (mg)	1190.18 ± 816.10	595.1	9.1%	971.40 ± 527.09	485.7	0.0%	♂200 EAR
Vitamin A (µg)	349.08 ± 203.07	55.8	81.1%	908.02 ± 918.38	43.0	70.0%	♂625 EAR
Thiamine (mg) Vit B1	1.00 ± 0.35	100	45.5%	1.30 ± 0.31	100	20.0%	♂1.0 EAR
Riboflavin (mg)	0.62 ± 0.24	56.3	100.0%	0.92 ± 0.36	58.1	64.7%	♂1.1 EAR
Niacin (mg) Vit B3	15.65 ± 8.20	130.4	54.5%	20.14 ± 5.78	132.4	0.0%	♂12 EAR
Vitamin B6 (mg)	1.96 ± 1.23	140.0	36.4%	2.46 ± 1.10	176.2	5.8%	♂1.4 EAR
Folate (µg)	324.49 ± 155.46	101.0	54.5%	410.32 ± 168.45	97.2	29.4%	♂320 EAR
Vitamin B12 (µg)	1.65 ± 1.43	82.5	81.8%	4.82 ± 6.29	68.5	52.9%	♂2.0 EAR
Pantothenate (mg)	5.25 ± 3.12	105.0	63.6%	5.46 ± 2.66	60.6	58.8%	♂5.0 AI
Biotin (µg)	20.59 ± 8.10	68.6	100.0%	37.50 ± 17.08	59.4	29.4%	♂30 AI
Vitamin C (mg)	34.45 ± 19.97	45.9	90.9%	53.17 ± 30.38	30.6	88.2%	♂75 EAR

Table 4.13: Continued

Vitamin D (IU)	88.40 ± 79.60	22.1	100.0%	121.19± 153.60	30 2	76.4%	♂♀ 400 IU
Vitamin E (mg)	8.82 ± 4.97	73.5	63.6%	9.26 ± 3.97	47.4	70.5%	♂12 EAR
Vitamin K (µg)	148.75 ± 407.60	123.9	0.0%	200.38 ± 179.15	166.9	58.8%	♂120 AI

EER: Estimated Energy Requirement (Institute of Medicine. 2003)

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

EAR: Estimated Average Requirement

RDA: Recommended Dietary Allowance

DRI: Daily Recommended Intake

NAR: Nutrient Adequacy Ratio

Estimated Energy Requirement (EER) on physical activity level (PAL) calculations ♂Men

4.10.3 Pre-intervention data for women: EG and CG

The women of the EG consumed 4010.83 ± 1300.89 kJ whilst the CG women consumed 3495.34 ± 1907.44 kJ compared to the requirement (EER) of 6212.05 ± 1255.75 EER (Roza *et al*., 1984). Both groups of women had lower intakes compared to the EER, particularly the CG.

The overall dietary nutrient intakes showed inadequate mean intakes for most nutrients by both groups of women at pre-intervention, except for dietary iron, Vitamin B3 and B6. In addition, the EG and CG group also showed adequate intakes of CHO and Vitamin B12. However, despite mean adequate intakes of these nutrients, not all the women met the EAR as large percentages still showed inadequate intakes, namely 33.3% for CHO; 24.2% for dietary Fe; 18.2% for Vitamin B3 and 28.2% for B12 in the EG as compared to 33.3%, 48.5%, 33.3% and 75.8% for dietary Fe, Vitamin B3, B6 and B12, respectively in the CG. Similar to the men, none of the women met the Ca, Mg and Vitmain D requirements (Table 4.17).

Table 4.14: Pre-intervention data for women in the EG and CG: Results of nutrient adequacy ratios (NARs) and % of respondents below the DRI values (sourced from the average of three 24-hour food recall surveys for women). The two groups are reported separately (EG n=39; CG n=33) (IoM, 2001, 2003, 2005, 2006; 2010, NICUS 2003)

Nutrients /day	EG Women (n=39) Mean ± SD	EG Women NARs Mean % of the DRI	EG % Women consuming <100% of the DRI	CG Women (n=33) Mean ± SD	CG Women NARS Mean % of the DRIs	CG % Women consuming <100% of DRIs	DRI for ♀women
Energy (kJ) EER	4010.83 ± 1300.89	64.6	46.2%	3495.34 ± 1907.44	56.3	48.5%	♀6212.05 ± 1255.75 kJ
Total protein (g)	32.28 ± 11.52	70.1	90.9%	29.58 ± 14.51	64.4	51.5%	♀46 RDA
Carbohydrates (g)	139.64 ± 55.16	139.6	33.3%	119.33 ± 45.84	34.6	51.5%	♀100 EAR
Total dietary fibre (g)	11.36 ± 4.56	54.0	97.4%	9.76 ± 5.17	46.4	93.9%	♀21 AI
Minerals and Vitamins							
Calcium (mg)	207.97 ± 157.10	17.3	100.0%	148.14 ± 105.57	12.3	100.0%	♀1200 AI
Iron (mg)	8.25 ± 3.44	165.0	24.2%	7.14 ± 3.20	142.8	33.3%	♀5.0 EAR
Magnesium (mg)	124.80 ± 46.84	47.0	100.0%	110.83 ± 45.76	42.6	100.0%	♀265 EAR
Phosphorus (mg)	470.27 ± 179.21	81.0	71.7%	402.95 ± 180.69	69.4	90.9%	♀580 EAR
Zinc (mg)	6.47 ± 2.84	95.1	46.2%	5.82 ± 2.99	85.5	57.6%	♀6.8 EAR

Table 4.14: Continued

Selenium (µg)	11.90 ± 8.88	26.4	100.0%	9.45 ± 8.83	21.0	96.9%	♀45 EAR
Iodine (µg)	17.57± 17.45	18.4	100%	11.50 ± 10.35	12.1	100.0%	♀95 EAR
Sodium (mg)	628.96 ± 412.52	314.4	6.1%	782.93± 412.52	391.4	2.0%	♀200 EAR
Vitamin A (µg)	289.39 ± 175.64	57.8	94.0%	352.70 ± 983.67	70.5	96.9%	♀500 EAR
Thiamine (mg) Vit B1	0.77 ± 0.31	85.5	53.8%	0.65 ± 0.33	72.2	87.9%	♀0.9 EAR
Riboflavin (mg)	0.55± 0.33	61.1	84.8%	0.46 ± 0.43	51.1	96.9%	♀0.9 EAR
Niacin (mg) Vit B3	13.36 ± 5.80	121.4	18.2%	11.38 ± 6.27	103.4	48.5%	♀11 EAR
Vitamin B6 (mg)	1.91 ± 1.21	146.9	28.2%	1.57 ± 0.98	120.7	33.3%	♀1.3 EAR
Folate (µg)	228.74 ± 103.92	71.4	71.8%	199.30 ± 109.42	62.2	87.9%	♀320 EAR
Vitamin B12 (µg)	1.12 ± 0.89	56.0	84.6%	3.20 ± 9.85	160.0	75.8%	♀2.0 EAR
Pantothenate (mg)	3.17 ± 1.71	63.4	82.0%	2.61 ± 1.83	52.2	93.9%	♀5.0 AI
Biotin (µg)	14.70 ± 5.00	49.0	100.0%	12.56 ± 7.01	41.8	93.9%	♀30 AI
Vitamin C (mg)	28.73 ± 35.20	47.8	84.6%	37.28 ± 43.11	62.1	81.8%	♀60 EAR
Vitamin D (IU)	72.8 ± 79.6	18.2	100.0%	60.4 ± 69.6	15.1	100.0%	♂♀ 400 IU

Table 4.14: Continued

Vitamin E (mg)	5.96 ± 3.70	49.6	87.9%	4.73± 3.01	39.4	96.9%	♀12 EAR
Vitamin K (µg)	74.72 ± 104.10	83.0	63.6%	33.80 ± 62.96	37.5	84.8%	♀90 AI

EER: Estimated Energy Requirement (Institute of Medicine, 2003), AI: Adequate Intake used where EAR (Estimated Average Req irement) is not available

EAR: Estimated Average Requirement, RDA: Recommended Dietary Allowance, DRI: Daily Recommended Intake, NAR: Nutrient Adequacy Ratio

Estimated Energy Requirement (EER) and Basal Metabolic Rate (BMR) calculations ♀Women

4.10.4 Post-intervention results for women (EG and CG)

The intake by the EG women was 5939.90 ± 2313.60 kJ whilst that by the CG was 3595.34 ± 2007.44 kJ compared to the required EER (kJ) for the total group of 6400.80 ± 1214.64 kJ (Roza *et al*., 1984). Even though both groups were below the EER, the EG women had a higher intake during the post-intervention compared to pre-intervention, as well as a much higher intake than the CG. A similar trend was observed for protein intake. The intake by the EG was 59.9 g ± 30.6 g, while the intake for the CG was 41.0 ±18.3 g. This suggested that protein consumption was on the increase among these farmers. Low fibre intake was observed for both groups during the post-intervention survey.

Micronutrient intake remained low for calcium and vitamin D for 100.0% of both groups. Interestingly, nutrient intakes for Vitamin B1 (87.9%) and riboflavin (96.9%) measured lower post-intervention than pre-intervention. The EG had improved iron, phosphorus, zinc, riboflavin, and Vitamin B12 intakes after intervention at rates of 100%, 29.1%, 16.6%, 66.7% and 62.5%, respectively.

Table 4.15: **Post-intervention results for the women in the EG and the CG: Dietary intake, nutrient adequacy ratios (NARs) and % of respondents below DRI values (sourced from the average of three 24-hour Food Recall survey for women. The data for the groups are reported separately (EG n=24; CG n=3) (IoM, 2001, 2003, 2005, 2006; 2010 & NICUS 2003)**

Nutrients /day	EG Women (n=24) Mean ± SD	EG Women NARs Mean % of the DRI	EG % Women consuming <100% of the DRI	CG Women (n=29) Mean ± SD	CG Women NARS Mean % of the DRIs	CG % Women consuming <100% of DRIs	DRI ♀Women
Energy (kJ) EER	5939.90± 2313.60	97.8	41.7%	3595.34± 2007.44	56.2	51.7%	♀6400.80 ± 1214.64 kJ EG
Total protein (g)	59.95± 30.62	130.3	29.2 %	41.01 ± 18.30	89.1	34.4%	♀46 RDA
Total fat (g)	43.68± 26.85	43.6	44.0%	42.45 ± 16.54	24.2	41.4%	♀100 EAR
Carbohydrates (g)	177.78 ± 53.23	177.7	4.2%	242.05 ± 45.84	242.0	13.7%	♀100 EAR
Total dietary fibre (g)	16.65 ± 6.46	79.2	70.8%	9.76 ± 5.17	46.4	93.9%	♀21 AI
Minerals and Vitamins							
Calcium (mg)	255.21 ± 144.34	21.2	100.0%	148.14 ± 105.57	12.3	100.0%	♀1200 AI
Iron (mg)	12.02± 4.36	240.4	0.0%	7.14±3.20	142.8	33.3%	♀5.0 EAR
Magnesium (mg)	200.15 ± 81.54	76.9	83.3%	110.83 ± 45.76	42.6	100.0%	♀260 EAR
Phosphorus (mg)	782.92 ± 360.88	134.9	29.1%	402.95 ± 180.69	69.4	90.9%	♀580 EAR

Table 4.15: Continued

Zinc (mg)	10.79 ± 5.21	158.6	16.6%	5.82 ± 2.99	85.5	57.6%	♀6.8 EAR
Selenium (µg)	24.18 ± 17.61	53.7	91.6%	9.45 ± 8.83	21.0	96.9%	♀45 EAR
Iodine (µg)	40.68 ± 40.78	42.8	9.8%	11.50 ± 10.35	12.1	100.0%	♀95 EAR
Sodium (mg)	1291.46 ± 757.62	645.73	0.0%	628.96 ± 412.52	314.4	6.1%	♀200 EAR
Vitamin A (µg)	548.25 ± 795.92	109.6	66.7.0%	352.70 ± 983.67	70.5	96.9%	♀500 EAR
Thiamine (mg)	1.16 ± 0.45	128.8	29.1%	0.65 ± 0.33	72.2	87.9%	♀0.9 EAR
Riboflavin (mg)	0.83 ± 0.53	92.2	62.5%	0.46 ± 0.43	51.1	96.9%	♀0.9 EAR
Niacin (mg)	22.31 ± 11.36	202.8	12.5%	11.38 ± 6.27	103.4	10.3%	♀11 EAR
Vitamin B6 (mg)	2.72 ± 1.38	209.2	35.3%	1.57 ± 0.98	120.7	33.3%	♀1.3 EAR
Folate (µg)	310.87 ± 132,79	97.1	12.5%	199.30 ± 109.42	62.2	87.9%	♀320 EAR
Vitamin B12 (µg)	4.24 ± 8.25	212	20.8%	3.20 ± 9.85	160.0	37.9%	♀2.0 EAR
Pantothenate (mg)	6.04 ± 3.85	82.7	41.7%	2.61± 1.83	52.2	93.9%	♀5.0 AI
Biotin (µg)	26.96 ± 12.38	89.8	54.2%	12.56 ± 7.01	41.8	93.9%	♀30 AI
Vitamin C (mg)	26.62 ± 17.02	44.3	95.8%	37.28 ± 43.11	62.1	81.8%	♀60 EAR
Vitamin D (IU)	86.80 ± 101.6	21.7	100.0%	60.4 ± 69.6	15.1	100.0%	♂♀ 400 IU

Table 4.15: Continued

Vitamin E (mg)	7.96 ± 5.35	66.3	83.3%	4.73 ± 3.01	39.4	96.9%	♀12 EAR
Vitamin K (µg)	90.23 ± 126.24	100.2	70.8%	33.80 ± 62.96	37.5	84,8%	♀90 AI

EER: Estimated Energy Requirement (Institute of Medicine, 2003)

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

EAR: Estimated Average Requirement

RDA: Recommended Dietary Allowance

DRI: Daily Recommended Intake

NAR: Nutrient Adequacy Ratio

Estimated Energy Requirement (EER) and Basal Metabolic Rate (BMR) calculations ***♀Women***

4.11 Consumption of Top-20 Food Items

4.11.1 Pre-intervention: Top-20 food items preferred by men

The results of the top-20 most consumed food items by the men (EG and CG) pre-intervention are presented in Table 4.16 A and Table 4.16 B, respectively.

Table 4.16 indicates the top-20 foods consumed by the EG men in the pre-intervention phase ranked by per capita intake. The most consumed foods over three days for this group of men were from the carbohydrate food group and included maize meal (220.95 g ± 18.15 g), which was 1st on the top-20 list. Other foods within the carbohydrate group included bread (78.33 g ± 2.68 g), white rice (50.52 g ± 8.43 g), steamed bread (32.74 g ± 5.75 g), samp and beans (21.43 g ± 7.05 g), sugar (18. 93 g ± 1.64 g) and oats (12.98 g ± 5. 13 g). A similar pattern was detected for the CG: maize meal (255. 20 g ± 25.14 g) which was 1st on the top 20 list, rice (108.29 g ± 11. 93 g), bread (99. 80 g ± 8. 55 g), samp and beans (56. 47 g ± 13.19 g) and lastly sugar (21.20 g ± 0.95 g), which was 11th. Tea intake was high on the list (134.05 g ± 8.72 g) in 3rd place.

Protein-rich foods included milk (62.50 g ± 3.67 g), chicken curry (36.71 g ± 11.16 g) which was 6th, beef curry (27.98 g ± 1.08 g), sugar beans (15.71 g ± 1.17 g) 11th, fried egg (10.60 g ± 3.95 g), chicken fried in batter (7.14 g ± 0.48 g) and canned baked beans (6.07 g ± 2.38 g). The protein range for the CG included similar proteins except for pilchards (14.22 g ± 0.54 g) which was 12th on the top-20 list for this group of men.

The EG group's fruit and vegetable consumption included cabbage (4.64 g ± 1.61 g) 16th and vegetable curry (2.86 g ± 0.55 g) 18th. The CG had vegetable curry (9.51 g ± 0.46 g) 15th and spinach (6.47 g ± 2.38 g) 16th at slightly higher intakes. Other food items for the EG included gravy (3.57 g ± 0.52 g) 17th, jam (1.79 g ± 0.57 g) 19th and margarine (1.67 g± 0.50 g) 20th. These foods were also consumed by the CG, who also consumed orange juice (68.63 g ± 10.20 g) 6th, scones (11. 76 g ± 2.18 g) 13th and biscuits (3. 82 g ± 1.33 g) 19th.

Table 4.16 A: EG men's top-20 consumed food items (ranked by frequency as measured by three 24-hour food recall questionnaires) (n=14)

No	Item	Mean *frequency (number of times consumed) (n)	Total group intake over 3 days (g)	Mean total intake over 3 days (g ± SD)	Mean intake per frequency (g ± SD)	Mean per capita intake per day (g ± SD)
1	Maize meal porridge	13	9280.00	3093.33±254.09	77.33±10.21	220.95±18.15
2	Tea	7	5630.00	1876.67±122.13	81.59±4.48	134.05±8.72
3	Brown bread (fortified)	11	3290.00	1096.67±37.47	32.25±4.89	78.33±2.68
4	Full cream milk	7	2625.00	875.00±51.34	41.67±15.52	62.50±3.67
5	White rice	7	2122.00	707.33±117.98	39.30±5.58	50.52±8.43
6	Chicken curry	6	1542.00	514.00±156.20	28.56±19.94	36.71±11.16
7	Steamed bread	5	1375.00	458.33±80.46	65.48±24.73	32.74±5.75
8	Beef curry	4	1175.00	391.67±15.12	39.17±3.09	27.98±1.08
9	Samp and beans	2	900.00	300.00±98.66	42.86±13.88	21.43±7.05
10	Brown sugar	12	795.00	265.00±22.91	7.36±1.29	18.93±1.64
11	Sugar bean curry	2	660.00	220.00±16.41	27.50±14.18	15.71±1.17
12	Oats porridge	2	545.00	181.67±71.89	45.42±25.62	12.98±5.13
13	Egg fried	1	445.00	148.33±55.29	29.67±20.21	10.60±3.95
14	Fried chicken batter dipped	1	300.00	100.00±6.67	33.33±6.67	7.14±0.48
15	Baked beans (canned in tomato sauce)	1	255.00	85.00±33.29	7.08±18.21	6.07±2.38
16	Cabbage stew or curry	1	195.00	65.00±22.55	16.25±10.41	4.64±1.61
17	Soup made with gravy powder	2	150.00	50.00±7.26	7.14±4.21	3.57±0.52
18	Vegetable curry	2	120.00	40.00±7.64	5.71±0.64	2.86±0.55
19	Jam/Marmalade	1	75.00	25.00±8.02	5.00±2.87	1.79±0.57
20	Margarine	2	70.00	23.33±4.19	2.92±0.29	1.67±0.30

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable

Table 4.16 B: CG men's top-20 consumed food items (ranked by frequency as measured by three 24-hour food recall questionnaires) (n=17)

No	Item	Mean *frequency (number of times consumed) (n)	Total group intake over 3 days (g)	Mean total intake over 3 days (g ± SD)	Mean intake per frequency (g ± SD)	Mean per capita intake per day (g ± SD)
1	Maize meal porridge	34	13015.00	4338.33±427.31	67.79±5.96	255.20±25.14
2	Tea	28	10165.00	3388.33±44.29	82.64±4.97	199.31±2.61
3	White rice	20	5523.00	1841.00±202.85	36.82±3.93	108.29±11.93
4	Brown bread (fortified)	26	5090.00	1696.67±145.31	38.56±4.56	99.80±8.55
5	Chicken stew or curry	16	3900.00	1300.00±164.58	40.63±4.07	76.47±9.68
6	Orange juice diluted	7	3500.00	1166.67±173.47	89.74±8.02	68.63±10.20
7	Samp and beans	6	2880.00	960.00±224.30	96.00±18.87	56.47±13.19
8	Full cream milk	18	2699.00	899.67±194.95	35.99±20.17	52.92±11.47
9	Beef stew or curry	3	1905.00	635.00±116.23	33.42±5.42	37.35±6.84
10	Brown sugar	26	1081.00	360.33±16.07	5.54±0.74	21.20±0.95
11	Sugar bean curry	7	785.00	261.67±11.82	21.81±19.19	15.39±0.70
12	Pilchard in tomato sauce	6	725.00	241.67±9.18	34.52±6.82	14.22±0.54
13	Scone, plain	3	600.00	200.00±37.12	40.00±12.62	11.76±2.18
14	Soup made with gravy powder	7	535.00	178.33±43.92	8.92±3.37	10.49±2.58
15	Vegetable curry	9	485.00	161.67±7.88	8.08±1.79	9.51±0.46
16	Spinach. sautéed	4	330.00	110.00±40.41	22.00±15.28	6.47±2.38
17	Baked beans (canned in tomato sauce)	4	325.00	108.33±15.12	18.06±1.73	6.37±0.89
18	Jam/marmalade	2	264.00	88.00±38.80	17.60±10.63	5.18±2.28
19	Biscuits	2	195.00	65.00±22.55	21.67±12.33	3.82±1.33
20	Margarine	2	165.00	55.00±11.67	3.93±0.48	3.24±0.69

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable

4.11.2 Post-intervention survey: The top-20 food items preferred by men (EG and CG)

The results for the men's top-20 most consumed food items post-intervention are presented in Tables 4.17 A (EG) and 4.17 B (CG).

The highest mean per capita intake of a food over three days by the EG men fell in the carbohydrate food group, which was maize meal (80.94 g ± 36.46 g), followed by non carbohydrate item which was tea (46.94 g ± 16.88 g). Other foods within the carbohydrate group included white rice (19.11 g ± 16.07 g), bread (16.44 g ± 6.30 g), macaroni and cheese (13.33 g ± 9.80 g), samp (11.56 g ± 3.27 g), steamed bread (7.28 g ± 2.36 g), and sugar (3.39 g ± 1.18 g). The results post-intervention indicated a much lower mean per capita intake of carbohydrates than post-intervention by the EG. However, the CG had higher carbohydrate intakes, especially maize meal (469.22 g ± 25.71 g) and white rice (164. 41 g ± 17.24 g) pre-intervention as compared to the EG post- intervention.

The protein food group intake was more diverse and more legume varieties were consumed. Mixed bean stew (38.28 g ± 19.35 g) was the main protein intake for the EG, and was 4th on the top-20 list. This was followed by chicken curry (10.83 g ± 4.13 g), milk (7.72 g ± 3.36 g), roast chicken (7.56 g ± 5.15 g), beef roast (5.61 g ± 2.98 g), egg (5.50 g ± 2.98 g), beef curry (4.14 g ± 0.72 g), three bean salad (4.00 g ± 3.61 g) and sugar beans (3.50 g ± 0.29 g). The animal protein intake was much lower for the EG post-intervention. In comparison with the CG, chicken consumption increased (83.92 g ± 12.75 g; 4th) as chicken curry and 30.00 g ± 4.59 g as roast chicken 10th. Next came pilchards (26.27 g ± 0.88 g; 11th). Legumes were infrequently consumed to the pre-intervention survey. These data indicate a much richer animal source diet for the CG than the EG.

Fruit and vegetable intakes were cabbage (33.14 g ± 8.49 g; 9th), spinach (23.24 g ± 6.46 g; 12th), banana (12.06 g ± 4.65 g; 14th), potato (9.90 g ± 1.87 g; 15th) and others such as tomato and onion, onion in gravy and butternut, while only vegetable curry was consumed by the EG (3.28 g ± 2.65 g; 19th) indicated more prevalent intakes for the CG. Squash drinks and margarine were consumed in equal amounts by the two groups.

Table 4.17 A: Post-intervention: Top-20 food items consumed by EG men (ranked by frequency consumed as measured by three 24-hour recall questionnaires) (n=10)

No	Item	Mean *frequency (number of times consumed) (n)	Total group intake over 3 days (g)	Mean total intake over 3 days (g ± SD)	Mean intake per frequency (g ± SD)	Mean per capita intake per day (g ± SD)
1	Maize meal porridge	10	7285.00	809.44±364.59	24.53±16.41	80.94±36.46
2	Tea	5	4225.00	469.44±168.81	27.61±0.60	46.94±16.88
3	Mixed bean stew	4[11]	3445.00	382.78±193.49	29.44±20.93	38.28±19.35
4	Diluted squash cold drink	4	3000.00	333.33±101.04	27.78±4.94	33.33±10.10
5	White rice	3	1720.00	191.11±160.73	17.37±25.01	19.11±16.07
6	Brown bread (fortified)	5	1480.00	164.44±63.01	10.28±6.19	16.44±6.30
7	Macaroni & cheese	1	1200.00	133.33±0.00	22.22±0.00	13.33±0.00
8	Samp and beans	1	1040.00	115.56±32.72	14.44±25.66	11.56±3.27
9	Chicken stew or curry	2	975.00	108.33±41.26	13.54±8.03	10.83±4.13
10	Full cream milk	2	695.00	77.22±33.55	11.03±7.29	7.72±3.36
11	Chicken roasted	2	680.00	75.56±51.54	12.59±14.07	7.56±5.15
12	Steamed bread	1	655.00	72.78±23.59	18.19±5.36	7.28±2.36
13	Beef stew or curried	1	505.00	56.11±29.83	11.22±8.66	5.61±2.98
14	Egg fried	1	495.00	55.00±31.75	11.00±10.58	5.50±3.18
15	Beef stew or curry	1	410.00	136.67±3.85	45.56±3.85	4.14±0.12
16	Three bean salad	1	360.00	40.00±36.06	10.00±18.03	4.00±3.61
17	Sugar bean curry	1	315.00	35.00±2.89	8.75±8.18	3.50±0.29
18	Brown sugar	8	305.00	33.89±11.82	1.36±1.02	3.39±1.18
19	Vegetable curry	2	295.00	32.78±26.48	5.46±6.04	3.28±2.65
20	Margarine	1	35.00	3.89±2.55	0.97±0.96	0.39±0.25

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable

[11] Yellow highlights how much the legumes have moved up in ranking and the frequent appearance of four times within the EG top 20 food list.

Table 4.17 B: Post-intervention: Top-20 food items consumed by CG men (ranked by frequency consumed as measured by three 24-hour recall questionnaires) (n=11)

No	Item	Mean *frequency (number of times consumed) (n)	Total group intake over 3 days (g)	Mean total intake over 3 days (g ± SD)	Mean intake per frequency (g ± SD)	Mean per capita intake per day (g ± SD)
1	Maize meal porridge	24	23930	7976.67±437.14	137.53±6.42	469.22±25.71
2	Tea	13	11250	3750.00±217.94	93.75±2.77	220.59±12.82
3	White rice	11	8385	2795.00±293.10	84.70±3.67	164.41±17.24
4	Chicken stew or curry	5	4280	1426.67±216.78	83.92±12.62	83.92±12.75
5	Brown bread (fortified)	8	2630	876.67±39.77	33.72±1.69	51.57±2.34
6	Full cream milk	13	2410	803.33±18.95	20.08±4.56	47.25±1.11
7	Diluted squash cold drink	3	2350	783.33±149.38	87.04±4.19	46.08±8.79
8	Beef curry	2	1750	583.33±48.11	58.33±17.86	34.31±2.83
9	Cabbage curry	3	1690	563.33±144.39	51.21±34.77	33.14±8.49
10	Chicken roasted	3	1530	510.00±78.10	51.00±8.04	30.00±4.59
11	Pilchards in tomato sauce curry	2	1340	446.67±15.03	63.81±10.34	26.27±0.88
12	Spinach sautéed	4	1185	395.00±109.79	32.92±15.69	23.24±6.46
13	Brown sugar	24	1095	365.00±10.14	5.00±0.63	21.47±0.60
14	Banana fresh	2	615	205.00±79.11	25.63±14.68	12.06±4.65
15	Potato boiled	2	505	168.33±31.81	21.04±1.60	9.90±1.87
16	Egg fried	2	450	150.00±20.28	21.43±10.14	8.82±1.19
17	Tomato and onion stewed (no sugar)	2	440	146.67±30.97	29.33±11.67	8.63±1.82
18	Butternut boiled	2	267	89.16 ± 6.78	14.82± 2.87	5.25± 1.50
19	Onion, in gravy	2	175	58.33±9.48	7.29±1.27	3.43±0.56
20	Margarine	4	100	33.33±4.19	2.78±0.43	1.96±0.25

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable

4.11.3 Pre-intervention: The top-20 food items consumed by women (EG and CG)

Tables 4.18 A and 4.18 B present the data for the top-20 foods consumed by women (EG and CG respectively) pre-intervention. The data are presented with the mean intake over three days and are ranked per capita intake.

The EG women mostly consumed carbohydrates, with maize meal (258.41 g ± 14.55 g) 1st on the top-20 list, followed by a non carbohydrate item which was tea (206.82 g ± 23.49 g). Other foods within the carbohydrate group were bread (118.03 g ± 9.24 g), white rice (90.06 g ± 7.21 g), sugar (31.14 g ± 2.06 g) and steamed bread (31.06 g ± 6.76 g). The women's carbohydrate intake was higher than the men's pre-intervention. The CG women consumed similar quantities of carbohydrates, but with a lower intake of maize meal (141.36 g ± 14.83 g) which was also 1st on the top-20 list, followed by rice (56.87 g ± 6.62 g), bread (30.81 g ± 8.93 g), steamed bread (14.04 g ± 4.12 g) and sugar (12.23 g ± 0.26 g).

The protein rich foods were also consumed at much higher quantities by the women as compared to the men for items, such as milk (104.32 g ± 8.69 g) which was 4th on the top-20 list, chicken curry (69.55 g ± 4.73 g; 6th), sugar beans (18.33 g ± 1.83 g; 11th), and fried egg (15.83 g ± 3.76 g; 13th). Their intakes of beef curry and roast chicken were lower. Similar to the carbohydrate intake, the CG had lower protein intakes compared to EG, except for beef curry (19.24 g ± 3.52 g; 10th).

The fruit and vegetable consumption of the EG included cabbage (15.98 g ± 3.55 g; 12th), spinach (14.62 g ± 0.04 g; 14th), vegetable curry (9.92 g ± 0.88 g; 16th) and banana (7.70 g ± 0.57 g); 18th). The CG had cabbage (25.00 g ± 12.03 g; 8th) and vegetable curry (5.86 g ± 0.67 g; 16th) at slightly higher rates. Other food items for the EG included fruit juice, cold drinks and margarine, while the CG had orange juice and soup powder mixed with water.

Table 4.18 A: Pre-intervention: Top-20 food items consumed by EG women. (ranked by frequency as measured by three 24-hour recall questionnaires) (n=39)

No	Item	Mean *frequency (number of times consumed) (n)	Total group intake over 3 days (g)	Mean total intake over 3 days (g ± SD)	Mean intake per frequency (g ± SD)	Mean per capita intake per day (g ± SD)
1	Maize meal porridge	28	17055.00	5685.00±320.12	67.27±13.60	258.41±14.55
2	Tea	19	13650.00	4550.00±516.73	79.55±2.86	206.82±23.49
3	Brown bread (fortified)	26	7790.00	2596.67±203.32	32.66±3.52	118.03±9.24
4	Full cream milk	18	6885.00	2295.00±191.14	41.32±4.59	104.32±8.69
5	White rice	20	5944.00	1981.33±158.57	32.89±4.28	90.06±7.21
6	Chicken stew or curry	16	4590.00	1530.00±104.04	29.54±6.50	69.55±4.73
7	Fruit juice diluted	7	3520.00	1173.33±48.60	68.91±1.66	53.33±2.21
8	Diluted squash cold drink	3	2815.00	938.33±110.51	94.58±11.91	42.65±5.02
9	Brown sugar	34	2055.00	685.00±45.28	6.64±0.89	31.14±2.06
10	Steamed bread	5	2050.00	683.33±148.67	48.30±8.72	31.06±6.76
11	Sugar bean. curry	6	1210.00	403.33±40.22	20.72±6.42	18.33±1.83
12	Cabbage curry	4	1055.00	351.67±78.20	25.35±2.30	15.98±3.55
13	Egg fried	3	1045.00	348.33±82.67	35.65±1.76	15.83±3.76
14	Spinach, sautéed	4	965.00	321.67±0.96	17.38±3.71	14.62±0.04
15	Beef curry	3	945.00	315.00±41.26	37.33±7.36	14.32±1.88
16	Vegetable curry	9	655.00	218.33±19.32	7.50±0.72	9.92±0.88
17	Soup made with gravy powder	7	643.00	214.33±23.71	9.74±4.41	9.74±1.08
18	Banana fresh	3	475.00	158.33±12.51	15.83±2.26	7.20±0.57
19	Chicken roasted	4	470.00	156.67±45.23	17.41±15.08	7.12±2.06
20	Margarine	11	375.00	125.00±15.90	3.58±0.49	5.68±0.72

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable

Table 4.18 B: Pre-intervention: Top-20 food items consumed by CG women (ranked by frequency and measured by three 24-hour recall questionnaires (n=33)

No	Item	Mean *frequency (number of times consumed) (n)	Total group intake over 3 days (g)	Mean total intake over 3 days (g ± SD)	Mean intake per frequency (g ± SD)	Mean per capita Intake per day (g ± SD)
1	Maize meal porridge	20	13995.00	4665.00±489.31	64.79±1.66	141.36±14.83
2	Tea	12	11940.00	3980.00±203.12	84.68±3.23	120.61±6.16
3	White rice	14	5630.00	1876.67±218.42	35.41±5.52	56.87±6.62
4	Chicken stew or curry	9	4080.00	1360.00±131.48	40.00±4.75	41.21±3.98
5	Orange juice, diluted	3	4000.00	1333.33±267.88	88.89±6.01	40.40±8.12
6	Brown bread (fortified)	12	3050.00	1016.67±294.55	22.59±23.33	30.81±8.93
7	Full cream milk	6	2699.00	899.67±194.95	35.99±20.17	27.26±5.91
8	Cabbage stew	2	2475.00	825.00±396.97	137.50±198.49	25.00±12.03
9	Pilchards canned in tomato sauce curry	2	1978.00	659.33±232.00	94.19±120.36	19.98±7.03
10	Beef curry	6	1905.00	635.00±116.23	33.42±5.42	19.24±3.52
11	Samp and beans	3	1720.00	573.33±182.01	52.12±41.36	17.37±5.52
12	Maltabella porridge	3	1490.00	496.67±117.58	45.15±27.95	15.05±3.56
13	Steamed bread	2	1390.00	463.33±136.07	51.48±38.48	14.04±4.12
14	Brown sugar	19	1211.00	403.67±8.60	5.31±0.55	12.23±0.26
15	Sugar bean curry	2	580.00	193.33±13.47	38.67±27.22	5.86±0.41
16	Vegetable curry	5	580.00	193.33±22.01	7.73±1.20	5.86±0.67
17	Soup made with gravy powder	6	550.00	183.33±46.71	7.97±3.76	5.56±1.42
18	Baked beans canned in tomato sauce	2	545.00	181.67±46.74	20.19±2.85	5.51±1.42
19	Fried chicken (batter dipped)	2	476.00	158.67±88.16	31.73±0.00	4.81±2.67
20	Peanut butter	3	366.00	122.00±27.30	10.17±3.72	3.70±0.83

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable

4.11.4 Post-intervention: Top-20 food items preferred by women (EG and CG)

The post-intervention results for the top-20 foods consumed by the EG and CG women are presented in Tables 4.19 A and 4.19 B, respectively. The EG, carbohydrates ranking showed a lower mean intake of maize meal (127.83 g ± 10.00 g; 1st), white rice (67.28 g ± 13.81 g; 4th), bread (60.51 g ± 4.83 g; 5th), sugar (8.55 g ± 1.08 g; 15th) and tea (91.72 g ± 9.37 g; 2nd). However, the CG had higher intakes post-intervention compared to the pre-intervention survey and against the EG. Maize meal intake was high (450.86 g ± 9.60 g; 1st), followed by rice (137.18 g ± 11.17 g; 3rd), sugar (17.37 g ± 0.50 g; 13th) and tea (212.82 g ± 16.31 g; 2nd).

In the protein group, chicken intake was higher for the CG (98.45 g ± 9.29 g; 4th) even though chicken was highest for the EG in this food group. Mixed legume varieties introduced by the study were also ranked in the top-10 foods post-intervention (24.90 g ± 6.62 g) and ranked 8th on this list. No legume consumption was detected for the women in the CG; however, a much wider fruit and vegetable intake was observed for these women.

Table 4.19 A: Post-intervention: Top-20 food items consumed by EG women (ranked by frequency as measured by three 24-hour recall questionnaires) (n=25)

No	Item	Mean *frequency (number of items consumed) (n)	Total group intake over 3 days (g)	Mean total intake over 3 days (g ± SD)	Mean intake per frequency (g ± SD)	Mean per capita Intake per day (g ± SD)
1	Maize meal porridge	29	12655.00	4218.33±249.95	65.91±18.02	127.83±10.00
2	Tea	17	9080.00	3026.67±234.29	84.07±7.37	91.72±9.37
3	Diluted cold drink squash	10	6695.00	2231.67±178.05	97.03±4.41	67.63±7.12
4	White rice	17	6661.00	2220.33±345.13	55.51±4.47	67.28±13.81
5	Brown bread (fortified)	22	5990.00	1996.67±120.66	38.40±2.49	60.51±4.83
6	Chicken stew or curry	10	4835.00	1611.67±173.12	53.72±10.18	48.84±6.92
7	Macaroni & cheese	3	4795.00	1598.33±308.11	72.65±9.40	48.43±12.32
8	Mixed bean stew[12]	10	2465.00	821.67±165.51	45.65±19.62	24.90±6.62
9	Full cream milk	9	2240.00	746.67±128.98	33.94±10.64	22.63±5.16
10	Chicken, roasted	6	2020,00	673.33±30.93	51.79±10.51	20.40±1.24
11	Samp and beans	3	1400.00	466.67±122.58	46.67±4.10	14.14±4.90
12	Beef stew	3	1295.00	431.67±90.83	53.96±19.34	13.08±3.63
13	Steamed bread	4	1105.00	368.33±50.04	36.83±3.87	11.16±2.00
14	Egg fried	5	880.00	293.33±28.00	29.33±7.00	8.89±1.12
15	Brown sugar	27	846.00	282.00±27.07	4.48±1.09	8.55±1.08
16	Sausage fried	3	635.00	211.67±35.13	26.46±4.50	6.41±1.41
17	Butternut boiled	4	430.00	143.33±16.19	5.12±13.73	4.34±0.65
18	Vegetable curry	3	340.00	113.33±25.89	16.19±10.93	3.43±1.04
19	Potato boiled	3	320.00	106.67±3.85	35.56±3.85	3.23±0.15
20	Margarine	3	145.00	48.33±9.18	3.22±1.00	1.46±0.37

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable

12 Yellow highlights how much the legumes have moved up in ranking and also it frequent appearance of two times within the EG top 20 food list.

Table 4.19 B: Post-intervention: top-20 foods consumed by CG women (ranked by frequency as measured by three 24-hour recall questionnaires) (n=33)

No	Item	Mean *frequency (number of items consumed) (n)	Total group intake over days (g)	Mean total intake over 3 days (g ± SD)	Mean intake per frequency (g ± SD)	Mean per capita intake per day (g ± SD)
1	Maize meal porridge	42	39225	13075.00±278.27	132.07±6.13	450.86±9.60
2	Tea	23	18515	6171.67±473.05	89.44±3.16	212.82±16.31
3	White rice	15	11935	3978.33±323.87	84.65±2.09	137.18±11.17
4	Chicken stew or curry	9	8565	2855.00±269.33	95.17±9.02	98.45±9.29
5	Samp and beans	4	5510	1836.67±433.51	131.19±23.15	63.33±14.95
6	Diluted squash cold drink	6	5230	1743.33±146.30	91.75±7.83	60.11±5.04
7	Brown bread (fortified)	13	4310	1436.67±125.45	35.04±1.47	49.54±4.33
8	Cabbage stew	9	3375	1125.00±78.58	38.79±13.38	38.79±2.71
9	Full cream milk	18	2939	979.67±81.98	16.60±4.20	33.78±2.83
10	Beef curry	3	2625	875.00±259.14	72.92±12.08	30.17±8.94
11	Pilchard canned in tomato sauce curry	5	2030	676.67±91.06	48.33±1.92	23.33±3.14
12	Spinach sautéed	4	1655	551.67±82.74	39.40±12.88	19.02±2.85
13	Brown sugar	42	1511	503.67±14.61	3.97±0.06	17.37±0.50
14	Banana fresh	5	1140	380.00±44.81	25.33±0.48	13.10±1.55
15	Sausage fried	4	1055	351.67±38.92	29.31±6.27	12.13±1.34
16	Butternut boiled	3	990	330.00±101.42	30.00±10.32	11.38±3.50
17	Tomato and onion. stew (no sugar)	3	595	198.33±63.52	39.67±22.76	6.84±2.19
18	Margarine	12	260	86.67±3.47	2.41±0.12	2.99±0.12
19	Peanut butter	4	215	71.67±17.24	5.97±1.65	2.47±0.59
20	Lemon juice	3	140	46.67±2.55	4.67±1.21	1.61±0.09

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable

4.12 Nutrient and Energy Intake through the Consumption of Fruit and Vegatables

In terms of fruit and vegetable intake, the results (Table 4.20) indicated that both the men and women were below the recommendations of the WHO (≥400 g) for daily consumption (WHO, 2003). The EG fruit and vegetable average portion size consumed was lower for women (50.1 g) when compared to men (60.6 g), while that of the CG was 43.0 g for men and 55.3 g for women. This was ranked at <20.0% of the daily recommendations for both the EG and the CG gender groups. The findings suggest that the EG was more likely to consume vegetables than fruit. There was also evidence that vegetables were additional ingredients in various dishes (e.g. in curries and stews). The starch bases were mainly maize meal, rice or bread/steamed bread eaten with most meals.

The men in the EG had a higher fruit intake than the men in the CG. These results highlighted the fact that alternative approaches had to be introduced to increase fruit and vegetable intake in recommended portion sizes, as the current nutrient intake was not adequate for these elderly farmers, even though these nutrients were prevalent (albeit in small quantities) in the top-20 food lists of both groups and genders.

The results suggest that fruit and vegetable consumption improved for both groups from the pre- to the post-intervention phase. This result was important as it was an objective of the study to increase fruit and vegetable consumption. However, the CG had a higher fruit and vegetable intake compared with the EG, which could have occurred because the EG may have focused on legume consumption, while neglecting other healthy food sources of healthy eating, such as fruit and vegetables.

Table 4.20: Mean intake of fruit and vegetables per person for both genders determined as an average of three 24-hour food recall questionnaires (Pre-intervention: EG n=53; CG n=50; Post-intervention: EG n=35; CG n=44)

Fruit and Vegetable Intake	Pre-intervention EG Men (n=14)	Pre-intervention EG Women (n=39)	Post-intervention EG Men (n=11)	Post-intervention EG Women (n=24)
Mean intake per person	60.6g	50.1g	70.6g	82.1g
Mean per capita intake (3 days)	99.6	138.7	218.7	338.3
Mean per capita intake per day	33.2g	46.2g	72.9	112.7
Percentage contribution of 400 g	15.2%	12.5%	17.6%	20.5%
Post-intervention: Fruit and vegetable Intake	Pre-intervention CG Men (n=17)	Pre-intervention CG Women (n=33)	Post-intervention CG Men (n=17)	Post-intervention CG Women (n=29)
Mean intake per person	43.0g	55.3g	102.4g	87.8g
Mean per capita intake (3 days)	50.5	83.7	602.5	405.6
Mean per capita intake per day	16.8	27.9	200.8	135.2
Percentage contribution 400 g	10.8%	13.8%	25.6%	21.9%

It is important to relate the summary in Table 4.20 to the data in Tables 4.16 A, 4.16 B, 4.17 A, 4.17 B, 4.18 A, 4.18 B; Table 4.19 A and Table 4.19 B, as these data reflect that fruit and vegetable intake was initially low, with a slight improvement detected in the post-intervention survey.

4.13 Macronutrient Distribution Range

The acceptable macronutrient distribution range (AMDR) (WHO, 2003) was compared with the nutrient intake results (Table 4.21) by averaging the data of three 24-hour food recall questionnaires for the EG and CG. The EG results indicated that the protein energy contribution to total energy intake was 13.8% for men, while it was 13.7% for women. For the CG men it was 12.1% and 14.4% for the women. Fat (10-15%) and carbohydrates (55-75%) intakes were within the recommended ranges for both groups and genders.

The EG men's consumed 15.6% protein sources which was above the recommended range. However, this was an improvement from the pre-intervention results. Fats and carbohydrates were in the normal ranges for both male groups. In comparison to their male counterparts, the EG women also had a higher protein intake (17.1%) and even though the fat contribution was within the recommended range, it was post-intervention (27.2%) slightly higher rather than pre-intervention.

Table 4.21: Pre- and post-intervention comparisons of energy distribution through macronutrient intake (Pre-intervention: EG n=53; CG n=50; Post-intervention: EG n=35; CG n=44)

Pre-intervention Macronutrients EG (n=53)	Mean ± SD	Mean total energy intake % contribution	Mean ± SD CG (n=50)	Mean total energy intake % contribution	WHO goal
Men - (n=14)			**Men - (n=17)**		
Protein (g)	**38.29 ± 16.78**	**13.8**	**20.45 ± 9.01**	**12.1**	10-15 %
Fat (g)	**25.51 ± 12.83**	**19.9**	**17.14 ± 10.82**	**22.2**	15-30 %
Carbohydrate & fibre (g)	**184.54 ± 59.40**	**66.3**	**110.52 ± 53.70**	**65.7**	55-75 %
Women - (n=39)			**Women - (n=33)**		
Protein (g)	**32.28 ± 11.52**	**13.7**	**29.58 ± 14.51**	**14.4**	10-15 %
Fat (g)	**24.20 ± 11.28**	**22.3**	**21.60 ± 12.00**	**22.8**	15-30 %
Carbohydrate & fibre (g)	**151.00 ± 59.72**	**64.0**	**129.09 ± 50.94**	**62.8**	55-75 %
Men - (n=11) EG			**Men - (n=17) CG**		
Protein (g)	**48.09 ± 20.56**	**15.6**	52.73 ± 15.00	**12.9**	10-15 %
Fat (g)	**33.67 ± 16.08**	**23.7**	37.39 ± 14.76	**19.9**	15-30 %

Table 4.21: Continued

Carbohydrate & fibre (g)	187.84 ± 71.92	60.7	274.28 ± 51.53	67.2	55-75 %
Women – (n=24) EG			Women - (n=29) CG		
Protein (g)	59.95 ± 30.62	17.1	59.30 ± 22.56	14.3	10-15 %
Fat (g)	43.68 ± 26.85	27.2	42.45 ± 16.54	22.2	15-30 %
Carbohydrate & fibre (g)	194.43 ± 59.6	55.7	264.29 ± 56.45	63.5	55-75 %

Source for acceptable macronutrient distribution range (AMDR): WHO, (2003)

It is important to relate the summary in Table 4.20 to the data in Tables 4.16 A, 4.16 B, 4.17 A, 4.17 B, 4.18 A, 4.18 B; Table 4.19 A and Table 4.19 B as the data indicate that these macronutrients (like carbohydrates and proteins groups) had high rates of consumption and that their intake was therefore within the WHO goals. A higher protein intake (17.1%) by the EG women was detected post-intervention.

4.14 Food Intake Frequencies and Diversity Scores

4.14.1 Pre-intervention: EG food diversity scores

Table 4.22 reports that the pre-intervention food group diversity score (FGDS) of the EG for the total number of individual food items consumed over the seven days prior to the survey was 90. The pre-intervention results for the EG (futher to be explained in Table 4.26) indicated that the mean FVS of food items consumed across all the food groups over a period of seven days was 42.8 (± 18.90). The majority (66.0% [n=35]) of the participants consumed 30-60 different food items, which reflected moderate food variety.

Table 4.22: Pre-intervention: EG household food group diversity for men and women of food consumed over a period of one week (n=53)

Meat Group n=4	Egg Group n=1	Dairy Group n=9	Cereal Group n=5	Legume Group n=7	Vitamin A Rich Group n=8	Fruit Group n=19	Vegetable Group n=16	Fat Group n=5	Total Individual Food Items Eaten by the Group n=90
0=00	0=09	0=00	0=00	0=00	0=00	0=00	0=00	0=00	<30= 10
1=33	1=44	1=41	1=30	1=44	1=44	1=19	1=20	1= 00	>30-60 =35
2=14		2=01	2=10	2=00	2=04	2=00	2=05	2=45	>60-90=08
3=00		3=05	3=00	3=01	3=02	3=00	3=00	3=07	
4=06		4=00	4=03	4=00	4=04	4=00	4=00	4=0 0	
		5=02	5=12	5=01	5=03	5=03	5=00	5=01	
		6=01		6=01	6=01	6=04	6=00		
		7=02		7=06	7=01	7=03	7=07		
		8=01			8=01	8=04	8=02		
		9=00				9=00	9=02		
						10=07	10=02		
						11=00	11=00		
						13=00	12=00		
						14=01	13=03		
						15=00	14=06		
						16=01	15=05		
						17=00	16=01		
						18=00			
						19=11			

Low = < 30 individual foods. Medium = 30-60 individual foods. High >60 individual foods (Matla, 2008)

Source: researcher

4.14.2 Post-intervetion: EG food group diversity scores

Table 4.23 presents the data of the food group diversity scores for the EG post-intervention. The total number of individual food items consumed over the seven days prior to the survey was 90. A total of 45.7% (n=16) consumed between 30-60 food items. This group consumed a higher variety of food across the nine food groups than the CG. As the average income (refer to Table 4.5) was ±R2 500 (±171 US$) and the food budget >R1 500 (±102 US$) per month, this was not an affluent community. However, they managed to consume a variety of food items. This was achieved even though the literature postulates that affluent people are generally known to consume a large range of food items across the food groups, due to being able to afford a range of diverse foods (Badami & Ramankutty, 2015).

Table 4.23: Post-intervention: EG household food group diversity for men and women for food consumed over a period of one week (n=35)

Meat Group n=4	Egg Group n=1	Dairy Group n=9	Cereal Group n=5	Legume Group n=7	Vitamin A Rich Group n=8	Fruit Group n=19	Vegetable Group n=16	Fat Group n=5	Total Individual Food Items Eaten by the Group n=90
0=00 1=23 2=10 3=00 4=00	0=10 1=25	0=00 1=28 2=01 3=05 4=00 5=00 6=00 7=01 8=00 9=00	0=00 1=19 2=05 3=10 4=00 5=01	0=00 1=05 2=03 3=09 4=05 5=08 6=05 7=00	0=00 1=02 2=10 3=09 4=08 5=06 6= 00 7=00 8=00	0=00 1=07 2=01 3=00 4=00 5=00 6=04 7=02 8=00 9=08 10=02 11=05 13=00 14=00 15=00 16=00 17=00 18=00 19=06	0=00 1=08 2=07 3= 00 4=00 5=00 6=03 7=06 8=00 9=00 10=01 11=03 12=02 13=00 14=03 15=00 16=02	0=00 1=00 2=16 3=18 4=00 5=01	0<30=10 >30-60=16 > 60= 09

Low = < 30 individual foods. Medium = 30-60 individual foods. High >60 individual foods (Matla, 2008).

Source: researcher

A comparison of the data presented in Table 4.22 (EG: pre-intervention) with those in Table 4.23 (EG: post-intervention) indicates that the consumption of the legume group by the EG increased in intake and variety during the intervention study. This was measurable using the post-intervention survey.

4.14.3 Pre-intervention: CG food variety scores

Table 4.24 presents the pre-intervention food variety scores for the CG. The number of individual food items consumed (FVS) over the seven days prior to the survey was 60. The majority of participants (54.0% [n=27]) consumed between 30-60 individual items, which reflected moderate food variety (63.2 ± 35.81, whilst post was 36.4 ± 14.9) (refer to Table 4.26).

Table 4.24: Pre-intervention: CG food group diversity for men and women of food consumed over a period of one week (n=50)

Meat Group n= 4	Egg Group n=1	Dairy Group n=9	Cereal Group n=5	Legume Group n=7	Vitamin A Rich Group n=8	Fruit Group n=19	Vegetable Group n=16	Fat Group n=5	Total Individual Food Items Eaten by the Group n=60
0=00 1=21 2=20 3=00 4=09	0=05 1=45	0=00 1=37 2=00 3=06 4=00 5=00 6=01 7=02 8=0 9=00	0=00 1=27 2=13 3=10 4=00 5=01	0=00 1=30 2=00 3=00 4=00 5=02 6=00 7=10	0=00 1=10 2=19 3= 00 4=10 5=11 6= 00 7=00 8=00	0=00 1=20 2=00 3=00 4=00 5=03 6=04 7=00 8=03 9=00 10=01 11=00 13=00 14=00 15=00 16=00 17=00 18=00 19=20	0=00 1=10 2=20 3=10 4= 00 5= 00 6= 00 7= 00 8 =00 9= 00 10=01 11=01 12= 00 13=04 14=00 15=01 16=03	0=00 1=00 2=25 3=22 4=00 5=03	<30=10 >30-60 =37 >60=03

Low = < 30 individual foods. Medium = 30-60 individual foods. High >60 individual foods (Matla. 2008).

Source: researcher

4.14.4 Post-intervention: CG food variety scores

Table 4.25 presents the post-intervention food variety scores for the total CG group. The number of individual food items consumed over the seven days prior to the survey was 60. The results indicated that the majority (59.0% [n=24]) had consumed between 30-60 individual items, reflecting moderate food variety.

Table 4.25: Post-intervention: CG food group diversity for men and women of food consumed over a period of one week (n= 44)

Meat Group n=4	Egg Group n=1	Dairy Group n=9	Cereal Group n=5	Legume Group n=7	Vitamin A Rich Group n=8	Fruit Group n=19	Vegetable Group n=16	Fat Group n=5	Total Individual Food Items Eaten by the Group n=60
0=00	0=08	0=00	0=00	0=00	0=01	0=00	0=00	0=00	<30=15
1=27	1=36	1=31	1=24	1=35	1=08	1=08	1=08	1=00	>30-60=26
2=14		2=00	2=11	2=00	2=10	2=00	2=10	2=21	>60=03
3=00		3=05	3=08	3=00	3=00	3=00	3=11	3=22	
4=03		4=00	4=00	4=00	4=09	4=00	4= 03	4=00	
		5=03	5=01	5=02	5=02	5=03	5=00	5=01	
		6=03		6=00	6=00	6=02	6=00		
		7=01		7=07	7=01	7=01	7=04		
		8=01			8=00	8=02	8=00		
		9=00				9=03	9=00		
						10=13	10=01		
						11=00	11=01		
						12=02	12=00		
						13=00	13=02		
						14=00	14=00		
						15=00	15=04		
						16=00	16=00		
						17=00			
						18=00			
						19=10			

Low = < 30 individual foods. Medium = 30-60 individual foods. High >60 individual foods (Matla, 2008)

Source: researcher

The comparison of the data presented in Table 4.22 (EG) and Table 4.23 (CG) (pre-intervention) with the data in Tables 4.24 and Table 4.25 (post-intervention) revealed that the FVS remained more or less similar in terms of total food items consumed by this group.

4.14.5 Summary of the food group diversity scores

No significant difference was observed between the FVS and DDS for the EG post-intervention. The cereal group had the highest mean (±SD FGDS of 9.6 [± 3.67]), followed by the other vegetable group (6.6 ± 2.2) and meat (6.5 ± 3.07) in the EG group pre-intervention. The ranking was similar in the CG group at pre-intervention. However, a significantly (p=0.000) higher mean ±SD FGDS for the legume group (5.7 ± 2.56) was observed for the EG post-intervention when compared with the pre-intervention (2.4±1.35) results. In addition, according to the FGDS, the legume group was ranked 4th post-intervention compared to 7th pre-intervention, significantly lower FGDSs were observed for the dairy, cereal, and vitamin A-rich fruit and vegetable groups post-intervention.

The cereal group had the highest mean ±SD FGDS of 9.6 (± 3.67), followed by the other vegetable group (6.6 ± 2.2), meat (6.5; ± 3.07), other fruit (5.3; ± 4.02), vitamin A-rich fruit and vegetables (5.0; ± 1.80) and the dairy group (4.3; ± 2.18). The legume group had an FGDS mean of 2.4 (± 1.35) while that of the fat and oil group was 2.1 (± 0.90). The post-intervention survey indicated a significant group intake (p= 0.000) of the FVS of 5.7 (± 2.5) and a slight drop in the meat group (6.1; ± 2.9). In comparison, the CG had a significantly lower FVS post-intervention. Similarly, significant lower FGDs were observed for all the food groups, except the egg group.

In comparison, the post-intervention survey indicated that the CG had a mean FGDS for food items consumed across all food groups in a period of seven days of 63.2 (± 35.81). The cereal group had the highest score, ranging from 2-5 with an FGDS mean of 13.0 (± 8.62), followed by the other fruit group (1-19; 12.0 ± 6.97) and the other vegetable group (1-16; 10.0 ± 6.72). The dairy group (1-9) had a mean of 8.0 (± 3.82), followed by the vitamin-A rich fruit and vegetable group (6.0; ± 4.52), and the meat group (7.2; ± 1.30). The legume group had a mean of 3.0 (± 1.82). The fat and oil group had a mean of 8.0 (± 2.04), while the egg group was the lowest of all the groups with an FGDS mean of 1.0 (±0.00). The post-intervention survey indicated significance for the FGDS for the CG (p= 0.000) and a lower legume intake (2.0 ± 1.2).

Table 4.26: Summary of the food group diversity scores for all food groups. Pre-intervention: EG n=53; CG n=50; Post-intervention: EG n=35; CG n=44

Food Groups	Mean FGDS Pre-inter[13]r. EG (n=53)	± SD	Ranges	Mean FGDS Post-inter. EG (n=35)	± SD	Ranges	Significance *p-value*
Meat	6.5	3.07	1-4	6.1	2.92	1-4	**0.540**
Eggs	1	0.00	0-1	1	0.00	0-1	**1.000**
Dairy	4.3	2.18	1-9	3.3	2.30	1-9	**0.045**
Cereals	9.6	3.67	1-5	7.3	4.05	1-5	**0.009**
Legumes	**2.4**	1.35	1-7	**5.7**	2.56	1-7	**0.000**
Vitamin A-rich fruit & Vegetables	5.0	1.80	1-8	3.8	1.88	1-8	**0.004**
Other Fruits	5.3	4.02	1-19	5.0	2.81	1-19	**0.681**
Other Vegetables	6.6	2.28	1-16	6.1	3.10	1-16	**0.416**
Fat and Oils	2.1	0.90	1-5	1.8	0.59	1-5	**0.062**
FVS	42.8	18.90	23-74	40.1	20.21	23- 74	**0.531**
DDS	8.59	±0.74		8.23	±1.11		**0.097**
Food Groups	**Mean FGDS Pre-Intervention CG (n=50)**	**±SD**	**Range of scores**	**Mean FGDS Post-intervention CG (n=44)**	**±SD**	**Range of scores**	
Meat	7.2	1.30	1-4	5.3	2.9	1-4	**0.000**
Eggs	1	0.00	0-1	1.0	0.0	1-1	**1.000**
Dairy	8.0	3.82	1-9	3.0	1.7	1-9	**0.000**
Cereals	13.0	8.62	2-5	8.8	3.0	1-5	**0.002**
Legumes	**3.0**	1.82	1-8	**2.0**	1.2	1-7	**0.003**
Vitamin A-rich fruit & Vegetables	6.0	4.52	1-8	4.3	0.9	1-8	**0.010**
Other Fruits	12.0	6.97	1-19	4.6	2.2	1-19	**0.000**
Other Vegetables	10.0	6.72	1-16	5.2	2.3	1-16	**0.000**
Fat and Oils	3.0	2.04	1-5	2.2	0.7	1-5	**0.011**
FVS	63.2	±35.81	23-75	36.4	±14.9	20-74	**0.000**
DDS	8.69	0.89		8.52	0.98		**0.412**

[13] Pre-inter means FGDS before the intervention were calculated whilst post-inter means FGDS were calculated after the intervention and then compared.

4.14.6 Results of dietary diversity scores

The pre-intervention dietary diversity scores (DDS) for the EG are presented in Table 4.27. According to the data, 98.1% (n=52) of the EG and 94.0% (n=47) of the CG consumed food in six to nine groups, which indicated high dietary diversity (6-9 food groups) (Matla, 2008). The medium DDS for the EG ranged across 4-5 groups with a prevalence of 1.9% (n=1) and 4.0% (n=2) for the CG. The EG group had no respondents with a low DDS, compared to 2.0% in the CG group (<3 food groups) (Matla, 2008). However, the post-intervention survey indicated that the EG had 97.1% (n= 34) and the CG group 95.4% (n=42) of respondents, indicating a high DDS (6-9 food groups) (Matla, 2008). No respondents had low DDS (0-3 groups) (Matla, 2008) in either of the groups post-intervention.

Table 4.27: Summary of dietary diversity scores for the two groups. Pre-intervention: EG n=53; CG n=50; Post-intervention: EG n=35; CG n=44

Number of food groups consumed (n=9) Pre-intervention EG	Frequency	Percentage (%)	Number of food groups consumed (n=9) Pre-intervention CG	Frequency	Percentage (%)
0-4 5 6 7 8 9	0 1 0 2 14 36	0 1.9 0 3.7 26.4 68.0	4 6 7 8 9	1 2 1 10 36	2.0 4.0 2.0 20.0 72.0
TOTAL	53	100.0	**TOTAL**	50	100.0
Number of food groups consumed (n=9) Post-intervention EG	Frequency	Percentage	Number of food groups consumed (n=9) **Post-intervention** **CG**	Frequency	Percentage (%)
5 6 7 8 9	1 2 6 5 21	2.9 5.7 17.1 14.3 60.0	4 6 7 8 9	1 1 5 8 29	2.3 2.3 11.4 18.2 65.9
TOTAL	35	100.0	**TOTAL**	44	100.0

Table 4.28 indicates lower DDS for the EG women post-intervention with statistical significance (*p*=0.044). However, the mean DDS still reflects a high dietary diversity pre- and post-intervention for both men and women. No significant changes were observed for the men.

Table 4.28: Mann-Whitney U analyses for DDS: Comparison of the pre- and post-intervention data for the men and women separately (EG, CG)

Group	Pre-intervention Mean Value ± SD	Post-intervention Mean Value ± SD	*Signifance* *p*-value
EG MEN	8.85 ± 0.36	8.72 ± 0.64	0.161
CG MEN	8.29 ± 1.35	8.29 ± 1.35	0.438
EG WOMEN	8.61 ± 0.74	8.41 ± 0.82	0.044
CG WOMEN	8.87 ± 0.41	8.65 ± 0.66	0.208

*The *p*-value represents the mean value comparison of the EG and CG pre-and post-intervention

4.15 Household Food Security Scale Measurement

4.15.1 Analysis of answers to the FSSM questionnaire

This instrument was used only in the pre-intervention phase and not in the post-intervention phase because emphasis was on measuring legume intake after the education programme. Thus, only this variable was measured. The results are presented in Table 4.29. It is indicated that 28.3% (n=15) of the EG and 42.0% (n=21) of the CG respondents worried about not having enough food in their households over the four-week period. Due to a lack of resources to access certain types of foods for consumption by other household members, 28.3% (n=15) of the EG and 32.0% (n=16) of the CG expressed concern about food accessibility. Limited food choices leading to eating what was not desired was evident in 34.0% (n=18) of the EG and in 40.0% (n=20) of the CG. Smaller meal portions were consumed by 30.2% (n=16) of the EG and by 40.0% (n=20) of the CG as they did not have enough food for all the members of the household to consume large portions. In the EG, 28.3%

(n=15) and CG 42.0% (n=21) in the CG sometimes had no food to eat due to a lack of resources. Going to bed hungry because there was no food was experienced by 17.0% (n=9) of the EG and by 12.0% (n=6) of the CG. In the EG, 11.3% (n=6) and 18.0% (n=9) in the CG went day and night without eating anything. A minority (35.8%; n=19) in the EG and in the CG (40.0%; n=20) indicated that they understood the term 'vulnerable group. Limited food waste management occurred as a small number of the EG (11.3%; n= 6) and of the CG (10.0%; n=5) indicated that they did not throw any food away. Legumes were perceived as an important food group by 92.5% (n=49) of the EG and by 94.0% (n=47) of the CG. The health benefits of legumes were understood by 81.1% (n=43) of the EG and by 72.0% (n=36) of the CG.

The results underscored the point that knowledge of nutritional benefits associated with a particular food does not always translate into the desire of individuals to consume that particular food. Access was highlighted as a critical mechanism in improving food consumption, as opposed to mere knowledge. Household food security status was more prevalent in the CG, while knowledge of the importance of legume intake was lacking in this group. Table 4.32 shows that the EG group was slightly less food insecure than the EG, but both groups had a limited understanding of what vulnerability is, which understandably limited their understanding of food security.

Table 4.29: Pre-intervention household food security levels (HFIAS) measured over the four weeks prior to the survey (EG n=53; CG n=50)

Questions	Percentage %	Number EG (n=53)	Percentage %	Number CG (n=50)
Did you worry that your household will not have enough food?	71.7 28.3	38 N[14] 15 Y[15]	58.0 42.0	29 N 21 Y
Were household members not able to eat the kind of food they preferred because of a lack of resources?	71.7 28.3	38 15	68.0 32.0	34 16
Did household members have to eat a limited variety of foods due to a lack of resources?	73.6 26.4	39 14	60.0 40.0	30 20
Did the farmer or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	66.0 34.0	35 18	60.0 40.0	30 20
Did the farmer or any household member have to eat a smaller meal than needed because there was not enough food?	69.8 30.2	37 16	58.0 42.0	29 21
Did anyone in the household eat no food because of lack of resources to get food?	71.7 28.3	38 15	52.0 48.0	26 24
Did the farmer or any household member go to bed at night hungry because there was not enough food?	83.0 17.0	44 9	88.0 12.0	44 6
Did the farmer or any household member go a whole day and night without eating anything because there was not enough food?	88.7 11.3	47 6	82.0 18.0	41 9
Do you understand what the term vulnerable group means?	64.2 35.8	34 19	30.0 20.0	60.0 40.0
Did you throw food away that was not consumed during a meal?	88.7 11.3	47 6	90.0 10.0	45 5
Do you think legumes are an important food group?	92.5 7.5	49 4	94.0 6.0	47 3
Are you aware of the benefits associated with legumes in a diet?	81.1 19.0	43 10	72.0 28.0	36 14

4.15.2 Measures to improve access to food

Figure 4.28 illustrates that the EG indicated various mechanisms that could be utilised to improve farmer food access such as finding another (second) job (41.0%; n=22). This suggestion was

[14] N represents No (of the total number) for every first value both columns.
[15] Y represents Yes (of the total number) for the second value for both columns.

supported by 14.0% (n=7) of the CG, who felt that it could improve food access as a second job would supplement income. In the EG, 31.0% (n=15) and 18.0% (n=9) in the CG indicated that starting an alternative business was an option. Finding employment for their children was suggested by 13.0% (n=7) of the EG and by 16.0% (n=9) of the CG. Some thought that producing their own food (by increasing production) was a good option. This group comprised 9.4% (n=5) of the EG and 34.0% (n=17) of the CG. Social support was perceived to be an alternative by only 5.6% (n=3) of the EG and 18.0% (n=9) of the CG. These results suggest that the farmers were considering alternative options to sustain their households. A higher number of the CG than the EG wanted the government to provide support and help sustain them as farmers.

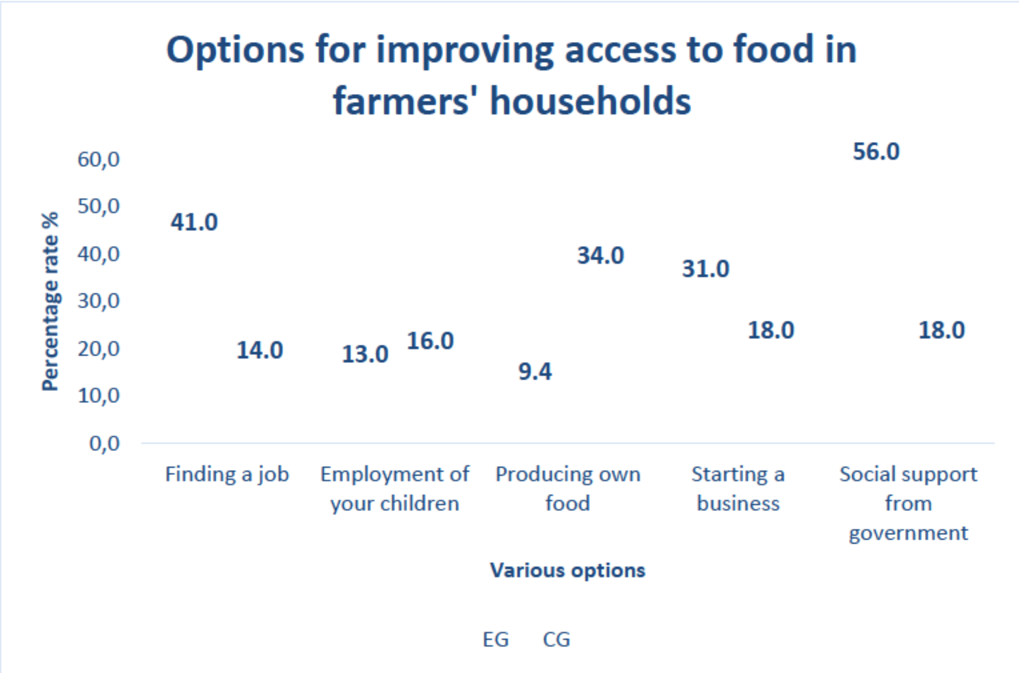

Figure 4.28: Various options that farmers suggested for improving food accessibility (EG n=53 and CG n=50)

4.15.3 Preferred food groups

Figure 4.29 illustrates the farmers' preferred food groups if extra cash was available. In the EG, 45.2% (n=24) indicated that the meat group was a significant food group to invest in buying such food items, while 36.0% (n=18) of the CG agreed with this view. Preference followed for the fruit and vegetable group (EG 22.6% [n=12] and CG 32.0% [n=16]); fats and oils (15.0% [n=8] of the EG and 10.0% [n=5] of the CG); and carbohydrates (13.2% [n=7] of the EG and 20.0%; [n=10] of the CG).

The legume group was last (4.0% [n=2] of the EG and 2.0% [n=1] of the CG). These results highlighted the fact that the desired but limited consumption of meat and fruit and vegetables was linked to a lack of financial resources. Another fact that became clear was that being a farmer in this study area did not guarantee access to a variety of fruit and vegetables nor did it guarantee access to meat. However, if intercropping practices had been adopted, it could have exposed the farmers and their households to a greater variety of fresh and nutritious crops that would have been more easily accessible. The meat group was the most commonly desired food group for both groups, followed by a desire for fruit and vegetable intake, which suggests that these farmers were limited when buying these foods.

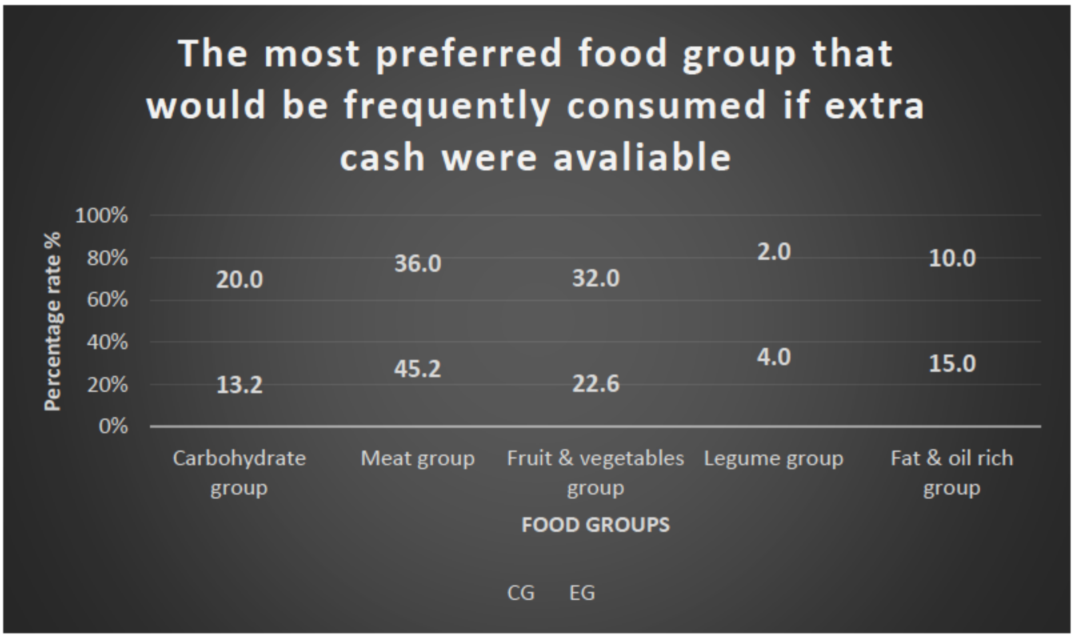

Figure 4.29: The food groups most preferred by the farmers to be frequently consumed if extra cash was avaliable (EG n=53 and CG n=50)

4.16 Legume Knowledge and Acceptability Levels

Table 4.30 presents the pre-intervention data for the EG and CG in terms of legume acceptability. Sugar beans was the most preferred and accepted cultivar as 90.6% (n=48) of the EG and 98.0% (n=49) of the CG indicated their preference for this variety. Sugar beans was also the only legume that appeared in the top-20 food item list of the women (Table 4.19 A and B). The second most commonly consumed legume variety was peanuts (indicated by 60.4% [n=32] of the EG and by

46.0% [n=23] of the CG), green beans (indicated by 50.9% [n=27] of the EG and by 44.0% [n=22] of the CG), cow peas (indicated by 34.0% [n=18] of the EG and 16.0% [n=8] of the CG), soy beans (indicated by 30.2% [n=16] of the EG and by 30.0% [n=15] of the CG), lentils (indicated by 26.4% [n=14] of the EG and by 24.0% [n=12] of the CG) and broad beans (indicated by 26.4% [n=14] of the EG and by 36.0% [n=18] of the CG). The least preferred legumes were green mung beans (EG: 13.2% [n=7] and CG: 8.0% [n=4]) and chickpeas (EG: 13.2% [n=13] and CG: 8.0% [n=4]). These results underscored the objective to promote less preferred legumes as part of the intervention project.

Table 4.30: Pre-intervention acceptability levels of legume varieties for possible consumption at household level (EG n=53; CG n=50)

Legume Variety▶	Sugar Beans 1	Green mung beans 2	Jugo Beans 3	Broad Kidney Beans 4	Soy Beans 5	Green Beans, fresh 6	Cow Peas 7	Chick Peas 8	Peanuts 9	Lentils 10
EG Choice Frequency	48	7	11	14	16	27	18	7	32	14
Acceptibility (%)	90.6	13.2	20.8	26.4	30.2	50.9	34.0	13.2	60.4	26.4
CG Choice Frequency	49	4	8	18	15	22	8	4	23	12
Acceptibility (%)	98.0	8.0	16.0	36.0	30.0	44.0	16.0	8.0	46.0	24.0

* (%) of the total percentage population

Legumes were consumed once a week by 77.4% (n=41) of the EG and by 66.0% (n=33) of the CG, followed by 16.8% (n=9) of the EG and 16.0% [n=8] of the CG who consumed them 2-3 times per week. Consumption of legumes occurred 4-5 times a week among 3.8% [n=2] of the EG and 6.0% [n=3] of the CG, and never among only 2.0% (n=1) of the EG and 12.0% [n=60] of the CG.

Legumes were thus consumed once a week by the majority of both groups. This depicts a similar trend of non frequent consumption legumes according to the SA guidelines for healthy eating (refer to Annexure N).

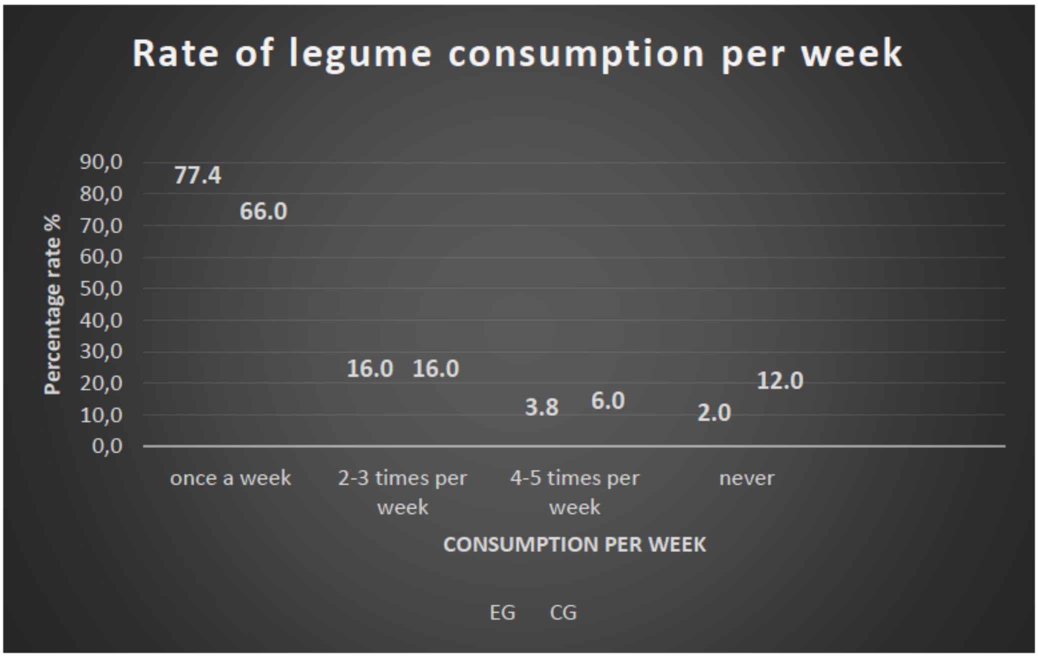

Figure 4.30: Frequency of legume intake per week (EG n=53 and CG n=50)

In terms of the difficulties the farmers experienced with the preparation of legumes as dishes, Figure 4.31 indicates that the majority of the farmers (32.1% [n=17]) in the EG experienced no challenges, whereas the majority in the CG (48.0%) stated that they experienced challenges because legumes required too much cooking time. Other challenges were not knowing how to prepare them (EG: 22.6% [n=12]) and family members' dislike of legumes (EG: 15.1% [n=8]). Very few found a lack of knowledge of the nutritional value of legumes a challenge (EG: 1.9% and CG: 2.0%). The predominant challenge was the long cooking time to make legumes palatable (CG: 48.0%). The education programme addressed the challenges identified in figure 4.31, also refer to table 4.32 for the perceptions formulated post-intervention.

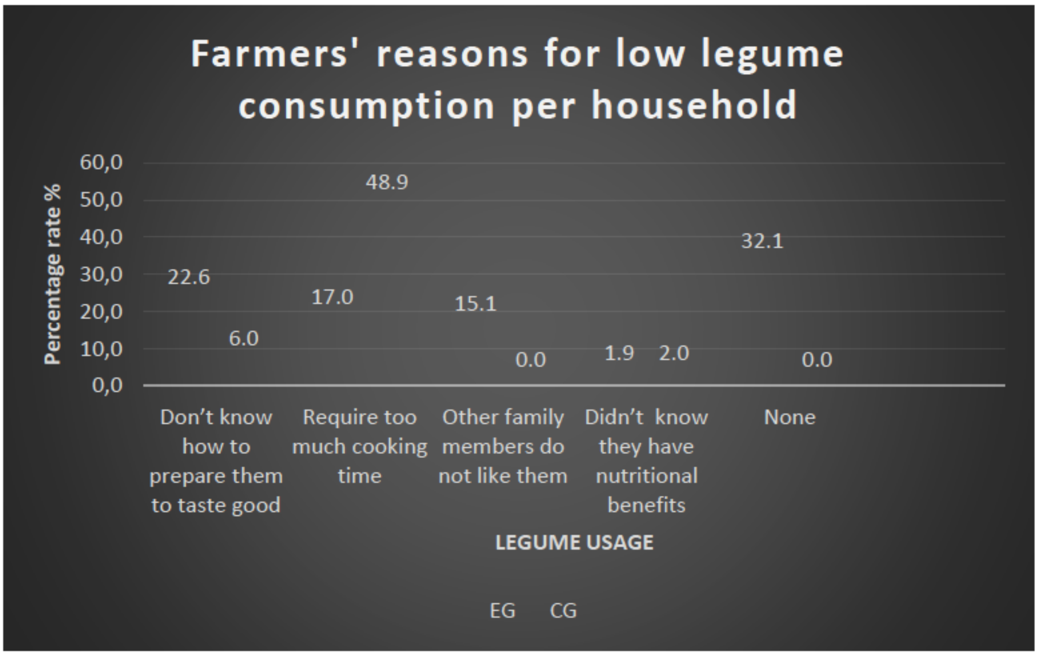

Figure 4.31: Factors causing challenges in terms of legume preparation/consumption (EG n=53 and CG (n=50)

The farmers were also surveyed in terms of their preference (acceptability levels) for legumes (Figure 4.32). The vast majority of the farmers were keen to consume various legumes for the purpose of the study (EG: 98.1% [n=52] and CG: 100.0% [n=50]). Farmers who indicated interest in planting new legume varieties comprised 98.1% (n=52) in the EG and 100.0% (n=50) in the CG. Only 1.9% (n=1) of the EG did not show interest in planting new legume varieties. The high rate for the CG members who were interested, even though they would not be given legumes for consumption or cultivation, might be attributed to their assumption that they would be included as recipients of seeds eventually.

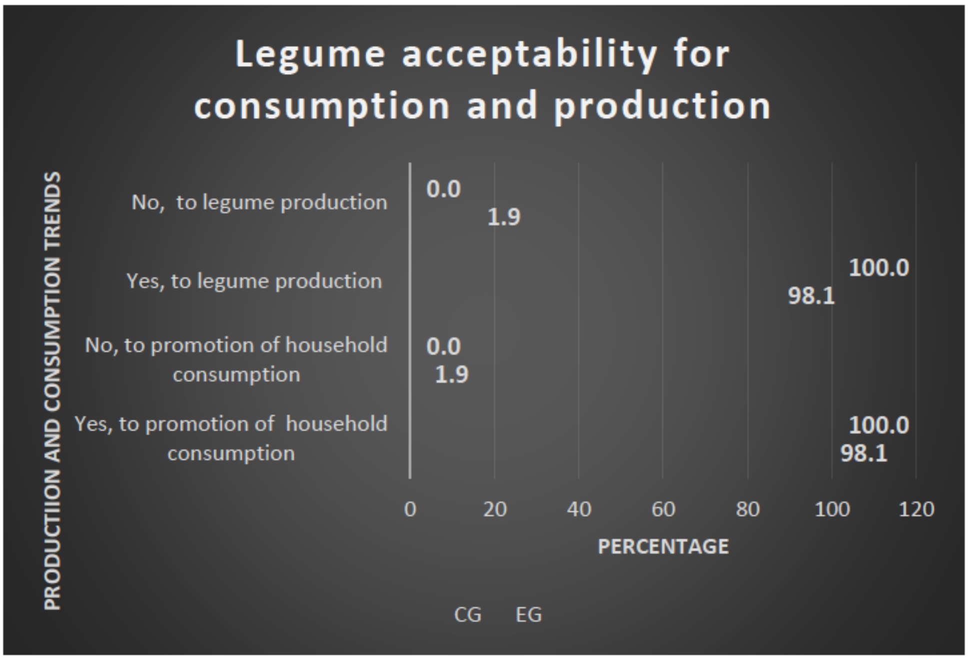

Figure 4.32: Acceptability levels to cultivate and consume legumes (EG n=53 and CG (n=50)

The farmers were asked which legume variety they would be most interested in cultivating. The responses were very similar to the responses for the consumption preferences. Table 4.31 indicates that the variety of preference for cultivation was sugar beans (EG: 56.6% [n=30]). Next were green beans (EG: 35.8% [n=19] and CG: 44.0% [n=22]), peanuts (EG: 35.8% [n=19] and CG: 46.0% [n=23]), jugo beans (EG: 20.8% [n=11] and CG: 16.0% [n=8]), broad kidney beans (EG: 18.9% [n=4] and CG: 36.0% [n=18]), cow peas (EG: 15.1% [n=8] and CG: 16.0% [n=8]), chick peas (EG: 9.4% [n=5] and CG: 8.0% [n=4]), soy beans (EG: 9.4% [n=5] and CG: 30.0% [n=15]) and green mung beans (EG: 5.6% [n=3] and CG: 8.0% [n=4]). The least preferred variety that they would cultivate was lentils (EG: 1.9% [n=1] and CG: 24.0% [n=12]). These results underscore the need to persistently motivate the farmers and to promote the cultivation of legume varieties for production purposes in this and similar communities. The results could be utilized for further research using CG members who did not grow or consume any legumes for this study.

Table 4.31: Pre-intervention acceptability levels of legume varieties for possible cultivation (EG n=53 and CG n=50)

Legume Variety▶	Sugar Bean 1	Green mung bean 2	Jugo Bean 3	Broad Kidney Bean 4	Soy Bean 5	Green Beans, fresh 6	Cow Peas 7	Chick Peas 8	Peanuts 9	Lentils 10
EG Choice Frequency	48	7	11	14	16	27	18	7	32	14
Acceptibility (%)	90.6	13.2	20.8	26.4	30.2	50.9	34.0	13.2	60.4	26.4
CG Choice Frequency	49	4	8	18	15	22	8	4	23	12
Acceptibility (%)	98.0	8.0	16.0	36.0	30.0	44.0	16.0	8.0	46.0	24.0

*** (%) of the total percentage population**

The intervention programme aimed to encourage the production and consumption of diverse legumes by bringing new knowledge to the farmers about this food and farming practices. Training on the production and consumption was necessary to increase the farmers' acceptability of legume varieties and to grow and consume them as a combined practice. Table 4.32 presents the quantitative results of the implications of the intervention project.

Table 4.32 Summary of impact on the intervention programme during post-intervention (n=53)

Questions	***Farmers' Responses***
How did the education programme improve your "production" of legumes?	"We learnt a new technique of germination and then transplanting legumes which is not how we have traditionally plant legumes" "We understood how each legume varieties responded to our Marian-hill climate area" "We learnt how to manage a legume crop and also how to report correctly so we can meet project goals" "We learnt to see how different pests needed to managed because each legume responded differently" "Through the training we negotiated with our co-operatives partners for planting space which was positive to see others accepting them especially those who did not attend the training" "We need more support for seeds for these legumes to plant in future "
How did the education programme improve your "consumption" of legumes?	"We learnt to mix legumes in one dish (which we have never done before) from just cooking sugar beans and made mixed bean stew dishes which we ate with our children" "Recipes and the training helped us to cook legumes differently from how we usually eat them we are used to a canned beans salads" "We have learnt to cook legumes and freeze them to save electricity" "Freezing also made us cook them in other days when we were lazy to boil them" "Legume pastes were tasty to put on our bread and steam bread" "We thought cow pea was eaten by cows and did not want to try it but we enjoyed the spread" "We did not know you can put garlic when cooking legumes" "Our families saw us trying new recipes for legumes"

4.17 Legume Production Yields and Survey Data (Intervention Phase: EG only)

The results of the experimental production of legumes reflected the efforts of the EG only during the intervention project to produce diverse legumes. The survey gathered pre-intervention data on plot sizes and knowledge of agricultural topics, as well as post-intervention data on production limitations, yields and the utilisation of the harvests.

4.17.1 Pre-intervention plot size data

The land space surveys (i.e. sizes of the plots of land) (Figure 4.33) showed that the majority (41.5% [n=22]) of the EG farmed on spaces of land of between 51-100 m^2. This group was followed by 33.9% (n=18) using 0-50 m^2; 15.1% (n=8) farming on 101-200 m^2; 5.7% (n=3) farming on 201-500 m^2; and only 3.8% (n=2) farming on large plots of land of between 501-1 000 m^2.

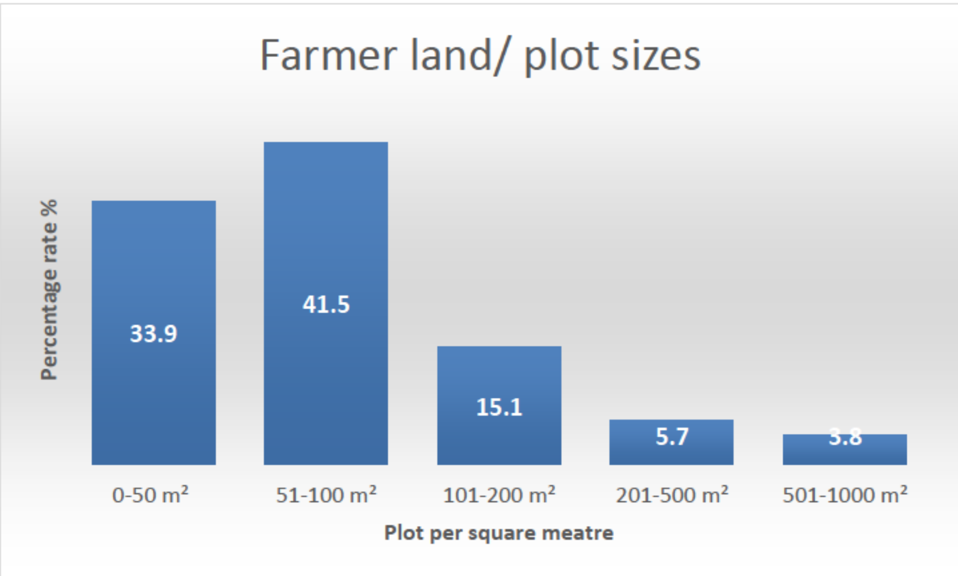

Figure 4.33: Farmers' plot sizes for production (n=53)

4.17.2 Knowledge prior to cropping

The programme introduced topics that focused specifically on legumes that were not familiar to the farmers (Table 4.33). Intercropping legumes and maize was the most common (69.8% [n=37]) method of planting that they were aware of. In a declining order, the farmers were knowledgeable about the conservation of agriculture (39.6% [n=21[), legume spacing (32.0% [n=17]) and legume germination and transplanting, as opposed to planting the seed directly in the soil (28.3% [n=15]).

Table 4.33: Legume knowledge prior to study: Extension of agricultural knowledge (n=53)

Agriculture Topic	Knowledge (%)
Legume germination and transplanting method	28.3% (n=15)
Legume spacing	32.0% (n=17)
Water-proofing application	3.7% (n=2)
Conservation agriculture	39.6% (n=21)
Intercropping legumes with maize	69.8% (n=37)

4.17.3 Challenges experienced during the trials

The main challenge reported in the first trial (Table 4.34) (2015/2016) was limited water supplies (83.0% [n=44]) and pest infestation control (83.0% [n=44]). These challenges were followed by limited land for cultivation (39.6% [n=21]); failure to grow legumes at the scheduled time (28.0% [n=15]); an unnaturally dry season (24.5% [n=13); forgetting training information (18.8% [n=10]); soil infertility (9.4% [n=5]); and the theft of sponsored seeds (1.8% [n=1]). These results were obtained from measuring instruments highlighted in (Annexure L).

Table 4.34: Legume cultivation challenges experienced per trial (n=53)

Legume production limitations (n=53)	Trial 1: 2015-2016 %	Trial 2: 2016-2017 %
Growing legumes at time scheduled for the project	28.0 (n=15)	18.8 (n=10)
Limited water supply	83.0 (n=44)	75.4 (n=40)
Soil infertility	9.4 (n=5)	5.6 (n=3)
Forgetting training information	18.8 (n=10)	9.4 (n=5)
Limited land area for cultivation	39.6 (n=21)	33.9 (n=18)
Theft of supplied seeds	1.8 (n=1)	5.6 (n=3)
Dry season	24.5 (n=13)	84.9 (n=45)
Pest infestation and control	83.0 (n=44)	75.4 (n=40)

4.17.4 Production rates (yields) of cultivated legumes (Trial 1 and Trial 2)

In trial 1 of the cultivation project, the highest production rate was achieved with red kidney beans (141.60 kg/ha^{-1} SD 162.11). This was followed by butter beans (80.75 kg/ha^{-1} ±198.25); jugo beans (74.90 kg/ha^{-1} ±140.37); chick peas (41.41 – 60 kg/ha^{-1} ±141.64); and green mung beans (1.13 kg/ha^{-1}±8.24). In trial two of the project (2016/2017), the legume that was predominantly produced by the farmers was red kidney beans (123.39 kg/ha^{-1} ±164.39). This was followed by the production of butter beans (93.30 kg/ha^{-1} ±178.42), jugo beans (70.28 kg/ha^{-1} ±149.44), cow peas (61.88 kg/ha^{-1}±115), chick peas (36.60 kg/ha^{-1} ±127.14) and green mung beans (1.13kg/ha^{-1} ±8.24) (refer to Table 4.35).

Table 4.35: Yield per cultivar Trial 1 (2015-2016) and yield per cultivar Trial 2 (2016-2017)

Trial 1: 2015-2016					Trial 2: 2016-2017	
Legume variety ▼	Number of Farmers Planting each variety	Mean yield kg/hectare	Std. Deviation	Number of Farmers Planting each variety	Mean yield kg/hectare	Std. Deviation
Chick peas	53	41.41	141.64	53	36.60	127.14
Butter beans	53	80.75	198.25	53	93.30	178.42
Red kidney beans	53	141.60	162.11	53	123.39	164.39
Cow peas	53	74.24	141.58	53	61.88	115.52
Green mung beans	53	1.13	8.24	53	1.13	8.24
Jugo beans	53	74.90	140.37	53	70.28	149.44
Total		**69.00**	**149.64**		**64.43**	**140.34**

*All 53 farmers participated in the planting of each legume variety

4.17.5 Significance values of crop yields

Table 4.36 indicates that there was a high legume variety significance (p=0.001) amongst the six legume varieties in the 2015/2016 trials. The same comparison was made in the 2016/2017 period and again there was a high significance (p=0.001) amongst the six legume varieties. Both trials showed significance in yields for each legume variety.

Table 4.36: Anova significance output of legume varieties Trial 1 (2015-2016) and Trial 2 (2016-2017) (n=53)

		Trial 1				Trial 2			
Sum of squares	df	Mean square	F	*Signature p-value*	Sum of squares	df	Mean square	F	*Significance p-value*
574459.19	5	114891.84	5.494	0.001	484009.434	5	96801.887	5.243	0.001
6524353.77	312	20911.39			5760238.679	312	18462.303		
7098812.92	317				6244248.113	317			

4.17.6 Mean crop yields

Table 4.37 indicates that for Trial 1, the mean yield of the crops cultivated by the women was 81.70 kg/ha^{-1} (SD 77.95), while it was 33.63 kg/ha^{-1} (SD 166.40) for the men. This indicates that the men had lower yields than the women. The data for Trial 2 indicated that the women had still produced more than the men, although their yield was smaller (69.93 kg/ha^{-1} ± 154.13) compared to trial 1; while the men produced slightly more (49.10 kg/ha^{-1}; ± 90.63), but their yield was still lower than that of the women.

Table 4.37: Yield per gender Trial 1 (2015-2016) and Trial 2 (2016-2017) (n=53)

	Field Trial 1			Field Trial 2			
Legume variety gender groups	**Gender frequency**	**Mean per gender**	**Std. Deviation**	**Legume variety gender groups**	**Gender frequency**	**Mean per gender**	**Std. Deviation**
Men	84	33.63	77.95	***Men***	84	49.10	90.63
Women	234	81.70	166.40	***Women***	234	69.93	154.13
Total	**318**	**69.00**	**149.64**	***Total***	**318**		**140.34**

In Trial 1 there was a high significance (*p*=0.011) between the yields of the women and the men, but in Trial 2, there was no significance (*p*=0.244) between the yields of the women and the men (Table 4.38).

Table 4.38: Anova significance output Trial 1 (2015-2016) and significance output Trial 2 (2016-2017) (n=53)

Legume variety groups between genders	Trial 1 Sum of squares 1	df	Mean square	F	*Significance p-value*	Trial 2 Sum of squares 2	df	Mean square	F	*Significance p-value*
Between Groups	142897.17	1	142879.17	6.49	**0.011**	26816.03	1	26816.03	1.36	**0.244**
Within Groups	6955933.79	316	22012.44			6217432.07	316	19675.41		
Total	**7098812.97**	**317**				**6244248.11**	**317**			

4.17.7 Utilisation of harvested legumes

The majority (90.6%; n=28) of the harvested legumes were utilised for while 5.6% (n=3) of the farmers never used the harvest (for consumption) and only 3.8% (n=2) sold the harvest. It is important to note that harvested legumes were from trial results, which could have been consumed during study in addition to the legumes already provided for consumption. These results underscore the need for a greater input if farmers want to sell their harvests to the surrounding community in order to improve their income (Figure 4.34). It is also important to note that legumes were mainly utilised for consumption as a measure to contribute to the food security status of the farmers' households. The results indicate that this goal was achieved.

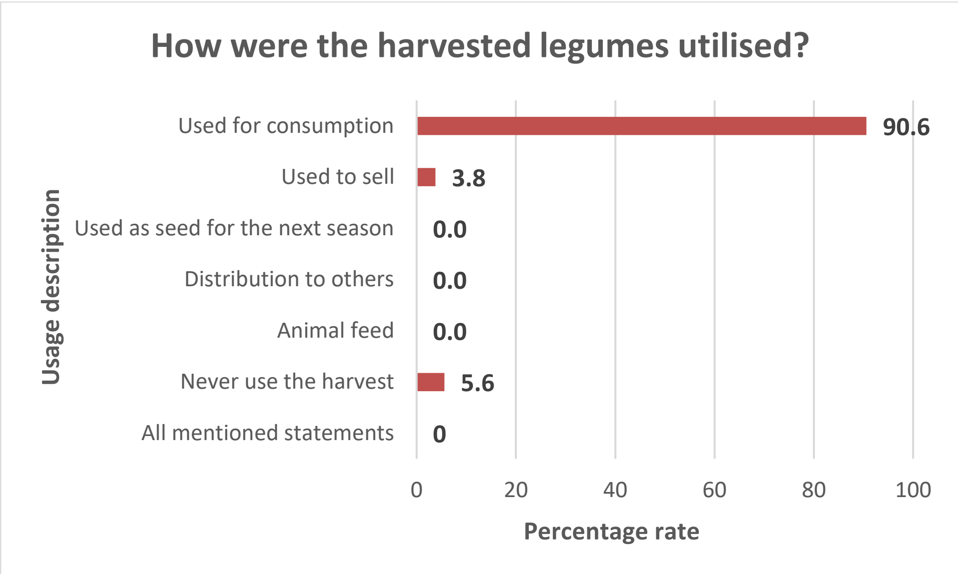

Figure 4.34: Usage of harvested legumes (n=33)

4.18 Correlations and Pattern Trend Analyses

The results of the baseline study as well as the pre-intervention and post-intervention surveys were used to analyse trends that emerged for participants from the baseline study to the post-intervention stage. These individuals developed a pattern during these phases and data were used to report the progression trends for individuals who were part of all the phases.

Key: Involving various phases of the study results explained in table 4.39

B: (Baseline) represents all the participants who were in the baseline study, as well as part of the intervention study

*BB- Participants who were in the baseline study as well as in the pre-intervention survey

*AB3- Participants who were part of the post-intervention survey for a 3-part comparison

The results in Table 4.39 indicate the participants who were in all three phases of the study. Statistically significant differences amongst the various phases for the men and women for SBP

(p=0.013) and cholesterol (p=0.033) are highligted. The Mann-Whitney U test indicated that there was no statistical significance for either the women or the men between the BMI (p=0.315) and WC (p=0.472), as determined by the post-intervention survey.

Table 4.39: Mann-Whitney U trend analyses for hypertension and cholesterol levels of EG participants who were surveyed in the baseline, pre-intervention and post-intervention phases (men and women)

Group	Men Mean ± SD	Women Mean ± SD	*Significance p-value*
SBP mmHg	164.67 ± 4.04	134.62 ± 20.49	**0.013**
DBP mmHg	84.00 ± 13.86	80.69 ± 11.50	1.000
CHOLESTEROL mmol/l	6.35 ± 1.11	4.51 ± 1.30	**0.033**
BMI kg/m²	32.40 ± 4.04	29.65 ± 6.31	0.315
WC (cm)	103.33 ± 9.80	98.08 ± 14.97	0.472

*The p-value represents the mean value comparison between women and men

Figure 4.35 indicates that the BMI for all the participants was high (90.0%; ≥ 25 BMI kg/m^2) during the baseline study but that it had dropped to 79.3% in the post-intervention survey. However, as the BMI dropped, the normal weight (18.5-24.99 BMI kg/m^2) of the participants increased from 10.0% at the baseline survey to 20.7% at the post-intervention survey.

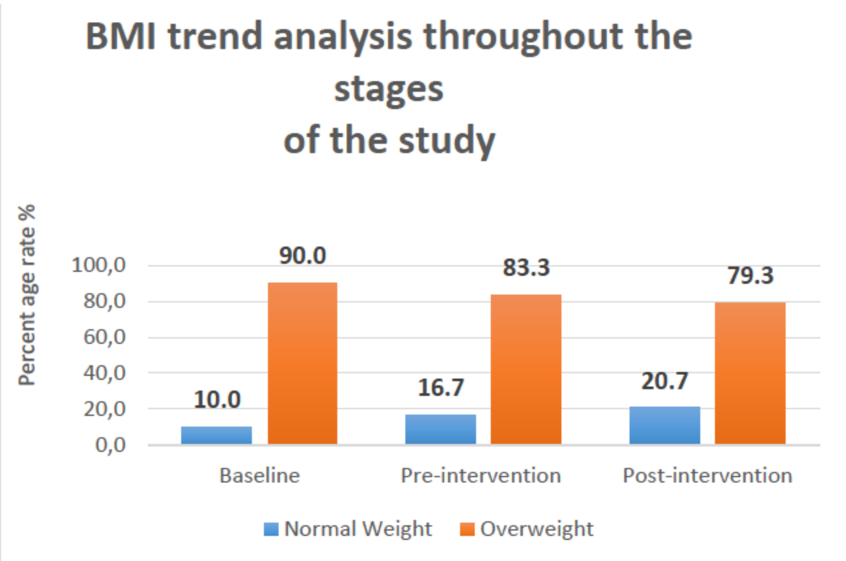

Figure 4.35: Comparison of BMI trend significance values for the total sample present in all the stages of the study

There was a decline in the mean values from the baseline study to the post-intervention survey of 151.1 mmHg (± 28.9) to 137.7 mmHg (± 21.51) for systolic blood pressure. The diastolic blood pressure started at mean values of 83.2% to 81.0% in the post-intervention phase. Table 4.39 confirms a correlation between systolic blood pressure and legume intake (see Figure 4.36).

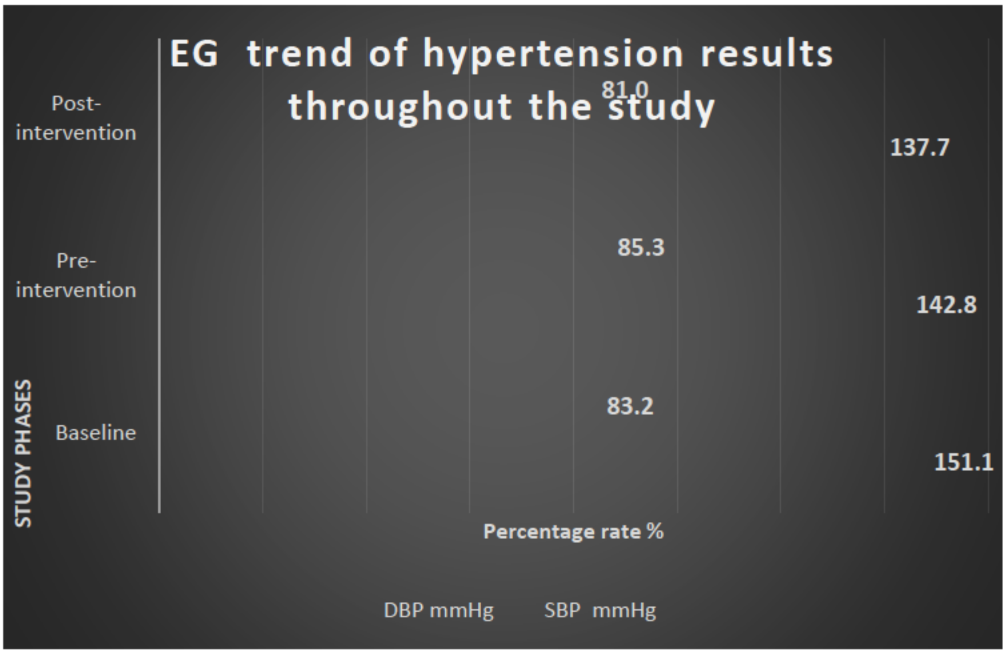

Figure 4.36: Systolic and diastolic progression trend

Figure 4.37 indicates that normal cholesterol levels (<5.17 mmol/l or 200 mg/dl) improved over the study period from 70.0% during the baseline study to 81.3% at the time of the post-intervention survey. The respondents with high blood cholesterol (≥6.20 mmol/l or 240 mg/dl) who might have been at risk of diabetes dropped from 30.0% (baseline) to 18.8% (post-intervention). Cholesterol also improved in terms of statistically significant values (refer to Table 4.39 and Table 4.11).

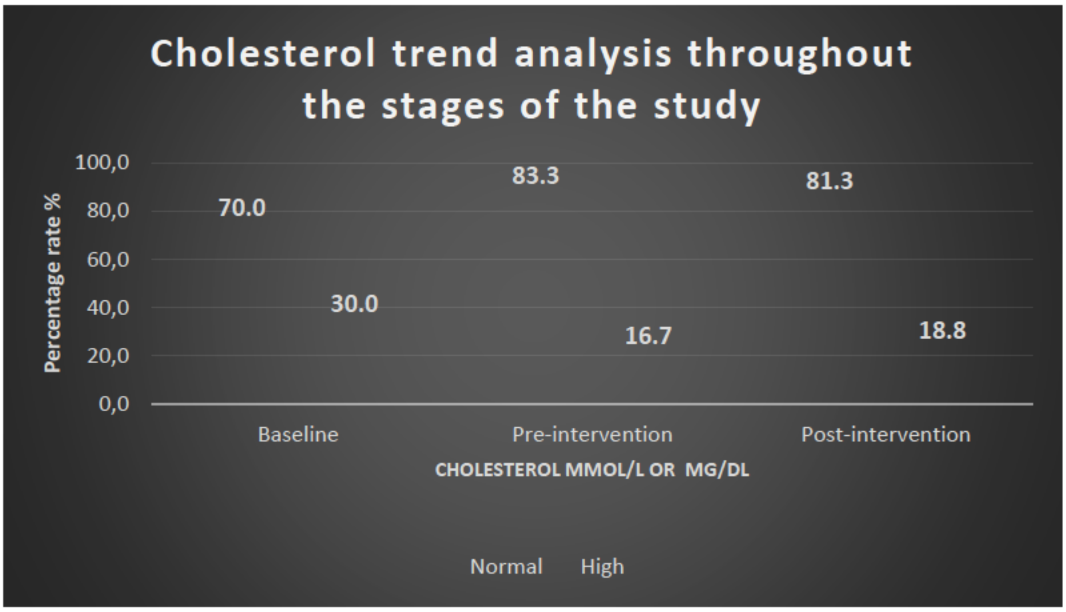

Figure 4.37: Results of cholesterol trend analyses

4.19 Summary and Discussion of Pre- and Post-Intervention Findings

Food insecurity caused limited food choices. The majority of the participants of both groups (EG and CG) indicated that the meat group was what they would mostly include in their diets if additional financial resources were available. This suggests that financial insecurity impacted food security in some of the households of the study group. Nutrition insecurity was therefore deemed a consequence of various socio-economic factors. The nutrition education programme gave guidelines on correct food choices and the importance of exercise in order for the participants to be more aware of the critical dangers associated with overnutrition. The majority of the farmers were living in a supportive environment as other members living in the households were able to provide social support (EG: 94.3% [n=50]; CG: 94.0% [n=47]). This support base facilitated the management of various daily activities and also enhanced the food security status by impacting household food budgets. The data indicated that food expenditure (per month) was >R1 500 for 92.0% (n=46) of the EG, and for 92.0% (n=46) of the CG. In both groups, various other household members had to be accommodated. Moreover, if these or some of the members were young or not working, it could have put additional strain on the farmers who had to manage their household budgets, as well as expenses associated with possible school fees and the unemployed. The results also suggest that a large portion of the sample encountered a variety of food insecurity challenges and that financial resources were pivotal in ensuring access to not only sufficient quantities, but also a wider variety of food items.

Self-employed farmers are generally more resilient in the face of household food insecurity and strategies to cope with food insecurity threats could be linked to gender as the majority of the participants in this study were women (FAO, 2017). According to Floro and Bali Swain (2013), self-employed women tend to adopt strategies for survival, which may have been a positive factor that assured that these farmers had access to food, although the variety of items was limited in many instances.

This study found that the socio-economic status of the two groups was similar. This was a logical outcome as the sample had been drawn from a farming community that had attended the AHS and that was not highly diverse in nature. As was the case in other studies, the role of socio-economic factors was vital in the food and nutrition security of the two groups. According to Hickey, Pouliot, Smith-Hall, Wunder and Nielsen (2016), providing social support to access food aids in achieving household food security as well as the improvement of livelihoods. This trend has been evident in developing nations and was evident in the current study since the food security survey indicated that a very small number of participants admitted that they had limited food supplies from time to time.

The nutrition outcomes as measured during the three study phases revealed that the diets of the farmers had a higher energy intake, particulary the EG women (4010.83 kJ ± 1300.89) than the EER value (6212.05 ± 1255.75 kJ) for active women of this group, as was measured by the pre-intervention survey. However, the post-intervention survey revealed that an even a higher energy intake (5939.90 ± 2313.60 kJ EG) existed than the EER value for active women (6400.80 ± 1214.64 Kj CG). These women also consumed a high carbohydrate (low in fibre) diet with low protein intake. Their diets were also generally very low in fibre, this suggests that they consumed refined carbohydrates which lacked fibre. According to Raynor and Champagne (2016), minor adjustments to food behaviour influence dietary changes, which can vary from a loss of 100 to >200 kJ/day and can influence weight management. This trend was detected in the EG men when the pre-intervention (4729.46 ± 1290.86 kJ) and post-intervention (5255.45 ± 1954.55 kJ) data were compared for energy intake. A higher energy intake after intervention (6942.03 kJ ± 1398.65) was indicated for the CG men (EER 5188.34 ± 1452.19 kJ). These results are supported by a consistent trend of overnutrition for both groups (Table 4.8, Figure 4.15 and Figure 4.16).

Findings by similar studies agreed that the South African diet is highly refined refer to section 1.3.2 (SADHS, 2016). Such studies have strongly argued that this leads to obesity prevalence and non-communicable diseases (Ronquest-Ross *et al*., 2015). The current study thus intended to encourage a more fibre-rich diet with the introduction of legumes in the diet of the EG. It was found that the fibre intake of the farmers improved when they included legumes in their diet. Increasing the fibre that is concentrated in legumes, also improves calcium absorption in the blood (Fabbri *et al*., 2016). Low intakes of vitamins like vitamin A, which that is necessary for eye health, resulted in eye problems in members of both groups. Other low nutrient intakes included calcium, magnesium and vitamins, A, D, E, K and C for a majority of the EG and the CG. However, the post-intervention survey revealed that the blood glucose values of the EG had significantly improved (p=0.038) for non fasting blood results. Conclusions that can be drawn underscore the significant impact of the consumption of legumes on nutritional security, as well as the overall health benefits associated with this food.

The trial group (EG) that consumed legumes had a legume FGDS with a mean of 2.4 (± 1.35), which was lower than that of the CG (3.0 ± 1.82). This suggested that further interventions were needed to promote legume production and intake by the farmers and, by extension, their households. The implementation of the programme showed increased mean FGDs (5.7 ± 2.56) for the EG, which was highly signficant (p= 0.000) for a mean DDS of 8.52 ± 0.98.

When the frequency of food intake was assessed, it was found that the cereal group was the most frequently consumed food by both the EG and the CG. These results correlated with the 24-hour recall data that indicated that the cereal group was in the top-5 foods consumed by the participants. However, the legume group was infrequently consumed, if at all, by the EG. Based on the food frequency and lifestyle data of the participants, it was surmised that the low protein and dairy intake by both groups was linked to restrictions in the buying power of these elderly farmers. Increasing prices of meat could further lower the intake of meat protein. Thus the introduction of plant protein sources such as legumes is a more viable alternative as this food source can be cultivated without extensive agricultural adaptations, as was demonstrated by the experimental and trial phases of the intervention project.

The baseline and pre-intervention data revealed disconcertingly inadequate dietary intakes in the diet of both men and women in both groups. However, the men in the CG had lower iron intake than the men in the EG. High iron intakes (compared to the UL) for the EG need further investigation as this can lead to iron toxicity, which could be attributed to the type of pots used as one of the contributing factors. However, such an investigation was beyond the scope of this study. A study by Gutiérrez-Uribe *et al*. (2016), who introduced legumes into the diet of trial participants, found that the consumption of 85 g of dry legumes contributed significantly (from 22.0% to 54.0%) to iron intake. These authors argue that this increase was vital in the treatment of other lifestyle diseases. Other studies also found that an increase in the intake of red kidney beans enhanced calcium levels for a more healthy life (Owuamanam, Ogueke, Iwouno & Edom, 2014; Percy *et al*., 2016) which is beneficial for eldelry bone functionality, managing blood pressure and diabetes. It must be noted that calcium can be lost during the cooking process of legumes. Therefore, other preparation methods should be explored and taught to ensure that nutrient retention is achieved (Chandrasiri *et al*., 2016). For example, consuming sprouts (a different method of preparing beans) can aid in counteracting anti-nutritional factors and in enhancing the bio-availability of nutrients in legumes. However, this method must be acceptable in order to be incorporated in the diets of this community.

The study found that the diet of the CG was much richer in fruit and vegetables than that of the EG which is a positive finding (this could be linked to non consumption of legumes whilst the EG mainly focused on legume consumption to meet study requirements). It was therefore deemed important to analyse the dietary patterns of both groups six months after the intervention phase in order to detect whether the increased consumption of legumes (after introducing these during the study) by the EG had signficantly improved their overall legume intake (p=0.000). It was found that the EG had focused predominantly on legumes, to the exclusion of other healthy food products such as fruit and vegetables. In this context, one must caution that one food group is not a panacea for all health-related issues. The strict monitoring of the legume food group could thus have restricted the intake of other food groups, particularly as the participating individuals were possibly not sufficiently monitored. However, regardless of the shortcoming referred to, there was an improvement in fruit and vegetable consumption by both groups from the pre-intervention phase to the post-intervention phase. This was an important finding as it was a study objective to increase fruit and vegetable consumption. However, the higher intake by the CG of fruit and vegetables (for example, post-intervention EG: men 70.6 g and women 82.1 g; CG: men 102.43 g and women 87.80 g) was somewhat disconcerting, after promoting overall fruit and vegetable intake according to SA guidelines in the educational programme. Should a similar study be conducted in future, it is suggested that the consumption of legumes be encouraged in combination with fruit and vegetables with other supporting interventions.

The findings related to the prevalence of obesity, overweight and central obesity in both groups were of concern. For example, the data for the post-intervention phase indicated that 90.9% of the men in the EG and 76.4% of the men in the CG and 95.8% of the women in the EG and 86.7% of the women in the CG, were overweight. These results correlate with findings of high obesity trends as a global phenomenon in middle-income countries, with particular concern for older persons (Lartey *et al*., 2019) As these figures were lower in the pre-intervention phase for both groups and genders, it was surmised that imbalanced diets contributed to weight gain. In this context, the study objective of a healthier lifestyle that would be enhanced by weight loss was not achieved.

Post-intervention data revealed that the majority (63.7%; n=7) of the respondents in the EG were obese (30->40 kg/m^2), followed by those who were overweight (18.5-24.99 kg/m^2) at 27.2% (n=3). This suggests that almost 90.9% (n=10) of this sample was over-nourished even though levels of food insecurity were detected. Therefore, dietary quality rich in refined carbohydrates and low in fibre due to lack of affordability of healthier foods can be linked to overnourishment and food insecurity. Those within a normal BMI range (18.5-24.99 kg/m^2) comprised only 9.1% (n=1) while nobody was underweight (<18.5 kg/m^2).

In comparison, the CG post-intervention had a high prevelance of overweight (BMI 25.00- 29.99 kg/m^2) at 47.1% (n=8), followed by those who were obese (30->40 kg/m^2) at 29.0% (n= 5), with only 23.5% (n=4) who were within the normal BMI range (18.5-24.99 kg/m^2). None were underweight (<18.5 kg/m^2). In the CG, 76.4% (n=13) was over-nourished. Obesity levels had improved slightly for the CG, as was revealed by the data of the post-intervention survey.

Metabolic syndrome and hypertension are associated with visceral adipose tissue (Kawada *et al*., 2016). In the pre-intervention phase of the current study, the metabolic risk indicators showed a great risk of lifestyle diseases amongst both study groups (94.9% of the EG was at risk, while 90.9% of the CG was at risk). The post-intervention survey revealed that the situation had not changed by any significant margin, as 95.8% of the women in EG and 90.0% of the women in the CG, as well as 90.9% of the men in the EG and 94.1% of the men in the CG, were still a risk due to a WHtR of ≥ 0.5. There were also statistically significant differences when comparing the genders of the groups per study phase, indicating that women were more at risk than men for metabolic risk. This correlated with evidence of blood cholesterol levels (high for 68.0% in the EG and for 43.0% in the CG in the pre-intervention phase). Such high blood cholesterol levels were still evident in the post-intervention tests, even after the South African guidelines for healthy eating guidelines had been introduced as part of the nutrition education training to lower intake of cholesterol-rich foods. Clearly, even after the intervention project, new lifestyle choices and dietary approaches had to be adopted by the study groups to help them deal with obesity and overweight. In this context, Raynor *et al.* (2016) argue that interventions to support weight management require lifestyle changes, which was a requirement that was obviously contrary to the norms and customs of the participants. According to De van der Schueren, Wijnhoven, Kruizenga and Visser (2016), malnutrition is likely to escalate and cause the existence of chronic diseases if olfactory changes do not occur in older persons. This sample group showed evidence of satisfactory overnutrition, which by extension could have been prevalent in the entire community where these participants resided.

Malnutrition associated with obesity is a dire threat in older people. For example, the prevalence of obesity and lack of sleep affect changes in orexins and ghrelin and result in decreased leptin (Lin, Lin, Chen, Wu & Tsai, 2016). The prevalence of obesity due to overnutrition was therefore a disconcerting finding that needs further investigation. This finding also correlates with other studies that identified a relationship between obesity, and malnutrition. For example, there was evidence of increasing obesity in the BMI classification of Obese I-III that was linked to malnutrition patterns in a study conducted by Fu *et al.* (2016). Socio-demographic variables play a significant role in the prevalence of obesity, which is also associated with gender interchanging (since they are influenced by different factors).

The current study found that even though women were predominantly malnourished, the men also had signs of being overweight, obese and at metabolic risk. There is an emerging trend of men becoming obese, even to the extent of exceeding obesity rates in women (Marqueta de Salas *et al*., 2016). With reference to the data for both the groups and the genders, it may be concluded that obesity is a complex challenge that needs to be addressed as a matter of urgency. An earlier study that took a step in this direction concluded that group dynamics and individual characteristics are pivotal in understanding BMI results, particularly in terms of obesity and central obesity (Raftopoulou, 2017).

Hypertension was also evident amongst members of both groups, and this finding sent out warning signals about the high risk for cardiovascular disease, implicating both groups. Even though the overall hypertension levels did not improve after the intervention, the CG was at a higher risk with 71.1% at grade 1-111. However, measuring the systolic and diastolic results revealed improvement in the EG regarding blood pressure after legume consumption. A significant relationship between legume consumption and improved systolic blood pressure was observed, with a statistical significance of $p<0.005$. This could also be linked to nutrition education on healthier eating and food choice implemented during the intervention phase. The post-intervention results indicated only slight improvement, confirming that this community required further interventions to address the existence and threat of hypertension. Unfortunately, this was beyond the scope of the study. These findings correlated with those of other sources that indicated that plant-based diets such as legumes are rich in fibre and can improve hypertension. More specifically, the risk factor of systolic blood pressure was significantly addressed by the study of Li *et al.* (2019a).

Sodium (NaCl) intake was high amongst both groups and exceeded the recommendations from the pre-intervention data. High sodium intake is a contributing factor for hypertension and the EARs for both men (EG: 844.72 g ± 319.267 g and CG: 1190.18 g ± 816.100 g) and women (EG: 778.18 g ± 468.654 g and CG: 1291.46 g ± 757.622 g) were exceeded, as revealed by the data of the pre-intervention survey. However, the post-intervention survey revealed that the mean values for the men (EG: 383.31 g ± 233.462 g and CG: 971.40 g ± 527.09 g) and for the women (EG: 628.96 g ± 412.525 g and CG: 875.23 g ± 425.572 g) had dropped to below the EAR. Sodium intake rates had thus dropped, which indicated that the baseline training (both groups) and the nutrition education programme (EG all phases; CG baseline study only) may have contributed to a lower sodium intake for the entire sample as this was encouraged as part of the nutrition education programme. However, further explorations need to be conducted regarding the association between the consumption of legumes in conjunction with a meat item, such as sausage that contains a high level of salt. A study conducted in India tested salt intake and its relationship with hypertension *(*Ravi *et al*., 2016) and found a correlation. In the current study, the high sodium intake could be attributed to seasonings (such as spices, stock cubes and soups which could have been used during the cooking) of the legume dishes (further investigations should further explore if other salty seasonings were used during the cooking process). This could have contributed to a high sodium intake through the bean dishes. However, extensive investigations need to be conducted to in order to determine measures that will encourage farmers like the ones in the study, to limit salt intake. Future research studies should formulate randomised clinical trials to further underscore the relationship between sodium and mechanisms of prevention within selected study groups.

Women who farm face diverse health challenges such as skin rashes, blurred vision and abdominal pain while in the field (Nyantakyi-Frimpong *et al.,* 2016b) and the nature and extent of such threats should be further explored. Be that as it may, the findings of the latter study correlated with those of the current study. For example, afflictions such as skeletal problems (EG: 58.5%; CG: 50.0%). poor eyesight (EG: 64.2%; CG: 74.0%), digestive problems (EG: 50.9%; CG: 48.0%) and lack of sleep and loss of memory (EG: 47.2%; CG: 38.0%) were common amongst the two groups as shown by the the pre-intervention survey. These signs of the ageing process, coupled with poor dietary choices, could have impacted the farmers' ability to function optimally and perform their daily tasks efficiently at home and in the field. However, it is surmised that the sleep problems experienced by the participants in this study could have been linked to obesity. During the pre-intervention phase there was a need to curb memory loss (since farmers were elderly and prone to forgetfulness) by ensuring that the participants followed the dietary guidelines given to them. Thus, the dates of meetings and food quantities were consistently emphasised and simple recipes were printed and distributed as often as possible during the meetings. This was to provide clear references in terms of the required legume intake and to effectively achieve reliable intervention outcomes.

High hyperglycaemic levels (a normal range was evident in only 20.0% of the EG but in 62.0% of the CG) were prevalent in both groups pre-intervention. It was thus necessary to take precautions not to compromise the health of those participants who were already at risk for diabetes. However, the post-intervention assessment indicated that there had been a shift in the CG towards the normal rate by 23.0% with no significance, but for the EG a significance of p=0.038 post-intervention was indicated. In general, the results implied that greater emphasis should be placed on maintaining normal blood glucose levels in both groups.

In the current study, there was evidence of high sugar consumption (particularly brown sugar) by the men in the CG. These men had a high pre-intervention brown sugar intake that was 34 times more than the rest of the group, with a mean intake frequency of 20.14 g. However, during the post-intervention phase, these men had a lower intake although it was still 24 times higher than that of other groups, with a mean frequency intake of 15.02g. Further investigations are required to evaluate the factors leading to food shortages and to determine if glycaemic control is practised by members of the study group. The prevalence of hypercholesterolemia was evident in both groups' pre-intervention (67.0% in the CG and 38.0% in the EG). In both groups, hypercholesterolemia was reduced to 23.0% and 9.0% in the CG and EG post-intervention, respectively. Regular screening would be necessary in the future to mitigate further (hypertension and stroke) risk, particularly for the CG.

The prevalence of high cholesterol and glucose levels that were above the recommended rates could be linked to low fibre in the diet of 100.0% of the men and 97.4% of the women in the EG pre-intervention, and in 100.0% of the men and 93.9% of the women in the CG, also pre-intervention. After the extended consumption of legumes, the post-intervention data indicates that there were statistically significant differences for both glucose (p=0.038) and TC (p=0.004) for the EG. This implies three factors that may have impacted this finding: (a) The farmers adhered to the legume intake requirements as prescribed and subsequently reported accurate details; (b) the period of the trial was sufficient, and a much longer and sustained change in diet could further underscore the significant role that legumes play to remedy high blood cholesterol levels; and (c) maybe the farmers sustained the consumption of the legumes because of interest developed in this group. According to Dodevska *et al*. (2013), dietary fibre lowers cholesterol serum levels and glucose through a process of gel layer formation. There was a correlation with these results in a similar study conducted in the ten European cities. These authors cautioned that an understanding of by participants did not always translate into a favourable reduced high fat intake pattern (Vyncke *et al*., 2013)**.**

The nutrition education programme offered the farmers guidelines on correct food choices and the importance of exercise to make them more aware of the critical danger associated with overnutrition. However, as was alluded to above, the results suggest that these dietary recommendations were a mere baseline intervention strategy and that more long-term intervention measures may be required to aicheve the desired outcomes of a more healthier ifestyle and physical health of elderly farmers who may be set in their food choices and consumption patterns. In this context, the persistent obesity trend could most probably be linked to the energy-dense diets that these farmers continued to consume in the intervention phase of the study and a lack of physical activity.

The high cholesterol levels in the participants could have had adverse effects on them as factors such as immunity and physiological processes could have been compromised (Kinno *et al*., 2019). Chivandi, Mukonowenzou, Nyakudya and Erlwanger (2015) argue that vulnerable groups are even more at risk due to micronutrient deficiency as it can be linked to environmental conditions (eg degredation of soil due to mining and poor rainfall) in sub-Saharan Africa. Shergill-Bonner (2013) also argues that the dietary needs of population groups can be affected by socio-economic factors that can lead to an under- or over-consumption of micronutrients. Future investigations are thus needed to determine which environmental and socio-economic factors might affect micronutrient deficiency in similar populations.

The results clearly revealed that greater emphasis on a low energy diet was required as this would have been the only way in which the overweight and obese participants could have achieved an improved body weight. Adulthood obesity has been linked to various factors (age, poor morbility and basal metabolic disorders) other than dietary intake. Therefore, future similar intervention programmes should take cognisance of the recommendations in studies on the lipid profile and metabolic risk disorders of obese people. A correlation between obesity and the food environment has also been found by studies such as the one by Susic and Varagic (2017). The food environment comprises not only which foods are accessible to individuals, but also to what they are being exposed to. Therefore, a food environment can influence the obesity profile of an individual or community (Dalle Molle *et al.*, 2016). Another factor that needs to be considered in future obesity prevalence studies is the correlation between obesity, hypertensive disorders and intensive therapeutic approaches in treating patients who face this dual combination of health risks (Susic *et* *al*., 2017). The reported results (on hypertension) could have been due to the use of calcium channel blockers in individuals who were hypertensive. However, further investigation is required regarding hypertensive medications and their direct influence on blood serum, as this was beyond the scope of the current study. The slight improvement (on hypertension) in the CG cannot be explained other than to surmise that the general information about the study they had received during the baseline study encouraged them to medicate (since the majority reported being on chronic medication which they obtained from local clinics) in order to address hypertension. Moreover, this group could have developed an interest in improving their lifestyle as the EG group was trained and regularly visited by nurses. Participants in the CG could have felt excluded and some may have decided (consciously or unconsciously) to improve their lifestyle.

The survey conducted in the pre-intervention phase showed that the study groups, particularly the EG, were not loath to incorporating legumes regularly in their diets. The majority were also keen to grow and produce new legume varieties, although the ultimate outcomes (EG group only) were not promising in some instances. Be that as it may, there was a positive start as new legume varieties were planted and consumed. The majority of the participants consumed legumes once a week (EG: 77.4% and EG: 66.0%). The data for the CG were interesting as they were not required to consume (the new introduced) legumes varieties as part of the trial, however they continued consuming the popular sugar beans. Conversely, some members of the EG did not adhere to the trial requirements for legume consumption. An effort was made to validate their reasons for this by administering the FFQ and the 24-hour food recall questionnaire as part of the post-intervention survey, with reference to the behavioural theory.

One finding that stood out was the participants' low protein consumption. According to Jyväkorpi *et al.* (2015), low protein intake is common amongst older people who are home-bound. They recommend that structured interventions are needed to address this concern. However, the elderly farmers were not home-bound as many were in the field either full-time or part-time. The study found that protein intake significantly increased for women (EG: a post-intervention rate of 59.95 ± 30.62 g vs their pre-intervention rate of 32.28 g ± 11.52 g). The protein intake by men also increased (EG: post-intervention 48.09 g ± 20.56 g vs pre-intervention 38.29 g ± 16.78 g). It is thus undeniable that their exposure to the nutrition programme improved their protein intake. However, protein intake remained low, especially for the men, while there was an improvement in protein intake by the women, as was revealed by the post-intervention data.

A study in Iran highlighted the value of knowledge about the relationship amongst specific food groups and the impact of increasing prices on urban household food security (Hosseini *et al*., 2017). It was based on this recommendation that legume preparation techniques and food tasting where acceptability of dishes was measured in the current study to enhance the understanding of the role of legumes in the food and nutrition practices of the elderly farmers and their households. The researcher disseminated recipes to the farmers that promoted the use of a combination of legumes and other healthy ingredients in one recipe to increase diversity in single meals. This was in an effort to adjust the norm of a single legume being used in a dish. This intervention aided in escalating legume intake and to rate legume varieties in the top-five food items consumed. This measure also aided in dropping the most commonly consumed legume (sugar beans) down the list for men, reflected in Table 4.22 and -Table 4.22.1. However, the fibre intake of the CG remained low. It must be acknowledged that they had not been required to include legumes in their diet, other than what they would normally have consumed. Improving legume consumption can improve fibre intake and address digestive problems (eg constipation and bloating) such as those detected in the pre-intervention survey (constipation and diarrhoea).

Another significant finding was that although legume intake increased, the consumption of other food groups that had commonly been consumed in the pre-intervention phase remained the same. This finding suggests that any dietary intervention that focuses on a particular food group will not necessarily cause a decline in the consumption of other undesirable foods but can merely serve as a substitution of foods that habitually appear in a diet. Legumes were intended as a substitution for meat, but the post-intervention survey revealed that meat and other habitual food items remained on the farmers' top-20 list. This suggests that future interventions should not only focus on the introduction of a particular type of food for diversity, but that measures should be devised to limit more undesirable food such as those containing high levels of sugar, salt and fat.

It was deemed critical to assess the top-20 food items to determine the participants' dietary intake patterns. Intervention studies should thus always take individuals' lifestyle and dietary habits into account when major shifts need to occur to adjust long-standing dietary patterns. Clearly, adjusting dietary patterns takes time and these patterns need to be monitored consistently. In the intervention project, indigenous legumes remained highly preferable to other less common legumes. The study achieved a measure of success as the EG participants were encouraged to consume legumes ≥4 days a week. This was achieved through training and skills development, which focused on preparation methods, storage and processing. The processing methods (eg sprouting, freezing and blending) of legumes that were encouraged intended to improve the dietary fibre intake and functional properties of legumes for consumption and nutrient availability. The processing methods applied during the tasting sessions were similar to those used in a study where mung beans were processed (into various forms) to yield fibre and functional properties (Chandrasiri *et al*., 2016).

It is important to note that regardless of the legume variety consumed, it is vital to prepare it well to ensure that its nutritional value is maintained (Dodevska *et al.*,2013). If legume dishes are tasty, it also positively encourages consumption and builds confidence in the product. The training programme that involved the EG only was similar to one used by Condrasky, Baruth, Wilcox, Carter and Jordan (2013), who aimed to train community members in churches to prepare healthy meals in order to build their confidence and skills and to improve the diet. The current study envisaged that the education programme would not only enhance the acceptability of legumes amongst the elderly farmers in terms of production and consumption, but that it would also open a door for increased marketing power for these farmers. It was also envisaged that legumes that had previously been ignored in the supermarket would now be recognised and used for production and consumption. However, in terms of marketing and financial gain, the scope of the study in terms of time, was insufficient, as the farmers had no financial gains from selling or marketing the legumes they had cultivated. The vast majority used their crops for household consumption that contributed to household food security and dietary diversity during the period in which the legumes were consumed.

Access to food for elderly people, and particularly access to legumes, is a critical driver in ensuring food security in the homes of ageing citizens. The intervention project thus introduced mechanisms to ensure future access to a healthy food source through production as well as consumption. In this endeavour, a multiple-angle perspective was used. However, the results of the intervention programme suggest that dietary diversity is influenced by accessibility, as well as by a positive perception of the food that is newly introduced and information on how to prepare and produce it. It is thus evident that not only an effective education programme but also consistent and persistent monitoring sessions are required for an extended period to alter the traditional perceptions and practices of study targets. The findings correlated with those of a study conducted in Bangladesh which indicated a relationship between food security (access, availability and utilization) and dietary diversity (Bidisha *et al*., 2017). This can be observed during the time when farmers had access to legumes, there were evident changes in top 20 list of food consumed (refer to table 4.18A, 4.18B, 4.19A; 4.19B).

On a positive note, education in terms of legume production and health benefits improved acceptability levels and encouraged the study participants to experiment with new legume varieties. However, the production results indicated higher yields of harvested legumes in the first trial (69.00 kg/ha) compared to the second trial (64.43 kg/ha) for red kidney beans only (Trial 1: 141.60 kg/ha SD 162.11 compared to Trial 2: 123.39 kg/ha SD 164.39). These high yields that were utilised for consumption meant that this food group contributed to food security in the homes of the successful farmers. Red kidney beans grew better than most of the other legume varieties, followed by cow peas and jugo beans. However, it may be prudent to tighten the gap using more trials with those legumes that did not grow successfully, by looking specifically at these legumes' limitations and by devising measures to improve their yields.

Based on the overall results, there is also a clear need to strengthen the socio-economic factors that can contribute to improved legume production, yield and sustainability. For example, the constraints associated with the cultivation of legumes at household level can be alleviated by addressing drought conditions through innovative water supplies (Burridge *et al*., 2016). Drought affected the majority of the farmers in the second trial (due to lower yields), regardless of the efforts of the municipality to provide them with water. Newly constructed reservoirs that are managed by the farmers themselves would be a step in the right direction.

The results revealed that there was a stronger correlation between female farmers and the successful production of legumes than with the success achieved by their male counterparts. Gender thus played a critical role in the more successful production of legumes. This could be attributed to the fact that the women were more committed to attending training sessions and they were also more interested in the legume preparation sessions. Women are traditionally the nurturers of families and this may account for their heightened interest in recipes and the taste of legume dishes. It was clear that the majority of the men would pass the message on to their partners or female members of the household and expect them to produce the recommended dishes. Earlier studies have highlighted the fact that, according to African tradition, it is predominantly women who till the land and tend the crops, while men attend to business and other matters (Thompson-Hall, 2016). However, Mutenje, Kankwamba, Mangisonib and Kassie (2016), demonstrated that female farmers were key players in decision-making as well as being tasked with the handling and storing of crops in Malawi. In the current study, it was clear that women played a vital role in crop production and in influencing the consumption of legumes. However, men also have a role to play as they can influence their female partners at home to prepare tasty dishes from their harvests or purchases. As the female partners of the men were not part of the training programme, education programmes and diversity should be rolled out to address this. Women can play a transformative role in agriculture, not only at home, but in the field as well (Grow Africa, 2017). However, further research that focuses on capacitating women in agricultural production and marketing strategies is required. However, the role of men remains vital in the agricultural sphere. The results of Trial 2 actually indicated that it was the men who improved production. This could be linked to their greater awareness due to the motivation they now had to achieve better yields. Thus, even though men and women often need to be approached in a different manner, both require extended knowledge of agricultural practices. The trainer should be cognisant of the fact that men are sometimes not easily influenced the first time around. In this regard, the study findings correlated with those of Thompson-Hall (2016). There are visible disparities between men and women farmers globally and most significantly in developing countries. Therefore, there is an need to tailor-make intervention programmes to address the unique needs of men and women in order to enhance food production.

The preparation of legumes played a critical role in addressing the challenges that the majority of the farmers faced in the pre-intervention phase. For example, the results indicated that a lack of knowledge of legume varieties was a contributing factor that prevented the participants from including this foodstuff in their diets. Concerns regarding taste, preparation and cost were thus addressed in the education part of the intervention programme in which the farmers, more specifically the EG, were encouraged to include legumes in their diets for the duration of the intervention period, as well as beyond. The results correlated with those of a study by Aggarwal, Rehm, Monsivais and Drewnowski (2016) in which the authors argued that nutrition education plays a significant role in tackling food-related misconceptions and beliefs. For example, nutrition education as an intervention that targets poor food-related beliefs and attitudes can be used as a strategy to tackle issues such as socio-economic and racial disparities that impact dietay intake.

A recommendation that emerged strongly from the findings is that there is an urgent need within the agricultural sector for the training of professionals (agricultural extension officers) that can function at grassroots level. Such specialists can play a significant role in addressing issues such as obesity as a public health concern (Wallner & Thompson, 2016). The current study utilised participants who were already part of the agriculture sector. Moreover, they were active community members who were already part of a municipal training initiative. The findings suggest that if such people are persistently trained at grassroots level, they can become advocates for the importance of legumes and many may also assist other community members their health and lifestyle. The study addressed the benefits associated with legumes by means of a practical journey and lived experiences involving elderly farmers. However, further initiatives specifically aimed at linking obesity and agriculture are needed. The findings revealed disconcerting evidence of the co-morbidity of various non-communicable diseases within the study sample and, by extension, this implies that the same problems may exist in other similar communities. The implications are strained medical costs for both the national and provincial healthcare system in South Africa. This correlates with a finding of a study conducted in the United States that identified a negative impact on the total medical care costs due to obesity. For example, it was revealed that a single patient can have from one to five non-communicable diseases in conjunction with obesity (World Economic Forum, 2017).

It is also important to take cognisance of the constraints that were identified by the farmers because each challenge required a specific solution. Furthermore, by addressing each on its own, the significance of developing sustainable cropping systems at provincial, municipal and household levels will be highlighted. Moreover, the identified constraints cannot be addressed by the farmers alone. Another study that advocates the need for future solutions to the unstable climate and continuous droughts in the Southern African region is that of Thierfelder *et al*. (2016). For example, the need for water security was evident in 81.1% (EG) and 84.0% (CG) of the study sample. However, no relationship could be determined amongst water security, poverty and food security based on the data of the pre-intervention survey. A study conducted in Limpopo alludes to these three variables and argues that relational effects do not necessarily have to be indicated amongst them in a community under study (Magombeyi, Taigbenu & Barron, 2016). The interest expressed by the farmers to grow legumes in the latter study indicated the possibility that they might use these cultivars in the future to improve their cropping systems. The authors also argue, as does this researcher that further studies are needed to investigate the integration of legumes with other crops. Increased legume production can positively influence a sustainable ecosystem environment and ensure nitrogen and soil enhancement. This hypothesis was tested in Malawi by Nyantakyi-Frimpong *et al.* (2016a) amongst smallholder farmers. Their study indicated that legumes were not only deemed essential for improved nutrition intake, but they were also vital in agriculture for the production of various crops and for the sustainability of the ecosystem.

4.20 Conclusion

Based on an analysis of the pre-intervention data, it was deemed important to expand the study by implementing a nutrition education programme (see section 4.20) to encourage farmers' dietary adjustments. To achieve this objective, the farmers needed to have a thorough knowledge of cultivation and preparation methods. This was achieved through training that took cognisance of the behaviour modification theory. There were many gaps in the diets of the farmers, which they acknowledged. They seemed keen to adopt dietary diversity and to produce legumes for themselves in a trial to address food scarcity by including this food group in their diets. Strategies used to stimulate their interest and to motivate participation were education and the provision of technical support. The post-intervention survey used these data to look in-depth at the impact of the changes that had been adopted and to determine the effects of the education and practical training programmes.

The ultimate aim was to use the intervention project to introduce legumes as an alternative plant-based source of protein to elderly farmers in the study area. Legumes have nutritional benefits that can improve the health status of farmers if consumed appropriately, in conjunction with other health practices. Part of the intervention project was an education programme that was implemented to increase the farmers' knowledge (legume production and product preparation skills) while it also aimed to establish positive attitudes towards legume production and consumption. By encouraging legume production, it was envisaged that these farmers would be able to become self-sufficient in the long-term by marketing their crops effectively. When the data were analysed and evaluated, parallels were drawn between the EG and the CG to assess the impact of the intervention programme. Even though the study yielded data that indicated the improvement of the nutritional status of some of the farmers in some areas, various gaps still existed that would need additional interventions. This was beyond the scope of the study and further studies should be conducted on an on-going basis. These should be aimed to provide a broader and updated view of the ability and potential of farmers to adapt to ever-changing agricultural needs and to sustain health benefits through appropriate dietary customs and practices.

CHAPTER 5

RESULTS OF THE FOLLOW-UP SURVEY CONDUCTED SIX MONTHS AFTER THE POST-EVALUATION SURVEY

5.1 Introduction

This chapter reports the data of a survey that was conducted six months after the post-intervention survey. This phase of the study is referred to as the follow-up survey (see the Conceptual Framework Table 1.1 in Chapter 1) and was conducted exclusively to monitor the long-term effectiveness of the intervention programme. The study surveyed the farmers of the EG who had cultivated and consumed legumes during the intervention phase of the study. Comparing data that were obtained soon after the intervention phase with data that were procured six months later was vital in determining whether the changes (improvement in health and dietary intake) had been sustained, and whether the long-term goal of the improved health of elderly farmers had been achieved. It should be noted at this point that the practical programme (i.e. the intervention project) was phased out soon after the post-intervention data had been collected as planned. The follow-up survey determined the farmers' application of their newly acquired knowledge and experiences of consuming legumes; their dietary and behavioural changes; and the acceptability levels in terms of legume cultivation and consumption. Figure 5.1 below presents the structure of this chapter in tabular form.

Figure 5.1: Conceptual framework of the study-Phase 5

5.2 Background to the Six-Month Follow-Up Survey

The overarching aim of the study was to promote legume consumption in an effort to address food and nutrition insecurity amongst elderly farmers (age 60 and older) in the Mariannhill area. The first main intervention measure was an education programme focusing on legumes, followed by a practical trial period during which the study participants were required to plant and consume legumes over a three-month period. The planting (cultivation) trial was conducted across two consecutive years as the first trial period (Trial 1) was unsuccessful for the EG (even though there was harvest of newly introduced legume varieties). Therefore, because there were no harvested legumes available for consumption in the first planting season (Trial 1), the participants were donated five varieties of legumes for consumption over a 3-month period. It is reiterated that although the training programme, the cultivation and the consumption of legumes occurred relatively interchangeably, these processes were reported chronologically in this dissertation (Chapter 4) for the sake of clarity.

The follow-up survey (Chapter 5) measured the impact of the intervention phase on the farmers' food and nutrition security. This survey was conducted with members of the experimental group (EG) only and thus excluded the control group (CG). Figure 5.1 presents the structure of the follow-up survey as part of the framework of the study.

For clarity, the terms experimental group post-intervention (EG-PI) and experimental group follow-up (EG-FU) will be used in this chapter, as well as in the discussion in Chapter 6.

5.3 Survey Methodology

Similar to the other phases of the study, this survey was also a component of the experimental nature of the study and utilised quantitative data. The methodology focused on a case control survey as the aim was to obtain data that could be compared with those of the post-intervention survey. The data are reported in this chapter while the findings are discussed in detail in Chapter 6, which will also serve as the concluding chapter of the dissertation.

A quantitative (statistical) research methodology was used to determine the relationship between the results of the EG-PI data and those of the EG-FU data. The administration of the survey questionnaires occurred in the AHS venue as before (i.e. all the baseline, pre-intervention and post-intervention surveys were conducted in this venue).

5.4 Sampling and Selection Criteria

The following considerations applied in the selection of the sample for the follow-up (FU) survey:

- It was necessary to determine if the farmers who had been included in the EG in the intervention phase had sustained what they had learnt and whether they were thus continuing to cultivate and consume legumes.
- It was also important to determine if the knowledge they had obtained and the training they had received had engendered a deeper understanding of the importance of legumes, and whether this had motivated these farmers to make life-changing decisions in terms of their health and livelihoods.

With reference to these considerations, the farmers who had served in the experimental group of the intervention phase were again approached to complete the survey questionnaires that were administered by the same well-trained field workers who had assisted during the intervention project. Of the 35 participants in the intervention phase, only 32 were available to complete the EG-FU survey questionnaires. Three members had dropped out due to illness.

5.5 Measuring Instruments

The following measuring instruments were used:

5.5.1 Nutritional assessment: dietary intake questionnaires

The nature of each of the dietary survey questionnaires was similar to what was reported in Chapter 3. The information was recorded on the dietary questionnaires for the EG in the pre-intervention phase, the post-intervention phase and again for the follow-up survey. To conduct the survey, 24-hour recall questionnaires (3x per individual farmer) to record their intake of three consecutive days prior to the survey and the food frequency questionnaire (1x per individual farmer) were administered. The sample size for the EG-PI was 35 (n=35), whereas it was 32 (n=32) for the EG-FU.

5.5.2 Legume knowledge acceptability evaluation feedback questionnaire (LKAEFQ)

The nature of the LKAEFQ (the nutrition assessment questionnaire) was similar to what was reported in Chapter 4. The information was recorded for both the EG-PI and EG-FU and the data of the post-intervention survey were compared with those of the FU survey. The sample size of the EG-PI was 35 (n=35), whereas it was 32 (n=32) for the EG-FU. The same methodology that was described in Chapter 3 was used to analyse and interpret this data.

5.6 Comparison of the Post-Intervention and the Six-Month Follow-Up Survey Results

5.6.1 Dietary intake and food consumption pattern indicators: EG-PI and EG-FU

The measurement of dietary intake and food consumption patterns was important in the follow-up survey to determine if legumes had been and were still being consumed by the farmers who had participated in the intervention programme. A time gap of six months between the PI and FU surveys was allowed in order to determine whether the participants had been sufficiently capacitated to sustain healthy eating habits without being dependent on support by the research team. It was thus envisaged that the data would also expose the level of self-reliance that the participants had achieved. The data that are presented focus on macronutrients and key minerals, namely calcium, iron and magnesium intakes. The same methodology described in Chapter 4 was used to analyse and interpret this data.

5.6.1.1 Dietary intake patterns [16]

a) Follow-up data for men compared with post-intervention data

The FU survey indicated that the energy intake of the men was 8192.06 ± 1970.01 kJ (EER 5193.72 ± 1170.20), which was higher compared to the EER and the results of the post-intervention survey. This suggests that the male farmers continued to ingest food with high energy content even after the intervention phase and regardless of the efforts of the research team to curb the intake of high energy foods. The FU survey indicated that protein intake had also increased for the EG (69.54 g± 17.78 g) compared to the post-intervention results (48.09 g ± 20.56 g). Carbohydrates (276.15 g ± 47.28 g) and fat (54.04g ± 30.64 g) intakes were also higher. The trend of low intakes of micronutreints that was detected post-intervention was consistent with the FU results.

b) Follow-up data for women compared with post-intervention data

The FU data revealed (refer to table 5.1) that the women had also increased their energy intakes (7090.40 ± 1691.90 kJ compared to the EER of 6301.76 ± 1074.86) (Roza *et al.*, 1984). This indicates that the energy intake of the women in the EG increased over the phases of this study. This latter intake was also above the EER value of 4133.2 kJ for active women and was even higher than the post-intervention rate for the EG, which was 5939.90 ± 2313.60 kJ. Both surveys indicated energy intake values that were far above the recommended EERs and it was concluded that the women in the EG had maintained a consistent trend of too high energy intake rates throughout the study.

As indicated by the FU results, protein intake was higher for the women in the EG compared to the post-intervention data, as the FU data revealed a mean intake of 62.41 g ± 15.65 g compared to 59.95 g ± 30.62 g post-intervention. Both these intakes were higher than the EAR rate of 46 g. Carbohydrate intake had also increased as indicated by the FU data to 224.7 g ± 52.52 g compared to the post-intervention mean of 177.7 8 g ± 53.28 g. However, dietary fibre intake also improved (21.60 g ±7.18 g) and so did dietary fat (49.78 g ± 17.55 g). Micronutrient intake retained a similar trend (of low consumption) as was detected by the post-intervention data.

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[16] It is important to note that the FU survey was conducted during the peak of winter, which could have influenced dietary intake.

Table 5.1: Comparison between data obtained by the post-intervention and follow-up surveys: Dietary intake of nutrients by respondents to determine adherence to DRI values (sourced from the average of three 24-hour food recall questionnaires) (men: EG n= 11; EG FU n=10; women: EG n= 24; EG FU n=22 (separately) (IoM, 2003, 2001, 2003, 2005, 2006; 2010, NICUS 2003)

Nutrients /day EG P1	EG PI Men (n=11) Mean ± SD	EG PI Men NARs Mean % of the DRI	EG PI % Men consuming <100% of DRI	EG FU Men (n=10) Mean ± SD	EG FU Men NARs Mean % of DRI	EG FU % Men consuming <100% of DRI	DRIs ♂ men
Energy (kJ) EER	5255.45 ± 1954.55	101.2	45.5%	8192.06 ± 1970.01	157.7	0.0%	♂5193.72 ± 1170.20 kJ EER
Total protein (g)	48.09 ± 20.56	85.8	72.2%	69.54 ± 17.78	124.1	20.0%	♂56 RDA
Total fat (g)	33.67 ± 16.08	33.6	50.0%	54.04 ± 30.64	54.0	50.0%	♂100 EAR
Carbohydrates (g)	167.91 ± 63.54	167.9	18.2%	267.15 ± 47.28	26.7	0.0%	♂100 EAR
Total dietary fibre (g)	19.93 ± 8.38	66.4	36.3%	17.59 ± 6.40	83.7	50.0%	♂30 AI
Calcium (mg)	260.72 ± 130.36	21.7	100.0%	359.49 ± 120.23	29.9	100.0%	♂1200 AI
Iron (mg)	11.91 ± 5.68	198.5	36.4%	16.02 ±	267	0.0%	♂6.0 EAR
Magnesium (mg)	188.51 ± 82.65	53.8	100.0%	262.21 ± 79.44	74.9	90.0%	♂350 EAR
Nutrients /day	EG PI Women (n=24) Mean ± SD	EG PI Women NARs Mean % of the DRI	EG PI % Women consuming <100% of DRI	EG FU Women (n=22) Mean ± SD	EG FU Women NARs Mean % of the DRI	EG FU % Women consuming <100% of DRI	DRIs ♂ men ♀women
Energy (kJ) EER	5939.90 ± 2313.60	97.8	41.7%	7090.40 ± 1691.90	112.5	0.0%	♀ 6301.76 ± 1074.86 kJ EER

Table 5.1: Continued

Total protein (g)	59.95 ± 30.62	130.3	29.2 %	62.41 ± 15.65	135.6	18.1%	♀46 RDA
Total fat (g)	43.68 ± 26.85	43.6	44.0%	49.78 ± 17.55	49.7	13.6%	♀100 EAR
Carbohydrates (g)	177.78 ± 53.23	177.7	4.2%	224.74 ± 52.52	224.7	0.0%	♀100 EAR
Total dietary fibre (g)	16.65 ± 6.46	79.2	70.8%	12.60 ± 7.18	102.8	54.5%	♀21 AI
Calcium (mg)	255.21 ± 144.34	21 2	100.0%	376.24 ± 192 23	31.3	100.0%	♀1200 AI
Iron (mg)	12.02 ± 4.36	240.4	0.0%	13.14 ± 2.84	262.8	0.0%	♀5.0 EAR
Magnesium (mg)	200.15 ± 81.54	76.9	83.3%	218.39 ± 54.95	82.4	95.4%	♀260 EAR

EER: Estimated Energy Requirement (Institute of Medicine. 2003)

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

EAR: Estimated Average Requirement; RDA: Recommended Dietary Allowance

DRI: Dietary Reference Intake

Estimated Energy Requirement (EER) and Basal Metabolic Rate (BMR) calculations ♂Men, ♀Women

5.6.1.2 Food intake patterns for men (FU data)

For comparative purposes, Table 5.2A (EG-PI) and Table 5.2B (EG-FU) present the data for the 20 foods mostly consumed during the intervention phase (as determined by the post-intervention survey) and in the six months after the intervention phase (as determined by the follow-up survey). The mean intake over three days was assessed and the data are presented per frequency consumed as well as per mean capita intake.

The FU survey indicated that the carbohydrate intake had increased, with maize meal (381.33 g ± 18.87 g) still 1st in the top-20 food items consumed list, followed by rice (153.50 g ± 8.95 g) which was 3rd; bread (86.67 g ± 7.19 g) in 6th position and steamed bread (50.33 g ± 7.12 g) (8th). Although not a carbohydrate, tea (a non carbohydrate) was consumed with sugar and milk and was high on the list (231.00 g ± 37.39 g). The protein-rich group showed no mixed legume varieties, but sugar beans had still been consumed (25.00 g ± 14.43 g) with a much higher chicken intake (127.67 g ± 37.54 g) in 4th position. More vegetables (cabbage, potato, tomato and onion, butternut, green salad and coleslaw) also appeared in the top-20 list, when compared to vegetable intake post-intervention.

The follow-up survey thus indicated that slight adjustments had occurred in the ranking of the preferred food items. The consumption of the top-5 foods seemed to remain fairly constant, but others seemed to shift position over the duration of the study, as well as in the six months following the post-intervention survey. The data indicated that refined carbohydrate intake was higher during the six months after the intervention project, and higher portion intakes occurred compared to the data of the post-intervention survey. Animal protein intake shifted down the ratings as higher amounts of plant protein (i.e., legumes) had been consumed. However, normal sugar beans and canned sugar beans returned to the list, replacing the mixed legume variety stew that had been consumed during the intervention phase. This suggests that if legumes are supplied to elderly farmers, their dietary intake can be adjusted (by famers incorporating them within their diet). The ranking order also shifted slightly as more emphasis was placed on tea and brown sugar, which could have been influenced by the arrival of the colder winter season. There was also an indication of lower legume diversity in the diet of these male farmers in the six months after the post-intervention survey.

Table 5.2A (n=11): Consumption of top-20 food items by men ranked by frequency consumed as measured by three 24-hour food recall questionnaires for the EG-PI

EG -PI: Post-intervention – men's top-20 food items (n=10)

No	Item	Mean *frequency (number of times consumed) (n)	Total group intake over 3 days (g)	Mean total intake over 3 days (g ± SD)	Mean intake per frequency (g ± SD)	Mean per capita per day (g ± SD)
1	Maize meal porridge	10	7285.00	809.44±364.59	24.53±16.41	80.94±36.46
2	Tea	5	4225.00	469.44±168.81	27.61±0.60	46.94±16.88
3	Mixed bean stew	4[17]	3445.00	382.78±193.49	29.44±20.93	38.28±19.35
4	Diluted squash cold drink	4	3000.00	333.33±101.04	27.78±4.94	33.33±10.10
5	White rice	3	1720.00	191.11±160.73	17.37±25.01	19.11±16.07
6	Brown bread (fortified)	5	1480.00	164.44±63.01	10.28±6.19	16.44±6.30
7	Macaroni & cheese	1	1200.00	133.33±0.00	22.22±0.00	13.33±0.00
8	Samp and beans	1	1040.00	115.56±32.72	14.44±25.66	11.56±3.27
9	Chicken stew or curry	2	975.00	108.33±41.26	13.54±8.03	10.83±4.13
10	Full cream milk	2	695.00	77.22±33.55	11.03±7.29	7.72±3.36
11	Chicken roasted	2	680.00	75.56±51.54	12.59±14.07	7.56±5.15
12	Steamed bread	1	655.00	72.78±23.59	18.19±5.36	7.28±2.36
13	Beef stew or curried	1	505.00	56.11±29.83	11.22±8.66	5.61±2.98
14	Egg fried	1	495.00	55.00±31.75	11.00±10.58	5.50±3.18
15	Beef stew or curry	1	410.00	136.67±3.85	45.56±3.85	4.14±0.12
16	Three bean salad	1	360.00	40.00±36.06	10.00±18.03	4.00±3.61
17	Sugar bean curry	1	315.00	35.00±2.89	8.75±8.18	3.50±0.29
18	Brown sugar	8	305.00	33.89±11.82	1.36±1.02	3.39±1.18
19	Vegetable curry	2	295.00	32.78±26.48	5.46±6.04	3.28±2.65
20	Margarine	1	35.00	3.89±2.55	0.97±0.96	0.39±0.25

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable

[17] Yellow highlights how much the legumes have moved up in ranking and also the frequent appearance within the EG top 20 food list.

Table 5.2B (n=10): Consumption of top-20 food items by men ranked by frequency consumed as measured by three 24-hour food recall questionnaires for the EG-FU

EG-FU top-20 foods consumed by men (n=10)

No	Item	Mean *frequency (number of times consumed)	Total group intake over 3 days (g)	Mean total intake over 3 days (g ± SD)	Mean intake per frequency (g ± SD)	Mean per capita intake per day (g)
1	Maize meal porridge	7	11440.00	3813.33±188.67	131.49±14.45	381.33±18.87
2	Tea	11	6930.00	2310.00±373.91	92.40±5.02	231.00±37.39
3	White rice	7	4605.00	1535.00±89.49	85.28±7.42	153.50±8.95
4	Chicken curry	8	3830.00	1276.67±375.36	85.11±21.92	127.67±37.54
5	Samp and beans	2 [18]	3250.00	1083.33±24.06	180.56±12.03	108.33±2.41
6	Brown bread (fortified)	9	2660.00	886.67±71.91	36.94±4.23	88.67±7.19
7	Diluted squash cold drink	3	2250.00	750.00±76.38	93.75±11.56	75.00±7.64
8	Steamed bread	3	1510.00	503.33±71.21	71.90±11.55	50.33±7.12
9	Cabbage stew	2	1220.00	406.67±107.98	101.67±33.39	40.67±10.80
10	Full cream milk	8	1180.00	393.33±56.58	17.88±0.34	39.33±5.66
12	Potato curry	3	1125.00	375.00±0.00	125.00±0.00	37.50±0.00
11	Egg fried	4	990.00	330.00±31.75	33.00±2.65	33.00±3.18
13	Sugar beans curry	2	750.00	250.00±144.34	125.00±72.17	25.00±14.43
14	Tomato and onion stew (no sugar)	2	565.00	188.33±58.22	37.67±21.67	18.83±5.82
15	Brown sugar	14	295.00	98.33±33.10	2.89±2.32	9.83±3.31
16	Butternut boiled	2	183.00	60.83±21.32	15.21±10.66	6.08±2.13
17	Margarine	3	110.00	36.67±11.34	3.06±0.96	3.67±1.13
18	French salad	2	50.00	16.67±9.62	8.33±4.81	1.67±0.96
19	Coleslaw	2	40.00	13.33±7.70	6.67±3.85	1.33±0.77
20	Salad dressing low-oil	2	20.00	6.67±3.85	3.33±1.92	0.67±0.38

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable

[18] Yellow reflects the ranking and frequency of legume intake during FU survey.

5.6.1.3 Food intake patterns as measured for women (FU data)

The twenty most frequently consumed foods by women were determined by measuring the mean intake over three days per frequency consumed, as well as the mean per capita intake.

A similar trend as was detected for men was observed for women as a higher carbohydrate intake was detected by the FU data. Even though tea (256.06 g ± 12.91 g) was the first ranked food item, maize meal (253.26 g ± 7.95 g), rice (121.82 g ± 9.32 g) and sugar (27.24 g ± 4.85 g) intakes were higher FU than post-intervention.

For protein intake, chicken curry intake (120.83 g ± 9.30 g) was detected as the 4th food on the top-20 list. Beef curry (19.85 g ± 10.08 g) was also higher but no legume consumption was detected by the FU survey. The fruit and vegetable intakes such as cabbage (11th on the list), spinach, banana and butternut had higher intakes when the FU results were compared with the post-intervention results for women of the EG.

The results indicated that the ranking had shifted slightly as more emphasis was placed on tea and brown sugar, which could have been influenced by the colder winter season. There was also an indication of lower legume diversity in the diet of these women six months after the intervention phase, which was similar to the trend that was detected for their male counterparts.

Table 5.3A Consumption of top-20 food items by women ranked by frequency consumed measured by three 24-hour recall questionnaires

EG -PI– Post-intervention top-20 foods for women (n=25)

No	Item	Mean *frequency (number of items consumed) (n)	Total group intake over 3 days (g)	Mean total intake over 3 days (g ± SD)	Mean intake per frequency (g ± SD)	Mean per capita intake per day (g ± SD)
1	Maize meal porridge	29	12655.00	4218.33±249.95	65.91±18.02	127.83±10.00
2	Tea	17	9080.00	3026.67±234.29	84.07±7.37	91.72±9.37
3	Diluted cold drink squash	10	6695.00	2231.67±178.05	97.03±4.41	67.63±7.12
4	White rice	17	6661.00	2220.33±345.13	55.51±4.47	67.28±13.81
5	Brown bread (fortified)	22	5990.00	1996.67±120.66	38.40±2.49	60.51±4.83
6	Chicken stew or curry	10	4835.00	1611.67±173.12	53.72±10.18	48.84±6.92
7	Macaroni & cheese	3	4795.00	1598.33±308.11	72.65±9.40	48.43±12.32
8	Mixed bean stew[19]	10	2465.00	821.67±165.51	45.65±19.62	24.90±6.62
9	Full cream milk	9	2240.00	746.67±128.98	33.94±10.64	22.63±5.16
10	Chicken roasted	6	2020.00	673.33±30.93	51.79±10.51	20.40±1.24
11	Samp and beans	3	1400.00	466.67±122.58	46.67±4.10	14.14±4.90
12	Beef stew	3	1295.00	431.67±90.83	53.96±19.34	13.08±3.63
13	Steamed bread	4	1105.00	368.33±50.04	36.83±3.87	11.16±2.00
14	Egg fried	5	880.00	293.33±28.00	29.33±7.00	8.89±1.12
15	Brown sugar	27	846.00	282.00±27.07	4.48±1.09	8.55±1.08
16	Sausage fried	3	635.00	211.67±35.13	26.46±4.50	6.41±1.41
17	Butternut boiled	4	430.00	143.33±16.19	5.12±13.73	4.34±0.65
18	Vegetable curry	3	340.00	113.33±25.89	16.19±10.93	3.43±1.04
19	Potato boiled	3	320.00	106.67±3.85	35.56±3.85	3.23±0.15
20	Margarine	3	145.00	48.33±9.18	3.22±1.00	1.46±0.37

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable

[19] Yellow highlights how much the legumes have moved up in ranking and the frequent appearance of two times within the EG top 20 food list.

Table 5.3B: Consumption of top-20 food items by women ranked by frequency consumed measured by three 24-hour recall questionnaires

EG-FU women's top-20 foods consumed (n=22)

No	Item	Mean *frequency (number of times consumed) (n)	Total group intake over 3 days (g)	Mean total intake over 3 days (g ± SD)	Mean intake per frequency (g ± SD)	Mean per capita intake per day (g ± SD)
1	Tea	62	16900.00	5633.33±283.99	90.86±1.66	256.06±12.91
2	Maize meal porridge	53	16715.00	5571.67±174.96	105.13±9.15	253.26±7.95
3	White rice	34	8040.00	2680.00±205.03	78.82±4.01	121.82±9.32
4	Chicken stew or curry	27	7975.00	2658.33±204.52	98.46±1.79	120.83±9.30
5	Full cream milk	57	4810.00	1603.33±49.79	28.13±4.28	72.88±2.26
6	Brown bread (fortified)	45	4340.00	1446.67±19.25	32.15±3.14	65.76±0.87
7	Sugar bean curry	13	3750.00	1250.00±208.33	96.15±20.05	56.82±9.47
8	Steamed bread	9	2950.00	983.33±76.98	75.64±7.22	44.70±3.50
9	Brown sugar	86	1798.00	599.33±107.36	6.73±3.05	27.24±4.88
10	Diluted cold squash drink	5	1500.00	500.00±166.67	100.00±57.82	22.73±7.58
11	Cabbage curry	11	1398.00	465.83±134.45	42.35±30.31	21.17±6.11
12	Beef curry	7	1310.00	436.67±235.00	87.33±55.28	19.85±10.68
13	Spinach sautéed	9	1013.00	337.50±59.76	48.21±11.91	15.34±2.72
14	Chicken roasted	6	620.00	206.67±15.40	25.83±4.81	9.39±0.70
15	Tomato and onion stew (no sugar)	11	620.00	206.67±79.41	34.44±19.63	9.39±3.61
16	Sausage fried	6	590.00	196.67±25.02	32.78±12.51	8.94±1.14
17	Egg, fried	6	550.00	183.33±10.58	26.19±1.76	8.33±0.48
18	Banana fresh	6	450.00	150.00±0.00	25.00±0.00	6.82±0.32
19	Margarine	28	250.00	83.33±2.55	2.98±0.19	3.79±0.12
20	Cheese cheddar	9	191.00	63.80±6.43	10.63±6.63	2.90±0.29

*Frequency of food is the number of times the food items were consumed by the entire group. The mean intake and the per capita are the average quantity each participant would have consumed if the entire group had consumed something notable

5.6.1.4 Intake of fruit, vegetables and AMDRs

Table 5.4 indicates that the fruit and vegetable intake by men and women did not meet the WHO recommendations of less than 400 g intake daily (WHO, 2003). The EG-PI mean per frequency and portion size intake was 70.6 g. while it was 58.7 g for the EG-FU men. However, the EG-PI women had an intake of 107.8 g which was higher than the EG-FU intake of 82.1 g per day.

EG-FU survey data indicated a slight increase in fruit consumption. However, the total fruit and vegetable intake was lower than the daily requirement of <30.0% for the EG-FU men and women. These findings suggest that there was a decline in fruit and vegetable intake, particularly for men, during the six months after the intervention phase.

Table 5.4: The fruit and vegetable mean intake per person (PI and FU surveys) for men and women as determined by the average of three 24-hour food recall questionnaires (WHO, 2003) (EG-PI n=35; EG-FU n=32)

Fruit and Vegetable Intake EG-FU	EG-FU Men (n=10)	EG-FU Women (n=22)
Mean intake per person	58.7g	107.8 g
Mean per capita intake (3 days)	82.5	421.5
Mean per capita intake per day	27.4	140.5
Percentage per capita intake contribution of 400 g	20.6%	26.8%
Fruit and Vegetable intake EG-PI	**EG-PI Men (n=11)**	**EG-PI Women (n=24)**
Mean intake per person	70.6g	82.1g
Mean per capita intake (3 days)	218.7	338.3
Mean per capita intake per day	72.9	112.7
Percentage per capita intake contribution of 400 g	17.6%	20.5%

Table 5.5 presents the results for the acceptable macronutrient distribution range (AMDR) index (WHO, 2003) that was used to compare the nutrient intake results with the results presented in Table 5.6 and Table 5.7 that were obtained from an average of three 24-hour food recall questionnaires per person. The EG-PI protein percentages indicated that protein contributed 15.6% to the total energy of the EG-PI men and 12.9% to that of the men in the EG-FU. However for the EG-PI women contributed 17.1% and 14.4% for the EG-FU of the total energy. Fat contributed 23.7% to the total energy of the men in the EG-PI and 19.9% to that of the men in the EG-FU, while it contributed 27.2% to the total energy of the women in the EG-PI and 24.4% to that of the women in the EG-FU. For both genders, these rates were within the WHO goals of 15.0-30.0% for fat recommendations.

The carbohydrate total energy contributions were 60.7% for the men in the EG-PI and 67.1% for the men in the EG-FU, while it was 55.7% for the women in the EG-PI group and 59.1% for those in the EG-FU. Both genders were within the WHO goals of 55-75%, but the men had a distinctly higher carbohydrate intake during the six months after the intervention project. The results thus indicated that the intake of all the macronutrients had remained within the recommended goals as determined by the post-intervention and the follow-up surveys. It was observed that the protein intake was higher for both women and men as determined by the FU survey, compared with the data of the PI survey, while fat intake was within the WHO goals. However, carbohydrate intake increased during the six months after the intervention project as was determined by the FU survey data.

Table 5.5: Comparison of energy distribution by macronutrients as determined by the averages of three 24-hour food recall questionnaires per person (nutrient goals: WHO, 2003) (EG-PI n= 35; EG-FU n=32)

			FU (n=32)			
Men EG-PI (n= 11)			**Men EG-FU (n= 10)**			
Protein (g)	48.09 ± 20.56	15.6	**Protein (g)**	69.54 ± 17.78	14.4	10-15%
Fat (g)	33.67 ± 16.08	23.7	**Fat (g)**	54.04 ± 30.64	24.4	15-30%
Carbohydrate & fibre (g)	187.84 ± 71.92	60.7	**Carbohydrate & fibre (g)**	294.74 ± 56.68	61.2	55-75%
Women EG-PI (n= 24)			**Women EG-FU (n = 22)**			
Protein (g)	59.95 ± 30.62	17.1	**Protein (g)**	62.41 ± 15.65	14.9	10-15%
Fat (g)	43.68 ± 26.85	27.2	**Fat (g)**	49.75 ± 17.55	25.9	15-30%
Carbohydrate & fibre (g)	194.43 ± 59.60	55.7	**Carbohydrate & fibre (g)**	246.34 ± 59.7	59.1	55-75%

5.6.2 Food variety

5.6.2.1 Consumption of a variety of food items: EG-FU

The follow-up results (Table 5.6) for the EG-FU indicated that the food variety score (FVS) for the total number of individual food items consumed over the seven days prior to the follow-up survey was 90. The majority of the participants (59.4%; n=19) had consumed between >30-60 individual food items across the nine food groups.

Only 9.4% (n=3) had consumed between 60-90 individual food items, while 31.2% (n=10) had consumed <30 food items. The high variety rate for a low number of people indicated the prevalence of high poverty levels amongst the sample, as wealthy people generally tend to consume a high variety of food (Gomes *et al*., 2019).

Table 5.6: Food group diversity consumed over a period of one week in the households of the men and women (EG-FU n=32)

Meat Group n=4	Egg Group n=1	Dairy Group n=9	Cereal Group n=5	Legume Group n= 7	Vitamin A Rich Group n=8	Fruit Group n=19	Veg. Group n=16	Fat Group n=5	Total individual food items consumed across all groups n=90
0=00	0=04	0=00	0=0.00	1=14	0=02	0-00	0=00	1=00	
1=22	1=28	1=25	1=17	2=03	1=10	1=07	1=08	2=18	<30=10
2=09		2=01	2=09	3=03	2=07	2=06	2=10	3=13	>30- 60 =19
3 =00		3=00	3=00	4=02	3=04	3=00	3=00	4=00	>60 = 03
4=01		4=00	4=03	5=04	4=03	4=00	4=02	5=01	
		5=02	5=03	6=03	5=05	5=02	5=00		
		6=01		7=03	6=01	6=02	6=00		
		7=02			7=00	7=03	7=02		
		8=01			8=00	8=00	8=01		
		9=00				9=02	9=02		
						10=01	10=02		
						11=00	11=00		
						13=00	12=00		
						14=01	13=01		
						15=00	14=02		
						16=1	15=01		
						17=00	16=00		
						18=00			
						19=06			

Low = <30 individual foods. Medium = 30-60 individual foods. High >60 individual foods (Matla 2008)

Source: researcher

5.6.2.2 Mean FGDS for food consumed by EG-PI and EG-FU

Table 5.7 indicates a mean of 40.1 (± 20.2) for FGDS food consumption across the nine food groups over a period of seven days prior to the survey, with 8.81 ± 0.47 DDS. No significant difference was observed in the FVS and DDS for the EG post-intervention.

The cereal group had the highest mean ±SD FGDS of 10.2 (± 3.8), followed by the other vegetable group (6.3 ± 2.9) and meat (5.9 ± 2.5) as detected by the FU data. The ranking was similar to that of the PI data, except for carbohydrates that was much higher. However, a significant drop (p=0.000) with mean ±SD FGDS for the legume group from 5.7 (±2.56) to 3.0 (± 2.2) was observed in the FU data. In addition, the legume group FGDS ranked 4th post-intervention and returned to the 7th position according to the FU survey data. There were no significant FGDS observed for the dairy, cereal, egg and vitamin A-rich fruit and vegetable groups in the FU data.

These results indicated that the frequency of legume intake per week had declined in the six months after the intervention programme as measured for the EG-FU. These results correlated with those reported in Table 5.8 in terms of the food variety scores over seven days. The post-intervention survey results indicated that acceptability levels had shifted back to their original levels of the post-intervention programme and the follow-up survey data six months after the intervention programme confirmed this downward trend. These results suggest that the education programme to encourage legume production and consumption played a significant role during the intervention project. However, the six-month follow-up survey showed a great decline in legume consumption and production. This could be attributed to the cessation of encouragement and measurements during meetings at the AHS and/or the fact that legumes were no longer donated to the farmers for consumption and cultivation.

Table 5.7: Summary of FGDS for all food groups (EG-PI n=35; EG-FU n=32)

Food Group	Mean FGDS EG-PI (n=35)	±SD	Range	Mean FGDS EG-FU (n=32)	±SD	Range	*Signifcance p-values*
Meat	6.1	2.92	1-4	5.9	2.50	1-4	**0.764**
Eggs	1	0.00	0-1	1.0	0.00	0-1	**1.000**
Dairy	3.3	2.30	1-9	3.6	2.10	1-9	**0.579**
Cereals	7.3	4.05	1-5	10.2	3.80	1-5	**0.004**
Legumes	**5.7**	**2.56**	1-7	**3.0**	**2.20**	1-7	**0.000**
Vit, A-rich fruit & Vegetables	3.8	1.88	1-8	3.8	1.10	1-8	**1.00**
Other Fruits	5.0	2.81	1-19	5.5	3.00	1-19	**0.485**
Other Vegetables	6.1	3.10	1-16	6.3	2.90	1-16	**0.786**
Fats and Oils	1.8	0.59	1-5	2.2	0.80	1-5	**0.024**
FVS	40.1	20.21	23-74	41.5	18.40	23-74	**0.786**
Mean DDS	8.23	±1.11		8.81	±0.47		**0.005**

The *p*-values are reflected in Table 5.9 for each group with total DDS mean intakes.

5.6.3 Dietary Diversity Score (DDS) results

The majority of the EG-PI respondents (91.4% [n=32]) had a high DDS, while 84.4% (n=27) of the EG-FU had consumed food across 7-9 groups and thus fell in the high category (high = 6-9 food groups). The medium diversity score with foods consumed from 5-6 groups was achieved by 8.6% (n=3) of the EG-PI and none from the EG-FU group (Matla, 2008).

Table 5.8: Summary of DDS rates (EG n=35 and EG-FU n=32)

Number of Food Groups Consumed n=9 EG-PI (n=35)	Frequency	Percentage (%)	Number of Food Groups Consumed n=9 EG-FU (n=32)	Frequency	Percentage (%)
5	1	2.9	5	0	0
6	2	5.7	6	0	0
7	**6**	**17.1**	**7**	**1**	**3.1**
8	**5**	**14.3**	**8**	**4**	**12.5**
9	**21**	**60.0**	**9**	**27**	**84.4**
TOTAL	**35**	**100.0**	**Total**	**32**	**100.0**

5.6.4 Nutrient adequacy results

These results indicated (refer to table 5.9) similar findings for both periods. However, the legume variety scores dropped in the six months after the intervention programme. This observation indicates that the intake had mostly been influenced by the intervention initiatives that had sustained the participants' interest only till shortly after the intervention programme, when legume consumption had increased to 4-5 times per week (EG-PI: 77.1% [n= 27]; EG-FU: 54.5% [n=18]). Table 5.9 highlights that there was no significance in the comparisons of FDGS between the EG-FI and the EG-FU. However, the mean DDS still reflects a high dietary diversity as reflected by the PI and FU data for both men and women.

Table 5.9: Mann-Whitney U analyses for DDS: Comparison of the EG-PI and the EG- FU survey data for the total groups (EG, CG)

Group	Post Intervention Mean ± SD	FU Survery Mean ± SD	*Significance p-value*
MEN	8.41 ± 0.82	8.71 ± 0.52	0.08
WOMEN	8.72 ± 0.64	8.90 ± 0.31	0.56

*The *p*-value represents the mean value comparison for the EG-PI and EG-FU.

5.7 Legume Knowledge and Acceptability Survey

5.7.1 The most frequently consumed beans as indicated by the PI and FU survey data

The post-intervention survey results indicated that jugo beans (85.7% [n=30]) were the most preferred legume after the intervention period, which was possibly due to the participants' exposure to the training programme. In a declining order, the preference for legume varieties was broad beans (74.3% [n=26]), cow peas (42.9% [n=15]) and red kidney beans as an alternative to sugar beans (42.9% [n=15]). The least preferred legumes were green mung beans and chick peas (22.0% [n=8]). The results indicated an improvement in the acceptability of legumes after the intervention phase in comparison to the pre-intervention phase (Chapter 4 Table 4.30 and 4.31). However, the follow-up survey six months after the intervention phase indicated that broad beans were now most generally accepted as the beans of choice for consumption by 66.6% (n=22) of the participants. This preference was followed by jugo beans (60.6% [n=20]), red kidney beans (51.5% [n=17]), cow peas (39.3% [n=13]), chick peas (12.1% [n=4]) and green mung beans (9.0% [n=3]). These results indicated that the two legumes that were still at the top of the preference list were jugo beans and broad kidney beans. These preferences replaced the almost exclusive consumption of sugar beans before the intervention project commenced (refer to table 5.10).

Table 5.10: Acceptability levels of various legumes after food tasting sessions for enhanced consumption (EG-PI n=35; EG-FU n=32)

Legume Type ▶	Red Kidney Beans 1	Green Mung Beans 2	Jugo Beans 3	Broad Kidney Beans 4	Cow Peas 5	Chick Peas 6
EG-PI (n=35)	15	8	30	26	15	4
% AC	42.9	22.9	85.7	74.3	42.9	11.4
EG-FU (n=33)	17	3	20	22	13	4
% AC	51.5	9	60.6	66.6	39.3	12.1

AC = Accept

5.7.2 Frequency of legume variety consumption: Post-intervention survey

The post-intervention survey indicated that the majority of the participants (77.1% [n= 27]) had eaten legumes 2-3 times per week, while only 22.9% (n=8) had consumed legumes 3-4 times a week. Figure 5.1 indicates that the majority of the EG-FU participants (54.5% [n=18]) had now dropped a category and were consuming legumes once per week. This phenomenon could be linked to a lack of regular provision of additional legumes to the participants. This category was followed by those who had consumed legumes 2-3 times a week (33.3% [n=11]) and those who had consumed legumes 4-5 times per week (6.1% [n=2]) in the EG-FU group.

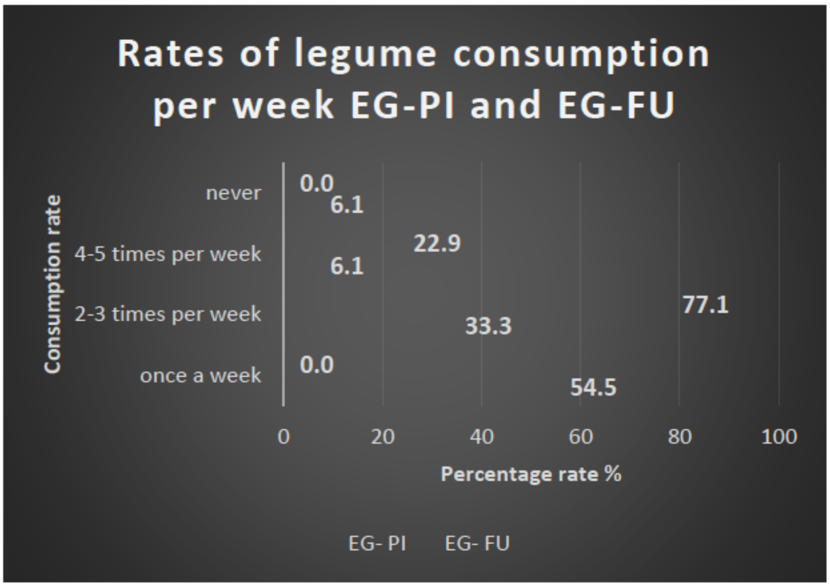


Figure 5.2: Low legume consumption pattern (EG-PI n=35; EG-FU n= 32)

5.7.3 Reasons for low legume consumption by EG-PI and EG-FU

Figure 5.3 indicates that the majority of the farmers in the EG-PI had experienced no challenges (88.7%; n=31) and had not been prevented in any way from consuming legumes during the intervention phase. Only 11.3% (n=4) indicated that preparing legumes had required too much cooking time. In comparison, after six months, the same group of participants (67.0% [n=22]) now indicated that the main reason for low legume consumption was that they had no longer been supplied with beans. This was followed by 30.0% (n=10) who indicated that their challenges were due to all the reasons listed, that electricity was becoming expensive (27.0% [n=9]); that they had forgotten how to prepare legumes (6.0% [n=2]); that the beans required too much cooking time (6.0% [n=2]); beans caused bloating (3.0% [n=1]); and that they had only consumed legumes to support the project (3.0% [n=1]).

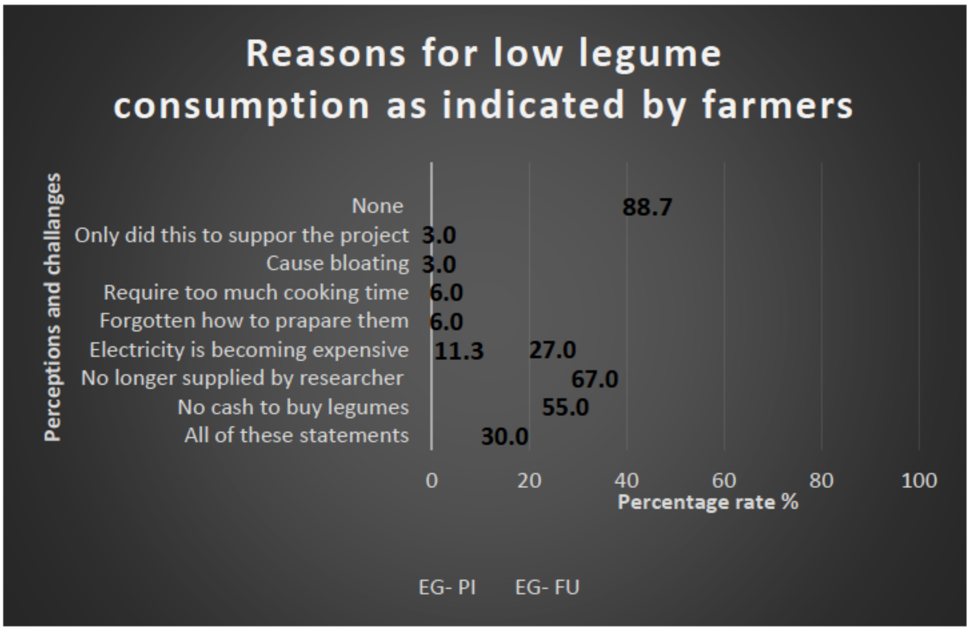


Figure 5.3: Low legume consumption patterns (EG-PI n=35; EG-FU n= 32)

5.7.4 Preference levels for legume production PI and FU

The majority of the participants [85.7% (n=30)] indicated that they would prefer to produce red kidney beans due to this cultivar's high yields compared to those of the other legumes that had been planted (see in table 5.11). Next in preference were the jugo bean (80.0% [n=28]) the broad kidney bean (74.3% [n=26]) and cow peas (42.9% [n=15]). The least preferred legume varieties for cultivation were green mung beans (17.1% [n= 6]) and chick peas (5.7% [n=2]). The follow-up survey indicated that the red kidney bean was still the most preferred variety for cultivation (87.5% [n=28]), followed by jugo beans (68.7% [n=22]), broad kidney beans (56.2% [n=18]), green mung beans (12.5% [n=4]), cow peas (9.3% [n=3]) and chick peas (6.5% [n=2]). The bean variety preferences had thus not altered much between the two surveys, except that cow peas were now one of the two least preferred bean varieties instead of mung beans (farmers could have found growing mung bean much easier and even though the cow pea showed higher yields refer to table 4.35).

Table 5.11: Acceptability levels for the cultivation of various legumes (EG-PI n=35 and EG-FU n=32)

Legume Type ▶	Red Kidney Beans 1	Green Mung Beans 2	Jugo Beans 3	Broad Kidney Beans 4	Cow Peas 5	Chick Peas 6
Number EG-PI (n=35)	30	6	28	26	15	2
% AC	85.7	17.1	80.0	74.3	42.9	5.7
Number EG-FU (n=32)	28	4	22	18	3	2
% AC	87.5	12.5	68.7	56.2	9.3	6.5

AC = Accept

5.7.5 Contextualising legume acceptability levels

The post-intervention survey indicated that all the farmers (100.0% [n=35]) wanted to consume and produce various legumes (Figure 5.4). This suggested that the project had motivated these participants to want to cultivate and effectively incorporate legumes in their diets, in order to improve their lifestyle. The follow-up survey reported similar findings as all (100.0% [n=32]) the participants still wanted to continue to consume (100.0% [n=32]) and produce (100.0% [n=32]) legumes. These results indicated that the farmers had been enthused by the programme as it created continued interest in legume production and consumption. However, the cessation of a regular legume supply in the six months after the intervention programme impacted their enthusiasm to the point that new varieties of legumes had declined in preferential ranking, indicating that the farmers had reverted to the legume foods that they had been used to. This finding indicated that access to legumes by means of a supplier was a major motivation for consumption, and it is thus logical to conclude that legume consumption declined in conjunction with the absence of a free supply. The declining interest in legume cultivation could also be linked to various limitations that the farmers experienced, such as seasonal planting requirements, abnormal weather patterns and other environmental factors such as water shortages that negatively influenced their experiences of legume cultivation practices and that impeded success.

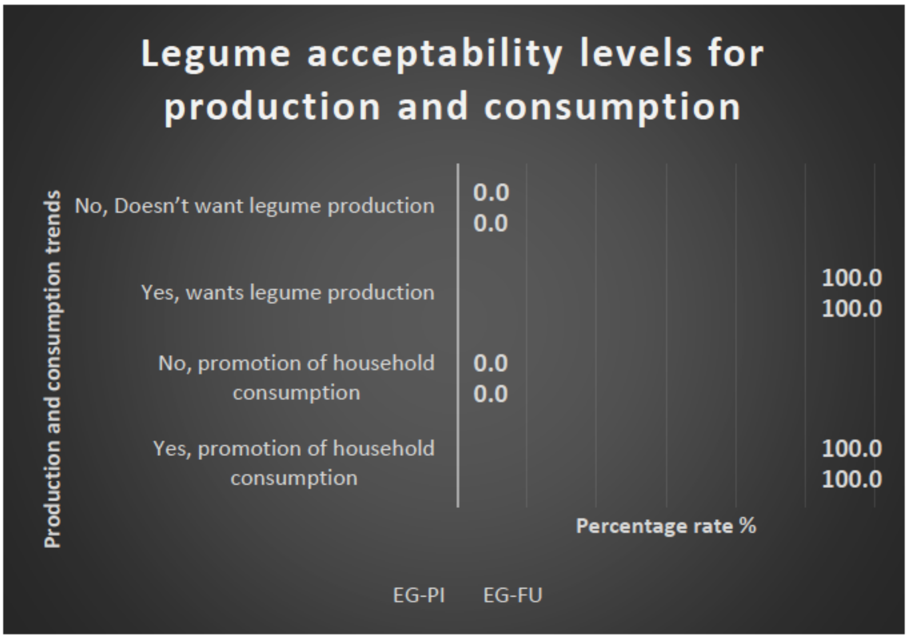
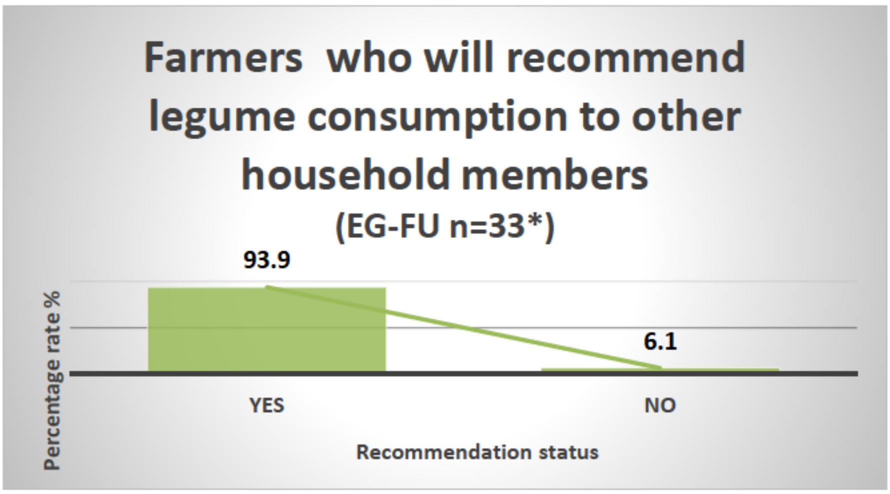


Figure 5.4: Legume consumption and production acceptability (EG-P n=35 and EG-P>6m n=32)

5.7.6 Recommendations by the EG-FU

Figure 5.5 indicates that 96.8% (n=31) of the EG-FU sample would recommend legume consumption to other household members, while only one farmer (3.1% [n=1]) indicated no further interest in sharing information or enthusiasm about legumes.



*Due to population dynamics, not all the participants completed all the questionnaires in full. The sample rate for the follow-up survey thus fluctuated between 32 and 33.

Figure 5.5: Viability of the programme for the sharing and scaffolding of information

5.7.7 Benefits of the intervention programme for the FU participants

Figure 5.6 indicates that the entire post-intervention sample (100.0% [n=32]) found that the education programme had improved their knowledge of legumes and that they benefitted from their participation in the programme.

Figure 5.6: Benefits of the intervention programme for the participants

5.7.8 Expansion of knowledge

Although legume production had virtually ceased after the intervention project, all the FU participants (100.0% [n=32]) still felt that the programme had improved their (nutritional and agricultural and dietary intake) knowledge about the production and consumption of legumes (refer to figure 5.7).

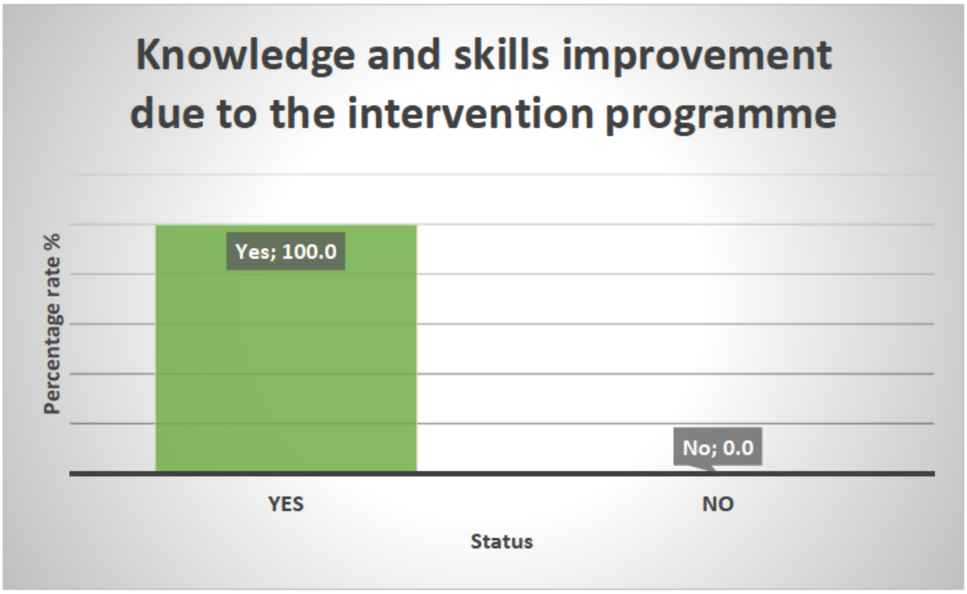


Figure 5.7: Role of the intervention programme in enhancing farmers' knowledge of legume consumption and cultivation (EG-FU)

5.7.9 Sustainability of the intervention programme

The majority (71.8% [n=23]) of the farmers were no longer producing legumes (refer to figure 5.8), while only 28.1% (n=9) were still engaged in legume cultivation six month after the intervention programme.

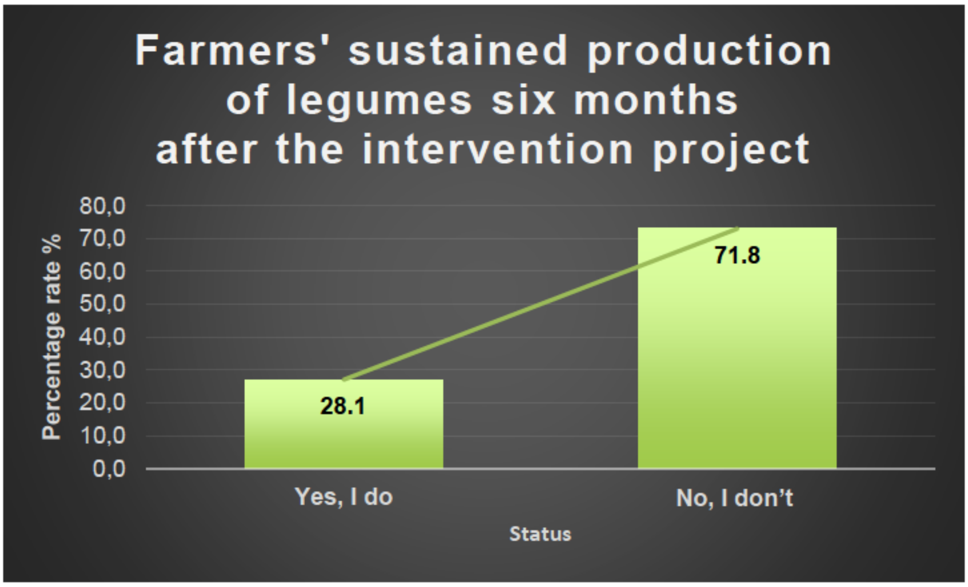


Figure 5.8: Legume production status at the time of the follow-up survey (EG-FU n=32)

5.7.10 Intention to persevere versus actual perseverance rates

Contrary to their actual perseverance rate (Figure 5.7), Figure 5.8 indicates that all the farmers (100.0% [n=32]) intended to continue to produce legumes based on their knowledge and understanding of the importance of legumes. It was deemed important to reconcile the findings presented in Figure 5.7 and Figure 5.8, as the farmers' willingness to persevere was dampened by the experience of constraints such as access to seeds, seasonal challenges and a lack of a sustainable water supply (Figure 5.2). These results also correlated with those in Table 5.3 and Table 5.4, where the trend of a lowered ranking of new legume varieties was indicated. However, the prominent reason for the decline in legume production and consumption after the intervention programme may be attributed to the cessation of the supply of free legumes for production. This undoubtedly also caused the decline in the consumption of legumes as was revealed by the follow-up survey. An important correlation in this regard is the finding that the number of individual food items was impacted by the economic status of the participants i.e. only few tended to consume a high rate of items across all food groups, while the majority tended to consume a medium to low variety of food items (Table 5.8). As this finding may suggest the prevalence of poverty amongst the participants, it may be logical to deduce that the procurement of seeds and legumes for cultivation and consumption was a challenge and that this impacted the sustainability of legume cultivation and consumption after the intervention programme.

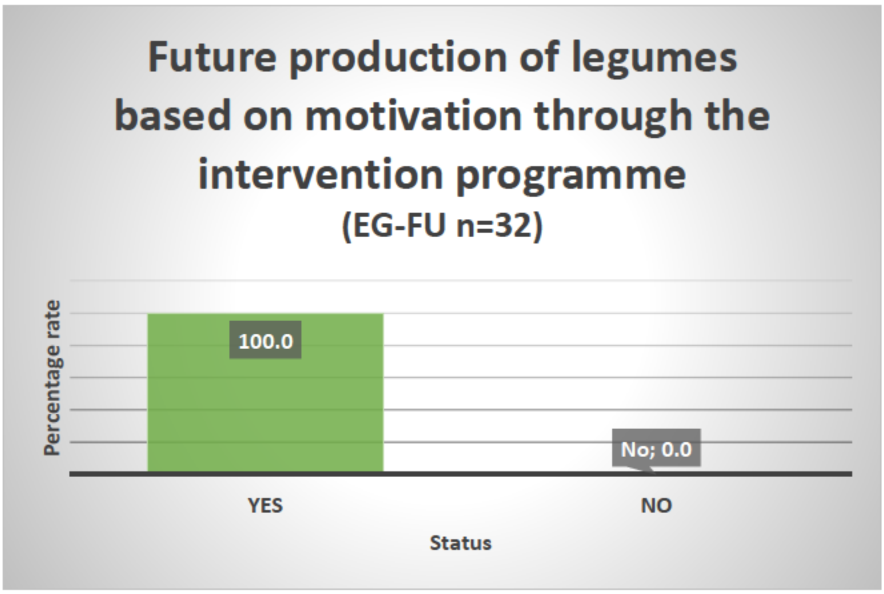


Figure 5.9: Motivation for future legume production

5.8 Limitations that Impacted the Achievement of the Main Study Goal

The majority of the study objectives were achieved, as was evidenced by the successes in terms of legume variety choices being accepted and consumed, production successes particularly for trial 1, healthier eating habits and enthusiasm for the project (refer to table 4.17A, 4.19A, 4.34). The observation of poor yields in trial 2 (refer to table 4.35) due to drought season and lack of access to legume packs during post-intervention (refer to figure 5.8) indicate that the objective of legume production which influenced project sustainability was a limition in the FU survey. However, the overarching goal of sustained and sustainable legume production and consumption in order to adopt and sustain a healthy lifestyle and dietary choices was achieved only insofar as knowledge and motivation were concerned. Clearly, sustained practical application of these acquired skills was a challenge for various reasons, with the suggestion that complacency and expectations when products were donated free of charge, were perhaps the most powerful stumbling blocks.

The study evaluated individual farmers' preferences for each legume variety. It was deemed important to establish this data as it would facilitate the establishment of group dynamic patterns in terms of choice and preference. Even though the most popular legume choice was sugar beans as was revealed by the pre-intervention survey data, red kidney beans became a popular choice during and after the intervention programme. However, sugar beans may once again have become the legume of choice for production and consumption as knowledge alone will not change dietary intake patterns. In this context, the behavioural theory that was adopted for this study argues that one needs to take cognisance of people's tendency towards complacency when there are no incentives to work towards a goal, particularly when donations are offered free of charge or responsibility since they can create a sense of dependancy.

The results of the follow-up survey clearly suggest that if there is no regular and affordable access to legumes, any project to encourage their cultivation and consumption may not have the desired results. This conclusion correlates with that of an earlier study that measured acceptability levels of uncommon plant sources in an attempt to gain understanding of a community's attitude and perception patterns (Mahomoodally & Ramalingum, 2015). The current and other studies (Amirzadeh Iranagh *et al*., 2018; Bird *et al.*, 2019) thus agree that education programmes are vital in empowering farmers to adapt to improved food and nutrition production and consumption practices. However, they argue that cognisance must be taken of the challenges and limitations of such endeavours, particularly when a practical component of such a programme involves free donations that require no input on the part of participants. The conceptual framework that future studies in the field may adopt should thus incorporate a reward system to encourage advancement and sustainability. For example, only successful endeavours may advance to the next level where an innovative reward awaits those who have made exceptional efforts. In this regard, current online gaming practices could be used as a powerful model to kick-start food and nutrition behaviour adaptations.

Another limitation to regular legume consumption was access to cash, as indicated in Chapter 4. The average household income of these farmers was between R1 000 and R2 000 per month (± US$141 with an average of about US$5 per day). This data excluded other social support mechanisms. This finding correlates with that of another study that indicated which farmer household income was a key factor that needed to be taken into account in addressing sustainable food security in sub-Saharan Africa (Conceição *et al*., 2016).

On an encouraging note, the impact that the programme had on the community was still positively felt at the time of the six-month follow-up survey. The six-month period was a measurable time gap to assess the impact of the intervention project. It was heartening to notice that all the farmers indicated continued interest in the production and consumption of legumes and that they indicated that their knowledge and skills had been expanded throughout the programme. However, their limited motivation to share the knowledge that they had gained, coupled with their perceived limited ability to continue to apply what they had learnt independently and to roll the programme objectives out to the entire community, was disappointing. Clearly, further studies involving interventions are required to encourage farmers to take ownership and to determine how they could extend their knowledge to the community at large. Farmers are vital agents in addressing food security through nutrition knowledge and agriculture practices, and every effort must be made to harness and extend this resource amongst communities to the benefit of all.

5.9 Conclusion

By adopting the behavioural change model as part of the conceptual framework of this study, the objectives were given direction and impetus. The growing knowledge, insight and motivation of the participating farmers were thus positively influenced and enhanced during the intervention phase. The study results demonstrated that the elderly farmers had the capacity to adopt new behaviours and to commit to a process of change. However, this occurred provided that continued support was given and that they had access to basic services and inputs such as seed, water and soil enrichment fertilizers. It became clear that legume knowledge and legume application and production skills that addressed food insecurity were not sufficient on their own to transform these farmers into committed agents of change. They required continuous support and encouragement, and many found it a challenge to adhere to the project requirements. The results suggest that their dependency on interventional facilitators and the researcher was a challenge that burdened many efforts to continue to adjust traditional food and nutrition practices and to embrace a dietary programme that would ensure their adoption of healthy dietary practices. In the initial phases of the intervention project, their food security status was given a boost and there were signs that it would flourish in some instances, but unfortunately the cessation of the intervention project saw a return to old habits and practices that seemed impossible to turn around after six months. The follow-up survey indicated that the farmers had returned to their time-honoured, normal lifestyles and that neither legume production nor consumption was thriving. Regular dietary patterns had again been embraced. In light of these findings, there is a clear need to find ways to challenge farmers to break the traditional perceptions that continue to exist amongst them in the communities they live. One solution seems to be to find ways of subsidising farmers to lower the burden of buying seeds. However, this might again be a case of giving a person a fish and he will have food for only one day (which simply refers an unsustainable simply a short-term solution). A project that requires striving towards a personal goal and that has innovative, built-in incentives to achieve tangible rewards for sustainable change seems to be the answer.

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The role of municipality staff was critical in addressing ward structure-based training and development, particularly because food and nutrition security was addressed. This training programme was dependent on the proximity of resources and a municipal constituency that provided access to knowledge and skills transfer. This study was therefore privileged in having the support and cooperation of a committed body of support staff that dealt efficiently with the many complex challenges of this project. In an to attempt address the aims and objectives of the study, an integrated and agriculture and nutrition education programme comprehensive (by encompassing both theory and practical applications). This was launched to address food insecurity amongst smallholder farmers in the Mariannhill area (refer to section 4.7.3). Study participants were selected from amongst a cohort of farmers who were associated with an eThekwini Municipality structure known as the Agricultural Hub Station. The programme was devised to advocate a more nutrition-sensitive approach to agricultural practices amongst elderly farmers in the study area.

The study set out to demonstrate that knowledge of both nutrition and agriculture could improve elderly people's nutritional and health status, while also influencing the cultivation of legume varieties for consumption. These objectives (refer to section 1.12.3) were achieved by means of a controlled trial that demonstrated legume cultivation and a nutrition programme that generated knowledge and encouraged the selected farmers to consume legumes in a trial three-month period. The participants of the EG were thus not only required to cultivate legumes in two successive planting seasons, but they also had to consume legumes over a specified period of three months. The CG was required to live their normal lives without any interventional endeavours. All the participants were monitored at specified intervals for comparative purposes.

The study objectives included the assessment of the participants' socio-economic, health and nutritional status; their biochemical indices; legume acceptability levels; household food security status; and agricultural knowledge. Other objectives mentioned in Chapter (in section 1.13.3) were addressed through measuring instruments provided in both Chapter 3 and Chapter 4. Based on information gleaned from the literature and the researcher's prior study experiences, the current study was based on the proven nutritional value of legumes and their value as an important food group. Anecdotal evidence indicated that legumes were not diversely incorporated in the diets of the community in the study area and that this food (protein-containing) group was not regularly consumed by smallholder farmers. Concerns about their health and nutritional practices had also been raised by various agents in the study area who had considerable knowledge about this community.

Against this background, the education programme aimed to extend the farmers' knowledge of the production, diverse usage, preparation and storage of legumes for sustained cultivation and consumption. The results indicated that the programme gradually shifted prevailing perceptions and attitudes for acceptance levels towards a more positive attitude towards legumes. Moreover, issues such as dietary diversity and eating patterns amongst smallholder farmers were addressed to a certain extent during the practical – or intervention – phase of the study. The interventions (for increased legume intake) that were initiated demonstrably impacted the biochemical data (blood glucose and cholesterol levels) of the active participants positively.

The consumption of legumes could have played a significant role in improving and stabilising the health of the farmers in a sustainable manner. However, as legumes were not a traditional or habitual food of choice amongst members of this community, encouraging the participants to incorporate them as a regular dish in their diets required a broad, inclusive strategy to change their eating patterns. In the endeavours to achieve this objective, it was found that knowledge of nutritional benefits alone could not transform their habits. A valuable lesson that was therefore learnt is that transformation should be coupled with access, availability, personal motivation and concerted endeavours. It is particularly the last two factors that are fundamental pillars of self-generated and sustainable food security.

6.2 Limitations and Challenges

6.2.1 Limitations

- The fact that some of these farmers were diabetic was a limitation as their health status could not be medically addressed by the study team. Thus, these farmers' dietary intake, consumption levels and blood indices could have affected some of the data. Due to late arrivals, diabetic patients mostly started the morning with a meal and they had to take their medication before the blood samples were taken. Moreover, fasting was very difficult for most of the elderly farmers because they were following their doctors' orders to eat in the morning. This could have been a limitation as it could have impacted the biochemical data.
- A particular limitation was that the soil quality of the land of many farmers was poor and they needed to do soil analyses for each plot before planting could commence. This was expensive and could not be funded by the study, which means that some farmers attempted legume cultivation in poor soil, which was a leading factor for the extremely poor yields of the first planting trial. The provision of manure by the municipality was also not closely monitored. The farmers could have inadvertently utilised the manure, if it was delivered, for their other crops as well, which means that the soil for legume cultivation may have been inadequately fertilised.
- Some farmers failed to follow planting instructions and adhered to traditional methods (direct seed planting instead of transplanting seedlings). This resulted in poor yields and an alternative method of seed provision for consumption had to be devised.
- Pest infestation impacted yields, and this also affected the enthusiasm of the farmers, with the result that some dropped out of the study due to lack of patience, others due to other illnesses. Fortunately, statistical calculations indicated that the drop-out rate did not significantly impact the data. No pesticide usage is allowed in this community as part of the municipal requirements to grow crops organically. This affected the management of pests and the lack of effective pest control affected the planting trials.
- Limited farming space impacted the varieties of legumes that the farmers were prepared to plant. Moreover, about 70.0% of the farmers planted the legumes outside the planting season as they needed to plant their customary crops (particularly maize) on the available

land. This impacted the legume yields adversely, to the extent that legumes had to be purchased and disseminated for consumption. This was a very disappointing limitation as the objective had been that the farmers would consume the products that they managed to harvest.

- Water shortages affected growth during an exceptionally dry season.
- The limited harvests impacted the results of the yields that could be achieved for the purpose of harvesting higher yields for more legume usage. None of the farmers was able to produce sufficient crops for marketing, and this objective was thus not achieved.
- Haemolysed blood serum is highly possible during blood sample taking which did occur. This required another collection for the affected participants and continuous assessments were necessary.
- The drop-out rate was not large among the control group, but it was disappointing amongst members of the experimental group as 18 of the original group had dropped out by the end of the intervention phase, leaving 35 of the original group of 53 for assessments in the post-intervention survey. All those who had not adhered to target dates for legume consumption assessments in the three-month consumption period were considered as drop-outs and their data were no longer considered.
- The necessity to donate legumes for consumption and the fact that the farmers did not experience the satisfaction of consuming and marketing their own harvests, were perhaps two of the most disconcerting limitations of the study. This lack of a sense of achievement was, in the researcher's view, one of the primary causes of the unfortunate drop-out rates and the lack of sustainability in the six-month period after the post-intervention survey. The fact that the donations of legumes stopped during this latter period was a clear indication that such trials should not rely on hand-outs if sustainable success is the goal.
- Measuring DDS was restricted to nine food groups, but twelve food groups could have determined a much more expanded food variety score.
- A paucity of global and South African research on legume production and consumption limited opportunities for comparative discourse.

6.2.2 Challenges

- The assessment of too many variables in order to address both food and nutrition insecurity in one project was a challenge, as this resulted in a vast set of results. Hence, Chapter 4 is extensive and broad.
- Transport to and from the education and training venue (the Agricultural Hub Station of the eThekwini Municipality) was a challenge. Although public transport was available for some, a few farmers who walked caused late arrivals and frustrating delays. It was particularly important to take blood samples at specific times, but food intake could have impacted the results. Blood samples needed to be collected in the morning and transported to the laboratory for analysis. Transport had to be hired to ensure that all the farmers were collected at determined pick-up points for timeous arrival at the right time for the intervention trials and also to be dropped off after meetings. However, although this was a costly enterprise, the goodwill of the researcher ensured that most farmers stayed committed and completed the project. The provision of transport also meant that they had to be picked up and dropped off in groups, so waiting for the completion of assessments for others caused some disgruntlement.
- The data collection period was too short in some instances, so alternative days had to be added for those who could not complete a session. This means that additional costs were incurred.
- The sheer volume of the data that needed to be collected during each phase sometimes caused restlessness and unnecessary absenteeism by farmers. The volume of data that had to be processed was also a challenge, but an efficient team (of field workers, nurses and municipal agricultural technician) and support group (chairman, the deputy chair and individual farmers who volunteered) assisted in this regard.
- The training venue had limited space. Therefore, there were constraints with the setup of all the fieldwork stations. This caused some exasperation due to lengthy waiting sessions.
- Public protests interfered with accessing transport (since taxis were banned from moving around) and thus arrival on site for scheduled meetings was a challenge. Meetings often had to be rescheduled, and this was efficiently facilitated by the AHS chairman did a sterling job in this regard.

- There was political instability due to local municipal elections. Ward councillors were murdered, which affected the sense of safety and security amongst the farmers who resided in the affected wards. These dire times evoked fear and attendance was poor at some stage during the study. Mobilization by key management became necessary to encourage the farmers to come back to the meetings and to complete the project.
- Growing a few varieties of legumes where land space was very limited, meant that many farmers focused on one legume variety only. The objective of the cultivation of multiple legume varieties was thus not achieved and it became evident that the consumption of diverse legumes would be restricted. This challenge was overcome by providing purchased legumes to the participants, which was not a desirable process but allowed the project to continue.
- Biochemical analyses are expensive and blood needed to be collected for the entire sample (EG and CG), and therefore repeats for individuals (who were absent) was not possible.
- Absenteeism due to various commitments − for example doctor appointments and visits to clinics, the death of family or community members, and illness – occurred frequently.
- It was a challenge to access the varieties of legumes in the required quantities.

6.3 Main Study Findings

The educational programme (promoted agriculture and nutrition) had to be craftily designed to intervene in the targeted sample that was drawn from a farming population in order to shift perceptions, attitudes and methods and to teach skills that would ultimately bring lifestyle adjustments if the community would willingly participate. Thus, discussion, monitoring, timely implementation and feedback sessions were necessary to ensure that the targeted objectives were met. Fortunately, the mobilization of farmers using a database and having a committed leadership team capacitated the study with stability and ensured synchronization of processes and events. In the end, this support structure encouraged most farmers not to withdraw, but to actively engage in all the processes. Socio-demographic profiles played a pivotal role in addressing the farmers' food and nutrition insecurity. Variables such as the role of family members, household settings, access to electricity, household budgets, water and waste access, and social support informed certain decisions pertaining to food choices, availability and utilization.

The production (or cultivation) of the legumes was influenced by the majority of the farmers' poor economic status. Thus, various inniatives such as the transport of farmers had to be devised to encourage sustained participation, regardless of their assurances of enthusiasm and support. In a community such as the one in which the study was conducted, the health status of farmers needs urgent attention and continuous monitoring. Non-communicable diseases that are prevalent require individual intervention to address the demands of each disease. In this context, it was found that the relatively easy access to healthcare did not necessarily address the health challenges that the farmers faced, thus other measures (ie. visits by local municipal staff during training sessions) were necessary to support the primary healthcare services that were available to them. Generally, clinics provide limited screening for, underlying health threats that could lead to further diseases complications. For example, obesity was a major concern that could not be addressed by dietary recommendations only, and both men and women were implicated in this risk. It was evident that experts who were trained in diverse healthcare foci would be needed to deal with the prevalence of obesity through a holistic approach. Other health conditions that were detected were associated with the ageing process and it became clear that, in the future, attention would need to be given to such conditions to limit further degeneration by means of relevant remedial action.

The monitoring of progressive health trends by obtaining and analysing biomedical data is necessary in studies of a similar nature in order to detect the impact and rate of these trends over a period of time. The study made it clear that it will be necessary to conduct such analyses at set time intervals because there are various factors that influence the absorption and bioavailability of nutrients in each individual. Biological processes play a vital role in ensuring that nutrients are accessible in the blood stream, and there is strong evidence that illness can also affect nutrient access (Kalaiselvi *et al.*, 2016). For these reasons, screenings of various other diseases besides self-reporting should be taken into account for each individual.

Measuring the dietary intake of the elderly farmers was an essential component of this programme after the legumes were consumed. It was therefore important to consider preparation, processing and storage methods to ensure that the dishes suggested were palatable, easy to prepare and tasty.

Legumes contributed significantly in providing micronutrients by means of the diet that was recommended (according to the SA healthy eating guidelines refered to in the study that informed the nutrition education content refer to Annexure N) and it was envisaged that their intake would contribute significantly to improved health status. There was indeed a measurable shift in the health status of some farmers who embraced the idea of the consumption of legume varieties during the three-month consumption period. However, by focusing on a diet of legumes, the participants lost sight of the importance of the intake of, or the abstinence from, other food items as well. This underscores the fact that dietary studies that focus on one nutrient-rich food source should incorporate information on the importance of a balanced intake of nutrients across all food groups simultaneously.

Another important finding was that it was much easier to use a variety of legumes in the intervention programme than a single one as it allowed for a wide range of choices and accommodated individual preferences. Micronutrient deficiencies can be combated through strict dietary control and dietary diversity. However, studies in this field should be longitudinal to effectively measure progression. There was evidence of legumes providing fibre when the post-intervention survey results were scrutinized. Fibre can also be increased with a regular intake of other sources such as fruit and vegetables, but these food sources were persistently lacking or limited in the diets of the participating farmers. Moreover, there high consumption of refined carbohydrates group combined with a high salt intake. This indicated entrenched dietary habits that would require long-term strategies to transform.

When legumes were readily accessible to the farmers at household level, dietary consumption patterns changed and improved. However, when the only access was through individual harvests, interest waned, and the project collapsed at grassroots level, when no further external impetus was provided. Admittedly, various restrictive factors caused poor harvests in the first trial in particular. Examples of these factors include, macro influences such as weather conditions, pest infestations and water shortages, and micro influences such as limited access to land and seeds to plant all the legume varieties. Poor harvests limited and even prevented the intake of the recommended legume quantities per day and only limited legume quantities could be consumed when harvested, whenever the season was favourable. Very limited quantities of the crops were available for marketing associated with lower yields.

Acceptability of legumes was enhanced when the intervention programme provided an exploratory platform for food testing, tactile experiences and practical preparation demonstrations that also enhanced the legume knowledge of the farmers about the nutritional value of legumes, which they self reported during practical sessions. However, despite the fact that acceptability levels remained high during the duration of the project, it did not always translate into immediate alignment with cultivation during the planting season, due to personal as well as environmental factors. The implication for future studies is that even though acceptability and willingness to engage in a food and nutrition project may be expressed, timely and active engagement may be subjective, which may be a barrier to achieving the study objectives.

It was found that the majority of households had adequate access to food, as food insecurity existed only in a minority of cases. However, noticeable constraints were evident in terms of regular access to certain types of food, which was associated with limited financial resources. It is important to consider that the implications of these challenges cascaded down to the entire household. The improvement of economic and business skills and enhanced access to land to open up alternative markets should thus be a driver of future interventions in order to combat the household food insecurity challenge that exists in the households of farmers in the study area.

It was found that vitamin A-rich crops were commonly produced as cash crops and were readily available in shops, while the municipality was also keen to ensure access to seeds by farmers. However, if legume production is to be sustained in this community, innovative strategies and interventions are needed to ensure profitable yields. The study demonstrated that production education alone was not sufficient in an environment where there were complex environmental and production constraints. A more intensive intervention is thus needed, and such a project will require the consideration of other factors such as farmer production patterns, land space, seasonality, access to resources, pest control measures and market dynamics. The promotion of legume cultivation will also require extensive soil analysis and fertilization; regular monitoring and support and the availability of other necessary resources that farmers will need in the field. Small-scale farmers face diverse challenges that range from nutrient-poor soil to household and even health constraints. Singly and in combination, all these factors culminate in barriers that hinder sustainable productivity. Moreover, it was clear that farming programmes in a municipal setting had to be halted when political challenges and conflict erupted. This experience signals a dire warning as health and food security in communities is compromised in such situations.

6.4 Recommendations for the Community

- Community-based nutrition services, health education, information and communication programs are needed to monitor and effectively reduce malnutrition and other health challenges in communities, where smallholder farmers operate.
- Further initiatives to improve their soil quality through soil treatments and analysis are required.
- Physical training, exercise facilities, sport-trainers and healthcare professionals should collaboratively assist in age-specific weight control programmes for elderly farmers.
- Stronger communication networks need to be created between communities, the municipality and household members to assist them in engaging in food and nutrition as well as health initiatives.
- Malnutrition requires sustainable solutions that can be achieved through collaborations between agricultural communities such as the one that participated in the study, and government policy directors.
- Public health nutrition experts (from national government) who may be invited in should visit farming areas and farmers' households to create education platforms in these settings.

6.5 Recommendations for the Municipality

- The Department of Agriculture, in collaboration with municipal staff, should launch public campaigns in collaboration with extensive advisory services, to enhance the role of legume consumption and dietary adjustments amongst farmers.
- Agricultural hub stations in the region should test viable means of growing legumes using urban agricultural methods that may be less time-consuming than traditional methods.
- Agricultural hub stations should also serve as a platform for further research into various legume varieties that can be sold and distributed at local markets.

- Visits of farms and extensive support by municipal officials during the planting season should be a regular occurrence as part of monitoring each plot and assessing cultivation patterns and challenges.
- The municipality should consider developing plant clinics in farming communities. The staff of these clinics should regularly observe crops and provide remedial measures to assist farmers in dealing with cultivation and other crop-specific challenges.
- Concerted interventions are required to deal with pest control while sustaining organic farming practices. It seems senseless to compel farmers to engage in eco-farming practices while not supporting them in acquiring and utilising biological pest control measures.
- Collaboration between the Department of Agriculture (under the Parks Division) and health services need to create further platforms for regular screenings by health professionals in order to determine and improve elderly farmers' health status. This could occur regularly at monthly meetings.
- The fact that legumes are cultivated and harvested by small-scale farmers is not sufficient to address dietary diversity modification. Thus, other means of large-scale production are required to supplement legume consumption during dry seasons.
- Due to land shortages, continued intervention programmes should be conducted to encourage farmers to practise intercropping in a sustainable manner. More land should also be made available to farmers so that they may extend and diversify their crops to aicheve dietary diversity.

6.6 Recommendations for Policy-Makers

- The establishment of guidelines, standards and agencies for the promotion of food and nutrition security, particularly amongst elderly farmers and farming communities, should occur on both a national and global scale.
- There is a need for policy reform to create a clear understanding of food systems/the value chain and health impacts associated with changing global demands. Such policies and guidelines should include measures that encourage smallholder farmer participation.

- There is a need in this country to adopt more concise yet explorative interventions to improve food and nutrition security. Such initiatives should be devised in consultation with smallholder farmers.
- There is a need to strengthen legume production and to evaluate, and hopefully escalate, the current limited production of these crops in South Africa. Researchers associated with research institutions should explore and encourage amendments to import and export regulations pertaining to legume varieties that are not locally produced, in order to make them more accessible to South African markets, particularly at a local level.
- The government must develop appropriate price support policies to ensure that small-scale farms are eligible for stable and profitable prices. Thus, subsidising vegetable and fruit seeds and seedlings should be a priority cost intervention to allow farmers to produce and consume more vegetables and fruit as this will promote the intake of micronutrients (such as calcium, magnesium), which will in turn improve cholesterol levels (Dodevska *et al.*, 2013).
- Extension programmes should not only provide vitamin-rich crop seeds to farmers but should also assist in providing starter packs with diverse legume seeds (not only sugar beans) to encourage diverse legume production.
- Extension services in the agricultural field should reform the current policy and subsidise soil analysis to assist farmers in properly understanding soil quality. They should also make recommendations on how to improve soil quality for the cultivation of various legumes because the departmental policy does not subsidise payment for these services.
- Policies should help smallholder farmers to either shift towards producing more nutritious and profitable foods or towards engaging in off-farm employment.
- Empowering women in agriculture will not only improve the climate for adaptation practices, but will also contribute to other societal gains, such as improved household nutrition.
- Policies on sugar and salt taxation currently in place in SA must be considered and relevant agents of transforming communities. Collaborating with municipalities in investigating the impact of these taxes on people at grassroots level, particularly on more vulnerable groups that are highly susceptible to non-communicable diseases is vital.
- There is a need to strengthen legume production and to evaluate the lack of sufficient yields for consumption and marketing. Various linkages amongst the public and private sectors,

food agencies and academia should be established to ensure that all stakeholders play their part in promoting the cultivation, consumption and marketing of legumes nationally.

- Policies regarding land reform and land use planning should promote more space for the cultivation of a variety of legumes without interrupting the flow of normal cash crops, which are habitually cultivated by smallholder farmers.

6.7 Recommendations for Future Research

- In future a comprehensive adoption of community engagement and devolpment principles should be adopted and extensively reviewed prior to any intervention to be conducted within this community.
- A behavioural intervention research programme should be designed that focuses specifically on older farmers (>50years) in order to address their perceptions, choices and cultural norms in terms of food intake and to encourage behavioural pattern shifts where necessary.
- There is an urgent need for future studies to underscore the link between micronutrients, cognitive impairment and multi-mobility amongst smallholder farming communities.
- It is imperative that national research institutions in this country work collaboratively with farmers on research projects to further investigate legume cultivation and consumption, as well as the effects of the consumption of this food on the health status of elderly farmers.
- The impact that climate change has on farming globally is affecting even smallholder farmers. There is thus a need for research on appropriate technologies that could assist such farmers in dealing with the effects of climate change and post-harvest losses.
- Various pests have emerged due to climate change. Hence there is a need for intensive research on this phenomenon, particularly to curb those pests that affect legume crops and impact production in farming communities, where legumes are cultivated.
- Further interventions in terms of micronutrient improvement are necessary, even within broader farming population groups, to ensure food and nutrition security amongst senior farmer citizens.
- There is a need to launch longitudinal, carefully constructed studies to investigate the relationship amongst current cooking practices, prevailing traditional recipes used at household level, dietary intake and the nutrition and health status of farmers.

- There is a need for in-depth biomedical research on nutrient-drug interactions in farmers who have non-communicable diseases.
- More research is needed to curb the prevalence of obesity. A clear lipid, glucose and endocrine profile should be provided for at-risk participants in such studies.

6.8 Final Reflections

Linking dietary intake and production of the same product in the same project can contribute to adverse effects on the research outcomes. It is thus important in future studies to continuously test production and consumption of the harvested crops separately, to ensure that yields effectively address food insecurity. In this study, the alternative supplementation of legumes for the farmers to consume over a specified period yielded positive results. This indicated that when there was access to legumes in regular farmer households, they could easily adapt to the requirement to consume food that addresses the need for food and nutrition security. The positive effect of the blood profile (in terms of glucose and cholesterol results at different intervals and for different trend analyses by gender) of the EG was a highlight of the study, as this indicated that legume consumption and empowerment to make healthier food choices showed desired results. However, when measuring the dietary intake that was purely dependent on the access to legumes through the harvested crops, there were restrictions as the farmers experienced challenges and sufficient harvests were limited due to various contributing factors.

In this context, one is reminded of the old adage: *Give a man a fish and he will have food for a day; teach a man to fish and he will have food for a lifetime*. This study may adapt this adage slightly: Give a farmer enough legumes and he/she will have food for three months; give a farmer incentives to work towards, and legume production will put money in his pocket and food in the mouths of his family for a long time. Unfortunately, this study fell into the trap of donations and good works (of assisting the community have access to resources), and limited success in terms of the ultimate goal was the result. The main objective of the study was to develop an agriculture and nutrition programme that would promote legume consumption and production by elderly farmers in order to ensure that their food and nutrition security would be improved significantly. Thus, selected farmers were assisted in prioritizing the consumption of legumes as a source of plant protein, fibre and micronutrients that would ensure dietary diversity and nutritional benefits. The study identified various challenges related to the farmers' health, nutrition intake, socio-economic conditions and agricultural knowledge. All these challenges underscored the complexity of the factors that shape and influence the food intake of communities. Farmers in general do not only produce food, but they also play a significant leading role in society and in their own households to ensure that healthy food is available for consumption. Therefore, if their health and agriculture production potential are compromised, the ripple effects are dire for their families and the community.

Structures in government, and particularly in decentralised local platforms provided by municipalities, have the power to contribute to overall profitability and development in agriculture. A municipality can further contribute to healthy communities by providing relevant training and development opportunities for farmers and by connecting them through a networking system to resources that will enhance food security. However, the core of the success of any such programme is the farmer's ability to maintain good health in order to address daily demands in a responsible and sustainable manner. Without support, knowledge and access to relevant platforms coupled with supportive policies and resources, smallholder farmers will be in a state of continuous degeneration. Interventions are thus necessary to ensure that researchers and other vital role-players equip and empower farmers as the agents of food security in thier communities. Future intervention studies that address legume production and consumption need to embrace the participation of all stakeholders, who need to collaborate in assisting farmers to deal with the many challenges that may prevent them from producing and consuming healthy food cultivars such as legumes. Only when this occurs as a matter of course, will food and nutrition insecurity that exists in many communities be addressed.

The study demonstrated that food and nutrition insecurity is influenced by many external factors that the intervention programme could not address. Thus, even though a behavioural shift was achieved during the intervention phase, the goal of sustainability and stability was not achieved, as was demonstrated by the results of the follow-up survey six months after the cessation of the intervention programme. The study clearly paved the way towards food and nutrition security amongst elderly farmers and by extension, that of their communities. However, the journey is far from over as more innovative approaches are required to ensure the sustainability of similar projects and their consequences in the future.

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ANNEXURES

ANNEXURE A DUT RESEARCH ETHICAL CLEARANCE IREC 026/15

ANNEXURE A1 CONFIDENTIALITY LETTER

I ………………………………….. participating as a ………………………………. in the study fully understand that this study is dealing with human beings personal information. Therefore I pledge not to discuss the information of participants with any other person. I will keep the information confidentially in order to ensure that participants' rights are protected.

____________________	__________	________________
Full Name of Participant	**Date**	**Signature**
_________________	__________	___________________
Full Name of Researcher	**Date**	**Signature**

ANNEXURE B PERMISSION LETTER FROM THE MUNICIPALITY

ANNEXURE B1 NEGOTIATION LETTER FROM RESEARCHER

ANNEXURE C INFORMATION LETTER FOR THE PARTICIPANT

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC)
CONSENT

Letter of information
Dear participant
Thank you for allowing me to explain to you my research study for your consideration.

Title of the Research Study:

The title of my study is "Addressing food and nutrition insecurity through the development and implementation of an agricultural and nutrition education programme on legumes for older farmers living in Mariannhill, Kwa-Zulu Natal, South Africa"

Principal investigator/s/researcher:

I, Xolile Mkhize, (Masters in Food and Nutrition) will be the main researcher.

Co-Investigator/s/supervisor/s:

Co-Investigator/s/supervisor/s: I am supervised by Professor Carin Napier (D Tech Food Service Management) and co-supervised by Prof Wilna Oldewage-Theron (PhD (Nutrition) and Prof Duffy (PhD Mathametics)

Brief Introduction and Purpose of the Study:

It is very important to do this study because the future of our South African food security status is highly depending on the retaining skilled producers. It is also import to improve the quality of the diet in order to alleviate the burden of disease the is done in conjunction with promoting the food based dietary guidelines. Older farmers need to have an improved nutrition and health status in order to lower the risk of diseases and mortality within this population group. Nutrition education is critical for older farmers to benefit both their lifestyle as well as improve the agricultural productivity. The study will help identify the factors affecting the quality of life for older farmers and assess their agricultural practices. The objective then is to develop a comprehensive programme that will aid to alleviate the burdens faced by this group. The focus will be on older farmers who are subsistent farmers within the area of Marianhill.
We will need 100 active participants of older farmers to participate in the study. This will provide valuable information that will assist in developing ways in which we can improve their nutritional status and agricultural practices

What will it involve?

- Ethical clearance was obtained from the Durban University of Technology
- I would need for you to sign a consent form to indicate that you agree to participate in the study, after I have explained the procedures to you.

- If you agree, you will be asked to complete 6 questionnaires in an interview situation and anthropometric measurements. It could take 1hr- 1hr ½ minutes
- The questionnaires will include
    1. Socio-demographic questionnaire
    2. Anthropometrics and health questionnaire
    3. 3 x 24 hour recall questionnaires
    4. Food frequency questionnaire
    5. Household food insecurity scale questionnaire
    6. Agricultural practices questionnaire
- You will not be required to remove any clothing except for shoes and jerseys when being measured
- Participation will be voluntary and you can withdraw at any time with no penalty

Cost of the study

The researcher will enquire all the related costs of the study participants will not form part of that.

Risks or Discomforts to the Participant

You will not feel any discomfort. All measurements and weighing will be done at Agricultural station hub and to homes of participants. You will be asked to remove shoes and jackets and jerseys only and you will not have to undress.

The results of the study will be shared with the Durban University of Technology, after the study has been concluded. Your name will not be mentioned, with the hope that interventions can be planned in the University 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.

Benefits

The participants will receive no financial benefit. Respondents will receive inputs for agricultural activity, training and opportunities to taste food products developed for sensory evaluation. Study costs and all expenses will be managed by the researchers' budget. Respondents will not be asked to contribute any financial input.

Remuneration

No financial gain will be provided to the participant only access to inputs that assit in growing legumes within respective areas of production

Confidentiality

All information gathered will be treated confidentially and all collectors of data will be trained and some are experts in the field

Reason/s why the Participant May Be Withdrawn from the Study: 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 injuries

No research related injuries are expected in this study**.**

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

Your participation will be greatly appreciated and thank you for allowing us to explain this study to you.

Kind Regards

Xolile Mkhize

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

Supervisor: Prof. Carin Napier

Co-supervisor: Ms Xolile Mkhize

Researcher: Xolile Mkhize 031- 9077643/xmkhize@mut.ac.za

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

Co-Supervisor contact: +27169509722/ wilna@vut.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

ANNEXURE D CONSENT FORM FOR THE PARTICIPANT

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   **Date**   **Time**   **Signature / Right Thumbprint**

Mina, ______________ (mcwaningi) ngivumelana ngokuthi waziswe ngakho konke okuphathelene nalolu cwaningo

_________________   __________   ___________________

Full Name of Researcher   **Date**   **Signature**

_________________   __________   ___________________

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

_________________   __________   ___________________

Full Name of Legal Guardian (If applicable) Date   **Signature**

ANNEXURE DD FIELD WORKER TRAINING MANUAL

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 individuals 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

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 10hours of 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 10 hours of fieldwork completed; any fieldwork completed by a fieldworker over and above the10 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.
- Fieldwork marks adds up to **10%** of the final mark for **WIL**.
- Students can be expected to do any of the following tasks as part of their 10 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	**Very good 10 - 9**	**Good 8 - 6**	**OK 5**	**Poor 4 - 3**	**Unacceptable 2 - 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						
All details included in completion of forms						
Followed the task through to the end						

Number of hours completed: ____________

General comments:
____
____
____

Researcher Signature: ______________________ Date: ______________

Print name: ____________________________

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/he must pay attention to detail, record all answers accurately, not skip over questions or make up answers.

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.

8. **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.

ANNEXURE E

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 from any reports or publications.

GENERAL INFORMATION

Subject code number: ________________________ Interviewer: ____________________

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

PERSONAL INFORMATION

Your role in the family

Father	Mother	Grandfather	Grandmother	Caregiver	Other, specify…………………….

2.2 When were you born? Year: Month: Day:

2.3 How old are you? ___________________years

2.4 Gender:

Male	Female

2.5 Are you a registered farmer?

Yes	No

If yes specify

Co-corporative association	
Dept of Agriculture	
Small business association	
Private association	
South African farmers association	
Ethekwini municipality	
Other	

3. ACCOMMODATION AND FAMILY COMPOSITION

Where do you live?

Town/City	Farm	Informal settlement	Rural village	Hostel	Other, specify…………..

Do other people live in your house?

How many people are living in your house?

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

Please complete the table below on all members of the household

Name of household member	Age (yrs)	Gender M / F	Family relationship	Does this person eat and sleep in this house at least 4 days a week?

Are all members' permanent residents in this house?

Yes	No

3.6 If yes, how long have you been staying permanent in this house?

< 1 year	1-5 years	>5 years

3.7 Do you have another home outside the Marainhill?

Yes	No

In what type of house are you staying?

Brick	Clay	Grass	Zinc/shack

How many rooms does your house have?

< 2 rooms	3-4 rooms	> 4 rooms

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

Yes	No

3.11 How would you describe the place where you are currently living?

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

3.12 Do you have the following facilities at home?

Water

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

3.11.2 Toilet facilities

None	
Pit latrine	
Flush / sewage	

Bucket system	
Other, specify………………………	

3.11.3	Waste removal	Yes	No

3.11.4	Tarred road in front of house	Yes	No
	Gravel road in front of house	Yes	No

To what extent do you have problems with your housing (e.g. too small, repairs, damp, etc.)?

……

3.13. Do you have problems with the following?

Mice / Rats	Cockroaches	Ants	Other pests, specify…………………………

WORK STATUS AND INCOME

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. Is your job?

Full time	< 25 hours per week

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

4.8. Is there any form of social support that you are getting monthly?

Yes	No

If YES, go to Question 4.10.

4.9. If NO, is your spouse (partner) in paid employment at present?

Yes, full time, permanent	
Yes, part-time, permanent (< 25 hours p w)	
Yes, temporary	
No, unemployed	
No, retired	
No, other, specify……………………….	

4.10. If YES, what is your spouse (partner)'s occupation or job?

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

<	>R1000	R1001-R1500	R1501-	R2001-R2500	> R2500-

> R 3000-R3500	> R3500-R4000	> R4000-R4500	> R4500-R6000	R6000- R 8000	R8000-R10 000	> R10 000

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

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

Always	Often	Sometimes	Seldom	Never

4.14 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 from second 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

4.15 How often do you buy food?

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

4.16 Where do you buy food?

Spaza shop	Street vendor	Supermarket	Other, specify…………………

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

≤ R 50	≥R 50 R 150	≥R 150– R 250	≥R250– R 350	≥R 350 – R 500	≥R500 – R1000	>R1000- R1500	> R1500- R2000	> R2000- R2500	> R2500

4.18 How much money do you give to each child to take to school for buying food / snacks PER WEEK?

50 c	R 1 – 2	R 2- 3	R 3 - 4	R 4 - 5	R 5- 10	> R10

4.19 What do you think will improve the access to food in your house as an intervention strategy?

Producing own food	Starting a business	Finding a job	Employment of your children	Social support from government	NGO support

5 EDUCATION AND LANGUAGE

5.1. What is the highest education you have?

None	Primary School	Standard 8	Standard 10	College	Other post school

5.2 What language is spoken mostly in the house?

Sotho	Xhosa	Zulu	Pedi	Other, specify…………………………….

6. ASSETS

Tick one block for every question:	Father	Mother	Sibling	Grandma	Grandpa	Aunt	Uncle	Cousin	Friend	Other
6.1 Who is mainly responsible for food preparation in the house?										
6.2 Who decides on what types of food are bought for the household?										
Who is mainly responsible for feeding/serving the child?										
Who is the head of this household?										
6.5 Who decides how much is spent on food?										

6.6 How many meals do you eat at per day?

0	1	2	3	> 3

6.7 Where do you eat most of your meals?

Home	Friends	Work	Buy	Other, specify……………………..

6.8 Where do your children eat most of their meals?

Home	Friends	School	Buy	Other, specify……………………..

6.9 Does your home have the following and how many?

	Yes	No	Quantity
Electrical stove			
Gas stove			
Primus or paraffin stove			
Microwave			
Hot plate			
Radio			
Television			
Refrigerator			
Freezer			
Bed with mattress			
Mattress only			
Lounge suite			
Dining room suite			
Electrical iron			
Kettle, electrical			

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

Food fire	Paraffin	Electricity	Gas	Coal	Other, specify……………

6.11 What type/s of pots do you use to cook your food (tick all relevant options)?

Cast iron	Aluminium	Stainless steel	Clay	Other, specify……………

Thank you very much for your co-operation. We appreciate the time.

ANNEXURE F

ANTHROPOMETRIC, HEALTH AND MEDICAL QUESTIONNAIRE

This questionnaire measures the nutritional status through anthropometrics and health profile of respondents.

Subject code number: ______________________ Interviewer: ___________________

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

Section A:

Surname		BMI	
First Names		WSTR	
Height/m		Weight/kg	
Gender	Male Female	Cholesterol/ mmol	
Waist Measure/cm		Blood Pressure SD/DP	

ARE YOU SUFFERING OR HAVE YOU SUFFERED FROM		**IF ANY ANSWER IS YES, GIVE DETAILS OF THE NATURE, SEVERITY AND DURATION OF ILLNESS**
1. Any skin disease?		
2. Any affection of the skeleton and/or joints? 2.1 If yes is does it pain during an agricultural acticity 2.2 Have you stopped agricultural activity due to painful skeletal or joints		
3 Any affection of the eyes ? 3.1 If yes, have you ever had cataract surgery?		
4. Any affection on teeth? 4.1 Do have difficulty eating? 4.2 Do you have any dentures?		
5. Any affection of the ears or nose (specify)		
6. Any affection of the heart or circulatory system?		

7. Any affection of the chest or respiratory system? 7.1 Do you work with soil, pesticides regularly?		
8. Any affection of the digestive system? 8.1 If yes is it the following?		
constipation		
diarrhoea		
ulcers		
irritable bowel syndrome		
heartburn		
9. Any affection of the urinary system and/or genital organs?		
10. Any nervous affection or mental abnormality?		
11. Any headaches		
12. Do you suffer from **Cancer?**		
13. Do you suffer from **Diabetes**		
14. Do you suffer from **Hypertension?**		
How do you know? Professional Diagnosed or Self		Specify ………………………..
15. Any other illness?		
16. Do have any of the following conditions?		

None	
Poor appetite	
Too much appetite	
Lack of sleep	
Loss of memory	
Swollen feet	
Weakness on wrist	

17. Would you say your usual level of physical activity is:	**Tick the correct block**
1. Heavy/ rigorous (running, playing tennis, swimming, doing heavy gardening, etc., at least three times per week)	
2. Moderate (Taking rigorous exercise once or twice a week, or steady walking, or other moderate activities at least three times per week)	
3. Light (playing golf, taking a stroll, or doing none rigorous activities occasionally)	

4. None (No exercise whatsoever)	

	YES	NO
18. Are you physically disabled and do you use artificial limbs?		
GIVE DETAILS OF THE NATURE AND SEVERITY OF THE DISABILITY ……………………………………………………………………………………………… ………………………………………………………………………………		

19. Do you smoke at this moment?	**Tick the correct block**
1. Yes	
2. No (Never smoked)	
3. No (Stopped)	

20. Do you make use of snuff at this moment?	**Tick the correct block**
1. Yes	
2. No (Never used)	
3. No (Stopped)	

21. Does you're spouse or partner smoke at this moment?	**Tick the correct block**
1. Yes	
2. No	
3. Not applicable	

	YES	NO
22. Have you undergone any operations?		
IF YES, GIVE DETAILS OF THE NATURE AND DATE OF THE OPERATION/S ……………………………………………………………………………………………… ………………………………………………………………………………		

Section C:

MEDICATION QUESTIONNAIRE:

	Yes	No
1. Do you use any medication?		
2. If no, go to the next block.		
3. If yes, what for/why? ……………………………………………………………………… ………………………………………………………………		
4. What is the name of the medication you are taking? ……………………………………………………………………… ……………………………………………………………		
5. What is the dosage and how often do you take this medication?.	**Dosage**	**How often?**

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

Which health facility is commonly used by the household?	**Tick the correct block**
1. Private Doctor	
2. Clinic	
3. Hospital	
4. Traditional Healer	
5. Other (please state):	

How does the household travel to the health facility?	**Tick the correct block**
1. On foot	
2. Taxi	
3. Bus	
4. Own transport	
5. Other (please state)	

I declare that the above-mentioned information is true and correct and that I have not withheld any information.
Signature……………………………………..Date…………………………………..

ANNEXURE G

24 – HOUR FOOD RECALL

Subject code number: ______________________ Interviewer: ___________________

Date: _______ / ________ / 20___

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					
During the morning at work or at home					

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

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 or supplements (tablets or syrup)		Yes	1	No	2
Folate					
Iron					
Other					
Give the brand name and dose of the vitamins/tonic:					

ANNEXURE H

FFQ LIST OF FOODS AND FOOD GROUPS DIVERSITY

Subject code number: ________________________ Interviewer: _____________________

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

GROUP 1: Meat foods (meat, poultry, fish) diversity	Y	N
Chicken		
Beef		
Pork		
Tinned fish (pilchards)		
Fish (fresh / whole)		
Lekgotlwane (finely chopped, cooked meat)		
Mutton		
Tinned fish (tuna)		
Chicken runners and heads		
Chicken livers		
Goat (meat)		
Mogodu and malana		
Dried meat (biltong)		
Viennas / polony		
Russians		
Sausage (wors)		
Steak		
Group 2: Eggs diversity		
Eggs		
Group 3: Dairy products diversity		
Milk, unpasteurized (cow)		
Evaporated milk (unsweetened)		
Maas/ inkomasi		
Powdered milk		
Skim or low-fat milk (pasteurized)		
Full cream milk (pasteurized)		
Cheese		
Custard		

Ice cream		
Yoghurt		
Ultramel		
Yogisip		

Group 4: Cereals, roots and tubers diversity	**Y**	**N**
Rice		
Pap (Maize)		
Macaroni/pasta/spaghetti		
Maize rice (mielierys)		
Samp (stampmielies)		
Bread (white or brown)		
Whole wheat bread		
Dumpling		
Fat cakes		
Scones		
Biscuits		
Buns / bread rolls		
Mabela (soft porridge)		
Maize meal porridge		
Corn flakes		
Oats		
Wheat bix		
Mageu		
Potatoes		
Sweet potatoes		
Amadumbe		
Umqombothi		
Traditional beer		
Group 5: Legumes and nuts		
Sugar beans (fresh/ dried/canned)		
Chick Peas (fresh/ dried/ canned)		
Cow peas (imbhubha/ dried)		
Jugo beans (izindlubu fresh/ dried/ canned)		
Red kidney bean (fresh/ dried/ canned)		
Broad white bean (fresh / dried/ canned)		
Green mung (fresh / dried/ canned)		
Green beans (fresh/ dried/ canned)		
Peanuts or any other nuts (raw/ roasted)		
Soya beans (fresh/ dried/ canned)		
Lentils (fresh/ dried/ canned)		
Soy chunks/mince		
Soy milk		
Peanut butter		
Group 6: Vitamin A rich fruits and vegetables diversity		
Pumpkin		

Carrots		
Wild leafy vegetables (morogo) Fresh and dried		
Spinach		
Butternut		
Apricots (Applelkoos)		
Peach (yellow cling)		
Mango		
Group 7: Other fruits (and juices) diversity		
Deciduous fruits		
Apple		
Peaches		
Pear		
Grapes (black/green)		
Plum		

Sub – tropical fruit		
Lemon		
Orange		
Naartjie		
Banana		
Pineapple		
Avocado		
Blueberry		
Cherry		
Kiwi fruit		
Raspberry		
Watermelon		
Wild watermelon(tsamma)		
Guava		
Juices		
Juice (100% pure juice e.g. Ceres/Liquifruit)		
Group 8: Other vegetables diversity		
Onions		
Cabbage		
Beetroot		
Rhubarb		
Turnips (raap)		
Gem-squash (lemoenpampoen)		
Tomatoes		
Green beans (fresh)		
Peas (fresh – green)		
Cauliflower		
Chili (red/green)		
Lettuce		
Mushroom		
Baby marrow		
Green pepper		

Sweet-corn (baby)		
Corn-on-the-cob(white)		
Garlic		
Group 9: oils and Fats diversity		
Butter		
Sunflower oil		
Margarine		
Lard		
Salad oil		

ANNEXURE I

HOUSEHOLD FOOD SECURITY SCALE QUESTIONNAIRE

This questionnaire covers certain aspects of your life, including work and personal details, will be used to evaluate the effectiveness of current policies/programs within the government aimed at addressing food security through as structured questionnaire (the questionnaires should detail all the 5 current programs in. The answers to these questions will be kept strictly confidential and the information will not be identifiable from any reports or publications.

GENERAL INFORMATION

Subject code number: ______________________ Interviewer: ___________________

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

HOUSEHOLD FOOD SECURITY MEASUREMENT

Household Food Insecurity Access Scale (HFIAS) Measurement Tool

NO	QUESTION	RESPONSE OPTIONS	CODE
1.	In the past four weeks, did you worry that your household would not have enough food?	0 = No (skip to Q2) 1=Yes	….|___|
1.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q3) 1=Yes	….|___|

2.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q4) 1 = Yes	....|___|
3.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q5) 1 = Yes	....|___|
4.a	How often did this happen?	= Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1 = Yes	....|___|
6.	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks)	....|___|

		3 = Often (more than ten times in the past four weeks	
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q9) 1 = Yes	....|___|
8.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (questionnaire is finished) 1 = Yes	....|___|
9.a	How often did this happen?	= Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	....|___|

Do you understand what the term vulnerable group means?

Yes	No

If YES (question 2.10) does it mean the following?

Disabled	Weak physically	Need extra care	older person	Other, specify………

What do you think will improve the access to food in your house as an intervention strategy?

Producing own food	Starting a business	Finding a job	Employment of your children	Social support from government	NGO support

If you had access to money which food group would you purchase the most?

Carbohydrate group	Meat group	Fruit & vegetables	Fat & oil rich foods	Legumes

Do you think legumes are an important group?

Yes	No

Are you aware of the benefits associated with legumes in a diet?

Yes	No

2.7 Do you ever throw food away any food produced?

Yes	No

If No, indicate the reason

Not enough to throw away	
Food doesn't spoil fast	
Extra foods is given away	
Food is eaten within the times	
Cultural requirement to it eat when presented	
Other	

Thank you very much for your co-operation. We appreciate the time.

ANNEXURE J

LEGUME KNOWLEDGE AND ACCEPTABILITY EVALUATION FEEDBACK QUESTIONNAIRE

Subject code number: _______________________ Interviewer: ____________________

In this study we want to investigate the acceptability levels of these legumes which have been demonstrated to you through various applications. This information is important in assisting providing an intervention of legumes that are socially and culturally acceptable so that they can be consumed regularly in your diets.

LEGUME ACCEPTABILITY FOR HOUSEHOLD CONSUMPTION

1.1 Please indicate which legumes do you find appealing to you and would consume them at a household level

LEGUMES	
Sugar beans	
Green mung	
Jugo beans	
Broad beans	
Soy beans	
Cow peas	
Chick Peas	
Peanuts/ other nuts	
Lentils	
None	

1.2 How many times a week would you consume the legumes indicated above

Once a week	2-3 per week	4-5 per week	7 days week	Never

1.3 Which legume do you prefer in all the ones you have mention?
……….

1.4 What has been the main challenge for limited legume intake in the past?

Challenge	
Don't know how to prepare them to taste good	
Require too much cooking time	
Other family members do not like them	
Cause bloating in the stomach	
Didn't know they have nutritional benefits	

All of the above	
None	

1.5 Would you recommend legumes to be consumed by other household members as well?

YES	NO

1.6 Did the educational programme improve your nutritional knowledge of legume benefits?

YES	NO

LEGUME ACCEPTABILITY FOR FOOD PRODUCTION

2.1 Would you consider growing a variety of legumes in the future?

YES	NO

2.2 If yes, please indicate which legumes do you find appealing to you and would consume them at household level

LEGUMES	
Sugar beans	
Green mung	
Jugo beans	
Broad beans	
Soy beans	
Cow peas	
Chick Peas	
Peanuts/ other nuts	
Lentils	
None	

2.3 If no, please indicate the reason

REASON	
Prefer for household consumption	
No market	
Too many limitations of growing legumes	
All of the above	
Not interested	
Other specify	

2.4 Did the educational programme improve your agricultural knowledge of legume production?

YES	NO

2.5 Explain how the programme improved your producrion of legumes

……
……
……

2.6 Explain how it improved the consumption of legumes

……
……
……

ANNEXURE K

THE TRADITIONAL AGRICULTURAL PRACTICES QUESTIONNAIRE

The purpose of the study is to find out about your agricultural practices that you use and have used.

GENERAL INFORMATION

Subject code number: ________________________ Interviewer: ____________________

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

1.1 Demographics:

Age				
Level of education				
Agricultural training				
Gender (m or f)				
Typology				

2. WATER

In this section we are going to talk about the water used by a household for drinking, cooking, bathing, or washing clothes, watering the garden and other household purposes like these.

2.1 Is the household able to get all the water it needs for normal household purposes?

Mostly yes..
Sometimes..
Mostly no...

2.2 Does the household have to fetch and carry water to the house each day?

Yes...
No..

2.3 About how far away is the water that has to be fetched?

Less than 100m......................................
100m - less than 500m...........................

500m - less than 1km.............................
1km - less than 5km...............................
5km or more..

____

2.6 Who in the household usually fetches water?

____

2.7 Do you generally have challenges of irrigating crops grown?

Yes	No

If yes, Indicate the course

Water is too expensive regularly	
Water shortages in the area	
Limited irrigating equipment	
All of the above	
Other, specify	

3. Land Access and Use

3.1 Land for Farming: Plot or Field

3.1.1 Does this household use land for farming that is

Communal...................	
Private (Own Farm)......	
Private (Rented)...........	
Other (Specify).............	
_____________________________	

3.1.2 How much of the land does the household use for growing crops and how much does the household use for grazing of animals?

Crop categories	Specify
All for crops	
Most for crops	
Half for crops and half for grazing	
Most for grazing	
All for grazing	

3.1.3 What is the total size of all land that is available to household members for growing crops? Record in hectares for those who can give this information.
_____________________hectares

If information cannot be given in hectares, think of a soccer field - is the total area smaller, about the same or bigger than a soccer field? If bigger: Determine about how many soccer fields the land the household could use for growing crops would cover? Interviewer: Remember: (i) A soccer field is about ½ hectare. (ii) One hectare equals approx. 2 acres

3.2.1 What are the sources of water, if any, used on the land used for growing crops? (Allow for multiple responses, up to three).

Source	X
River/Stream	
Dam	
Borehole	
Tank	
Municipality	
Rain	
Neighbour	
Other (Specify)	

3.2.2 And which is the main source? (Single mention)

Main Source	X
River/Stream	
Dam	
Borehole	
Tank	
Municipality	
Rain	
Neighbour	
Other (Specify)	

3.2.3 About how much water do you use for crops per day?

____

3.2.4 How do you get this water to the crops?

____

3.2.5 About how much of the land used for growing crops is the household able to water from these sources (and not counting rain)?

Quantity	
Less than half	
About half	
More than half.	
All vacant	
None	

4.0 Agriculture - Subsistence/Small-Scale

4.0.1 Crop Production Including Home Consumption

4.1 Do you grown legumes for crop production?

Yes	No

4.2 If yes where is it used?

Utilization	
Household use	
To sell to markets	
For school projects	
For animal feed	
All of the above	
Other specify….	

If No

4.3 What could be the cause?

Reasons	X
Lack education on how to growing legumes	
Have never considered it	
Growing Season restraints	
Not sufficient land	
No market	
All of the above	
Other specify…………………..	

4.4 Interviewer Ask: What crops, if any, did the household harvest in the past year? (Tick the relevant name and record estimated kg measure box for each crop harvested.)

	Was it for home consumption?	Was it for selling?	Amount (kg)
01= Maize Grain			
02= Maize Fresh			
03= Sorghum			
04= Wheat			
05= Potato			
06= Orchard Fruit			
07= Bananas			
08= Grapes			
09= Dry Beans			
10= Pumpkin/Squash			
11= Green Vegetables (Specify)			
12=Millet			
13=Other Tubers			
14=Peanuts/Nuts			
15=Tomato			
16=Onion			
17=Sugar/Cane			
18=Other Vegetables			
19=Pasture Crops (Lucerne)			

20=Commercial Flowers			
21="Imifino", "Morogo" berries, mushrooms			
22=Other:			

5. AGRICULTURAL PRACTICES

5.1 What do you use for land preparation?

………………………………………………………………………

5.2 Do you own cattle that you can use as draft power for tillage operations?

………………………………………………………………………

If no, what do you use for land tillage operations? Eg hire ox-drawn implements

………………………………………………………………………

5.3 What are the effects of this on your farm production?

………………………………………………………………………

5.4 What guides your decision making about climate?

………………………………………………………………………

5.5 What guides your decision making about crop management?

………………………………………………………………………

5.6 Which indigenous technologies would you pass on the next generation for effective plant growth….. Specify

Technology 1	
Technology 2	
Technology 3	
Technology 4	
Technology 5	

6. COMPUTER MODELS

6.1 Are you familiar with any prediction models (eg. Apsim)?

Yes......................
No........................

If Yes

6.2 Which models?

....

6.3 Have you used it?
Yes......................
No........................

6.4 From whom/where have you heard about these models?

....

6.5 Where/How did you learn about it?

....

6.6 Do you think the model in is good at yield prediction?
Yes......................
No........................

6.7 Do you apply any models in your decision making?
Yes......................
No........................

6.8 Would you use a model for crop yield predictions if it were provided and explained to you?
Yes......................
No........................

If not please give reasons.
6.9 Any other comments:

7. MARKET ANALYSIS
7.1 Do you have a strong market for your crops?

Yes	No

If no indicate the reason

Too much competition	
Poor marketing	
Poor access to the market	
Lack of transportation	
All of the above	
None of the above	

7.2 Do you want to grow your market?

Yes	No

If no, state the reason

Not enough human resource	
Not well physically	
Time consuming	
All of the above	
None of the above	

ANNEXURE L

POST EVALUATION OF LEGUME PRODUCTION EXPERIMENTAL GROUP PLANTING PROGRESS

This survey provide information on the agricultural intervention of the project and necessary challenges encountered and yield.

Subject code number: ________________________ Interviewer: ____________________

Please classify your plot size

Plot Size	Yes
0- 50 sqm	
51-100 sqm	
101- 200sqm	
201-500 sqm	
501- 1000sqm	
>1001 sqm	
None	

1.2 Which of the following legumes did you plant? Indicate by a tick

	Tr-1		Tr-2	
Bean varieties	Yes	No	Yes	No
Chick pea				
Butter bean				
Red kidney				
Cow pea				
Green mung				
Jugo bean				
None				

1.3 What was the cause of not planting all these legumes?

1. Limited space	
2. Challenges with germination for some bean	
3. Did not plant during the right planting season	
4. Challenges with co-orp members/me wanting to grow other items	
5. Only grew legumes I liked	
6. Theft of seeds	

1.4 Have you planted these legumes before?

YES	NO

1.5 Which beans grew best in your production? Indicate

Legume varieties:	Yes	No
Chick pea		
Butter bean		
Red kidney		
Cow pea		
Green mong		
Jugo bean		

1.6 Would you continue to grow these legumes in future?

YES	NO

1.7 Which major challenges did you encounter when growing legumes?

Growing beans on scheduled time for the project	Trail 1	Trial 2
Limited water facility		
Soil infertility		
Forgetting training information		
Limited land area to grow		
Theft of seed		
Dry season		
Pest infestation: control		
All of the above		

1.8 Did you benefit from the bean production training?

YES	NO

1.9 Were you aware of the following topics covered in the training before this training?

Yes No

Legume germination and transplanting method		
Legume spacing		
Water proofing application		
Conservation agriculture		
Intercropping beans with maize		

1.10 Did you view the trial bean plot at Marian hill hub for continuous learning?

YES	NO

1.11 Did you benefit from the nutrition training?

YES	NO

1.12 Are you able to prepare beans in variety of ways now?

YES	NO

1.13 Have you harvested any beans from your garden?

YES	NO

SECTION 2

2.1 Harvested weight per legume type

0. Nothing 1= 500g 2 =1kg 3= 2kg. 4= 3kg 5=4kg. 6=5kg 7=6kg 8 =7kg 9= 8kg 10= 9kg 10=> 10kg

Harvested Bean varieties per plot	Seed input	Harvested Yield	Seed input	Harvested Yield
Chick pea				
Butter bean				
Red kidney				
Cow pea				
Green mong				
Jugo bean				

2.2 What did you do with harvested legumes?

1. Used for consumption	
2. Used to sell	
3. Used as seed for the next season	
4. Distributed to others	
5. All of the above	
6.Animal feed	
7.Never used the harvest	

2.3 Have you planted the legumes 6> months after the project was completed?

YES	NO

2.4 Would you continue to grow these legume varieties if you no longer have access to seeds from the project?

YES	NO

ANNEXURE M

DEVELOPED AND SENSORY EVALUATED RECIPES BY THE RESEARCHER

RECIPE 1

SPREADS: Can be eaten with bread, steamed bread

100g bean any variety

2ml crushed garlic

5ml ground cumin

15ml salad oil/ 15 mayonnaise

5ml lemon juice

60ml water, optional

In a food processor process all the ingredients in to form a paste. Add salt and pepper to taste

RECIPE 2

Mixed bean spread

250g bean varieties

10ml crushed garlic

15ml ground cumin

45ml salad oil/ 15 mayonnaise

15ml lemon juice

60ml water, optional

In a food processor process all the ingredients in to form a paste. Add salt and pepper to taste

RECIPE 3

Izindlubu (Jugo) & peanut spread

100g izindlubu/ jugo bean

2ml (2tsp) crushed garlic, optional

5ml ground cumin

15ml salad oil/

50g peanuts
5ml lemon juice
In a food processor process all the ingredients in to form a paste. Add salt and pepper to taste

RECIPE 4

BEAN BREYANI

100g cooked 5 bean varieties
20ml salt
50g fresh maize,
3 cups of rice
1 onion, finely chopped
½ green pepper
60ml oil
5ml curry powder
50g brown lentils cooked, optional

Method:

1. Soak all beans over-night and boil each until tender
2. Gently fry onions until slightly cooked and add curry powder and green peeper cook until browned
3. Add all the beans and allow to cook for a few minutes and herbs
4. Add in the rice and lentils in the mixture and serve

RECIPE 5

SPICY BEAN SOUP

1 onion, finely chopped
10ml garlic, crushed
10ml garum masala
10ml curry powder
1 carrot, chopped
100g white broad bean, cooked
100g red kidney bean, cooked
100g cow pea, cooked
3L vegetable stock
2, chopped red chillies, optional

Method

1. In a pot gently fry the onions and garlic and curry powder
2. Add carrot and stock gently cook with 2 minutes
3. Add the beans and cook until tender add chilli

RECIPE 6

BEAN STEW

300g beans, soaked over night

5ml salt

30ml oil

1 onion finely chopped

5ml curry powder

5ml danhia powder

2ml turmeric powder

2 cloves crushed garlic

5ml tomato paste

100ml chicken stock

Parsley

Method:

1. Cook beans until soft and ready
2. Pour oil in a pot and gently cook onions and crushed garlic
3. Once browned add tomato paste and beans and chicken stock cook until well combined 10-15 minutes
4. Add parsley and serve with rice, phuthu, or steamed bread

RECIPE 7

BEAN AND PASTA SALAD

250g (2 cups) of pasta shells

300g cups of broad bean

125ml mayonnaise

100g cooked spinach

In a salad bowl combine all these things together.

ANNEXURE N NUTRITION EDUCATION GUIDE

ANNEXURE O

LANGUAGE EDITOR 1

ANNEXURE OO

LANGUAGE EDITOR 2