Impact of Crop Productivity and Market Participation on Rural Households' Food and Nutrition Security Status: The Case of Mpumalanga and Limpopo provinces, South Africa

By

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ABSTRACT

The agricultural sector has proven to be the backbone of improving rural households' food security and livelihoods in developing countries. However, the sector faces numerous challenges, such as insufficient access to technology, institutional difficulties, inappropriate policies, poor infrastructure, and unsuccessful links to the markets, making it difficult for smallholder farmers to participate in the formal market sector. Smallholder farmers in South Africa are still trapped in low-productivity traditional technologies that have a negative impact on output and livelihoods. Low agricultural productivity and lack of market access threaten the efforts of alleviating poverty and improving food security. The study's main objective is to analyse the impact of crop productivity and market participation on rural households' food and nutrition. The specific objectives were to assess the determinants and intensity of market participation among smallholder farmers; estimate the impact of market participation on the food and nutrition security status of the smallholder farmers; analyse the factors affecting crop productivity among smallholder farmers, and evaluate the effect of crop productivity on household food and nutrition security status in the study area. The study used secondary data, which was collected from a total of 1520 respondents who were selected through stratified random sampling. The study focused on two provinces (Mpumalanga and Limpopo) in South Africa, based on the predominance of smallholder farmers.

While assessing the determinants and intensity of market participation among smallholder farmers, the results of the DH estimation model show that the gender of the household head, family member working on the farm, wealth index, and agricultural assistance, age of household head and family member with HIV were statistically significant factors influencing market participation. The result from the second hurdle showed that the perceived intensity of market participation was influenced by marital status, educational level of the household head, wealth index, access to agricultural assistance, household size, household age, and family member with HIV. The study also analysed the effect of market participation on the food security of smallholder farmers. The household food insecurity access scale (HFIAS) results revealed that out of the total sample size, 85% of the households were food insecure while 15% were food secure. The gender of the household head, receiving social grants, wealth index, and having a family member with HIV significantly influenced farmers' market participation. The results of the extended ordered probit regression model showed that household size, having a family member with HIV, agricultural assistance, educational level of household head, ownership of livestock, age of household head, gender of household head, and having access

to social grants variables were statistically influencing the food insecurity situation of smallholder farmers.

The Household Dietary Diversity Score (HDDS) showed that in the overall sampled population, 57% of smallholder farmers had the highest dietary diversity, followed by medium dietary diversity (25%), and the lowest dietary diversity was 18%. The t-test results showed that farmers who participated in the market enjoyed higher HDDS than those who did not participate in the market. The Food Consumption Score (FCS) showed that in the overall population, the acceptable FCS was 54%, followed by a borderline food consumption score of 30%, and the poor food consumption score was the least at 16%. The gender of the household head, receiving social grants, and the wealth index significantly influenced farmers' market participation. The results from Poisson endogenous treatment effect model showed that the nutrition status of smallholder farmers was statistically influenced by agricultural assistance, access to market information, household size, ownership of livestock, access to social grants, wealth index, and involvement in crop production variables. The result from the ordered logistic regression model showed that household size had a negative and significant impact on the food consumption score of smallholder farmers. Gender of household head, irrigation type, social grant, and amount harvested had a positive and significant effect on the food consumption score of smallholder farmers. The results from the Tobit regression model showed crop productivity of smallholder farmers was significantly influenced by the gender of the household head, irrigation system, a family member with HIV, involvement in crop production, access to agricultural assistance, and wealth index of smallholder farmers variables. Lastly, the study determined the impact of crop productivity on household food and nutrition security status in the study areas. The results from the CMP model showed that ownership of livestock, harvest, disability in the family, household size, and gender statistically influenced the food (in)security of smallholder farmers. The results also showed that social grants, agricultural assistance, harvest, and household size significantly impacted the nutrition status of smallholder farmers.

The results from this study support the findings of many previous studies conducted in developing countries and show that more intervention is still needed. It is recommended that government, researchers, policy makers, and other stakeholders work together to close the existing gaps between research, policies, programmes, and extension services directed to smallholder farmers. This will help to improve crop productivity and market participation of smallholder farmers, which will, in turn, enhance their food and nutrition security.

DECLARATION 1

I, Simphiwe Innocentia Hlatshwayo, declare that:

i. The research reported in this dissertation, except where otherwise indicated, is my own original research.

ii. This dissertation has not been submitted for any degree or examination at any other university.

iii. This dissertation does not contain other person's data, pictures, graphs, or other information unless specifically acknowledged as being sourced from those people.

iv. This dissertation does not contain other authors' writing unless specifically acknowledged as being sourced out from them. Where other written sources have been quoted, then:

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As the candidate's co-supervisor, I, Prof Albert Modi, agree to submission of this dissertation for examination.

Co-Supervisor 'signature:..... Date: ……

Prof Albert T Modi

As the candidate's co-supervisor, I, Prof Tafadzwanashe Mabhaudhi, agree to submission of this dissertation for examination.

Co-Supervisor 'signature:..... Date: ……

Prof Tafadzwanashe Mabhaudhi

DECLARATION 2: PUBLICATIONS

The following publications form part of the research presented in this study.

Publication 1 – Chapter 4.

Hlatshwayo, S.I., Ngidi, M., Ojo, T., Modi, A.T., Mabhaudhi, T. and Slotow, R., 2021. A typology of the level of market participation among smallholder farmers in South Africa: Limpopo and Mpumalanga Provinces. *Sustainability*, *13*(14), p.7699.

Publication 2 – Chapter 5.

Hlatshwayo, S.I., Ngidi, M., Ojo, T., Modi, A.T., Mabhaudhi, T. and Slotow, R, 2022. The effect of market participation on food security of the rural smallholder farmers in Limpopo and Mpumalanga provinces, South Africa. *Agriculture 2022, 12(7),*1072.

Publication 3 – Chapter 6.

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DEDICATIONS

This piece of work is dedicated to my late parents, especially to my late mom, who was the one who encouraged me to further my studies up to this level. Her exact words" *Mntwanam ngicela uqhubeke nokufunda ngifuna ukukbona usugqoke ijazi elibovu*''. With this piece of work, I can happily say I did fulfill my mom's dream. May her precious soul continue to rest in peace.

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ACRONYMS AND ABBREVIATIONS

APAP	Agricultural Policy Action Plan
ATT	Average treatment effect on the treated
CASP	Comprehensive Agricultural Support Programme
CMP	Conditional Mixed Process
DAFF	Department of Agriculture, Forestry and Fisheries
DALRRD	Department of Agriculture, Land Reform and Rural Development
DHM	Double-hurdle Model
FAO	Food and Agriculture Organisation
FPL	Food Poverty Line
GDP	Gross Domestic Product
HDDS	Household Dietary Diversity Score
HFIAS	Household Food Insecurity Access Score
HFPS	Household Food Production Strategy
HIV	Human Immunodeficiency Virus
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IMR	Inverse Mills Ratio
NDA	National Development Agency
NHSN	National Home Sharing and Short Break Network
NPFNS	National Policy on Food and Nutrition Security
NUS	Neglected and Underutilized Species
OLS	Ordinary Least Squares
PRM	Poisson Regression Model
SAVAC	South African Vulnerability Assessment Committee
SPSS	Statistical Software for Social Sciences
Stat SA	Statistics South Africa
UNDP	United Nations Development Programme
ZIP	Zero-Inflated Poisson

CHAPTER ONE

GENERAL INTRODUCTION

1.1. Background

Food security is an economic and social right protected in the South African constitution, and it is an essential aspect of livelihoods and socioeconomic development in rural and urban areas (Weinberg, 2014). South Africa is believed to be a food-secure nation that produces enough staple foods and can import food if required to meet the basic nutritional requirements of its population (Food and Agriculture Organization (FAO), 2011). However, South Africa is experiencing a rapidly increasing rate of household food insecurity at the household level. Approximately 40-50% of South Africans live in poverty, and 10.9 % (6.8 million) of the total population is experiencing undernutrition and hunger (FAO, 2018), the majority being children, women, and the elderly. Subsistence agriculture and market access can effectively reduce rural poverty and food insecurity, creating employment and human welfare (Kamara *et al*., 2019). Sibhatu and Qaim (2017) reported that subsistence farming accounts for 40% of the total rural household income. Focusing on factors that will enhance smallholder agriculture will bring about a lasting solution to the problems of rural poverty and food insecurity, and there is a need to rethink policies and institutions that support food security initiatives (Juma, 2015).

Food security is a broad term that can be defined in numerous ways by different organisations worldwide. The basic definition of food security is that it refers to the ability of individuals to obtain sufficient food on a day-to-day basis (Masipa, 2017). The United Nation's definition of food security states that "everyone must always have adequate access to food to be healthy and thus be actively involved in a sustainable livelihood (FAO, 2011). Many factors contribute to food insecurity at the household level, which includes: macroeconomic imbalances, poverty, increased population, gender discrimination, poor health, and illiteracy (Akinboade, 2018). Food security in rural areas of South African households largely depends on cash incomes, rural agriculture, and government grants, which are not adequate to address all the needs of a healthy and sustainable livelihood. Rural households have a deprived socio-economic status, making them vulnerable to food insecurity as they cannot compete in the formal open market due to low purchasing power (Buheji *et al*., 2020). On the other hand, nutritional security is defined as "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" (United State Department of Agriculture, 2016). A well-organized marketing system can provide better prices to farmers and improve the availability of competitively priced produce to consumers (Pavithra *et al*., 2018). Improving existing markets and developing a new market in rural areas can help overcome marketing problems faced (Pavithra *et al*., 2018).

Smallholder farmers are facing challenges in participating in the modern economy because they do not produce enough for them to sell and also, and they have limited access to formal markets (Von Loeper *et al*., 2016). Most smallholder farmers live in remote rural areas with poor roads, poor infrastructure, a lack of knowledge about marketing among farmers, and an inadequate quantity of products to attract sufficient buyers (Abdu-Raheem and Worth, 2011). They are still trapped in low-productivity traditional technologies that have a negative impact on output and livelihoods (Obi and Seleka, 2011; Calzadilla *et al.*, 2014). FAO (2008) reported that other reasons for farmers not participating in complex marketing may include risk aversion, fear of cost, and business structures poorly organised to meet market standards. All the challenges stated make smallholder farmers rely more on traditional social networks and mechanisms for marketing their produce. McGuire and Sperling (2016) stated that most smallholder farmers still use barter, traditional labour payment, or gifts to obtain or exchange crops. In addition, smallholder farmers mainly produce for consumption, and also, they produce more staple crops for survival, not for health. It is believed that improvement of crop productivity can ensure the direct availability of a variety of food items for household consumption, subsequently improving diet quality and nutrition. Also, increased crop productivity can lead to more market participation where smallholder farmers can sell a diverse range of commodities, leading to increased and stable incomes that households can use to buy diverse food items in times of price volatility, thereby minimizing market risks.

It is, therefore, important to understand the crop and marketing systems, challenges, and conditions that smallholder farmers live in and operate to develop strategies and technologies that are tailor-made for farmers and aimed at improving farmers' food and nutrition security status.

1.2. Statement of Research Problem

Improvement of subsistence farming can increase agricultural production, which will have an implication for farm income. Enhanced farm income can increase purchasing power and improve food access and livelihoods (Kassie *et al*., 2017). An understanding of rural

households' production, consumption, food security, marketability, and profitability can be accomplished through proper and purposeful research (Mashamaite, 2014). Smallholder farmers operate in a dynamic environment that affects them through different socio-economic conditions. Smallholder farmers have given so much attention to improving their crop productivity; however, they are operating on small land sizes, lack technologies, and have poor managerial skills. This affects their level of crop productivity and market participation, thus affecting their food and nutrition security status. The low levels of crop productivity make them less diversify their production and produce mainly for consumption and unable to sell in the market.

Rural households face numerous challenges that force them to go for cheap and easily accessible foods. They buy and grow crops that are mainly for their survival. Healthy and nutritious foods are expensive to them. Most rural households are involved in agriculture which is supposed to contribute to their food security; however, they are situated in areas associated with insufficient development and poor service delivery and provision (Khapayi and Celliers, 2016). They are faced with inadequate basic infrastructure, poor roads, shortage of electricity and water, inaccessibility to markets, lack of credit, inadequate education and health facilities, and high unemployment (Khapayi and Celliers, 2016). Rural households are economically marginalized, which always results in food insecurity, where they cannot purchase food while it is available. Lack of market information to farmers results in post-harvest losses since farmers produce more without the information on targeted customers. They incur more losses on perishable crops such as vegetables since they do not have proper storage facilities to store their produce for a long time. The option is to sell in local communities at lower prices and receive less income, greater home consumption, crop losses, and poor food security due to limited access to quality nutritious food (Godfray *et al*., 2018).

The agricultural programs and policies have failed to achieve food security in rural areas despite the massive investment by the government. The agricultural policies persistently marginalized subsistence farming which made their access to resources such as credit, land, and technology to be reduced (Khan, 2001). These policies are perceived to have rules, norms, and standards which are impossible for subsistence farming as they will bring additional costs. In addition, the policy makers develop policies based on data collected at a national level, not at a household level, and their implementation is not monitored. Commercial farmers benefit more from government policies since they have resources, information, and a market. This implies that subsistence farming is not perceived to contribute significantly to food security.

In this study, the selected provinces (Mpumalanga and Limpopo) are mainly dominated by rural households involved in agricultural activities. However, these provinces are experiencing high poverty levels, food insecurity, and malnutrition. Previous empirical studies have considered determinants of market participation and intensity (Sebatta *et al.*, 2014; Singh-Peterson and Iranacolaivalu, 2018; Ojulu, 2020). determinants of crop productivity (Mango *et al*., 2017; Mekuriaw *et al.*, 2018; Myeni *et al.*, 2019), food security (Walsh and van Rooyen, 2015; Baiyegunhi *et al*., 2016; Sinyolo and Mudhara, 2018). Few studies have been conducted on the impact of market participation and crop production on food and nutrition security status, except for Rangoato and Oluwatayo (2018). While Rangoato and Oluwatayo (2018) conducted a study on market access and productivity of smallholder maize farmers in South Africa, their study focused on one crop. Therefore, this study aims to investigate whether market participation and crop productivity for different types of crops produced by smallholder farmers have improved household food and nutrition security status among smallholder farmers.

1.3. Rationale/ significance of the study

Improvement of crop productivity among smallholder farmers can enable them to produce more and participate in the market. Thus, their opportunity to make an income mainly depends on their ability to compete in the market. However, they face many challenges that make it difficult for them to participate in the market. Market access and improved crop productivity are the strategies that could address food insecurity and malnutrition in rural areas, yet they are still low. Understanding how to market participation and crop productivity can improve the food security and nutrition status of rural households is fundamental. There is a need to engage with smallholder farmers, give them the attention they need, and understand their production system, marketing system, perception of food security and how to improve it, and how the challenges they face can be addressed. Therefore, the study identifies factors influencing crop productivity and market participation and also the impact crop productivity and market participation have on household food and nutrition security status.

This study's findings and recommendations provided knowledge to agricultural policymakers for the amendments and formulation of agricultural policies and interventions to improve market participation in the smallholder farming sector. The study findings contribute significantly to the global and national efforts to increase agricultural production and address food insecurity by improving farmers' market participation and increasing crop productivity

which will, in turn, improve their livelihoods and food security. The study's findings can also help achieve the outcomes of the national Food and Nutrition Security policy and some of the Sustainable Development Goals, such as eradicating poverty and zero hunger.

1.4. Aims and objectives

It was hypothesized that rural households' production of diverse crops and market accessibility could improve household food security and nutritional status. It is crucial to ascertain how subsistence production systems work so that new ways and strategies can be developed to help farmers produce crops sustainable and economically feasible crops. Therefore, the study aims to assess whether crop productivity and market exposure can improve household food security and nutritional status in selected communities of Limpopo and Mpumalanga, South Africa.

The specific objectives were to:

- assess the intensity and determinants of market participation among smallholder farmers;
- estimate the impact of market participation on the food and nutrition security status of the smallholder farmers;
- analyse the factors affecting crop productivity among smallholder farmers; and
- determine the impact of crop productivity on household food and nutrition security status in the selected areas

1.5. Research questions

- What are the factors that influence smallholder farmers to participate in the market?
- Does market participation have an impact on household food and nutrition security status?
- What are the factors that influence smallholder farmers' crop productivity? and
- Does crop productivity have an impact on household food and nutrition security status?

1.6. Definition of terms

Market participation- different studies define market participation in several ways. Market participation refers to sales as a fraction of total output for the sum of all household agricultural crop production, including locally processed and industrial crops, fruits, and agro-forest (Rios *et al*., 2009). Mmbando (2014) defined market participation by using household expenditure and agricultural produce sold, whereby the volume of agricultural products sold determines

market participation. Musara *et al*. (2018) stated that market participation refers to commercialization, which means that when smallholder farmers participate in the market, they move from subsistence farming to commercial farming, exchanging products and services.

Crop productivity- is the quantitative measure of crop yield in a given measured field area. Crop productivity can also be defined as the ability of farmers to allocate the inputs they have to produce economic outputs efficiently. The use of improved new crop varieties and the efficient application of agrochemicals significantly contribute to increased crop productivity.

Smallholder farmers-The term smallholder farmer has many definitions depending on a particular country, the context, and the ecological zone (Pienaar and Traub, 2015). The word 'smallholder' is usually used interchangeably with terms such as 'resource-poor,' 'small-scale,' and 'peasant farmer' in some instances. Smallholder farmers can be defined as those who do not have enough resources to produce their crops and rear livestock and possess small areas of land (less than 2ha). These farmers are mainly involved in subsistence farming, producing more for consumption and selling the surplus to their local communities. Similarly, in South Africa, smallholder usually means the total number of individuals or farmers participating in this kind of agriculture (Pienaar and Traub, 2015).

Nutritional status- Nutritional status has been defined as an individual's health condition as the intake and utilization of nutrients influences it. It is also the body's condition due to the influence of disease-related factors (Hu *et al*., 2011).

Food security- The United Nations Food and Agriculture Organization (FAO) currently uses the following definition: Food security occurs when all individuals have physical, financial, and social access to adequate, secure, and nutritious food that serves their nutritional requirements and food preferences. South Africa adopted the FAO definition of food security.

Food insecurity- food insecurity is the opposite of food security, described as a situation where households have limited or uncertain ability to access adequate quality food due to poor economic and social conditions (Dowler and O'Connor, 2012).

1.7. Outline of the thesis

This study has got nine chapters, including this introductory study. Chapter 2 provided the literature review of the study. It provided theoretical and empirical evidence on the impact of market participation and crop productivity on households' food and nutrition security status. Chapter 3 briefly provided information on the methods and materials that were used during the

collection of data. The remaining chapters consist of four studies, each answering specific objectives concerning the impact of market participation and crop productivity on households' food and nutrition security status. The last chapter presented the conclusions and policy implications of the research findings and associated recommendations for further research. The following stipulates the integral aspect of the study.

CHAPTER FOUR: ***A Typology of the Level of Market Participation among Smallholder Farmers in South Africa: The Case of Limpopo and Mpumalanga Provinces***

A double-hurdle model was used to analyse factors influencing smallholder farmers' decisions regarding participation in the agricultural market.

CHAPTER FIVE: ***Impact of market participation on food security of the smallholder farmers in Limpopo and Mpumalanga provinces, South Africa*****.**

In estimating the impact of market participation on the food security of smallholder farmers, the Household Food Insecurity Access Scale (HFIAS) and extended ordered probit regression model was used.

CHAPTER SIX: ***Impact of market participation on the nutrition security status of the smallholder farmers in Limpopo and Mpumalanga provinces, South Africa*****.**

The Household Dietary Diversity Score (HDDS) and Poisson endogenous treatment effect model were employed to estimate the impact of market participation on nutrition security status.

CHAPTER SEVEN: ***Factors affecting crop productivity among smallholder farmers in South Africa: The Case of Limpopo and Mpumalanga Province***

The Tobit regression model was employed to analyse factors that affect crop productivity among smallholder farmers.

CHAPTER EIGHT: ***The impact of crop productivity on households' food and nutrition security status in Limpopo and Mpumalanga provinces, South Africa.***

The Household Dietary Diversity Score (HDDS), Household Food Insecurity Access Scale (HFIAS), and Conditional Mixed Process (CMP) model were used to quantify the effect of crop productivity on the food and nutrition security status of smallholder farmers in Limpopo and Mpumalanga provinces, South Africa.

CHAPTER NINE: ***Conclusions and Recommendations*****:** Finally, the study presented conclusions and policy implications for the study.

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CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

A review of the literature on the theory and the empirics relating to the impact of crop productivity and market participation on household food and nutrition security status is presented in this section. An overview of smallholder agricultural crop production and marketing, a description of smallholder farmers, and smallholder agricultural constraints are also presented in this section. The state and concepts of food security in South Africa and the contribution of smallholder agriculture to food security are also presented. This chapter also includes determinants of market participation and its impact on household food and nutrition security status. Determinants of crop productivity and its effect on household food and nutrition security status are also presented in this chapter. The chapter concludes with a review of the analytical techniques of the study and conceptual framework.

2.2. Description of smallholder farmers

The definition of a smallholder farmer varies by authors across countries and agro-ecological zones (Dixon *et al*., 2001; Mudhara, 2010). Even though Chamberlin (2008) noticed a commonality among various authors' definitions as being associated with low income, lack of land, poor infrastructure, low input technologies, resource-poorness, poor access to land and capital, and lack of market orientation and risk exposure. As varied as smallholder farming is, Oettle *et al.* (1998) noted that it mainly occurred among black rural residents that produce on small unsustainable plots of land. In line with this, Ngemntu (2010) stated that in the South African context, the term smallholder refers to the total number of black rural households involved in agricultural activities on a small scale. Moreover, Tittonell *et al.* (2010) related smallholder farmers with limited resource endowments compared to other farmers in the agricultural sector. All these definitions bring about a racial distinction within the agricultural sector, particularly in the South African context, although democratization is pursued.

The word smallholder is usually used interchangeably with words such as peasant farmers, emerging farmers, small-scale farmers, resource-poor farmers, subsistence farmers, and emerging farmers (Ntshangase, 2014; Mdlalose, 2016). Smallholder farmers, especially in developing countries like South Africa, are presented with various unfavourable production factors. According to Pienaar and Traub (2015), they can be identified with low agricultural yields, substantial seasonal labour changes, outdated techniques, limited access to credit, and

insufficient support services. These factors prevent smallholder farmers from accessing the market and make it challenging to gain purchasing power and stability in their production sector. Cousin (2013) also alluded that most smallholder farmers mainly produce for their own consumption and sell the surplus there afterward. This is because they have an insufficient resource base, affecting their effort to provide an adequate livelihood.

Smallholder farmers are characterised by small plots of land, producing subsistence crops with one or more cash crops that entirely depend on household labour (Pienaar and Traub, 2015). Chamberlin (2008) regarded smallholder farmers as those with less than two hectares of land and a low resource base. Similarly, Lahiff (2000); Rapsomanikis (2015) reported that smallholder farmers have landholdings ranging from 0.5 – 1.5 hectares, which also falls below the two-hectare bar, with only a few farming on holdings larger than 5 hectares. This affects their productivity and willingness to participate in the market, thus resulting in producing mainly for consumption, not for selling.

Family labour is also another main characteristic of smallholder farming. Rapsomanikis (2015) stated that smallholder farmers rarely outsourced labour for production activities; they mainly rely on household/family labour. This was confirmed by Cousins (2010), who reported that smallholder farmers generally rely on family labour during the production cycle, particularly during the cultivation and harvesting phases. Lowder *et al*. (2014) added that the maintenance of a household's agricultural activities is either done by the owner or their family instead of hired labour. This means that the labour cost is eliminated as family members invest more time and energy in production. Contrary to this, Walsh and van Rooyen (2015) noted that although family members supply most farm labour, hired labour is also used. Hired labour is often seasonal, depending on the demand for activities in that specific production season.

2.3. Overview of smallholder agricultural crop production and marketing in South Africa

2.3.1. Smallholder crop production

Smallholder agriculture is characterised by animal and crop production (Shackleton *et al.*, 2001; Gautam and Andersen, 2016; Makate *et al*., 2016). It is a highly diversified agricultural practice where smallholder farmers produce crops and raise animals for their families. Hove and Gweme (2018) reported that it is characterised by outdated technology and the use of traditional/ indigenous knowledge in almost all agronomic practices. This is because most smallholder farmers are old and uneducated and are reluctant to use sophisticated modern

technology. Almekinders (2000); McGuire and Sperling (2016) then classified the production of traditional seeds and crops by smallholder farmers as an informal production system.

The informal production system is categorized by the use of self-saved seeds of native crops, informal crop markets, and informal storage and maintenance of the indigenous knowledge base (Gill *et al.*, 2016). Gill *et al*. (2016) outlined that an informal production system involves managing, improving, planting, harvesting, and storing crops using smallholder farmers' knowledge, experiences, and skills. There is less use of fertilizers, genetically modified crops, and mechanization. Unlike formal production systems, informal production system generally excludes governmental, institutional, or private control of seed and crop activities. Smallholder farmers, primarily women–dominated, produce diverse crops, which are often more diverse than commercial farmers (Sibhatu *et al*., 2015). They produce more stable crops but diversify their production to attain improved diets. The various crops include staple maize, beans, sweet potatoes, potatoes, and vegetables such as cabbage, carrot, beetroot, spinach, and onion (Sibhatu *et al*., 2015). Some smallholder farmers also have native fruit trees of apples, peaches, pears, and avocados.

As diverse as smallholder farming is, the sector is susceptible to inconsistent weather patterns and climate change, making it depend more on drought-tolerant crops. Ncube (2018) reported that it primarily depends on dryland farming subjected to uneven rainfall patterns. Most smallholder farmers do not have access to proper irrigation systems. The drought-tolerant crops include staple crops such as maize, beans, potatoes, and indigenous crops. This brings attention to the fact that smallholder farmers are recognised as significant sources of indigenous crops, also known as Neglected and Underutilized Species (NUS). Indigenous crops are well known for being drought and heat-stress-tolerant, requiring fewer inputs for growth and adaptation to semi-arid and arid conditions (Mabhaudhi *et al.,* 2017). They are also a primary food and nutrition security source for many rural households and can potentially contribute to sustainable food systems under climate change. Another reason smallholder farmers do not broadly diversify their crop production or produce fewer vegetables is the issue of storage facilities. Obetta and Daniel (2007) found that in most developing countries, smallholder farmers are faced with many challenges that make them choose storage facilities that are cheap and easy to construct, irrespective of their inadequacy in maintaining the quality of seeds and crops. The challenges influencing farmers' choice of storage methods include unavailability of the materials, cost, and lack of skills in building the proper storage facilities. Mboya (2011) found that Tanzania's most used storage facilities were roofs, sacks, and buckets. This storage

affected the quality of crops since they were affected by pests and insects. Therefore, smallholder farmers look at the nature and life span of the crops before they grow them. Vegetables are easily perishable and have less shelf life span, making it difficult for farmers to grow them, resulting in more losses and costs.

2.3.2. Smallholder crop marketing

Smallholder farmers mainly produce for household consumption (Tshuma, 2014). This was confirmed by many studies conducted in rural areas (Jari and Fraser, 2009; Cousins, 2010; Sibhatu *et al*., 2015). These studies reported that most smallholder farmers' foods are produced in bulk for consumption than selling. This is because of the high population density they face in rural areas of developing countries. However, some smallholder farmers sell the surplus to get income. Rapsomanikis (2015) reported that even though smallholder farmers are not fully involved in formal markets, they use their diverse crops to stabilize revenue and manage unforeseen circumstances during shocks and distress. In line with this, Soukand *et al.* (2020) stated that smallholder farmers are highly dependent on informal markets to sell their produce because of the inadequate linkages with formal markets.

Formal marketing involves the proper movement of crops through different value chains of actors, including merchants, distributors, agro-dealers, and end-users (Shepherd, 2007). In contrast, informal marketing involves selling or exchanging what they produce on the farm to other farmers, neighbours, or the local community. Smallholder farmers' integration into the formal market is often hindered by the sophisticated systems involved in gaining market entry (Sikwela, 2013). Barriers to market entry are associated with physical, socio-economic, and institutional limitations associated with poor infrastructure (roads), access to transport, and meeting quality standards in terms of international trade (Baiphethi and Jacobs, 2009). Christian *et al*. (2019) mentioned that smallholder farmers are affected by poor market access and information, inadequate technological access, inappropriate policies, and a lack of extension services. Wiggins and Keats (2013) also reported that smallholder farmers lack the skills, information, and knowledge in marketing to compete in the formal market. Mwesigye (2006) added that they lack financial capital for investments and do not have sufficient strength to benefit from opportunities in national and international market chains. Moreover, FAO (2008) reported that smallholder farmers operate in small heterogeneous groups that are difficult to organize, formally register or license, and produce a low volume of crops, affecting their market participation incentives.

Most smallholder farmers live in remote areas, making it difficult to access the output and input markets. This means that smallholder farmers' crop markets will remain marginalized and function poorly and very locally. Nekhavhambe (2017) reported that smallholder farmers face high transaction costs in participating in the market. Entering the market requires start-up costs. The sales in the formal markets occur in different channels that need administration and transportation costs. Khapayi and Celliers (2016) stated that smallholder farmers lack managerial and logistics skills that are important in maintaining supply and meeting food safety and quality requirements. FAO (2008) reported that other reasons for farmers not participating in complex marketing may include risk aversion, fear of cost, and business structures poorly organised to meet market standards.

With all the challenges affecting smallholder farmers, they depend on traditional social networks and mechanisms for marketing their produce. Most smallholder farmers use barter, traditional labour payment, or gifts to exchange or obtain seeds and crops (Almekinders, 2000; McGuire and Sperling, 2016). Most crop exchange occurs within the community, between members of the same social class and ethnic group. Most smallholder farmers end up being price takers and do not have much power to influence market decisions. They sell their crops at a lower price to avoid losses due to perishability and rotting.

An understanding of smallholder farmers' crop production and marketing systems can allow the development of technologies and strategies that are in farmers' production capabilities and suit their cultural values and beliefs. The fact that the government neglects informal crop and marketing systems, researchers, and policymakers has led to more inequalities, poverty, food insecurity, and a high employment rate in rural households. Therefore, these stakeholders must recognize the importance of smallholder subsistence farming and protect and conserve the traditional knowledge linked to it for future generations (Padulosi *et al.*, 2013).

2.4. Smallholder agricultural constraints

The constraints that affect smallholder farmers are not different from the characteristics and description of their crop and marketing systems. These constraints affect production, harvesting, and storage until the produce reaches the end-user. They were identified a long time ago by many researchers', particularly in rural areas, but they still affect farmers and do not get any better. Adegbite and Machethe (2020) noted that smallholder agricultural growth is retarded by the lack of aspiration, farming resources, knowledge about farming and marketing improvements, and inadequate incentives to drive such developments. The main factor that

accelerates these constraints is that smallholder farmers are situated in remote areas with limited access to basic facilities. The conditions common to all smallholder farmers include poor infrastructure, poor access to land, poor transportation, lack of market information, storage facilities, and extension services (Mabuza *et al*., 2013). These constraints worsen food insecurity, poverty, and unemployment in rural areas.

Baloyi (2010) classified constraints that affect smallholder farmers as internal, external, and socio-demographic factors. The internal constraints are the ones that mainly affect the production, harvesting, and storage of smallholder farmers' crops. These constraints include poor farming and management practices, poor irrigation systems and storage devices, lack of land, water, and soil management, and inefficient use of fertilizers and improved inputs. Mpandeli and Maponya (2014) stated that the small lands that smallholder farmer operates on worsen all the constraints since they result in poor management of farm practices, which contribute to poor performance and low yields. These led to poor crop production and increased food insecurity among smallholder farmers.

The external constraints are complex since farmers cannot control them; they emerge from an outside agricultural perspective. These constraints include poor infrastructure, limited access to credit facilities, natural disasters, lack of access to agricultural extension, high transaction costs, and inadequate legislation and policies. These constraints are likely to affect the marketing side of the smallholder farmers and create barriers to their agricultural opportunities. The socio-demographic constraints include lack of education, gender inequalities, cultural beliefs, and age. These factors mainly affect smallholder farmers at the personal level. Smallholder farming in developing countries like South Africa is primarily dominated by illiterate and aged farmers who are responsible for the livelihood of rural households. These farmers mostly rely on their indigenous knowledge to manage their farms (Brown, 2012; Myeni *et al.*, 2019). Kolawole *et al*. (2014) stated that indigenous knowledge is unreliable and results in poor managerial capabilities. Gender inequality is still a burning issue in rural areas since it is associated with cultural beliefs. According to Kapungu (2013), men and women are not given equal rights in land, resources, and production duties. Kapungu (2013) attests to this. The study reported that women face numerous cultural customs that hinder them from accessing better production and financial services, making them more involved in subsistence farming. The unequal distribution of resources always favours men and results in more poverty, food insecurity, health conditions, and disease in women and children.

2.5. The state and concepts of food security in South Africa

2.5.1. Concepts of food security

Food security is a broad term defined in different ways by different scholars and organizations worldwide. The United Nations Food and Agriculture Organization (FAO) definition is primarily used, and South Africa adopted it. FAO (2006) defined food security as all people's ability to access food that is always required for a healthy life. FAO (2008) stated that "food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." Additionally, World Bank (2009) defined food security as the ability of households to have consistent access to quality foods that are in sufficient quantities for all the household members. The opposite of food security is food insecurity, which is defined as a situation that exists when households lack access to resources that help them to acquire food through production or purchasing, inadequate utilization of resources at the household level, which in turn results in negative healthy living and well-being of households (Hendriks, 2016). Turyahabwe *et al*. (2013) added that food insecurity denotes a situation whereby families cannot meet their daily nutritional food requirements. Food insecurity is the main result of poverty and healthy diseases that affect households.

The ability of households to access sufficient food is measured using four pillars, known as food availability, food access, food utilization, and food stability (FAO, 2008). This means that a household is considered food secure when all the pillars of food security are met. If not, the household is considered food insecure, increasing the chances of a household suffering from hunger and malnutrition. Food availability is where adequate quantities of food are available for all individuals' consumption. The food can be available at a national level through domestic food production, domestic food stocks, commercial food imports, and food aid (FAO, 2006). At the household level, especially in rural areas, food availability is more associated with the household crop, livestock production, and purchasing power. Rural households have the issue of affordability, food can be available, but they do not have the means to access it. This is because rural areas are dominated by low-income households (FAO, 2017). Food accessibility refers to the ability of households to acquire food, which is achieved when families have enough resources to obtain food (World Food Programme, 2009). The International Fund for Agricultural Development (IFAD) and FAO (2013) indicated that resource endowments like income, labour, and land determine a household's ability to access food. This means that

households with sufficient land and income can afford and produce adequate food and overcome hunger. This is different with rural households since they live in conditions that are not favourable for them to access food easily. Chijioke *et al*. (2011) reported that rural households face higher prices, insufficient land to produce, floods and droughts, poor access to the market, and poor infrastructure, which affect their access to good quality foods.

In the food utilisation pillar, it is assumed that nutritious food is available and accessible; therefore, it refers to converting food to nutritional benefits in the human body to consistently keep an active and healthy lifestyle (FAO, 2006). Pinstrup-Andersen (2009) referred to food utilisation as the ability of households to attain sufficient nutritional intake for a certain period. The diverse food utilisation is less in rural areas since most of the rural households barely consume nutritious food; they consume more starch, affecting their dietary diversity. Herforth *et al.* (2020) reported that rural households consume more starch for survival, not health. On the other hand, food stability is the continuous balance between availability, access, and utilization to ensure an active, healthy lifestyle (FAO, 2006). It refers to the availability of food for the household over time. At the household level, it is achieved when unforeseen shocks such as death, drought, or floods do not impede food availability and access for the household (Jemal and Callo-Concha, 2017). Therefore, all four interconnected pillars need to be present for households to be considered food secure. The weakening of one pillar endangers food security as a whole, which can be at national, household, or individual levels.

2.5.2. The state of food security in South Africa

South Africa is considered a food-secure country as it can produce enough food for its consumption and provide a surplus for exporting (FAO, 2017). It also can import some of the food required to meet a balanced diet. Food security at a national level is measured using indicators such as trade balance, food production, Gross Domestic Product (GDP), and per capita income (FAO, 2002). However, food security at the national level does not guarantee food security at the household level. At the household level, food security is measured by households' ability to access nutritious food. Many South African households cannot access adequate food, making them food insecure. Stat SA (2017) reported that in 2017, almost 20% of South African households had severely inadequate food access. At the same time, in 2017,

approximately 6.8 million South Africans experienced hunger (Stat SA, 2017). Integral food security Phase Classification (2021) reported that about 9.34 million households (16% of the population) in South Africa were faced with high levels of severe food security in 2020. These statistics show that food insecurity is still a significant challenge for many households and individuals.

Food insecurity in South Africa is due to the unequal distribution of food and per capita income to everyone in the country (Altman *et al.,* 2009; Musemwa *et al*., 2015). This was attested by FAO (2015), which reported that the country could have enough food for its entire population; however, the unequal distribution results in some households having less than the required daily meals, which leaves them more susceptible to food insecurity. Several authors (FAO, 2006; Hendriks, 2013; Ngema *et al*., 2018) have reported that smallholder farmers in South Africa are the most susceptible to food insecurity. Irrespective of the fact that smallholder farmers can grow food for a living, they lack the necessary resources that will help them continuously meet their dietary needs, be it through production or purchase.

Smallholder farmers are faced with many challenges that threaten their food security. These challenges include climate change, international trade regimes, unstable household food production, population growth, high unemployment, poor storage facilities, diseases, and poverty (Mvelase, 2017). Van Wyk and Dlamini (2018) stated that constraints such as increasing fuel and oil prices, climate change, and global economic activities have an impact on increasing food prices. The persistent rise in food prices causes a severe problem for unprivileged rural households since they are net buyers of most of the food. Stat SA (2017) also mentioned that most rural households are constrained by the inability to secure employment or to generate income, fewer income-earners and many dependents characterize them and also, and they are more vulnerable to economic shocks. All these unfavourable conditions have affected rural households' mental, physical and financial health, which accelerated severe food insecurity, poverty, and diseases.

Government policies and programs have been developed to intervene in the food security of households; however, these programmes do not serve the purpose they intend to, which is why the number of people who are food insecure keeps increasing. These policies and programs include Rural Development Programme, Household Food Production Strategy (HFPS) (2011), Comprehensive Agricultural Support Programme (CASP), National Policy on Food and Nutrition Security (NPFNS) (2013), and Agricultural Policy Action Plan (APAP) (2015).

Improvement of these interventions can help to improve household food security as smallholder farmers will be able to produce enough and participate in the market. Hunger, malnutrition, poverty, and food insecurity can be eliminated as more investments are made in smallholder agriculture.

2.6. The importance of smallholder agriculture and its contribution to food security

The agricultural sector is the main contributor to the livelihoods and economies of many households in developing countries like South Africa (Mwadalu and Mwangi, 2013). Approximately 70% of the rural households in South Africa depend on agriculture and are involved in smallholder subsistence farming (National Treasury, 2019). Many studies have reported that agriculture has proven to be the backbone of the enhancement of livelihoods and food security of rural households in the country (Salami and Brixiova, 2010; Carreón *et al*., 2011; FAO, 2017). FAO (2017) reported that smallholder agriculture provides around 70% of employment and serves as a tool to generate income for many rural households. Salami and Brixiova (2010) also added that smallholder agriculture plays a significant role in job creation, economic growth, and poverty alleviation. Almost 43.7% of the rural households in South Africa practice agriculture as the primary source of food, whereas 37.5% list agriculture as a source of extra food (FAO, 2015). Therefore, the importance of agriculture to rural livelihoods and food security in the country cannot be underestimated.

Smallholder farmers can produce diverse crops, which are required to meet a balanced diet and also helps to enhance dietary diversity. Musemwa *et al.* (2015) stated that rural households in South Africa obtained their food through purchasing in the markets; however, the food was mainly supplemented by various household food production. Moreover, smallholder farmers use their diverse crops to make income by selling surplus and buying other foodstuffs they cannot produce. Baiphethi and Jacobs (2009) indicated that many smallholder farmers regarded smallholder agriculture as a main or extra source of income. This shows that smallholder agriculture has great potential to address food insecurity, poverty, and malnutrition despite the fact it is still faced with continuous challenges. Therefore, the intervention in increasing smallholder farmers' productivity and marketing is essential to ensure long-term food security.

2.7. Factors affecting market participation by smallholder farmers in developing countries

Marketing is a formalized system that can be directed from seed producer to farmer or via a chain of actors, including distributors, merchants, and agro-dealers until the end user(Shepherd,

2007). Marketing aims to identify, anticipate and satisfy customers' needs and achieve suppliers' objectives (Kiyoshi *et al*., 2012). To smallholder farmers, marketing means selling or exchanging what they produce on the farm with other farmers, neighbours, or the local community. To a retailer, marketing means promoting goods and services to their consumers. Markets play an essential role in production as they act as a mechanism for exchange. Market participation by smallholder farmers is vital as it results in the coordination and efficient use of resources, goods, and services (Alene *et al.,* 2008). It allows smallholder farmers to derive benefits such as income and accessible opportunities for rural employment (Alene *et al.,* 2008). In addition, the involvement of farmers in the market sector can expose rural households to other market activities such as transportation, processing, and selling, which can employ those unwilling to participate in the farming sector (Singh-Peterson and Iranacolaivalu, 2018). In developing countries such as South Africa, market participation can promote sustainable agriculture and economic growth and lessen poverty and inequality. Unfortunately, smallholder farmers face difficulties in accessing markets, as a result, markets fail to effectively perform their duty, which is to provide profits and income to smallholder farmers.

Several determinants of smallholder farmers' market participation can be categorized as institutional, technical, and socio-demographic factors. It is essential to this paper to identify the constraints that smallholder farmers are faced within market participation. The institutional factors include transaction costs, contractual arrangements, inappropriate policies, and market information flows. Many studies conducted in rural economies of developing countries confirmed that smallholder farmers lack adequate market information and contractual arrangements which allow them to participate in the market formally *(Sebatta et al*., 2014; Alene *et al.,* 2008; Omiti *et al.,* 2009; Minot and Sawyer, 2016). These factors result in high transaction costs and may cause farmers to either stop participating in the market or participate in informal markets (Makhura, 2002; Minot and Sawyer, 2016). Jari and Fraser (2009) revealed that market information, expertise on grades and standards, contractual agreements, social capital, market infrastructure, group participation, and tradition significantly influenced household marketing behaviour in the Eastern Cape Province in South Africa. Many farmers did not participate in the market because they lack market information, expertise on grade and standards and contractual agreements. This was substantiated by , who found that smallholder farmers in Uganda failed to access the market information due to remoteness and lack of access to market arrangements which affected their decision to enter the potato market to sell. The study also found that few farmers were visited by extension officers who provided information

on market availability and new and improved varieties that enhanced the farmer's knowledge and provided a range and choice of market opportunities. This indicates the level of inequality in service deliveries among farmers in rural areas.

Technical factors are those factors that allow input and output to be accessible on the market at lower costs and allow diversification of markets. These factors are typically influenced by organization, regulations, and improvements in technology (Alene *et al.,* 2008). The factors include market transportation facilities, road infrastructure, household asset holdings, telecommunication networks, storage facilities, and access to extension services. In South Africa, many smallholder farmers live in remote areas with limited services, such as poor road infrastructure, storage, and transportation facilities. Communication links and they have limited capacity to add value to their produce (Osmani and Hossain 2015) conducted a study on factors affecting market participation by smallholder farmers in rural and peri-urban areas. The results showed that peri-urban farmers sold higher proportions of their output than those in rural areas. This was because of the distance from the farm to the market, poor market information, and roads experienced by farmers in the rural areas, which affected their sales. These findings were supported by Zamasiya *et al.* (2014), who found that ownership of radios, television, and cell phones improved access to market information and positively affected the household's decision to participate in the soybean market in Zimbabwe.

Household asset holdings can help to alleviate any production and market shocks that smallholder farmers experience. Assets such as land, livestock, human capital, and farm implements are crucial for marketable surplus production at a smallholder level (Jayne *et al.*, 2010). In South Asia and Sub-Saharan Africa, almost 60% of rural households own less than 1 ha of farmland, and approximately 80% of rural households have less than 2 ha of cropland (Lowder *et al.,* 2016). Farmers owning small farms may be unable to raise the necessary surplus to sell at the market (Achandi and Mujawamariya, 2016). South Africa is faced with an increasing population which causes a decline in per capita farm sizes, especially in rural areas. This influences their ability to feed themselves and their families and sell the surplus in the market. Smallholder farmers with more land can produce more crops, and they can be able to expand their production to ensure sustainable supply to the market. Osmani and Hossain (2015) found that smallholder farmers with adequate land, household labour, and farm income had a moderate level of market participation and 57% sales in their produced crops. It can be said that holding farm assets can enable smallholder farmers to exercise economies of scale by adopting modern technologies (Marenya and Barrett, 2007).

The socio-demographic factors that affect smallholder farmers' participation in the markets can include household head age, marital status, household size, source of labour, education, and gender. Farming in rural areas is mainly dominated by women involved in subsistence agriculture. Rural women are an essential resource in developing countries' agriculture and the rural economy (Hunt and Samman, 2016). They often manage multifaceted households, provide an agricultural labour force and pursue multiple livelihood strategies. However, female farmers grow subsistence crops mainly for household consumption, and cash crops meant to provide income are grown primarily by male farmers (Hill and Vigneri, 2014). Sebatta *et al.* (2014) showed that females were less likely to participate in the process of selling potatoes in Uganda. Related to that, Hill and Vigneri (2014) found that in Uganda, female farmers sold coffee in the same market as male farmers; however, females significantly got lower prices for the same coffee.

Furthermore, Kyaw *et al*. (2018) conducted a study on farmers' participation in the rice markets in the central dry zone of Myanmar; the results revealed that 77% of the market participants were male, while 23% were female. On the contrary, Zamasiya *et al*.(2014) found that in Zimbabwe, male-headed households were less likely than female-headed households to participate in soybean markets. The study concluded that legumes are believed to be women's crops in developing countries. These indicate that even in farming, there is still gender inequality, and the role of female farmers is underrated.

In South Africa, most smallholder farmers are old and uneducated; they rely more on their traditions, which makes them reluctant to adopt modern technologies that will improve their participation in the market (Randela *et al.*, 2008). Participation in the market declines with age as older farmers are more susceptible to risk aversion and conservative attitudes (Bahta and Bauer, 2012; Musah, 2013). It can be said that education can empower a farmer to make informed decisions and be able to identify market opportunities. Sebatta *et al*. (2014); Adeoti *et al*. (2014) found that in Uganda and Nigeria, farmers' educational status showed a positive relationship with market participants in their studies. Marital status affects farmers' market participation differently; Egbetokun and Omonona (2012) identified marital status as a major factor influencing market participation and reported a positive and significant impact in Nigeria. Contrarily, Adeoye and Adegbite (2018) stated a significant but negative effect of marital status on involvement in markets. Nwafor (2020) found that in Nigeria, 80% of married farmers participated in the market, and 20% did not participate. All the results obtained in the

different studies show that more training and workshops need to be conducted in rural areas to increase farmers' market participation, taking into consideration the constraints they face.

All the abovementioned constraints result in high transaction costs, which prevent farmers from getting meaningful benefits from their trading activities, thus discouraging farmers from marketing activities. Smallholder farmers operate under informal production systems and depend on traditional social networks and mechanisms for marketing their produce. Most smallholder farmers use barter, traditional labour payment, or gifts to exchange or obtain seeds and crops (Almekinders, 2000). Most of their produce exchange occurs within the community, between members of the same social class and ethnic group. Most smallholder farmers are price-takers and do not have much power to influence market decisions. Monyo and Bänziger (2004) stated that more than 90% of farmers' necessities are met through these informal channels. There is an urgent need to strengthen market information delivery systems, upgrade roads, encourage market integration initiatives, and establish more retail outlets with improved market facilities in remote rural areas to promote production and trade in high-value commodities by rural farmers. Therefore, analysis of the factors affecting smallholder farmers' market participation will help design appropriate policy instruments, institutions, and other interventions for their sustainable economic development. It can be concluded that more research is needed to provide evidence-based information for policy and government interventions.

2.8. Effect of market participation on food and nutrition security of the rural smallholder farmers

Market participation by smallholder farmers can increase production and productivity and thus contribute to household income, leading to improved food security outcomes. Smallholder farmers gain economies of scale and use technology efficiently to improve productivity when they enter the market. In addition, they gain purchasing power as they earn more income and buy other food items they cannot produce (Mulenga *et al*., 2021). Several studies (Hernandez *et al*., 2007; Rao *et al*., 2012; Maertens *et al*., 2012; Asfaw *et al.*, 2012; Michelson, 2013; Muriithi and Matz, 2014; Andersson *et al.*, 2015) discussed the role of the market participation on-farm productivity and household income. Their findings show that participating in markets can allow farmers to improve farm productivity and enhance household earnings.

Hernandez *et al*. (2007) studied Guatemala's supermarkets, wholesalers, and tomato growers. It was found that smallholder farmers who participated in the supermarket channels were better

than those who participated in traditional market channels. Smallholder farmers who traded with supermarkets had more capital and produced higher yields, and made more profit in the supermarkets. This was supported by the findings of Rao *et al*. (2012), which indicated that the participation of farmers in supermarket channels increased farm productivity and positively impacted technical efficiency and scale efficiency in Kenya. In addition, Andersson *et al*. (2015) also reported that vegetable producers who participated in the market channels received more income in Kenya than those who did not. Market participation also plays a vital role in the welfare of smallholder farmers. Muriithi and Matz (2014) assessed the welfare effect of vegetable commercialization on smallholder producers in Kenya; the study found a positive correlation between vegetable commercialization and household welfare. The study also found that the commercialization of vegetables through the export market was consistently associated with increased income. Moreover, Maertens *et al*. (2012) also reported that export supply chains could bring positive welfare effects through product-or labor-market effects and indirect and direct effects.

Michelson (2013) found that smallholder farmers that participated in the supermarket supply chains had improved household welfare and increased household productive asset holdings. Bellemare (2012) analyzed the effects of contract farming on household welfare proxied by household income by using cross-sectional data and addressing the self-selection issues with an instrumental variable approach. The author found that the contract stimulates household income and reduces the vulnerability of household earnings. In addition, Asfaw *et al*. (2012) evaluated the impact of adopting improved legume technologies on rural welfare measured by consumption expenditure in rural Ethiopia and Tanzania. The study found that assuming enhanced agricultural technologies significantly impacted consumption expenditure in rural Ethiopia and Tanzania. The study also added the potential role of technology adoption in improving rural household welfare. Higher consumption expenditure from improved technologies could lead to lower poverty, improved food security, and a more remarkable ability to withstand risk. Having said all the benefits that market participation has on household income, welfare, and productivity, not all smallholders have an opportunity to participate in the market, and not all of them enjoy the gains in the market. Andersson *et al*. (2015) revealed that many smallholder farmers dropped out of the supermarket channel due to many constraints. Some smallholder farmers participating in market channels have high input use, especially chemicals, so the high input expenditures affect their profit rates, and the income gains cannot be sustained (Hernandez *et al*., 2007; Andersson *et al*.,2015). These are some of

the reasons why most smallholder farmers prefer or end up relying on traditional market channels, which affect their food and nutrition security. Few empirical studies, especially in South Africa, evaluate the impacts of agricultural market participation on household food and nutrition security in developing countries, especially in South Africa.

Seng (2016) conducted a study to assess the effect of market participation on farm households' food security in rural Cambodia in terms of household dietary diversity score. The study found that households who participated in the market enjoyed higher household dietary diversity scores and had improved households' food security than those who did not participate. Additionally, Mulenga *et al.* (2021) found that market participation in Zambia enhanced household dietary diversity and nutrition of rural households. The study also reported that market participation improves household production diversity, leading to improved food security. Moreover, Manda *et al.* (2020) found that selling cowpea to rural and urban traders in Nigeria significantly increased household food expenditure, income, and food security. Their results also showed that selling cowpea to rural and urban traders increased household income by 17% and 13%, respectively. Ogutu *et al.* (2020) assessed the impact of commercialization on household food security and dietary quality, with a particular focus on calorie and micronutrient consumption in Kenya. The studies found that commercialization significantly improved food security and dietary quality regarding calorie, zinc, and iron consumption. The studies also reported that commercialization contributed to higher incomes and added nutrients from purchased foods.

The literature has shown that market participation has a considerable role in improving household income, productivity, and food and nutrition security in rural households. The different studies have shown that if all smallholder farmers can participate in the market, most of the constraints they face can be eradicated. Enhancing market access is essential for rural economic growth and making smallholder agriculture more nutrition-sensitive.

2.9. Factors affecting crop productivity and their impact on households' food and nutrition security

Despite past efforts made by extension services, government institutions, and agricultural researchers, crop production in South African smallholder farms remains lower than the potential for the land (Blignaut *et al*., 2015; Department of Agriculture, 2012; Mutero *et al*., 2016). The low yields that smallholder farmers experience is caused by prolonged droughts, limited water and nutrient availability, degraded soils, and unproductive farming practices (Moeletsi and Walker, 2013; Moswetsi *et al*.,2017). The predicted increase in these factors due

to climate change threatens the sustainable production of crops by smallholder farmers (Turpie and Visser, 2013). Food crop production is the primary source of income generation in rural areas of South Africa; however, it is inadequate to improve the well-being of rural households. Furthermore, the contribution of food crop production to rural livelihoods is hindered by the high cost of production (Gautam and Andersen, 2016). This has resulted in low input, poor soil fertility, and low mechanization, leading to low agricultural output (Sheahan and Barrett, 2017; Asfaw *et al*., 2018). Smallholder farmers can increase their agricultural and crop productivity using sustainable agricultural practices, crop diversification, and mixed farming practices while conserving natural resources. Schroth and Ruf (2013); Mulwa *et al*. (2017) reported that farmers could improve their crop productivity by diversifying their agricultural production system to sustain food security, reduce susceptibility to poverty and increase their incomes. Even so, farmers' crop productivity is affected by numerous challenges and differs within smallholder farmers, areas, and resources that smallholder farmers possess. Several factors determine the crop productivity of smallholder farmers, which can be categorised as external, internal, and socio-demographic factors.

Internal factors affecting smallholder farmers' crop productivity include soil, fertilizers, inputs, irrigation system, agricultural practices, and land. The land is one of the most critical factors that affect agricultural production. Regardless of the need to improve the use of mechanization and the subsequent decline of agricultural output, the problem of food production and the question of limitations in the availability of cultivable or arable land remains crucial (FAO, 2015). South African smallholder agriculture is mainly dominated by resource-limited farmers, mostly farm in small homeland areas. The farmers own approximately 13% of the total arable land, while commercial farmers own 87 % (Aliber and Hart, 2009; Mudhara, 2010; Von Loeper *et al*., 2016; High-level panel, 2017). Myeni *et al*. (2019) found that about 38% of smallholder farmers owned between 0.51 and 0.1 ha of farmland, followed by 36% of farmers with farm sizes between 0.25 and 0.51 ha, and only 3% had farmland more significant than 3% per household. These results were substantiated by many previous studies, which reported that most South African smallholder farmers possess less than 2 hectares of land (Mpandeli and Maponya, 2014; Mutero *et al*., 2016; Von Leoper *et al.*, 2016). The small communal land that smallholder farmers occupy limits them from adopting feasible agricultural practices, which need financial investments and the use of improved inputs, resulting in uncertainties. Ownership of small land also led to poor crop productivity and increased food insecurity among smallholder farmers. On the other hand, Hall *et al*. (2009) stated that farmers with large farm

sizes are most likely to invest and adopt an appropriate agricultural practice that enables them to obtain high yields and sell the surplus in the market. In addition, ownership of large land can serve as collateral which will allow farmers to acquire loans and invest in their farms

Smallholder farmers can have access to land, but if they are not aware of appropriate agricultural practices, technology, improved inputs, and irrigation schemes to use, they may not utilise the land, and they will leave some of it idle. Myeni *et al*. (2019) studied barriers affecting the sustainable agricultural productivity of smallholder farmers in the Eastern Free State of South Africa. The study found that adopting sustainable agricultural practices was influenced by knowledge of different sustainable practices, farm equipment owned, and access to land, credit, and extension services. The study also found that awareness of sustainable agricultural practices positively influenced the adoption of traditional and new sustainable agricultural practices. This was supported by Giller *et al*. (2011); Mutyasira *et al*. (2018), who reported farming is a knowledge-intensive industry, and most farmers get their information needs from a wide range of channels which helps them to choose relevant agricultural practices. However, the Department of Agriculture (2012) states that most farmers rely on indigenous knowledge of crop production since it is more precise and simpler to understand, while scientific agricultural practices require formal training and education. This shows that farmers need more training on adopting agricultural practices that cater to the conditions that smallholder farmers live and operate in. This can help to improve food security among smallholder farmers in rural areas.

The irrigation system allows smallholder farmers to water their crops in a controlled way and helps them not depend on unreliable rainfall. The type of irrigation scheme that farmers can choose depends on the type of soil, crop, water source, and budget. Most smallholder farmers do not have access to appropriate irrigation schemes. Some farmers have smallholder irrigation schemes that perform poorly and have not delivered on their development objectives of increasing crop production and improving rural livelihoods (Denison and Manona, 2007). Fanadzo *et al*. (2010) assessed the cropping system and management practices used by smallholder farmers in South Africa; the results showed that water management limited crop productivity. The results also showed that irrigation application and system efficiencies were below the norm; also, the type of irrigation farmers use was not based on the crop type and growth stage. This study was in line with Post *et al.* (2012), who found that farm practices contributed to poor performance and low yields in irrigation systems. On the contrary, Oni *et al.* (2011); Sinyolo *et al.* (2014) found that irrigation systems had a positive role in rural

households' welfare and food security. The contradicting results from smallholder farmers show that farmers have not yet reached the efficient and effective use of irrigation systems, and intervention is still needed.

The external factors affecting smallholder farmers' crop productivity can include access to credit, good infrastructure, and agricultural extension services. The inadequate effect of agricultural extension services in farming systems is not surprising since many previous studies found the same results in past analyses of the productivity of agriculture in developing countries (Aliber and Hall, 2012; Kruger and Gilles, 2014). These studies have reported that the poor performance of extension services is due to many factors, such as poor program design, administrative inefficiency, and weaknesses in information delivery systems. Some extension officers fail to transmit knowledge to farmers. Extension officers use a top-down approach which conveys information as a package comprising recommended practices (Fleischer *et al*. 2002). This is observed as a less effective method for improving the knowledge of smallholder farmers since most of them are uneducated; more participatory approaches must be used to extend knowledge to smallholder farmers (Fleischer *et al*. 2002). Farmers' level of experience and knowledge regarding technologies such as hybrid seed, fertilizer, and pest management strategies is minimal and depends on extension services (Van Den Berg, 2013). Van Den Berg (2013) stated that the adoption of new technologies is affected by socioeconomic factors and the region's lack of efficient extension services. The study suggested that training of extension personnel in basic technologies used in modern farming must be provided to farmers.

Furthermore, the study also suggested addressing the problem of the inefficiency of extension services by adopting an alternative extension paradigm, such as farmer field schools. This approach was also supported by Lewu and Assefa (2010) in Limpopo. Despite the negative impact that extension services so far had on farmers' crop production, fewer studies Sasa (2010); Ackello-Ogutu (2011); *Oni et al*., (2011) found that access to extension services had a positive impact on productivity and income generation. Therefore, addressing the inadequacy of extension services is important as it denies smallholder farmers many opportunities in the agricultural sector. It decreases the crop productivity of smallholder farmers and affects their ability to fight hunger, malnutrition, and food insecurity.

The demographic and socio-economic factors that hinder the agricultural productivity of smallholder farmers include educational level, age, gender, and household size. It is essential

to understand these factors since they affect the agricultural productivity of smallholder farmers at the household level. Many studies in South Africa and other developing countries reported that access to education could positively impact smallholder farmers' adoption of sustainable agricultural practices (Diale, 2011; Muzangwa *et al*., 2017; Marenya *et al*., 2017). Educated farmers usually have better access to information on viable agricultural practices and their use. They are also more likely to adopt and use modern inputs more effectively and efficiently (Diale, 2011). According to Muzangwa *et al.* (2017), education increases the ability of farmers to use their resources efficiently and obtain, analyze and interpret information. The study added that farmers with educational status have better access to agricultural extension services and training. Most South African smallholder farmers have inadequate education (Mudhara, 2010; Lehohla, 2013; Myeni *et al.,* 2019). The low level of literacy that farmers experiences have a direct and indirect impact on their agricultural productivity as new technology adoption and information need a certain level of formal education and training (Kolawole *et al.*, 2014). In addition, most modern technology and sustainable agricultural practices are attainable in complex academic language, which makes it difficult for uneducated farmers to understand and use them (Lehohla, 2013).

Smallholder farming in South Africa is mainly dominated by older people responsible for rural households' livelihood. Myeni *et al.* (2019) conducted a study on the adoption of sustainable agricultural productivity of smallholder farmers in the Limpopo Province of South Africa; the study found that 41% of farmers were between 52–66 years, 26% were above 67 years, and only 8% of farmers were between 20-35 years. These results were supported by Van den Berg (2013), who found that the number of young people involved in farming was deficient, and a large percentage of farmers were women older than 60. This matter needs serious attention as future agricultural productivity will be vulnerable if there is low youth involvement in agriculture. Young people are more educated and more likely to adopt new technologies. However, due to high unemployment, young people emigrate from rural to urban areas in search of better opportunities and lifestyles, leaving farming to older people (Brown, 2012). Previous studies in South Africa have indicated that older farmers mostly rely on their indigenous knowledge to manage their farms (Brown, 2012; Koatla, 2012, Myeni *et al.*, 2019). This has resulted in inadequate managerial capacity and loss of benefits from modern technology as their indigenous knowledge is becoming unreliable due to variability (Kolawole *et al*., 2014). Furthermore, it has also been shown that older farmers tend to be more risk averse, which could affect their decision-making on adopting new technology, which they may see as

high-risk (Van den Berg, 2013). It is, therefore, essential to integrate indigenous knowledge and scientific agricultural management practices as this will improve the agricultural productivity of smallholder farmers.

Women are the predominant working force in crop production over men (Diale, 2011; Hunt and Samman, 2016). They grow subsistence crops mainly for household consumption (Hill and Vigneri, 2011). Female farmers can manage complex households, provide an agricultural labour force and pursue multiple livelihood strategies. Contrary to this, Myeni *et al.* (2019) found that men headed 52% of household farms. The study explained that this was because of the emigration of retired males (>65 years) from urban areas to rural areas. Whande (2010) attested to this; the study explained that retired male usually uses their pension funds as capital for farming to enhance their retirement packages. Furthermore, Cultural ideologies of men being superior to women have resulted in gender inequalities that have left most black women without land and not involved in significant decision-making at the household level (High-level panel, 2017). The effect of household size differs within areas and farmers. Some previous studies found that household size had a positive impact on agricultural productivity since smallholder farming depends on family labour, so an increase in household size will lead to more responsibilities shared on the farm and more economically efficient (Mango *et al*., 2014; Osmani and Hossain, 2015; Kyaw *et al.,* 2018). Adeoye and Adegbite (2018) found the household size to have a positive effect on agricultural productivity; this study explained that an increase in household size causes farmers to produce more for household consumption, leading to labour inefficiency and producing less output for the market.

All these Constraints that affect smallholder agricultural production do not get better; instead, they lead to more poverty, unemployment, and food insecurity in rural areas. The literature showed that there is a lot that is still needed to be done to improve agricultural productivity. It was noticed that the main intervention required is the provision of less sophisticated technology and training of smallholder farmers on modern inputs and sustainable farming practices. It can be concluded that government, researchers, and other stakeholders need to revisit the existing agricultural extension services and policies to ensure that they achieve the intended goals and that they cater to the conditions that smallholder farmers operate and live on. Furthermore, they need to monitor the production of smallholder farmers to trace the improvement.

2.10. Review of analytical techniques of the study

2.10. 1. Household food insecurity access scale (HFIAS)

The Household Food Insecurity Access Scale (HFIAS) was developed to deal with complexities emanating from food insecurity issues (Coates *et al*., 2007; Swindale and Bilinsky, 2007; Bilinsky and Swindale, 2010). The scale entails nine food security-related questions. These questions are grouped into three categories. The first category looks at the anxiety and uncertainty of food supply, while the second category of questions looks at the insufficient food quality (food variety and select items). The last set of questions is about the impact of food deficiencies (inadequate food intake and its physical consequences). HFIAS is a subjective rural appraisal tool that looks at respondents' perceptions of their household food security based on the food consumed in the previous four weeks (Headey and Ecker, 2013). HFIAS has been extensively used by various studies in food security Ndobo *et al*., 2013; Gebreyesus *et al*., 2015; Pandey and Bardsley, 2019; Awodele and Olajide, 2020; Gewa *et al*., 2021; Roy *et al*., 2022).

Ndobo *et al*. (2013) employed HFIAS to determine the extent to which food insecurity prevails in households in South African townships. The results showed that 49% of the households were vulnerable to food insecurity. Food insecurity was more prevalent in female-headed households (63.8%) than in male-headed households (42.9%). To assess the state of food (in) security in rural communities of different ecological zones of the Kaligandaki Basin, Nepal, Pandey, and Bardsley, 2019 used the Household Food Insecurity Access Scale (HFIAS). The results showed poor food availability from subsistence production in the Middle Mountains and Trans-Himalaya. In contrast, most households with sufficient purchasing power could access additional food from the market. Net food security was poor, with the highest level of insecurity in the Middle Mountains, followed by the Trans-Himalaya and the Tarai.

Awodele and Olajide (2020) employed the Household Food Insecurity Access Scale (HFIAS) to measure the extent to which households were food secure in the Patigi Local Government Area of Kwara State, Nigeria. The food security index showed that 77 percent were moderately food secure, and about 66 percent of households skipped meals because of insufficient funds to buy food. The food security status of households worsened with an increase in household size; women aged 35-39 years experienced a high degree of food insecurity. Gewa *et al*. (2021) used the Household Food Insecurity Access Scale (HFIAS) to assess household food insecurity status with mothers as the primary respondents in rural Kenya. The results showed that Poultry-keeping; cereal/grain, any vegetable, and traditional vegetable production; and crop diversity were significantly associated with lower household food insecurity.

Roy *et al*. (2022) examined household food insecurity and dietary diversity of women of reproductive age in the rural areas of northwest Bangladesh. The study used cross-sectional data collected from 252 smallholder households to measure household food insecurity with the Household Food Insecurity Access Scale. The results showed that most families were mildly insecure (51.2%), followed by moderately insecure (27.4%). The households felt the anxiety of food insecurity for more than six months a year (Food Security Index = 2.10 out of 4.00). Education of household heads, household size, access to information sources, access to credit support, and perceived impacts of climate change on crop production was identified as determinants of household food insecurity. The study recommended that appropriate interventions be formulated to improve the food and nutrition security in the study areas.

2.10.2. Household Dietary Diversity Score (HDDS)

The HDDS is usually constructed using data on dietary intake in the previous 24 hours (Swindale and Bilinsky, 2006). The HDDS indicates the variety of food and dietary diversity accessible to a household (Kennedy *et al.,* 2010). In the HDDS assessment, food items are categorized into 12 standard food groups, with each food group counting toward the household score if a food item from the group was consumed by anyone in the household in the previous seven days (Jones *et al.,* 2014). The food groups include cereal, vegetables, meat, roots and tubers, poultry and eggs, fruits, fish and seafood, pulses/legumes/nuts, milk and milk products, oil/fats, sugar/honey, and miscellaneous (which includes spices, sauces, salt, and other condiments).

Jones *et al*. (2014) used a modified Household Dietary Diversity Score (HDDS) to determine the relationship between farm production diversity and household dietary diversity and to identify determinants of this relationship in Malawi. The results showed that the association of increased farm diversity as measured by a combined crop and livestock measure on dietary diversity was significantly greater in women-headed households than those headed by men (HDDS: $P = 0.008$; FCS: $P = 0.076$). The positive association of farm diversity with dietary diversity was also more significant in wealthier households ($P < 0.05$). Consumption of legumes, vegetables, and fruits was strongly associated with greater farm diversity. Mahmudiono *et al*. (2017) employed a Household Dietary Diversity Score to determine the relationship between dietary diversity and child stunting in an Indonesian context. The prevalence of child stunting was 39.4%, and the percentage of households consuming food

groups high in protein and calcium, like dairy products (41%) and meat/poultry (65%), was lower than other food groups. The unadjusted model revealed that higher dietary diversity scores were associated with a lower likelihood of child stunting (OR=0.89; 95% CI=0.80-0.98). This relationship remained significant after adjustment for family size, maternal literacy, food expenditure, breastfeeding, energy, and protein intake (OR=0.89; 95% CI=0.80-0.99).

In the study of Cordero-Ahiman *et al*. (2021), the Household Dietary Diversity Score (HDDS) was used to analyse the dietary diversity among households in the rural area of the Paute River Basin, Azuay Province, Ecuador. The results showed that the average HDDS of food consumption was 10.89 foods. Of the analysed food groups, the most consumed were cereals; roots and tubers; fruits; sugar/honey. In addition, the determinants that best explained the HDDS in the predictive model were housing size, household size, per capita food expenditure, area of cultivated land, level of education, and marital status of the head of household. To determine household dietary diversity during the COVID−19 pandemic in Bangladesh, Kundu *et al.* (2021) applied Household Dietary Diversity Score (HDDS). The results showed that the overall mean score of HDD was 6·22 (S D 5·49). Being a rural resident, having no formal education, having an occupation of household head other than a government job, and having a low monthly income were potential determinants of lower HDD. Approximately 45 % and 61 % of Bangladeshi households did not get the same quantity and same type of food, respectively, as they got before the pandemic. Over 10 % of respondents reported that they lost their job or had to close their businesses, and income reduction was written by over 70 % of household income earners during the COVID-19 pandemic, which was negatively associated with HDD.

2.10.3 Double-hurdle model

The Double-hurdle (DH), Tobit, and Heckman sample models are the most commonly used sample selection models to correct the presence of zeros in observed data (Wodjao,2007). However, many previous studies have chosen the double hurdle model over the Tobit and Heckman sample selectivity models (Wodjao, 2007). Mather *et al*. (2013) stated that the DH model produces estimates superior to the other two sample models when dealing with true zeros. The double-hurdle model, introduced by Cragg (1971), expresses the idea that an individual's decision on the extent of participation in an activity is the result of two processes: the first hurdle, determining whether the individual is zero types, and the second hurdle, determining the extent of participation given. The double-hurdle model has been widely used in several market participation studies such as Mather *et al*. (2013); Mabuza *et al.* (2014);

Ndoro *et al*. (2014); Achandi and Mujawamariya (2016); Sinyolo *et al*. (2017); Anang and Yeboah (2019); Zondi *et al*. (2022).

Mabuza *et al*. (2014) used the double-hurdle model to examine the effects of transaction costs on producers' choice of marketing channels and the number of mushrooms supplied in Swaziland. The results from the double-hurdle model showed that producers' decisions of where to sell their mushrooms are significantly affected by household labour endowment, production capacity, access to cooling facilities and market information, and producers' bargaining position. Meanwhile, the quantities of mushrooms sold are significantly influenced by the difficulty in accessing reliable transport and producers' level of uncertainty in meeting buyers' quality requirements. Ndoro *et al*. (2014) used the double-hurdle model to determine factors within the sustainable livelihood framework (SLF) influencing market participation and supply volume decisions in rural South Africa. The results showed that the low rate of market participation could be explained by the broader aspects of the livelihoods of smallholder cattle farmers, including limited access to financial, social, and natural capital, as well as the difference in livelihood strategies and motivations. Based on these findings, the study extracted the implications for designing livestock extension programs in OLM and South Africa.

In examining the impact of social grant dependency on the incentives of smallholder maize producers to participate in the market in KwaZulu-Natal province, South Africa, Sinyolo *et al.* (2017) employed a double-hurdle model. The study's results showed a negative association between social grant dependency and market participation, suggesting that social grant-dependent households are more subsistent, producing a less marketable surplus. Moreover, homes with access to social grants sold fewer quantities of maize in the market, indicating reduced selling incentives. Anang and Yeboah (2019) employed a double-hurdle model to determine the factors influencing participation in off-farm work and the predictors of actual amounts earned outside the farm in Northern Ghana. The results revealed that gender, farming experience, years of education, and access to credit determine participation in off-farm work. In contrast, farming experience, years of education, and geographical location choose income from off-farm employment. The paper concludes that measures to enhance rural income diversification will spur the rural economy, and these measures should seek to address the problem of low levels of formal education in rural areas.

In the study of Zondi *et al*. (2022), they applied a double-hurdle model to estimate factors that influence the market participation of indigenous crops by smallholder farmers while also

analysing the extent of market participation in South Africa. The study showed that a farmer's decision to participate in the market is highly dependent on gender, off-farm income, access to market information, and a family member being infected by HIV. Factors such as household size and access to the market had statistical significance in the extent of market participation by smallholder farmers. The study recommended the need to intensify appropriate training for farmers and extension workers involved in indigenous crops and the importance of giving indigenous crops necessary considerations by the government and research institutions so that their demand in the market could increase.

2.10.4. Extended ordered probit regression model

The extended ordered probit regression model was proposed by McKelvey and Zavoina (1971, 1975) for the analysis of ordered, categorical, non-quantitative choices, outcomes, and responses. As Greene and Hensher (2010) explain, the model platform is an underlying random utility or latent regression model. It recognizes the indexed nature of various response variables. The extended ordered probit regression model has been applied in several vehicle crash severity studies, such as Kockelman and Kweon (2004), Lamondia *et al*. (2014), and Shen *et al.* (2021). However, this model has rarely been used regarding the impact of market participation on food security.

2.10.5. Poisson endogenous treatment effect model

The Poison endogenous treatment effect model addresses the effect of unobserved variables on an outcome. It is used to address selectivity biases. Danso-Abbeam *et al*. (2021) examined whether rural households in Southwest Nigeria are increasing the extent of climate change adaptation practices through their participation in non-farm employment. The endogenous treatment effect model was used to account for selectivity bias. The results showed that rural non-farm jobs increased smallholder farmers' adaptive capacities and that participants would have used fewer adaptation techniques if they had not participated in non-farm work. Donkoh (2019) employed Poisson regression with endogenous treatment effect to investigate the factors influencing access to agricultural credit and the impact of adopting SAPs in selected SSA countries while accounting for selectivity bias. Based on a sample of 3000 households, the results showed that about 47.5% of the respondents, as against 52.5%, had access to credit. The commonest technologies adopted were intercropping, integrated nutrient management, crop rotation, and soil and water conservation. The estimation results suggested that access to credit,

formal education, and land ownership led to the adoption of SAPs. However, while group membership facilitates access to credit, households headed by relatively old farmers had a lower probability of accessing credit than those led by the young.

Nyaaba *et al*. (2019) used an Endogenous treatment effect model to analyse the factors affecting awareness and willingness to pay for crop insurance in the Tolon District of Ghana. The result indicated that 48% of the respondents were aware of crop insurance. The results showed that the sex of the farmer, extension training, and adoption of good agriculture practices were significant factors affecting awareness of crop insurance. Also, willingness to pay for crop insurance was influenced by household size, years of farming experience, farm size, and respondents' awareness of crop insurance. The study concluded that increasing awareness of crop insurance is an effective way to enhance farmers' willingness to pay. Hence, any intervention to promote crop insurance adoption should target awareness campaigns to increase awareness, especially among male farmers.

2.10.6. Tobit regression model

The Tobit model also called a censored regression model, is designed to estimate linear relationships between variables with lower and upper limits (McDonald and Moffitt, 1980). The Tobit model fits well in the data that considers the qualitative difference between zero and continuous observations (Bukenya, 2017; Oduniyi, 2018). The model was extensively applied by several studies such as (Martey *et al*., 2012; Ele, Omini, and Adinya 2013; Kabiti *et al*. 2016; Rubhara and Mudhara, 2019; Rubhara *et al*. 2020).

Martey *et al*. (2012) employed Tobit regression analysis to quantify the magnitude and direction of factors influencing the intensity of commercialization by farm households in Ghana. The Results indicated a higher annual growth rate of cassava production (16%) compared to maize production (6%). The extents of maize and cassava commercialization were 0.53 and 0.72, respectively, while total agricultural commercialization concerning these two crops was 0.66. The study observed, among other things, that output price, farm size, households with access to extension services, distance to market, and market information determined the extent of commercialization. Kabiti *et al*. (2016) determined factors that affect the smallholder commercialization of farming enterprises in the Munyati resettlement area, Chikomba district in Mashonaland East Province, Zimbabwe. The study used the Tobit model to regress the indices and farmer-specific variables. The paper revealed that the farmers were

fairly commercialized for input and output. In addition, factors that determined input and output commercialization were varied.

In the study of Rubhara and Mudhara (2019), they used the Tobit regression model to determine the commercialization levels of smallholder farmers and the factors affecting their decisions to commercialize, intending to identify strategies for advancing commercialization in the Shamva District of Zimbabwe. Based on the randomly selected sample of 281 farmers, the results showed that the gender of the household head, access to draft power, access to extension, access to markets, access to finance, and several crop variables positively influenced commercialization. Age of household head, number of cattle, off-farm income, and communal landholding was negatively associated with commercialization levels. Rubhara *et al*. (2020) employed the Tobit regression model to analyse the impact of cash crops on household food security in Shamva District, Zimbabwe. Tobit regression results showed that cash crop production ($p < 0.1$), non-farm income ($p < 0.01$), total arable land ($p < 0.05$), and access to draft power ($p < 0.05$) positively influenced household food security. Household size negatively impacted food security ($p < 0.05$). While the results from this study suggested the need to promote cash crop production, it should not be regarded as the panacea for addressing food insecurity.

2.10.7. Conditional mixed model

Makate *et al*. (2016) investigated the impact of crop diversification on two outcomes of climate-smart agriculture; increased productivity (legume and cereal crop productivity) and enhanced resilience (household income, food security, and nutrition) in rural Zimbabwe. Using data from over 500 smallholder farmers, the study used a conditional (recursive) mixed process framework to correct for selectivity bias arising due to the voluntary nature of crop diversification. The results showed that crop diversification depends on land size, farming experience, asset wealth, location, access to agricultural extension services, information on output prices, low transportation costs, and public information access. The results also indicated that an increase in the adoption rate improved crop productivity, income, food security, and nutrition at the household level. Overall, the results showed crop diversification's importance as a viable climate smart agriculture practice that significantly enhances crop productivity and resilience in rural smallholder farming systems. Therefore, the study recommended wider adoption of diversified cropping systems, notably those currently less diversified, for greater adaptation to the ever-changing climate.

Alhassan *et al*. (2020) tested the hypothesis of whether credit impacts productivity and whether productivity, in turn, impacts market participation under a simultaneous modeling framework of credit, productivity, and market participation in Ghana. Using data from the Ghana Living Standards Survey Round 6, the study applied a conditional mixed process estimation technique to correct for selectivity bias and unobserved endogeneity. The study found that credit positively impacts productivity and market participation. Furthermore, other determinants such as roads, public transport, radio and phone, and compliance with extension advice positively influenced productivity, while the availability of markets and multiple cropping in a season increased the decision to sell maize. These findings implied that the transmission mechanism to transform the subsistence nature of Ghanaian agriculture into a sector characterized by commercial agriculture was to enhance access to credit, which in turn would stimulate productivity and improve market engagement.

Melesse *et al*. (2021) examined the determinants of debt financing choices among small-scale manufacturing enterprises in Ethiopia—with a particular focus on the role of government policies. The study used survey data gathered from 1321 enterprises in the Amhara region of Ethiopia. It employed a conditional mixed process (CMP) system estimation technique to test the effect of public policy on firm debt levels. The relevant econometric findings confirmed that policy activism through training and related intervention schemes boosts debt utilization in the start-up finance mix. At the same time, it lowers the probability of firms' falling into higher debt levels over time. The results also showed that enterprises with some debt mix in their start-up capital are more likely to be in higher debt categories than those enterprises that kick-start exclusively with their internal resources. In addition, the findings also revealed that self-reported profitability, firm age, and ownership structure strongly affect the degree of firms' indebtedness. The study was the first to apply conditional mixed process system estimation on firm-level data from Ethiopia to test the effects of government policies on debt-level choices.

2.11. Theoretical framework

The process of developing a theoretical framework is influenced by the availability of theories for a particular study and the study's objectives. The basic principles for a practical, theoretical framework involve usefulness, validity, and a rich dataset to accord small groups representation in the clusters (Pienaar, 2013; Hair *et al.*, 2014; Kajombo *et al*., 2014). Smallholder farmers are characterised by being heterogeneous, and they operate in a dynamic environment.

Therefore, this study adopted the Theory of Access and sustainable livelihood and food security framework.

The theory of access was developed by Ribot and Peluso (2003); it differentiates between one's right to access resources and one's ability to benefit from these. Ribot and Peluso (2003) argue that people may hold the right to access a particular resource but may not necessarily have the ability to use the resource in a productive way to benefit from it due to a lack of structural and relational mechanisms such as technology, capital, knowledge, authority, labour, social relations, market mechanisms, and identity. Ribot and Peluso (2003) analysed access along the two variables of "bundle of rights" and "bundle of powers." In this perspective, "access" must go beyond the classical definition of "the right to benefit from things" and also incorporates "the ability to derive benefits from things" (Ribot and Peluso, 2003). Therefore, according to the theory, bundles of powers operate parallel to rights-based access mechanisms to shape how resource users gain control and maintain benefits (Mutea, 2020). In this study, this theory was chosen because it gives a comprehensive framework for examining the role of market participation and improved crop productivity and their outcome on household food and nutrition security. Smallholder farmers in South Africa have a right to participate in the market and productive resources; however, they do not have the power to gain access, maintain and benefit from the markets and productive resources due to many constraints. These constraints include a lack of market information, poor farming and management practices, poor infrastructure, lack of agricultural extension, and poor access to land. The poor interaction between the right to access the market and productive resources and the ability to benefit from these makes smallholder farmers more vulnerable to food insecurity and malnutrition. Therefore, the study assessed how market participation and crop productivity determinants affect household food and nutrition security.

This study also adopted the sustainable livelihood and food security framework, recognizing that households are decision-makers in a dynamic environment. This framework considers that smallholder farmers use numerous assets to develop livelihood and food security strategies within the vulnerability context (Scoones, 2009). The framework also helps to organize the factors that constrain or enhance food security and livelihood opportunities and shows how they interact (Serrat, 2017). The food security and livelihood strategies that smallholder farmers undertake are poor, diverse, and complex; however, this framework appreciates their significant implications on their livelihood and food security outcomes. The framework state that smallholders analyse constraints and identify opportunities that will help them to improve

food security and livelihood (Bhandari and Grant, 2007). In this study, sustainable livelihood was derived from the ability of smallholder farmers to improve crop productivity and produce more, as well as access the market and sell their produce to make income. Different factors that affect smallholder farmers' food and nutrition security were identified, and their impact on food security was determined. The factors include income, access to extension services, ownership of livestock, high transaction costs, access to market information, access to the irrigation system, distance to the market, and demographics.

2.12. Conceptual and empirical framework

In estimating the specific objectives listed in this dissertation, various research methodologies are used. The main goal of market access and improved crop productivity is to enhance food and nutrition security, resulting in sustainable household livelihoods. It is, therefore, important to understand how market, socio-economic and institutional factors interact to enhance or constrain market participation and crop productivity of smallholder farmers, which in turn affect household food and nutrition security. The conceptual framework provided in this study shows that smallholder farmers are affected by many factors, which can be grouped into three categories (market, socioeconomic and institutional factors). It was conceptualized that socioeconomic and institutional factors impact market participation and crop productivity, while market factors mainly affect market participation. These factors' positive influence on smallholder farmers leads to improved crop productivity (more crops produced), which then leads to high market participation. High market participation resulted in increased income, leading to improved food security, dietary diversity, and sustainable livelihoods. Figure 2.1 illustrates the interrelationship among the critical variables in the study.

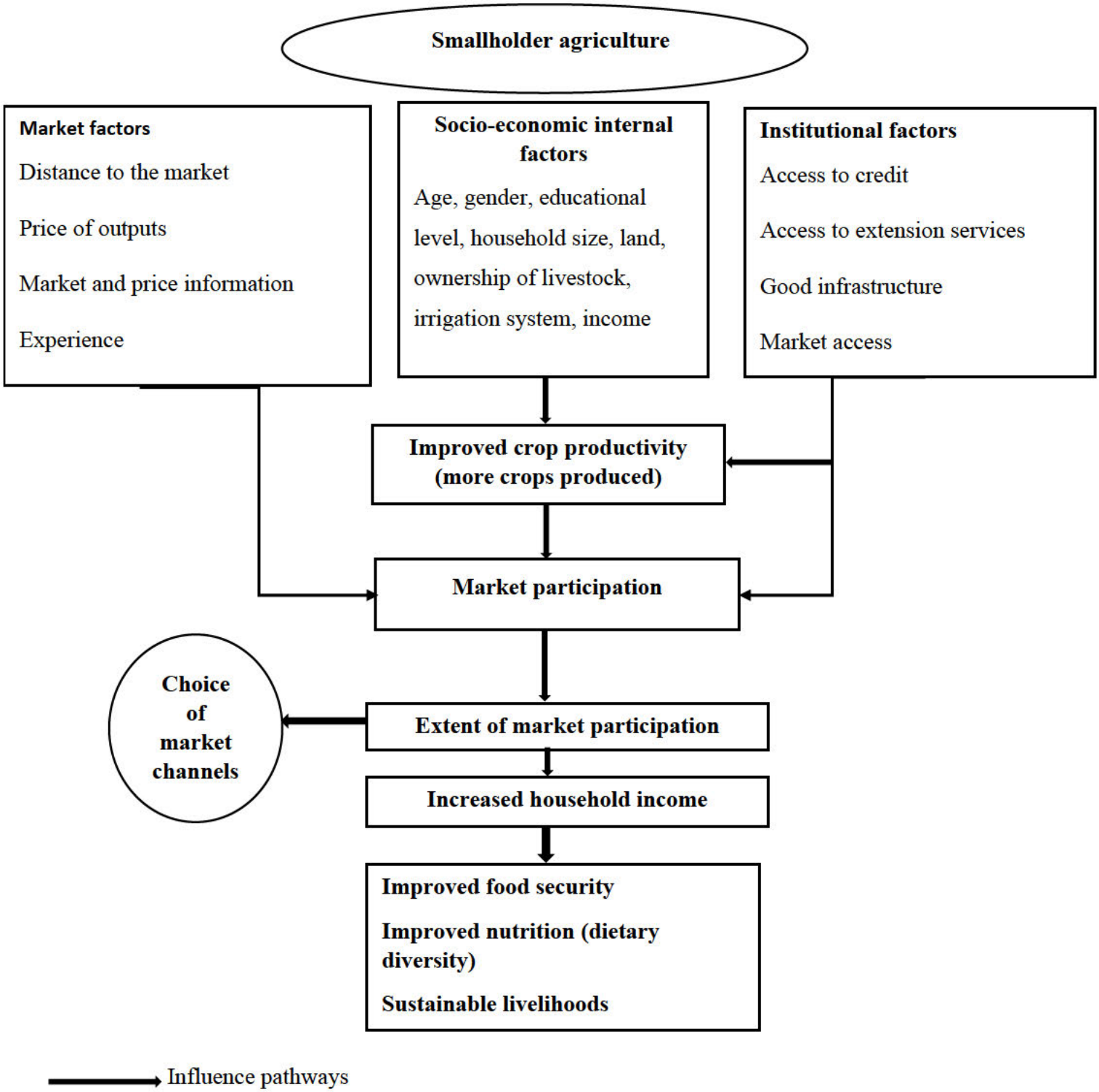

Figure 2.1: Diagrammatic representation of the conceptual framework

Source: Adapted from Otekunrin *et al*. (2019)

To meet the first specific objective of the dissertation, the double-hurdle (DH) model was employed to analyze the determinants of the level of market participation among smallholder

farmers in South Africa. The double-hurdle model initially proposed by Cragg (1971) assumes that smallholder farmers' decision to participate in the market can be modeled as a two-step decision process. Smallholder farmers decide whether to participate in the market and determine the volume of crops to be marketed. Therefore, market participation is observed to have two independent scenarios, the first scenario being the unobservable decision of a farmer to participate in the market (first hurdle) and the second being the observed extent (intensity) in which smallholder farmers' market in the participation (second hurdle). This implies that not all sampled farmers can participate in the market, and choosing only farmers who participate in the market can lead to sample selection bias. Therefore, the double hurdle was employed to correct the possibility of bias due to sample selection.

The variables in the first equation (first hurdle) of dependent variables were estimated using the probit model. The probit model accounts for the clustering of zeros due to non-participation, and it is used to predict the probability of whether smallholder farmers participate in the market or not (Musah, 2013). In the second step (second hurdle), an inverse Mills ratio (IMR) regressor was added to the sales equation to correct potential selection bias. The Poisson regression model (PRM) and the zero-inflated Poisson (ZIP) models were used to analyze count data because diagnostic tests discovered the absence of over-dispersion and under-dispersion (Greene, 2008).

The second objective focuses on the effect of market participation on the food security of smallholder farmers. Firstly, the Household Food Insecurity Access Scale (HFIAS) was used to measure the access component of household food insecurity based on the food consumed in the four previous weeks. The scale contains nine questions that focus on a household's food access anxiety and uncertainty, also the quality and quantity of food consumed (Coates *et al*., 2007). The questions asked were based on the problems experienced in accessing for the past 30 days. These questions were grouped into three categories depending on the level of food insecurity severity. Question 1 indicated anxiety, questions 2-4 indicated inadequate quality, and questions 5-9 showed insufficient intake.

Secondly, the Extended ordered probit regression model was used to analyze food insecurity severities among smallholder farmers empirically. The Ordered probit regression model was more helpful in this study as it recognizes the indexed nature of different response variables; in this objective, food insecurity severities were the ordered responses. And also, in this model, the Underlying indexing is a latent but continuous descriptor of the reaction. In contrast, in the

ordered probit model, the random error related to this constant descriptor is assumed to follow a normal distribution. Therefore, the ordered probit regression model is preferred over other models as it allows the data's ordinarily and increases the degrees of freedom available for estimating parameters (Greene, 2000). The model determines the observed and coded discrete food insecurity severity variable; thereafter, the probabilities associated with the coded responses of an ordered probit model are formulated. The interpretation of this model's primary parameter set is as follows: positive signs are associated with higher food insecurity severity as the value of the related variables increase, while negative signs suggest the converse. These interactions must be compared to the ranges between the various thresholds to determine the most likely food insecurity classification for a smallholder farmer.

Lastly, there was a potential for unobserved influences arising from the heterogeneity of some explanatory variables. Therefore, the study used a sensitivity analysis to check the robustness of the estimated results. For the selected sample size, the Average treatment effect on the treated (ATT) of the three food insecurity categories was compared with the expected average impact on the three food insecurity categories.

The third objective focuses on assessing the effect of market participation on the nutrition status of smallholder farmers. The nutrition status of smallholder farmers was evaluated based on a variety of food and dietary diversity accessible to smallholder farmers using the Household Dietary Diversity Score (HDDS). HDDS measures the economic ability of a household to access a variety of foods, and higher levels of HDDS imply improved chances of a household consuming enough of all food components necessary for good health. The dietary diversity data was obtained through 24-hour recall questions about the food groups consumed by smallholder farmers. The study followed the standard 12 food groupings recognised by Swindale and Bilinsky (2006). The 12 food groups include cereal, vegetables, meat, roots and tubers, poultry and eggs, fruits, fish and seafood, pulses/legumes/nuts, milk and milk products, oil/fats, sugar/honey, and miscellaneous (which includes spices, sauces, salt, and other condiments).

The study recognized that smallholder farmers' decision to participate in the market is based on various factors, such as their productive inputs and socio-demographic characteristics, resulting in self-selection bias. This means that farmers' participation in the market cannot be randomly allocated; therefore, their choices of whether to participate in the market can be influenced by observed and unobserved characteristics that correlate with the outcome

variables. This results in missing counterfactual data; the observed outcome will be in one state, and the counterfactuals cannot be observed for each group (Wooldridge 2003). The study adopted the instrumental variable Poisson regression model to correct this issue. This model uses the count outcome with the Poisson distribution of the error term to estimate the causal effect of participating in the market nutrition security status (Danso-Abbeam *et al.*, 2021). The average treatment effect was measured on the treated (ATT). Takahashi and Barret (2014) defined it as the average difference in potential outcomes of smallholder farmers with or without participation in the market. In estimating ATT, there was an issue of unobserved counterfactual situations. This resulted to bias estimates as it was impossible to observe the potential outcomes of farmers who participated in the market had they not participated. Therefore, the issue was addressed using the endogenous Poisson treatment effect described by Terza (1998). This model corrects for endogeneity and sample selection using the count data model with endogenous treatment (Miranda, 2004).

To meet the fourth objective, The Tobit regression model was employed to quantify the magnitude and direction of the factors influencing smallholder farmers' crop productivity. The study followed many previous studies that used the model (Martey *et al*., 2012; Ele, Omini, and Adinya, 2013; Kabiti *et al*., 2016; Rubhara and Mudhara, 2019; Rubhara *et al.*, 2020). The model was chosen because it assumes that smallholder farmers have a two-step decision process in crop production. Smallholder farmers decide whether or not to produce a crop and also decide on the volume of crops they produce. The model also assumes that both decisions are affected by the same set of variables (Buke, 2009). According to McDonald and Moffitt (1980), the model is more appropriate for analysing variables with lower and upper limits. In this study, the dependent variable, Crop Productivity, is lower censored at zero and upper censored at one as it can only take values between zero and one. Smallholder farmers who did not participate in crop production had zero-crop productivity, while those who participated in crop production had crop productivity of one. The Tobit model fits the data well as it considers the qualitative difference between zero and continuous observations, unlike the ordinary least squares regression method (Bukenya, 2017; Oduniyi, 2018).

To address the last objective, which focuses on the impact of crop productivity on the food and nutrition security of smallholder farmers in the selected study areas. The study started by measuring dietary diversity and food insecurity among smallholder farmers. To measure dietary diversity, the study used HDDS following the same procedure outlined in the third objective. To measure food insecurity, the study used HFIAS following the same procedure

outlined in the second objective. The study also used Conditional Mixed Process (CMP) to correct for endogeneity and sample selection. Smallholder farmers' crop productivity is affected by many unobserved factors, making it an endogenous variable, and failure to control for this endogeneity may result in biased and inconsistent estimates. Then, the CMP introduced by Roodman (2011) was used to manage the endogeneity nature of crop productivity, which can significantly over or under-estimate the impact of crop productivity on food and nutrition security status. In the first equation, an ordinary least squares (OLS) regression is used to estimate the impact of crop productivity on smallholder farm food and nutritional security status. However, the actual impact of crop productivity is overstated in the regression model used in the first equation, which leads to the formation of the second equation, which best describes Crop productivity (CP) as a potentially endogenous variable. After that, the two equations are joined within a Conditional Mixed Process (CMP) framework. The CMP addresses the selection bias that occurs because of the unobserved factors that affect the outcome variables by building from the seemingly unrelated regression framework and allowing for cross-equation correlation of the error terms.

2.13. Conclusion

This chapter reviewed the literature on the impact of market participation and crop productivity on household food and nutrition security. The characteristics of smallholder farmers were described in detail, and the constraints that affect their production were also represented. The study used previous studies to describe factors affecting crop productivity and market participation among smallholder farmers. Also, the relationship between these factors, crop productivity, and market participation was described, showing how they impact food and nutrition security among smallholder farmers. The study also used previous studies to develop theories and concepts that backed up the study. Overall, the literature showed that smallholder agriculture does have the potential to improve food and nutrition among smallholder farmers; however, there is still a lot of intervention that is needed, and more research needs to be done to provide evidence-based information to policymakers, government, and other stakeholders. It can be hypothesized that smallholder farmers could improve household food security with improved crop productivity and participate in the market to increase income among food-insecure households, particularly in rural areas. The following chapters present the findings of the research.

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CHAPTER THREE

MATERIALS AND METHODS

3.1. Introduction

This chapter focuses on the study area, data collection, and analysis methods employed in this study. At the beginning of the chapter, the study areas (Limpopo and Mpumalanga Provinces) were described to provide brief background information about the areas where the study was conducted and data collected. The chapter also provides a bit of information on the models that were used in this study.

3.2. Description of study areas

This research was part of a bigger baseline assessment study conducted in the nine provinces in South Africa in 2016/2017. The primary purpose of the bigger study was to obtain a comprehensive understanding of livelihood systems and to determine the extent of food and nutrition insecurity in South Africa. However, this current study aims to assess the impact that market participation and crop productivity have on smallholder farmers 'food and nutrition security status. Therefore, this study used secondary data collected in the different provinces in South Africa (refer to Figure 3.1) in 2016/2017; however, the focus was only on two provinces (Limpopo and Mpumalanga). The two provinces are mainly occupied by smallholder farmers who live in rural areas. According to Lehohla (2016), approximately 68% of the province's land area is used for agricultural purposes. The agricultural sector combines subsistence, emerging crops, livestock, and commercialised farming (Mpumalanga Municipalities, 2018).

Mpumalanga province is located in the North-Eastern part of South Africa. It covers about 6.5% of the country's land area. It comprises about 4,04 million people, with 72% involved in agriculture (Christopher, 2017). This province is divided into Highveld and Lowveld regions and has a very diverse climate (Ubisi, 2020). The Highveld has cold frosty winters with moderate summers, and the Lowveld region receives mild winters and a subtropical climate (Census, 2011). The province gets temperature that ranges from 6˚C and 20 ˚C in winter and 20 ˚C and 38 ˚C in summer. The rainfall precipitation annually for the province varies between 750 and 867mm (IDP, 2014). This province contributes to the agricultural economy through farms such as maize, cotton, groundnuts, sugar, potatoes, wheat, and indigenous crops such as Amaranth, Vegetable Cowpea, African eggplant, Okra, and pumpkin (Lehohla, 2016).

Different kinds of fruit are also produced in this province, including mangoes and oranges in the subtropical low-veld and peaches produced at higher elevations.

The second study area is in Limpopo province. Limpopo is situated in the Northern part of South Africa, covering about 125 754km² of area, which is only 10.2% of the country's total area. Its population is about 5 8 million, with five districts of Mopani, Vhembe, Capricorn, Waterberg, and Sekhukhune (Christopher, 2017). The people in this province are mainly involved and dependent on agriculture for survival, as 89% of the people's occupation is agriculture. The distribution of rain in Limpopo province is uneven and erratic. The average rainfall is ±5 00 mm/annual, with most of it falling during summer (October to March), while the other three seasons are generally dry (Cai *et al.*, 2017). The average summer temperature is around 27°C, though maximum temperatures can be as high as between 45º and 50°C. These climatic conditions give rise to frequent droughts (Cai *et al.*, 2017). The major crops grown by smallholder farmers in the province include maize, potatoes, beans, and vegetables (Lehohla, 2016).

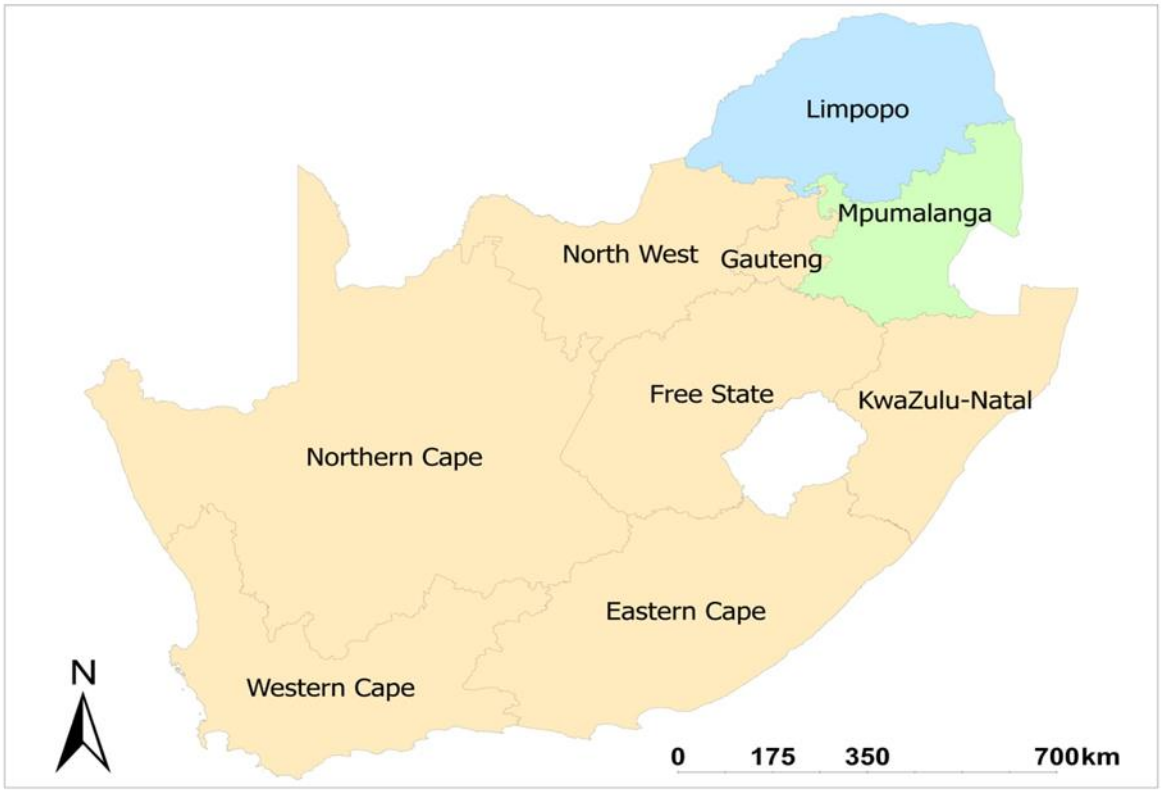

Figure 3.1: Map of South Africa showing the two different provinces (Mpumalanga and Limpopo) used in this study. Source: http://www.demarcation.org.za/

3.3. Data collection method

The study used a quantitative research methodology. Data on key agricultural, food and nutrition security indicators were collected from a household sample drawn using a multi-stage stratified random sampling technique to collect quantitative information through a survey of 3 districts of Limpopo and four districts of Mpumalanga. The multi-stage stratified technique is a random sampling process that allows individuals in a specific population to have an equal and independent chance of being selected (Mertens, 2003). This technique was used because it is easy to implement, cheap to use, and requires the slightest knowledge of the population to be sampled. It also allows large sampling as large samples are accurately representative of the population while smaller samples produce less accurate results, and they are likely to be less representative of the population. In each site, the livelihood population, including farmers, was divided into strata based on similar characteristics or variables (socio-economic characteristics, outputs, sales, household sizes, and institutional factors). Smallholder farmers were asked to list all the different types of crops they produce, consume and sell. The population of the Livelihood Zones (geographical areas in which people broadly share similar patterns of livelihoods) produced by the South African Vulnerability Assessment Committee (SAVAC) in 2014 was used as the assessment's sample frame. Accordingly, the current study used secondary data as the Department of Agriculture collected, Forestry and Fisheries (DAFF) in 2016/2017 using surveys (Appendix B). The DAFF surveys covered random samples of about 4 286 rural smallholder farmers in four provinces of the country. However, in this study, 1520 respondents were randomly selected from two provinces (Limpopo and Mpumalanga). From the chosen sample size, 386 smallholder farmers were involved in crop production, and 389 participated in the market. The main focus of the study was first to identify the factors that affect market participation and crop productivity of smallholder farmers and then assess the impact that market participation and crop productivity have on the food and nutrition security status of smallholder farmers.

The data were collected in 2016/2017; however, the findings based on these data are still relevant and significant in improving the food and nutrition security status of smallholder farmers through market participation and crop production. The insights drawn from the findings based on these data are still important and critical to enhancing the existing literature, considering that these data are reported at the household level. At the same time, other national datasets, such as the General Household Survey conducted by Statistics South Africa, are aggregated at a provincial level to form representation; the findings based on these data are

relevant for the government and policymakers because the results can inform policy and program interventions at a household level. In addition, as a custodian of these data, the government is interested in what comes from the data regarding policy and program recommendations. Permission to use this dataset was granted by the SAVAC (Appendix A), suggesting their willingness to see these data being used to help inform better programming based on evidence.

3.4. Methods of data analysis

The quantitative data were analysed using STATA statistical software (version 13), Excel, and Statistical Software for Social Sciences (SPSS) version 24. The descriptive statistics were performed to summarise the key socio-economic characteristics of the sampled smallholders. It was performed to show mean averages, standard deviation, and percentages of the factors affecting crop productivity and market participation among smallholder farmers. The crop productivity and market participation of smallholder farmers is influenced by factors that can be grouped as internal, external, and socio-demographic factors. Socio-demographic factors include variables such as the age of the household head, gender, household size, marital status, and educational level. Internal factors or Household assets include ownership of livestock, off-farm income, a family member with a disability, and family member with HIV, labour, irrigation system, yield, and land. External factors include access to market information, agricultural assistance, social grant, and distance to the market.

The study employed different econometric analytical tools to achieve the specified objectives. The double-hurdle model (DHM) was used to determine the determinants of market participation among smallholder farmers. The DHM was perfect for the study as it assumed that smallholder farmers' decision to participate in the market could be modeled as a two-step decision process. Firstly, the smallholder farmers decide whether or not to participate in the market, and secondly, they decide on the volume of crops to be marketed. The model was employed to also correct the possibility of bias due to sample selection. However, the specification of the double-hurdle model, where econometric analysis was applied, is discussed in detail in chapter 4 to avoid repetition of information.

Following many other previous studies (Pandey and Bardsley, 2019; Awodele and Olajide, 2020; Gewa *et al*., 2021; Roy *et al*., 2022) from developing countries, Household Food Insecurity Access Score (HFIAS) was employed in this study to analyze and measure the food insecurity status level of the rural households. It was used to measure the access component of

household food insecurity based on the food consumed in the four previous weeks. The Extended ordered probit regression model was used to assess the food insecurity severities among smallholder farmers. This model was more helpful in this study as it recognizes the indexed nature of different response variables. The detailed model specification for the analytical tools is provided in Chapter 5 to avoid the repetition of information.

The nutrition status of smallholder farmers was assessed based on the variety of food and dietary diversity accessible to smallholder farmers using the Household Dietary Diversity Score (HDDS). The dietary diversity data was obtained through 24-hour recall questions about the food groups consumed by smallholder farmers. The Poisson regression model was used to correct for self-selection bias on the effect of market participation on the nutrition status of smallholder farmers. This model uses the count outcome with the Poisson distribution of the error term to estimate the causal effect of participation in the market nutrition security status (Danso-Abbeam *et al*., 2021). Detailed information about the analytical tools is provided in Chapter 6.

Following many previous studies (Martey *et al*., 2012; Ele *et al.,* 2013; Kabiti *et al*., 2016; Rubhara and Mudhara, 2019; Rubhara *et a.l,* 2020), the study used the Tobit regression model to determine factors influencing crop productivity of smallholder farmers. The model was chosen because it assumes that smallholder farmers have a two-step decision process in crop production. Firstly, Smallholder farmers decide whether or not to be involved in crop production; secondly, they decide on the number of crops they produce. The model also assumes that both decisions are affected by the same set of variables (Buke, 2009). However, to avoid repetition of information, the model specification is discussed in detail in chapter 7. To correct for endogeneity and sample selection on the impact of crop productivity on the food and nutrition security of smallholder farmers objective, the study used Conditional Mixed Process (CMP). The model was used to control the endogeneity nature of crop productivity, which can significantly over or under-estimate the impact of crop productivity on food and nutrition security status. Similarly, to avoid repetition of information, the full model specification is provided in chapter 8.

3.5. Ethical consideration

Ethical consideration is about keeping the privacy and confidentiality of participants used during research Fouka and Mantzorou (2011). This means that whatever answers are recorded by the researcher will be recorded with complete confidentiality of participants. Because the

information provided by participants may be sensitive, which may be dangerous if the participants' names were disclosed, ethical consideration is critical to protecting the participants' identities. In the case of this study, where secondary data is used, the researchers were granted permission to use this data by the South African Vulnerability Assessment Committee (SAVAC), led by the Secretariat hosted at the Department of Agriculture, Land Reform, and Rural Development.

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CHAPTER FOUR

A TYPOLOGY OF THE LEVEL OF MARKET PARTICIPATION AMONG SMALLHOLDER FARMERS IN SOUTH AFRICA: LIMPOPO AND MPUMALANGA PROVINCES

4.1. Introduction

The agricultural sector continues to be strategic in the development of developing nations in Africa, where smallholder farming is the dominant livelihood activity. The agricultural sector in South Africa accounts for around 2.3% of the country's GDP, 40% of export earnings, and 4.6% of employment in the country (Stats SA, 2019). In South Africa, Statistics South Africa (Stats SA) (2019) showed that 13.8% (2.33 million) of all households are agricultural households, many of them situated in rural areas. Smallholder agriculture provides about 70% of the employment in rural households and is the primary source of income (Poole, 2017). Smallholder agriculture plays a vital role in food security, job creation, reasonable income distribution, poverty alleviation, and linkage creation for economic growth (Cervantes-Godoy and Dewbre, 2010; Corsi *et al*., 2017; Poole, 2017; Abraham and Pingali, 2020). The agricultural sector has proven to be the backbone of improving the country's rural food security and livelihoods (Mama, 2020). However, the sector is facing numerous challenges, such as insufficient access to technology, institutional difficulties, inappropriate policies, poor infrastructure, and unsuccessful links to the markets, which make it difficult for smallholder farmers to participate in the formal market sector Christian *et al*., 2019).

In South Africa, there are two types of marketing (formal and informal). Formal marketing involves the formal movement of crops through a different chain of actors/players, such as seed producers, crop growers, distributors, merchants, and agro-dealers, while informal marketing involves the decentralized market distribution where smallholder farmers sell or exchange crops directly with other farmers, neighbors, or local communities. Smallholder farmers produce traditional crops more for consumption, and they depend on informal markets to sell their surpluses due to inadequate linkages with formal markets (Soukand *et al.*, 2020). This emphasizes the need to reconsider policies and institutions that support smallholder agricultural participation in the formal markets.

Market participation holds significant potential for revealing suitable opportunity sets necessary for providing better incomes and sustainable livelihoods for smallholder farmers (Fischer and Qaim, 2012; Gwiriri *et al.*,2019; Meemken, 2020). Facilitating the development of market participation by smallholder farmers can be crucial in helping households to alleviate

food poverty and food insecurity (Barrett, 2010; Mango *et al.*, 2014). It can also enable smallholder farmers to access affordable production inputs; hence, this will ensure that farmers are not trapped in low productivity–low return farming activities that lead to food vulnerability. Using better-quality inputs will improve the ability of smallholder farmers to produce enough marketable surplus and subsequently lead to a better market orientation of goods produced by farmers (Kirimi *et al.*, 2013). The need for developing smallholder market participation has been progressively recognized in efforts to achieve agricultural transformation in developing countries (Ingabire *et al.*, 2018). However, smallholder farmers, particularly in South Africa, face several barriers preventing them from gaining access to markets and productive assets.

Many smallholder farmers in South Africa are inactive participants, often obliged to sell low (immediately after harvest) and buy high; with little information on where to conduct transactions, they end up being price takers (Macdonald, 2019). The constraints affecting smallholder farmers in market participation can be classified as technical, institutional, and socio-demographic factors (Macdonald, 2019). Smallholder farmers living in remote areas with poorly maintained roads and market infrastructure, inadequate transport and storage facilities, and a lack of skills and information cause high transaction costs of market participation (Jari and Fraser, 2012; Sebatta *et al.*, 2014). Farmers mainly produce for consumption and sell the surplus to their local communities; the small surplus they produce prevents them from participating in a competitive market and exposes them to high risks and transaction costs that limit them to a non-contestable market dominated by a few influential buyers (World Bank, 2007). They are faced with incapacities to have contractual agreements, low access to extension agents, poor organizational support, low use of the improved seed, and low use of fertilizer, all of which make it difficult for farmers to commercialize (Quisumbing and Pandolfelli, 2010). Other factors that affect farmers' participation include household size, age and education, source of income, marital status, and human immunodeficiency virus (HIV) status of household members. The impact of HIV on agriculture is significant, as it results in a decline in agricultural production (FAO, 2019).

HIV affects the number of workers available for agricultural activities, leading to low production and productivity, and thus reduces the food stocks that could potentially be taken to the market as part of the outputs for smallholder farmers. The HIV pandemic has affected national development and household economies, worsening poverty and inequalities (Drimie, 2002). It increases the mortality rate of young and productive people, which affects smallholder agriculture since it is labour-intensive (Johnston, 2008). The epidemic worsens inequalities and

poverty and reduces labour productivity and supply, which slows economic growth (FAO, 2019). Furthermore, when these conditions get worse, they make households even more at risk and vulnerable to the epidemic. Therefore, it is important to prioritize the improvement of smallholder agriculture to increase the economic activities of smallholder farmers so they can competitively participate in the market. The provision of support by the government, policymakers, and other stakeholders can improve the productivity and profitability of smallholder farmers.

Research has been done on market participation in different parts of developing countries such as South Africa. Several studies have been conducted on market participation involving livestock farming, such as cattle and goats (Uchezuba *et al*.,2009; Nwafor *et al.,* 2020; Lutta *et al*., 2021); other studies considered constraints to market participation (Alene *et al*., 2008; Omiti *et al*.,2009; Sebatta *et al.,* 2014; Singh-Peterson and Iranacolaivalu, 2018). However, there is limited knowledge of the participation of smallholder farmers in the market within the South African context. Against this backdrop, this study sought to understand the typology of the level of market participation among smallholder farmers in South Africa. The study attempted to fill the research gap and contribute to the generation of evidence for policymakers to realize the inequalities that still exist in the market of South Africa and the need to review existing policies. Therefore, the study generated new empirical information on the simultaneous interaction of household decisions of market participation and the most influential factors on the market participation of smallholder farmers in South Africa.

4.2. Analytical framework

The marketing decision of crop farmers was modeled as a two-step decision process: (1) the household decides whether or not to participate in the market, and (2) the household decides on the volume of crops to be marketed. The double-hurdle model Cragg (1971), cited by Achandi and Mujawamariya (2016) was used to model this two-step decision process, following numerous other market participation studies (Mather *et al.,* 2013; Mabuza *et al*., 2014; Ndoro *et al.*,2014; Achandi and Mujawamariya,2016; Sinyolo *et al.,* 2017; Anang and Yeboah, 2019). This model was chosen over the Heckman sample selection model, which many studies have used (; Musah, 2013; Bwalya *et al.,* 2013; Sebatta et al., 2014; Osmani and Hossain, 2015; Kyaw *et al.,* 2018). The Heckman method addresses the statistical challenge posed by cases where market sales equal zero as a missing data problem. However, when considering the issue of zero market sales, representing a zero amount of maize output sold as

a missing value is not a good economical choice for a model to explain (Mather *et al.*, 2013). The double-hurdle model produces estimates superior to the Heckman model when dealing with true zeros.

According to the double-hurdle model, a farmer faces two hurdles while deciding on market participation: whether or not to participate in the market and how much of their crop to sell. With the assumption that the error terms in the equations are conditionally uncorrelated on all covariates, the standard errors from separate estimations are also valid for statistical inference. If the conditionally uncorrelated errors assumption does not hold, coefficient estimates from separate regressions will be biased (Williams *et al*., 2013). According to Wooldridge (2002), testing for conditionally uncorrelated errors follows the same method as the Heckman test for selection bias. Although it is not technically necessary for identification, it is standard to impose at least one justifiable exclusion restriction when estimating the second stage. The null hypothesis that the first and second-stage errors are conditionally uncorrelated is tested using the standard t-statistic for the coefficient estimate on inverse mill ration (IMR). If the coefficient estimate is statistically significantly different than zero, we reject the null hypothesis, and the model must be re-estimated to conduct valid inference (De Luca and Perotti, 2011). If we fail to reject the null, we re-estimate second-stage parameters excluding IMR.

The dependent variables in the first equation were estimated using the probit model. The probit model accounts for the clustering of zeros due to non-participation, and it is used to predict the probability of whether smallholder farmers participate in the market or not (Musah, 2013).
The double hurdle model was stated as follows:

$$Y_i = 0 \; if \; Z_{ni} < 0$$

$$Y_i = 1 \; if \; Z_{ni} > 0 \qquad (1)$$

Where Y_i is an indicator variable equal to unity for smallholder farmers participating in the market. Z_{ni} is the quantity of crop sales made by smallholder farmers *i*

The participation equation can then be written as:

$$Y_{i^*} = \beta_{1i} X_{1i} + \in_{1i} \qquad (2)$$

Where Y_{i^*} the latent level of utility farmers gets from participating in the market and ε is the error term.

The binary model is then stated as follows:

$$Y = \begin{bmatrix} 1; if \ \ farmers \ sell \ crops, \\ 0 \ if \ otherwise \end{bmatrix} \quad (3)$$

In exact terms, the probit model in stage one of estimation is stated as follows:

$$P_r(Y_1) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ...\beta_n X_n + \in \quad (4)$$

Where $P_r(Y_1)$ is the probability of a smallholder farmer deciding to sell crops in the market or not, β_0 is a constant, β_1 ….. βn are parameters to be estimated, X_1 …. X_n are the vector of explanatory variables identified in Table 4.1, and ε is an error term.

Table 4.1: Factors that are estimated to affect market participation decisions.

Variable name	**variable definition**	**Variable type and measurement**	**Hypothesized Effect on Market Participation**	**Results received by Sebatta *et al.* (2014); Kyaw *et al.* (2018)**
Household age	Age of the household head	In years (continuous)	±	+
Gender of household head	Gender of household head	Dummy (1= male, 0=female)	+	−
Marital status	Marriage status of the household head	Marriage status (dummy)		
Household size	Number of family members	Size of household (continuous)	−	−
The educational level of household	Education level of the household head	Years of education (continuous)	+	+
Livestock	Ownership of livestock	Dummy (1= yes, 0=no)	±	−
Distance to the market	Distance to the market	In kilometers (continuous)	−	−
Market information	Access to market information	Dummy (1= yes, 0=no)	+	+

Agricultural assistance	Access to extension service	Dummy (1= yes, 0=no)	+	+

Notes: ± indicates whether the hypothesized effect will be positive or negative, + indicate a positive estimated impact, and – indicate the negative estimated effect—source: Own analysis.

In the second step, an additional regressor in the sales equation will be included to correct for potential selection bias. This regressor is the inverse Mills ratio (IMR). The IMR is computed as Equation (5):

$$\frac{\phi\left(h\left(\frac{W_i}{\alpha}\right)\right)}{\phi\left(W_i,\alpha\right)} \tag{5}$$

Where φ is the normal probability density function. The second-stage equation is given by Equation (6):

$$\mathrm{E}=\left(Y_i/Z\right)=f\left(x_i\beta\right)+r\frac{\phi[h\left(\frac{W_i}{\alpha}\right)]}{\phi\left(W_i,\alpha\right)} \tag{6}$$

Where *E* is the expectation operator, *Y* is the (continuous) proportion of rice sold, *x* is a vector of independent variables affecting the quantity sold, and β is the vector of the corresponding coefficients to be estimated. The extent of participation is indicated by the following:

$$H_i=X_i\beta+V_i \tag{7}$$

Where H_i is the number of crops marketed, X_i is a vector of covariates that explain this amount, β is a vector of unobserved parameters to be estimated, and *Vi* is a random variable indicating all other factors apart from *X*.

Count data are non-normal and hence are not well estimated by ordinary least squares (OLS) regression (Maddala and Flores-Lagunes, 2001). The most common regression models used to analyze count data models include the Poisson regression model (PRM), the negative binomial regression model (NBRM), the zero-inflated Poisson (ZIP), and the zero-inflated negative binomial (ZINB). PRM and NBRM regression models have become standard for analyzing response variables with non-negative integers (Greene, 2008). The PRM and ZIP models were used in this study because diagnostic tests revealed the absence of over-dispersion and under-dispersion. Following Wooldridge (2002) and Greene (2008), the density function of the Poisson regression model is given by:

$$P_r(Y=y)=\frac{\ell^{-\delta(y)}\delta_i(Y)^y}{\phi(1+Y)} \quad (8)$$

Where; $\delta_i = Exp(\Omega + L^i\Psi)$ and $Y_i = 0$, 1… i is the number of crops sold by farmers and L vector of predictor variables and Ω Ψ are the parameters to be estimated. Greene (2003; 2008) show that the expected number of events δ (in this case, the number of crops sold by farmers) is given as;

$$E(Y=y)=Var(Y_i/y_i)=\sigma_i=Exp(\Omega+L\Psi) \quad (9)$$

Empirical estimation procedure and hypothesis testing

Estimating the model outlined above in Equations (1) to (10) followed a series of regression diagnostics. Variables in both stages of the model were first checked for normality using Exploratory Data Analysis using the coefficient of kurtosis and skewness. An inverse mill ratio (IMR) predicted from the first hurdle was used as a covariate in the count data model (second hurdle) to correct for selectivity bias.

4.3. The study area, sampling, and data collection technique

The study area, sampling, and data collection technique are the same as in chapter three.

4.4. Results

4.4.1. Descriptive results

4.4.1.1. Demographic and Socioeconomic Characteristics of Farm Household concerning Market Participation

Out of the sample of 1520 rural households, 386 were crop producers, and 1134 were non-crop producers. The descriptive analysis revealed that 389 farmers participated in the market and 1131 did not (Table 4.2).

Table 4.2: Demographic characteristics of smallholder farmers in Limpopo and Mpumalanga province, South Africa.

Variables	**%**	**Freq**
	Crop production	
Crop producers	25	386
Non-crop producers	75	1134
Overall	100	1520
	Farmers' participation in the market	
Market participant	12.6	389
Non-market participant	74.4	1131
Overall	100	1520

	Mean	Standard Deviation (SD)
Number of crops sold	2.16	1.27

Source: authors' analysis

Tables 4.3 and 4.4 show the differences in demographic characteristics between market participants and non-market participants. The t-test result showed that the mean age and education were insignificant among farmers' market participation. The mean age for market participants was 1.24, while for non-market participants, it was 1.29. The mean years spent in formal school by market participants was 35.41, while for non-market participants, it was 33.41. There were significant differences ($P < 0.05$) in the mean output of crops and market participation. The average yield harvested for market participants was 2242.69kg, while it was 717 kg for non-market participants. This means that market participants' farmers had higher yields than non-market participants, making them consume and sell the surplus in the market. The intensity of market participation as measured by the number of crops sold among the smallholder farmers is presented in Table 4.2. The mean crops sold of 2.16 with a standard deviation of 1.27. To analyse the determinants of the intensity of market participation of households, the number of crops sold in the market was hypothesised as an outcome variable. The dependent variable is a countable dependent variable, measured in number and represents an actual number of crops sold per smallholder farmers in the market.

Table 4.3: Demographic characteristics of smallholder farmers in Limpopo and Mpumalanga provinces

Characteristics	Market participation	mean	F value	Degrees of Freedom	P-value
Household age	Yes	1.24	1.009	129	0.317
	No	1.29		21.52	
Education of household head	Yes	35.36	0.000	102	0.989
	No	33.41		17.14	
The total output of crops (KG)	Yes	2242.69	25.622	818	0.000***
	No	717.17		134.00	

Note: ***, **, * Indicate significance at 1%, 5%, and 10%, respectively. Source: authors' analysis

Table 4.4: Demographic characteristics of smallholder farmers in Limpopo and Mpumalanga provinces, South Africa.

Variable	Market participant (N=389)		Non-market participant (N=1131)		Overall Freq
	%	Freq	%	Freq	
Gender of household					
Female	77	300	61	688	988
Male	23	89	39	443	532
Access to agricultural assistance					
Yes	26	100	28	318	418
No	74	289	72	813	1102
Access to market information					
Yes	15	60	34	387	447
No	85	329	66	744	1073
Ownership of livestock					
Yes	23	89	37	414	503
No	77	300	63	717	1017

Source: Authors' analysis

The results revealed that 77% of market participants were female while 23% were males. Among non-market participants, 61% were females, and 39% were males. In terms of access to agricultural assistance, 26% of market participants had access to extension officers, while 74% did not have access. Among non-participants, 28% had access to agricultural assistance, while 72% did not have access. Regarding market information, 15% of market participants had access, while 85% did not. Among non-market participants, 34% had access to information, while 66% did not have access. The results also showed that 23% of market participants had livestock, while 77% had no livestock. Regarding non-market participants, 37% had livestock while 63% did not own any. Non-market participants had more livestock when compared to market participants. Table 4.5 show the different means and standard deviation of all the demographic characteristics of smallholder farmers in Limpopo and Mpumalanga provinces, South Africa.

Table 4.5: Demographic characteristics of smallholder farmers in Limpopo and Mpumalanga provinces, South Africa.

Variable	*Mean*	Standard Deviation (SD)
Gender of household head	1.27	0.45
Household age	49.12	11.89
Marital status	4.21	2.44
Household size	4.93	2.71
	33.58	40.30
The educational level of household		
Ownership Livestock	1.77	0.42

	1.86	1.82
Distance to the market		
	1.94	0.24
Access to market information		
Access to agricultural assistance	1.92	0.27
Family member with HIV	0.47	0.79
A family member worked on a farm	0.98	0.76
Social grant	1.99	0.73
Irrigation type	1.52	0.50
The total output of crops (KG)	3556.22	88187.067

Source: Authors' analysis

4.4.2. Factors influencing the decision of smallholder farmers to participate in the market

The results in Table 4.6 highlight the determinants of market participation among smallholder farmers in the Limpopo and Mpumalanga provinces of South Africa. The first hurdle equation of the double hurdle model showed that the gender of the household's salary and agricultural assistance were all significant at a 1% level. Surprisingly, education level and distance to the market did not significantly impact the decision of smallholder farmers to participate in the market. Furthermore, these variables had unexpected coefficient signs (negative for education level and positive for distance to the market).

Table 4.6: Probit results for determinants of market participation of crop farmers (first-hurdle)

Variables	**Coef.**	**S. E**	**p-value**	**Margins**	**S. E**	**P-value**
Household size	0.027	0.051	0.600	0.000	0.001	0.599
Gender of household head	1.034	0.379	0.006***	0.015	0.005	0.007***
Household Age	-0.017	0.010	0.086*	-0.000	0.000	0.084*
The educational level of household	-0.244	0.656	0.710	-0.004	0.009	0.710
A family member worked on a farm	1.308	0.469	0.005***	0.019	0.007	0.005***
Social grant	-0.248	0.252	0.325	-0.004	0.004	0.326
WEALTH INDEX	1.143	0.274	0.000***	0.016	0.004	0.000***
Irrigation type	0.361	0.386	0.350	0.005	0.006	0.349
Family member with HIV	-1.204	0.565	0.033**	-0.017	0.008	0.027**
Distance to the market	0.163	0.494	0.742	0.002	0.007	0.741
Agricultural assistance	2.145	0.573	0.000***	0.031	0.008	0.000***
Constant	-0.207	0.982	0.833			
Mean dependent variable	0.649					
Pseudo r-squared	0.958					
Chi-square	1788.386					
Prob > chi2	0.000					

Note: ***, **, * Indicate significance at 1%, 5%, and 10% level, respectively

Source: Authors' analysis

Gender of the household was positively related to the probability of household market participation and was statistically significant at 1%. The result also showed that household age negatively and significantly impacted the farmer's decision to participate in the market. Access to agricultural assistance showed a positive coefficient and was statistically significant at a 1% level. The results revealed that family members working on the farm had a positive coefficient and were statistically significant. Having a member in a family that is HIV positive negatively impacted a farmer's participation in the market and was significant at a 5% level.

4.4.3. The determinants of the market participation level of smallholder crop farmers: count data model (second-hurdle)

The results on factors influencing the level of market participation among the smallholder farmers are as presented in Table 4.7. An inverse mill ratio (IMR) predicted from the first hurdle was used as a covariate in the count data model (second hurdle) to correct for selectivity bias. The IMR was statistically significant, showing that selection bias was a problem. Since the coefficient was significant, the null hypothesis (no selection bias) is rejected. Hence, a double hurdle model is justified for estimating determinants and market participation levels while correcting for selection bias problems. As depicted in Table 4.5, the estimation of the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) is important to indicate a better model in analysing count data of the market participation level of smallholder farmers. This study focuses on two count models: the Poisson regression model and the Zero-Inflated regression model. Starting from the AIC values, the Poisson and Zero-Inflated regression models show 16060.206 and 16067.302, respectively. Similarly, the Poisson and Zero-Inflated regression models for BIC values reveal 16040.238 and 16140.62, respectively. It is clearly shown that the AIC value is much smaller in the Poisson regression model as compared to the Zero-inflated Poisson model. In the same vein, the BIC values also corroborate the results of AIC, justifying the use of Poisson over the ZIP model with the smaller value. Comparing both observations from AIC and BIC values, the Poisson regression model fits better in analysing the count data level of market participation of smallholder farmers in the study area. The second hurdle equation showed that household size, age, HIV status of a family member, and agricultural assistance were all statistically significant.

Table 4.7: Determinants of the level of market participation of smallholder crop farmers: count data model (second-hurdle)

	Poisson regression			Zero-Inflated Poisson Regression		
Variables	**Coef.**	**St. Err**	**P-value**	**Coef.**	**St.Err.**	**P-value**
IMR	0.135	0.062	0.030**	0.135	0.062	0.030**
Marital status	-0.192	0.086	0.025**	-0.192	0.086	0.025**
Household size	0.009	0.003	0.001***	0.009	0.003	0.001***
Gender of household	-0.025	0.035	0.469	-0.025	0.035	0.469
Household age	0.001	0.000	0.012**	0.001	0.000	0.012***
Education level of household	-0.141	0.077	0.066*	-0.141	0.077	0.066*
A family member worked on a farm	0.008	0.070	0.907	0.008	0.070	0.907
Irrigation type	0.085	0.064	0.184	0.085	0.064	0.184
Family member with HIV	0.580	0.082	0.000***	0.580	0.082	0.000***
Distance to the market	-0.110	0.088	0.212	-0.110	0.088	0.212
Agricultural assistance	-0.073	0.024	0.002***	-0.073	0.024	0.002***
WEALTH INDEX	-0.089	0.037	0.017**	-0.089	0.037	0.017**
Social grant	0.033	0.039	0.408	0.033	0.039	0.408
Constant	2.324	0.147	0.000***	2.324	0.147	0.000***
If the household resides				-7471.85		
Constant				-7947.60		
Mean dependent variable	13.516			13.516		
Pseudo r-squared	0.008			1400.000		
Chi-square	122.279			122.279		
Number of obs	1400.000			1400.000		
Prob > chi2	0.000			0.000		
Akaike crit. (AIC)	16060.206			16067.30		
Bayesian crit. (BIC)	16040.238			16140.62		

Note: ***, **, * Indicate significance at 1%, 5%, and 10%, respectively.

Source: Authors' analysis

The results showed that marital status negatively influenced smallholder farmers' participation level and was statistically significant at a 5% level. The household size indicated a positive impact on farmers' participation level and was statistically significant at a 1% level. Unlike in the first hurdle, household age positively influenced smallholder farmers' level of participation in the market, statistically significant at a 5% level. The effect of educational level on the level of participation in the market by farmers differs in many studies depending on the area of the study. In this study, the result revealed that the educational level of the household had a negative influence on the level of participation in the market by farmers and was significant at the 10% level. This study showed surprising results on the impact of agricultural assistance on farmers' participation in the market. Access to agricultural assistance negatively affected the level of participation in the market, and it was statistically significant at a 1% level.

4.5. Discussion

The study's objective was to determine the factors that affect the level of market participation among smallholder farmers. The results showed that smallholder farmers could not access extension services and market information. This is because smallholder farmers live in remote areas with poor communication and inadequate infrastructure, and most are illiterate; thus, access to market information is hampered. This result is in line with the findings from Aliber and Hall (2012), who reported that the South African government suffers from funding constraints which lead to less funding for agricultural support services. The agricultural sector is understaffed with extension officers. The hired ones do not get adequate training on market issues, so they can't provide sufficient market information since they are incompetent. The Department of Agriculture, Land Reform, and Rural Development (DALRRD) (2008) reported that they are unaware of the existence of most smallholder farmers because they exist in heterogeneous groups and are not formally registered.

4.5.1. Factors influencing the decision of smallholder farmers to participate in the market

The possible explanation for the negative impact on education might be that the more educated age group is young people, and they are not interested in farming in most cases; they are in other occupations. Osmani and Hossain (2015) substantiated this, who found that young household heads are more motivated to choose and study careers other than farming. The positive effect distance to the nearest town had on a farmer's decision to participate in the market was also found by Sebatta *et al*. (2014), who concluded that it is easier to access buyers who offer better payment terms in the nearest town than far away from the town. Achandi and Mujawamariya (2016) studied rice market participation; the results showed a positive relationship and explained that when rice sold in a market further away from the village might have low transaction costs for wealthy farmers.

The positive relationship between gender and market participation among smallholder farmers implies that gender plays an important role in agriculture. Sebatta *et al.* (2014) reported that males are more likely to participate in the market and that males decide whether to sell or not and how much. Females are more involved in the production side. This aligns with the study of Hill and Vigneri (2014), who posited that females are mainly involved in subsistence farming while males grow crops for cash income for the family's needs.

The negative impact of age on market participation might arise because smallholder agriculture mainly involves older people who are reluctant to participate in the market because of many factors, including time consumption, transaction costs, and the distance to the market. Contrary to these results, other studies found a positive relationship between age and farmers' market participation (Randela et al., 2008; Nwafor, 2020). Sebatta *et al*. (2014) stated that the decision to participate in the market depends on one's position in the order of hierarchy in the headship of the family. The older household tends to make a decision that affects the family's well-being; they sell a higher proportion of their produce in the market.

The results showed that agricultural assistance positively impacted market participation among smallholder farmers. This could be attributable to the fact that when farmers receive agricultural assistance, especially from the government, they produce more and decide to sell more in the market. They receive market training, inputs, and market information. They also get access to new technologies that create more market opportunities for them to market. These results were in line with Jari and Fraser (2012); Kyaw *et al.* (2018), that found that extension services have a positive and significant influence on market participation by smallholder farmers.

Smallholder farming mainly depends on family labour rather than hired labour, so having a family member working on a farm could lead to optimum production as responsibilities will be shared among family members. Egbetokun and Omonona (2012) substantiated this, who reported that having more family members working on the farm leads to high production, and more surplus is sold in the market. Knowing the wealth index of smallholders had indicated a positive and significant impact. This is because when farmers know their resources and living standards, they tend to utilize what they have and produce effectively.

Having a family member that is HIV positive had a negative impact on farmers' participation in the market. This is because as HIV-positive member increases, farmers are likely to not participate in the market due to less time allotted for agricultural production. It can also decrease labour since smallholder production depends on family labour for agricultural activities if the HIV member is part of farming. According to Food and Agriculture Organization (FAO) (2010), an increasing number of sick HIV-infected in rural areas threatened survival strategies and food security. Rural households are disadvantaged as they have little access to appropriate information and health services and are less able to equip themselves with the knowledge to prevent transmission risks (FAO, 2010).

4.5.2. The determinants of the market participation level of smallholder crop farmers: count data model (second-hurdle)

Marital status had a negative impact on the level of participation of smallholder farmers. This result was similar to that of Adeoye and Adegbite (2018), who found a significant but negative effect on marital status on the level of participation. On the contrary, Egbetokun and Omonona (2012) identified marital status as a major factor that influences the level of participation in the market.

The positive result on household size in this study was unexpected as many studies have found a negative influence of household size on the level of participation in the market (Mango *et al.*, 2014; Kyaw *et al.*, 2018; Adeoye and Adegbite, 2018). These studies explained that an increase in household size causes farmers to produce more for household production. Omiti *et al.* (2009) demonstrated that large household size is labour inefficient and makes less output, leaving less surplus for sale. However, Egbetokun and Omonona (2012) found similar positive results to this study, indicating that most smallholder farmers use family labour for farming activities; therefore, an increase in household size would lead to an increase in farm size cultivation, thereby increases in farm produce to sell.

Household age showed a positive impact on the level of market participation. This means older farmers are willing to sell more in the market than young ones. Older farmers tend to make better decisions and have greater contacts in the market, enabling them to find a better market for their produce. When older people retire from their other occupations, they invest their funds into farming, which is why they produce to sell to keep inherence for the future generation. International Fund for Agricultural Development (IFAD) (2017) reported that rural youth lately stated that access to information, lack of credit, and negative perceptions around farming are the leading reasons why most young African people leave smallholder agriculture. The high unemployment in rural areas may cause young people to migrate from rural areas in search of better opportunities in urban areas or other countries (IFAD, 2017).

First, the study estimated the first-stage probit model and predicted an inverse Mills ratio (IMR) around the probability of being a market participant. The second stage uses the count data estimator that assumes conditionally uncorrelated errors and includes *IMR* predicted from the first hurdle as an explanatory variable to correct for selection bias. In the second hurdle, smallholder farmers that participated in the market are old, and their retirement funds are used

for farming. The most relevant results in South Africa are those received in the first hurdle because most smallholder farmers are old and uneducated.

The possible explanation for adverse results on the educational level can be that most of the educated people are young people and they are not mainly involved in agriculture. Other studies found a positive and significant relationship between educational level and farmers' participation in the market (Egbetokun and Omonona, 2012; Adeoti *et al.*, 2014; Adeoye and Adegbite, 2018). These studies explained that the positive relationship showed that the increased level of education in the household makes them gather more information and new opportunities in the market for their produce. Education empowers farmers to make informed decisions and detect market opportunities. The authors added that farmers could combine education and traditional knowledge to produce and sell more.

Agricultural assistance from the government, policymakers, and other stakeholders can enhance smallholder farmers' production, marketing, and consumption and lead to sustainable production. However, this study found a negative impact. An explanation for this might be that some extension workers do not train farmers properly. They sometimes provide farmers with sophisticated technology and inputs without any training. These results were contrary to many other studies by Jari and Fraser (2012); Fischer and Qaim, 2012; Sebatta *et al*. (2014); Kyaw *et al.* (2018), which found a positive and significant relationship. These studies explained that having access to agricultural assistance can provide information on market access and improved varieties that can improve farmers' knowledge of production. It can also improve access to technology.

4.6. Conclusion and recommendations

The involvement of smallholder farmers in marketing can play a critical role in meeting their goals, such as food and nutrition security, poverty alleviation, and sustainable agriculture. This study found that numerous factors, such as socioeconomic, market, and institutional factors, constrain market participation. Smallholder farmers' market participation was affected by factors such as education level, the gender of the household, and agricultural assistance. The results revealed that household size, household age, HIV status of a member of a family and agricultural assistance, marital status, and educational level were found to have significant influences on the level of market participation.

Agricultural extension and advisory services considerably contribute to economic and social development, including facilitating smallholder farmer development. Therefore, this suggests

that to develop smallholder farmers and improve their market participation, there is a need to offer quality extension and advisory services. The government needs to improve the performance of agricultural extension services in South Africa. More competitive extension workers need to be hired and trained in marketing so that in their advisory duties to farmers, marketing the product is core and parcel of their message delivery. Generally, smallholder farmers do not get agricultural assistance and market information because they are not formally registered, exist in non-homogeneity groups, and the Department of Agriculture, Land Reform, and Rural Development is faced with budget constraints. It is recommended that the government, extension workers, and policymakers encourage organized smallholder farmers into groups to help them in large numbers simultaneously. When the farmers are organized, the services from the government can be coordinated better as appointed committee members could be responsible for accessing those services on behalf of the whole group. The government should support the smallholder farmers by providing training that is sensitive to the fact that they are generally uneducated. Therefore, the information should be packaged in a way that is easy for them. To improve smallholder farmers' production and productivity, the government must ensure their support is timely and well-targeted to those who most need it. Intensive programs are required to encourage youth to participate in agriculture as most young people are literate and can easily grasp marketing information. Much attention and support must be given to women's participation in market participation. They also need to be empowered by the government and other interested stakeholders to fully participate in the decision-making relating to the price of their products and where to sell it. More workshops, especially for young people and women, need to be conducted in rural areas to raise awareness of the importance of agriculture.

In light of these findings, the government and policymakers must revise the agricultural marketing policies and redo policies that will favour the condition that smallholder farmers live and operate on. The government needs to do follow-ups on policy implementation so that accessibility to the market and sales of crops can improve.

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CHAPTER FIVE

THE DETERMINANTS OF MARKET PARTICIPATION AND ITS EFFECT ON FOOD SECURITY OF THE RURAL SMALLHOLDER FARMERS IN LIMPOPO AND MPUMALANGA PROVINCES, SOUTH AFRICA

5.1. Introduction

Food insecurity is still a primary concern worldwide, and the chances of achieving the Zero Hunger target by 2030 are slim, as more than 820 million people are experiencing hunger and malnutrition (FAO *et al*., 2019). Most food-insecure and malnourished people are found in developing regions, mostly in sub-Saharan Africa (United Nations Development Programme (UNDP), 2012; FAO *et al.,* 2012; FAO, 2015). While South Africa is considered food secure as a nation, not all South Africans are considered food secure at the household level (FAO, 2017). For instance, about 9.34 million households (16% of the population) in South Africa will face severe food security levels in 2020 (Integral food security Phase Classification, 2021). About 20.6% of households will experience hunger in 2020 (Stats SA, 2021). Household food security is highly dependent on income as most households rely on purchased food. However, about 55.5% of South African residents live in poverty, the majority being children, women, and the elderly (Stats, 2019). Additionally, 25.2% of South Africans live below the food poverty line (FPL) (Modjadji and Madiba, 2019). The country is facing epidemiological and nutritional transformation (about 25% of children under the age of 5 years are stunted, and 40% of women are obese) (Sartorius *et al*., 2019; Modjadji and Madiba, 2019).

Approximately 80% of South Africa's rural population attain their livelihood from agriculture (Baiphethi and Jacobs, 2009). This population generally depends on smallholder agriculture for food, employment, and income (Baiphethi and Jacobs, 2009). This shows that agriculture remains a backbone in many rural households, vital in improving food security and reducing poverty (FAO, 2015). Despite all the potential that smallholder agriculture has, the sector is still faced with several challenges that limit its potential to ensure that all people in rural areas can acquire sufficient quantity and quality of food, either through their production, purchase, or equitable food distribution (Grafton *et al*., 2015; Hendriks and Olivier, 2015; Sinyilo and Mudhara, 2018; Tomita *et al.,* 2020). Smallholder farmers that operate under smallholder agriculture can be identified as those who own small areas of land (less than 2 ha) on which they produce crops and rear livestock with limited resources (Salami *et al*.2017). South Africa has approximately two million smallholder farmers (Stats SA, 2016). These farmers are mainly

involved in subsistence farming, producing primarily for their consumption and selling the excess within their local areas. Smallholder agriculture is categorized by low productivity, poor infrastructure, low input, lack of capital, technology, and knowledge, subsistence production system, inability to reach economies of scale, which are essential to compete in the regional and global markets, and inaccessibility to input and output markets (Dodfray *et al.,* 2010; Negash and Swinnen, 2013; Mojo *et al.,* 2017). These constraints, coupled with increased population growth, pressure the sector to generate enough food for the South African population. However, South Africa has great potential for agriculture, so promoting market-oriented agriculture would significantly enhance rural farm households' well-being in terms of food security. Market participation among smallholder farmers is expected to lead to more specialized production systems to ensure efficient resource use (Mulenga *et al.,* 2021).

Smallholder farmers' livelihoods in developing countries can be improved by integrating them into the market (Olwande *et al.,* 2015). Market entrance is a strategy that can ensure that smallholder farmers' food necessities are met and that they make adequate income for their immediate consumption needs, investments, and social purposes (Mathenge *et al.,* 2010). It can also lead to more comparative advantages in resource use, which can be shown in improved productivity through economies of scale, higher incomes, and access to new opportunities, which can lead to well-being gains for smallholder farmers (Jaleta *et al*., 2009; Mathenge *et al.,* 2010). Smallholder farmers can be consumers and producers in the market. They can participate in the agricultural output markets and derive income from sales, buying food items unavailable from their production, thereby contributing to their dietary diversity and food and nutrition security (Sibhatu *et al*., 2015). Consequently, market participation is expected to affect several aspects of rural households that influence their well-being, such as income, productivity, production, and food and nutrition security. Despite the potential benefits that market access can offer, smallholder farmers may still not interact directly with the market. Smallholder farmers' market participation is affected by many factors, such as market imperfections, technical inability, inappropriate agricultural policies, limited knowledge, price instability, and socio-economic factors (Roa and Qaim, 2011; Seng, 2016). This has resulted in smallholder farmers producing mainly starchy cereal crops and few protein-enriched crops, limiting food diversity from their own production (Ng'endo *et al.*, 2018). The failure of smallholder farmers to access markets has shown that there are inequalities in the food security strategy implemented by the South African government (Sobratee *et al*., 2022). The National Food and Nutrition Security Policy was developed in 2013 to ensure the accessibility,

availability, and affordability of safe and nutritious food at household and national levels (National Development Agency (NDA), 2013). However, there is still an issue of availability, affordability, and accessibility within smallholder production (Hendriks, 2014). Therefore, it is important to assess how to market participation affects food and nutrition, so that evidence-based information can be provided to improve food security and market policies.

Despite the importance of market participants in the food security strategies of many developing countries such as South Africa, limited empirical knowledge exists on the linkages between the two. Fusco et al. (2020) posited that similar observations were found in developed countries, suggesting a need to give attention to developing and developed countries. Other studies (Dowler and O'Connor, 2012; Kirwan and Maye, 2013; Miewald and McCann, 2014) have also investigated the problem of food security in economically developed countries. Several studies (Alene *et al.,* 2008; Omiti *et al*., 2009; Sebatta *et al.,* 2014; Singh-Peterson and Iranacolaivalu, 2018) have paid more attention to analysing factors determining farmers' market participation in various parts of developing countries. On the other hand, food security studies (Sinyolo *et al*., 2014; Musemwa *et al*., 2015; Walsh and van Rooyen, 2015; Sinyolo and Mudhara, 2018) have not investigated the role of market participation. There is, therefore, a need for quantitative research linking market participation to food security indicators to offer empirical-based evidence of the role market access plays in reducing rural hunger, food insecurity, and malnutrition. Against this backdrop, the presented study has the following aims: (1) to determine the factors that influence market participation among smallholder farmers and (2) to quantify the effects of market participation on rural farming households' food security in two Provinces of South Africa.

5.2. Analytical framework

The quantitative data were analyzed using STATA statistical software (version 13) and Statistical Software for Social Sciences (SPSS) version 24. The descriptive statistics analysis was performed to compare the sampled population's socio-economic factors and food security status between smallholder farmers who participated in the market and those who did not. The food security assessment used the internationally accepted food measurement tool: The Household Food Insecurity Access Scale (HFIAS).

The HFIAS was used to evaluate the "access component of household food insecurity" considering the information provided in a month (Coates *et al.,* 2015). This scale has about

nine questions based on an individual's food access uncertainty and anxiety. Also, the questions were based on the amount of quality food consumed by a household. Tables 5.1 and 5.2 show the responses received from participants when they were asked the nine questions. The main aim of the survey was to evaluate whether participants had encountered any problems accessing food for 30 days. The questions that were asked were divided into three parts which showed an increasing level of severity of food insecurity: (question 1), inadequate quality (questions 2–4), and insufficient intake (questions 5–9). The participants were asked to specify the occurrence of the situation, i.e., if the situation had occurred rarely or never occurred (once or twice in the past month), sometimes (three to ten times in the past month), or often (more than ten times in the past month).

Table 5.1: Household food insecurity access scale survey among smallholder farmers in the 2016/2017 season in Mpumalanga province.

Do You or Your Household Members Have the Following Problems with Ensuring Food Security Due to Financial Problems/ lack of resources:	**Last 30 days**			
	No	**Rarely (1 – 2 times)**	**Sometimes (3 – 10 times)**	**Often (more than 10 times)**
Worry about not having enough food	147	212	199	51
Do not eat your kinds of preferred food	110	225	216	58
Limit the diversity/quality of meals	102	230	211	66
Consume some foods that you do not want to eat	105	227	209	67
Limit has eaten food portions	161	227	179	41
Limit the number of meals	186	213	161	49
No food to eat of any kind in your household	353	139	95	21
Go to sleep at night hungry	465	85	37	22
Go a whole day and night without eating anything	496	60	30	20

Source: Own analysis

Table 5.2: Household Food Insecurity Access Scale survey among smallholder farmers in the 2016/2017 season in Limpopo province.

Do You or Your Household Members Have the Following Problems with Ensuring Food Security Due to Financial Problems/ lack of resources:	**Last 30 days**			
	No	**Rarely (1 – 2 times)**	**Sometimes (3 – 10 times)**	**Often (more than 10 times)**
Worry about not having enough food	231	276	305	98
Do not eat your kinds of preferred food	166	286	332	123
Limit the diversity/quality of meals	157	287	329	137
Consume some foods that you do not want to eat	157	285	325	141
Limit eaten food portions	240	288	287	94
Limit the number of meals	266	268	270	104

No food to eat of any kind in your household	511	191	159	48
Go to sleep at night hungry	667	123	72	48
Go a whole day and night without eating anything	728	86	63	31

Source: Own analysis

The study assessed whether market participation by smallholder farmers would increase their food security. It was hypothesised that smallholder farmers participating in the market could experience improved food security. The income obtained from their produce could be used to buy other healthy foodstuffs they cannot produce and to buy more inputs for sustainable production and improved productivity.

5.2.1. Extended ordered probit regression model for ordered responses

Ordered probit regression models recognize the indexed nature of various response variables; in this application, food insecurity severities are the ordered response. Underlying the indexing in such models is a latent but continuous descriptor of the response. The random error associated with this continuous descriptor is assumed to follow a normal distribution in an ordered probit model. The ordered probit regression model is preferred to multinomial logit and other probit models as it allows the data's ordinarily and increases the degrees of freedom available for estimating parameters. Multinomial logit is associated with undesirable properties such as the independence of irrelevant alternatives and lack of a closed-form likelihood (Greene, 2000).

The ordered probit can be estimated via several commercially available software packages and is theoretically superior to most other models for the data analysed in this work. The following specification for the extended ordered probit regression model was used:

$$T_n^* = \beta' Z_n + \varepsilon_{n,}$$

Where T_n^* is the latent and continuous measure of food insecurity severity faced by smallholder farmers n in a rural area, Z_n is a vector of explanatory variables describing the socio-characteristics of farmers, β is a vector of parameters to be estimated, and ε_n is a random error term (assumed to follow a standard normal distribution).

The observed and coded discrete food insecurity severity variable T_n is determined from the model as follows:

$$
\begin{aligned}
T_n = 0 \ &if \ -\infty \le T_n^* \le \mu_1 (Food \text{ secured}) \\
1 \ &if \ \mu_1 < T_n^* \le \mu_2 \ (Mildly \ to \ food \text{ secured}) \\
2 \ &if \ \mu_2 < T_n^* \le \mu_3 \ (\text{moderate to food insecured}) \\
3 \ &if \ \mu_3 < T_n^* \le \infty \ (Severely \ food \ in \text{secured})
\end{aligned}
$$

Where the μ_i represent thresholds to be estimated (along with the parameter vector β).

The probabilities associated with the coded responses of an ordered probit model are as follows:

$$
\begin{aligned}
P_n(0) &= \Pr(T_n = 0) = \Pr(T_n^* \le \mu_1) = \Pr(\beta' z_n + \varepsilon_n \le \mu_1) \\
&= \Pr(\varepsilon_n \le \mu_1 - \beta' z_n) = \phi(\mu_1 - \beta' z_n) \\
P_n(1) &= \Pr(T_n = 1) = \Pr(\mu_1 < T_n^* \le \mu_2) \\
&= \Pr(\varepsilon_n \le \mu_2 - \beta' z_n) - \Pr(\varepsilon_n \le \mu_1 - \beta' z_n) \\
&= \phi(\mu_2 - \beta' z_n) - \phi(\mu_1 - \beta' z_n) \\
P_n(k) &= \Pr(T_n = k) = \Pr(\mu_k < T_n^* \le \mu_k + 1) \\
&= \phi(\mu_{k+1} - \beta' z_n) - \phi(\mu_k - \beta' z_n) \\
P_n(K) &= \Pr(T_n = K) = \Pr(\mu_K < T_n^*) \\
&= 1 - \phi\left(\mu_K - \beta' z_n\right)
\end{aligned}
$$

Where n is an individual, k is a response alternative, $P(T_n = k)$ is the probability that individual n responds in a manner k , and ϕ ( ) is the standard normal cumulative distribution function. In the increasing nature of the ordered classes, the interpretation of this model's primary parameter set β is as follows: positive signs indicate higher food insecurity severity as the value of the associated variables increase, while negative signs suggest the converse. These interactions must be compared to the ranges between the various thresholds to determine the most likely food insecurity classification for a particular smallholder farmer.

Table 5.3 represent the explanatory variable that affects market participation among smallholder farmers.

Table 5.3: A priori expectations for the explanatory variables used in the models

Variables names	**Variable type and measurement**	**Hypothesized effect on Market Participation**	**Hypothesized impact on household food security**
Age of the household head	Age of the respondent head in years	±	±

Gender of household head	1= if a respondent is male, 0 otherwise	+	+
Marital status	1= if the respondent is married, 0 otherwise	±	±
Household size	The farm household's total family members	−	−
Education level of the household head	Years of education (continuous)	+	+
Ownership of livestock	1= if the respondent owned livestock, 0 otherwise	±	±
Access to market information	1= if respondents had received information on the market, 0 otherwise	+	+
Involvement in crop production	1= if respondents had been involved in crop production, 0 otherwise	+	+
Disability in the family	1= if there is a member in the family that lives with a disability, 0 otherwise	−	−
Access to agricultural assistance	1= if respondents had access to extension services, 0 otherwise	+	+
Family member with HIV	1= if there is a member in the family that is HIV positive, 0 otherwise	−	−
A family member worked on a farm	1= if there is a member that worked on a farm, 0 otherwise	+	+
Income	1= if there is a member that worked for a wage salary, 0 otherwise	+	+
Social grant	1= if there is a member in a family that received a social grant, 0 otherwise	±	±
Irrigation type	1= if the respondent had access to an irrigation system, 0 otherwise	±	±

Source: Own analysis

5.3. The study area, sampling, and data collection technique

The study area, sampling, and data collection technique are the same as in chapter three.

5.4. Results

5.4.1. Descriptive analysis of the results

The data reveals that out of the total sample of 1520 smallholder farmers, 389 (representing 12.6%) of the smallholder farmers were market participants, while 1131 (representing 74.4%) had not participated in the market, as shown in Table 5.4.

Table 5.4: Demographic characteristics of smallholder farmers in Limpopo and Mpumalanga province, South Africa.

		Market participants	Non-Market participants	Total
Province name	Mpumalanga	176	433	609
	Limpopo	213	698	911
Total		389	1131	1520

Source: own analysis

5.4.1.1 Occurrence of Food Insecurity by Household Characteristics Based on HFIAS Categories

The Household Food Insecurity Access Scale, which is aimed at determining households' access to food, revealed that overall (n=1520), 85% of the households were food insecure, and only 15% were food secure, indicating that the majority of the households were experiencing difficulties when it comes to food access. Regarding the HFIAS tool categories, 51% were severely or moderately severely food insecure, indicating severe challenges relating to access to food by those surveyed households.

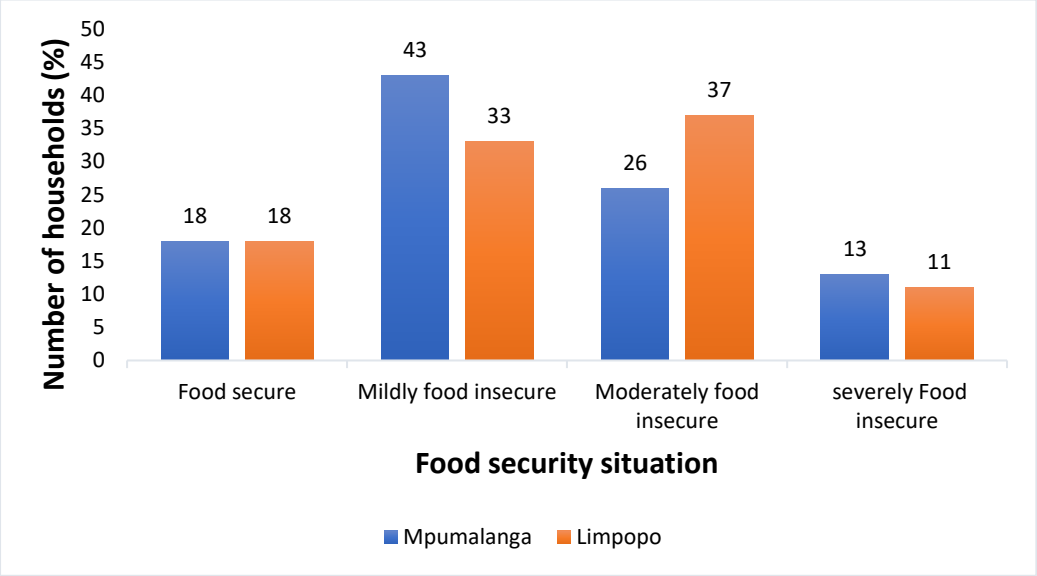

Figure 5.1: Food insecurity situation of the smallholder farmers in the two provinces (Mpumalanga (n=609) and Limpopo (n=911)). Source: own analysis

Analysis of the food security situation for the two provinces revealed that the majority of farmers in Mpumalanga province were mildly food insecure (43%), while in Limpopo province, the majority of farmers were moderately food insecure (37%) (Figure 5.1). About 13% of farmers were severely food insecure in Mpumalanga, and about 11% were severely food insecure in Limpopo, indicating that some of these farmers experienced difficulties accessing food.

5.4.2. Determinants of market participation among smallholder farmers

The results in Table 5.5 highlight the determinants of market participation among smallholder farmers in the Limpopo and Mpumalanga provinces of South Africa. The marginal analysis results showed that the gender of the household head had a positive statistically significant ($p < 0.10$) impact on market participation among smallholder farmers. This means that more males participated in the market. Having a family member with HIV had a negative and statistically significant impact on market participation among smallholder farmers.

Table 5.5: Factors influencing market participation among smallholder farmers

Market participation	Probit			Marginal effect		
	Coeff	**St.Err.**	**p-value**	**dy/dx**	**St.Err.**	**p-value**
Household size	0.032	0.045	0.476	0.001	0.001	0.477
Gender of household head (male=1, 0 otherwise)	0.644	0.319	0.043**	0.015	0.008	0.053*
Age of household head	-0.004	0.008	0.599	-0.000	0.000	0.600
The educational level of the household head	-0.258	0.426	0.546	-0.006	0.010	0.545
Marital status of household head (married =1, 0 otherwise)	-0.151	0.452	0.739	-0.004	0.011	0.739
Agricultural assistance	0.235	0.423	0.566	-0.002	0.011	0.543
Family member with HIV	-1.222	0.473	0.010**	-0.029	0.011	0.011**
Social grant	1.184	0.335	0.000***	0.028	0.008	0.001***
Wealth index	1.021	0.163	0.000***	0.024	0.005	0.000***
Amount Harvested	0.000	0.001	0.785	-0.000	0.000	0.785
Constant	0.509	0.798	0.524			
Mean dependent var	0.649					
Pseudo r-squared	0.926					
Chi-square	1268					
Akaike crit. (AIC)	120.8					
Prob > chi2	0.001					
Bayesian crit. (BIC)	170.4					

Notes: Dependent variable is market participation; ***, **, * Indicate significance at 1%, 5%, and 10% levels, respectively—source: Own analysis.

Contrary to the expectations, social grants had a positive and statistically significant ($p < 0.01$) impact on market participation among smallholder farmers, i.e., households with social grants

participated more in the market than those without social grants. The increasing wealth index had a significant positive increase in market participation among smallholder farmers.

5.4.3. Determinants of market participation on the severity of food insecurity (HFIAS) - Extended ordered probit regression model

The Ordered probit regression model was estimated for food insecurity severity in terms of HFIAS of all the smallholder farmers that have or have not participated in the market. Table 5.6 provides the estimated results of ordered probit models of food insecurity severity of smallholder farmers who participated and those who did not participate in the market. Since the dependent variable, HFIAS, increases with food insecurity severity, positive coefficients suggest the likelihood of more severe food insecurities and negative coefficients otherwise.

Table 5.6: Determinants of household food insecurity access scale using Extended ordered probit regression

	Non-market participants			**Market participants**		
Household Food Insecurity Access Scale (HFIAS) category	**Coef.**	**Std.Err.**	**P-value**	**Coef.**	**Std.Err.**	**P-value**
Age of household head	0.003	0.003	0.339	-0.006	0.002	0.012**
Household size	0.039	0.019	0.000***	0.085	0.015	0.000***
Gender of household head (male=1, 0 otherwise)	-0.556	0.196	0.004***	-0.257	0.184	0.162
The educational level of the household head	-2.301	0.640	0.000***	-0.637	0.548	0.245
Marital status (married=1, 0 otherwise)	-0.664	0.944	0.482	0.700	0.629	0.266
Irrigation type	0.174	0.267	0.514	0.414	0.307	0.177
Agricultural assistance	0.134	0.201	0.000***	0.195	0.131	0.000***
Ownership of livestock	-0.785	0.404	0.052*	-0.658	0.608	0.279
Income	-0.613	0.351	0.081*	0.330	0.408	0.419
Social grants	0.079	0.249	0.750	-0.419	0.233	0.072*
Wealth index	0.040	0.240	0.867	0.507	0.281	0.701
Access to market information	0.313	0.255	0.219	0.134	0.147	0.364
Disability in the family	0.574	0.950	0.546	-0.923	0.740	0.212
Family member with HIV	0.209	0.462	0.651	1.057	0.458	0.021**

Constant	2.519	0.261	0.000			
HFIAS categories						
Cut1	-0.921	0.645	-2.184	-1.704	0.892	-3.452
Cut2	1.489	0.650	0.215	0.771	0.893	-0.979
Correlation (market participation and HFIAS categories)	-1.000					

Notes: Dependent variable is HFIAS; ***, **, * Indicate significance at 1%, 5%, and 10% levels, respectively. Source: Own analysis.

The age of smallholder farmers that participated in the market was statistically significant at 5%, and it had a negative coefficient, i.e., as the age of smallholder farmers increases, they experience less food insecurity (Table 5.6). The household size of both market participants and non-market participants had a significant positive impact on the HFIAS, i.e., an increase in household size for both farmers and those who do not participate in the market increased in food insecurity severity. The gender of the household had a significant adverse effect on the HFIAS of non-market participants but with no difference for market participants (Table 5.6). As expected, access to agricultural assistance had a significant positive impact on the HFIAS, i.e. agricultural assistance was associated with increased food insecurity severity. The educational level of the household head had a significant adverse effect on the HFIAS of the non-market participants, with better-educated households that did not participate in the market being less likely to be food insecure. Also, livestock ownership had a statistically significant negative impact on the HFIAS of non-market participants, i.e., smallholder farmers that owned livestock, and did not participate in the market, were less likely to experience food insecurity.

It is generally assumed that higher-income households are more likely to be food secure. Indeed, income significantly negatively affected the HFIAS of the non-market participants, meaning that family members with income were food secure. Also, access to social grants significantly negatively affected the HFIAS of the market participants, i.e., smallholder farmers who received social grants and participated in the market were less likely to be food insecure. Lastly, having a family member with HIV significantly positively impacted the HFIAS of the market participants, i.e., as HIV-positive household members increase, there is a likelihood that farmers who participate in the market become more food insecure (Table 5.6).

5.4.3.1 Treatment effects of market participation on the HFIAS

The main objective of this study was to assess the effect of market participation on the food security of smallholder farmers in terms of HFIAS. The Extended ordered probit regression results showed that the food insecurity severity was associated with the positive coefficients received from the determinants of market participation. The study recognized that smallholder farmers' decision to participate in the market is based on various factors such as their productive inputs and socio-demographic characteristics, which are heterogeneous and can result in self-selection bias. Therefore, a sensitivity analysis was conducted to check the robustness of the estimated results. For the whole sampled population, the Average Treatment effect on the Treated (ATT) of the three food insecurity categories was compared with the expected average impact on the three food insecurity categories, as shown in Table 5.7.

Table 5.7: Treatment effect of market participation household food insecurity access scale

Food categories	Mean	ATT	t-stat	% change
p3 (mildly to food secured)	0.0614	0.0642	87.8587***	100%
p2 (Moderate food insecure)	0.7544	0.7675	54.5656***	98%
p1 (severely food insecure)	0.1840	0.1910	0.08535***	98%

***, Indicate significance at 1%. Source: Own analysis.

These results show that there was no major difference between the expected results and the conditional treated results. This means that the positive coefficients of the explanatory variables are associated with an increase in food insecurity severity in terms of HFAIS, whether farmers are participants or non-participants in the market. It can be concluded that the estimated effects of market participation on food security are also robust in general.

5.5. Discussion

The study's main objective was to assess the impact of market participation on the food security of smallholder farmers in the Mpumalanga and Limpopo provinces of South Africa. The overall results on HFAIS categories showed that most (85%) households were food insecure. This is because smallholder farmers in rural areas face numerous challenges threatening their access to healthy and nutritious food. Smallholder farmers in rural areas of South Africa can grow food for a living; however, they lack the necessary resources that will help them to continuously meet their dietary needs either through production or purchase (Hendriks, 2013; Ngema *et al*., 2018). In this study, the determinants of market participation were assessed, followed by their impact on household food security.

Gender plays a vital role in agriculture; males and females have different roles to ensure crops are produced and marketed effectively. Rural women are an essential resource in agriculture, providing labour (Hunt and Samman 2016), and are mainly involved in the production side Vigneri (2014). Males are the ones that participate more in the market; they are primarily engaged in cash crops that are meant to provide income than subsistence crops that are grown for consumption (Sebatta *et al.,* 2015). Our results confirmed that male-headed households indeed participate more in the market. On the other hand, the negative relationship between the gender of the household and the HFIAS of non-market participants implies that female-headed households were involved in other non-farm activities that provided money for them to spend more on different kinds of food and enhance household food security. However, this result was contrary to other studies (Taruvinga *et al.,* 2013; Magaña-Lemus *et al.,* 2016). Taruvinga *et al*. (2013) found that female-headed households participating in the market were food secure compared to male-headed households. Magaña-Lemus *et al.* (2016) found that male-headed households who participated in the market were more food secure as they had more capital and resources to increase their food security. Males and females play different roles in agriculture, which ensures that their families are well taken care of, and their food security is improved (Hill and Vigneri, 2014; Sebatta *et al.,* 2015; Samman, 2016).

Having a family member that is HIV positive had a negative impact on a farmer's participation in the market. This is because having a sick family member increases stress and affects other family members' mental and physical health (Cuadros *et al.,* 2019). This affects their decision to be involved in crop production and their decision to participate in the market (Cuadros *et al.,* 2019). National Home Sharing and Short Break Network (NHSN) (Undated) stated that having a family member with HIV is associated with time, financial costs, and physical and emotional demands, which affects education/training and work decisions. HIV affects the number of workers available for agricultural activities, leading to low production and productivity, and thus reduces the food stocks that could potentially be taken to the market as part of the outputs for smallholder farmers (FAO 2010). Most rural households depend more on social grants for a living (Waidler and Devereux, 2019). This study confirmed that access to social grants had a positive impact on market participation and a negative effect on the HFIAS of the market participants. This result was in line with that of Sinyolo (2016), who found that in rural areas, there are high levels of unemployed and shortages of economic opportunities, which result in rural households depending more on social grants for everything they do. The farmers use their social grant to purchase more inputs to use on the farm and

produce more for consumption and sale. Access to social grants can increase the productive and human capital capacity of many rural households (Sinyolo *et al.,* 2017). Contrary to these results, Sinyolo *et al. (2017)* found a negative association between social grant dependency and market participation, suggesting that social grant-dependent households are more subsistent, producing a less marketable surplus, which could lead to susceptibility to food insecurity.

Older smallholder farmers participated more in the market because smallholder agriculture mainly involves older people (Hlatshwayo *et al., 2021*). Older people tend to make better decisions when it comes to farming, as most of them use their retirement funds to invest in farming (Hlatshwayo *et al.,* 2021). Therefore, they produce enough variety of crops for home consumption and sell the surplus. Sinyolo and Mudhara (2018) explained that the increasing age of smallholder farmers is associated with increased social capital and experience in managing resources which helps them to be food secure. Social capital denotes the contacts, networks, and trust that allow farmers to use their resources more effectively (Kim and Kang, 2014).

The household size of both market participants and non-market participants positively impacted the HFIAS. This is because large households only produce staple crops for survival, not for their health (Kutiwa *et al.,* 2010). Moreover, an increase in household size causes farmers to produce more for consumption, and fewer sales are made from agricultural products. This result was in line with that of Martey *et al.* (2012), who reported that large household size reduces marketable surplus that might help farmers to receive income that will help them to purchase healthy foods and be food secure.

Agricultural assistance from the government, policymakers, and other stakeholders is supposed to improve smallholder farmers' production, marketing, and consumption, which can lead to more production of diverse crops and improve the food security of smallholder farmers. Access to agricultural assistance can provide information on market access and improved varieties that can improve farmers' knowledge of production (Sebatta, 2014; Kyaw *et al.*, 2018). It can also help farmers with various seeds that will help them produce diverse crops for sale and consumption (Jari and Fraser 2012; Fischer and Qaim 2012). However, in Nigeria, there was a negative relationship between agricultural extension and credit market participation among smallholder rice farmers (Ojo *et al.,* 2019). In this study, agricultural assistance increased food insecurity. The possible explanation for this might be that sometimes smallholder farmers do not receive enough or inadequate government assistance and end up utilizing whatever

resources they have to produce only staple crops (De *et al.,* 2005). Extension officers understaff the agricultural sector in South Africa, and poor training on sustainable crop production methods such as crop diversification means they do not provide sufficient market information or support (DALRRD 2008). Farmers rely on traditional methods to produce staple crops (Hlatshwayo *et al.,* 2021).

The educational level of the household head increased the food security of the non-market participants. This could be attributable to the fact that household heads with higher education can better access and use information that can improve their ability to improve their households' food security. They are also able to distinguish between healthy and non-health foods. The result is consistent with other studies (Kassie *et al.,* 2014; Mango *et al.,* 2014; Sinyilo and Mudhara, 2018). Also, the result revealed that livestock ownership negatively impacted the HFIAS of non-market participants. This implies that smallholder farmers that owned livestock and did not participate in the market were less likely to experience food insecurity. This is because livestock ownership is a sign of wealth in most developing countries like South Africa, especially in rural areas (Bundala *et al.,* 2020). So, households with more livestock are most likely to spend more on healthy food and are food secure. Bellemare and Barrett (2006) reported that livestock ownership helps ensure that food is always available as it can be sold during a food shortage.

The result showed that income had a Negative Effect on the HFIAS of the non-market participants. This is because households with income could spend a variety of foods. The result was substantiated by Gebre (2012), who found evidence that households with access to employment and income are likely to be food secure, and their household food security status is positive. Also, Taruvinga *et al.* (2013) found a positive association between income and food security statuses. It can be concluded that income leads to the high demand for various foods that lead to food security.

5.6. Conclusion and recommendations

Improved education among smallholder farmers can improve both market participation and food security. Workshops and focused training that will help farmers engage with different people and encourage them to explore other things are needed. This will help in utilizing resources as farmers will be exposed to different kinds of help and be willing to take the risk. While agricultural services are expected to improve market participation and food security, the findings of this study indicated that agricultural assistance did not improve food security. There

is a need to urgently address extension officers' shortages while also providing adequate training for improved quality service delivery to smallholder farmers. In the same vein, the age of the household showed a positive impact on food security; it is recommended that young people are also encouraged to participate in agriculture. This can be done by doing workshops in rural areas that will demonstrate different careers in agriculture and the importance of youth involvement in agriculture.

Access to social grants showed the potential to improve market participation and food security. However, some studies found social grants an as a disincentive to participate in crop production. To ensure that social grant is used effectively and sustainably, the government should re-look at giving cash to households. Sinyilo *et al.* (2017) recommended a policy option where some of the grants are offered as 'in-kind support', which is specific to the intended individual beneficiary, instead of fungible cash. Mtyingizane *et al.* (2020) recommended that the state and development agencies consider supplementing social grant support with more sustainable food security programmes such as investing in education and agricultural infrastructure for domestic food production. With these programs, households will be self-reliant with sustainable means of accessing adequate food, diversified diets, and an increase in daily meals.

Overall, it is advisable that the government and policymakers revise their agricultural marketing and food security policies and redo them so that they can cater to food and nutrition security improvement at household level and also consider the conditions under which smallholder farmers live and operate. The government needs to follow up on policy implementation so that rural households' food and nutrition status security can be improved and sustainable crop production can be attained, which will lead to more access to markets and crop sales.

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CHAPTER SIX

EFFECT OF MARKET PARTICIPATION ON NUTRITION SECURITY OF THE RURAL SMALLHOLDER FARMERS IN LIMPOPO AND MPUMALANGA PROVINCES, SOUTH AFRICA

6.1. Introduction

Hunger and malnutrition are complex global problems. Despite improvements in food and nutrition security over the last few decades, the prevalence of undernutrition remains high, especially in developing countries (Sibhatu *et al.*, 2015). Approximately 690 million of the world's population was reported malnourished in 2019 (FAO *et al*., 2020). In most Southern African countries, nutrient malnutrition is caused by inadequate dietary diversity, as most households lack essential vitamins and minerals (Akombi *et al.*, 2017; Drammeh *et al.,* 2019; Adeyeye *et al.,* 2021). Almost 2 billion people suffer from micronutrient malnutrition, primarily due to low intake of vitamins and minerals such as iron and zinc (International Food Policy Research Institute (IFPRI), 2014). Nutritional deficiencies cause an enormous health burden in terms of lost productivity, impaired physical and mental human development, susceptibility to various diseases, and premature deaths. Women and children are most susceptible to malnutrition (Sibhatu *et al.,* 2015). Previous studies revealed that malnutrition puts children at risk of catching infectious diseases, stunts growth increases the severity of infections, reduces school and work performance, and causes fatality in children under five years (Baird *et al*., 2016; Fink *et al*., 2017; Getahun and Fetene, 2021). Furthermore, the studies also showed that pregnant and lactating women are more vulnerable to malnutrition as they are responsible for their diets and their children. This shows the importance of investing more in nutrition as it can also enhance households' food security.

Nutrient deficiency, malnutrition, and lack of dietary diversity are common among rural smallholder farmers since they mainly rely on few starchy staple food sources and have limited market access (Berhane *et al.*, 2016). Smallholder farmers operate in remote areas with poor infrastructure, poor transportation, and lack of capital, technology and knowledge that will help them access the market. The poorly functioning market in rural areas contributes to farmers producing mainly for their consumption rather than selling (Bellon *et al.,* 2016). This means that most smallholder farmers depend on their production to meet their dietary diversity needs, which is not adequate. Having access to the market, farmers can be able to both meet their dietary diversity needs and also receive income. Getahun and Fetene (2021) reported that better access to the market could make smallholder farmers produce high-value agricultural products,

giving them a comparative advantage and helping them earn high expected income. Markets provide the opportunity for farm production to contribute to poverty reduction through the income obtained from sales of farm produce (Ssajakambwe *et al.*, 2020). Markets also drive production since they incentivize farmers to strive to meet the demands of buyers in terms of quality and quantity (Obi *et al*., 2012). There is a need to emphasize the role of market access to improved nutrition since it promotes the equal distribution of foods and incomes and creates opportunities for smallholder farmers to access more foods than what they produce (Ssajakambwe *et al.*,2020).

It is, therefore, important to empirically investigate the fundamental link between market participation and nutrition security (dietary diversity). Thus, understanding the linkages between household participation in agricultural output markets and dietary diversity could help inform nutrition interventions on how agricultural commercialization and rural markets can be leveraged to improve nutrition outcomes among smallholder farmers. Regardless of the essential role, that market participation has in enhancing smallholder farmers' nutrition security status of smallholder farmers; there is minimal evidence-based information that links the two, especially in South Africa. Mulenga *et al.* (2021) assessed how participation in output markets affects the dietary diversity of rural smallholder farmers in Zambia. Ssajakambwe *et al.* (2020) determined the relationship between market access and nutritional security in addition to factors influencing farmers' market access and improved nutrition among smallholder maize farmers in Uganda. Lenjiso *et al.* (2016) examined the effects of smallholder milk market participation on young children's household and intra-household dietary diversity and nutritional status in Ethiopia. These studies were conducted in other parts of Africa and indicated the gap in linkages between the two in South Africa. Against this backdrop, the study attempts to determine the factors that influence market participation among smallholder farmers. The study also quantifies the effect of market participation on rural households' nutrition security status in two provinces of South Africa.

6.2. Analytical framework

The quantitative data were analysed using STATA statistical software (version 13) and Statistical Software for Social Sciences (SPSS) version 24. The descriptive statistics were obtained to provide the critical socio-economic characteristics of the sampled smallholders and compare how they differed regarding nutrition security between market participants and non-market participants. The food security assessment employed the internationally accepted food

and nutrition measurement tool: The Household Food dietary diversity score (HDDS) and Food Consumption Score (FCS).

The HDDS indicates the variety of food and dietary diversity accessible to a household (Kennedy *et al*., 2011). The dietary diversity data is obtained through 24-hour recall questions about the food groups consumed by a household. The standard 12 food groupings identified by Swindale and Bilinsky (2006) were followed. The 12 food groups are cereal, vegetables, meat, roots and tubers, poultry and eggs, fruits, fish and seafood, pulses/legumes/nuts, milk and milk products, oil/fats, sugar/honey, and miscellaneous (which includes spices, sauces, salt, and other condiments). The food referred to here excludes food consumed from outside the household, such as restaurants, social gatherings, or any other unusual events that would otherwise misrepresent regular food consumption at the household level. The HDDS in this study was used as an outcome/ dependent variable to show nutrition diversity among market and non-market participants. The Food consumption score (FCS) is calculated using the frequency of consumption of different food groups consumed by a household during the seven days before the survey.

The study aims to evaluate market participation's effect on the nutrition security status of smallholder farmers. It is, therefore, assumed that smallholder farmers who participate in the market can receive income and buy more nutritious food to keep up with their required daily food intake. In the jargon of impact assessment, we would say an analysis of the impact of the treatment selection (market participation) on the outcome variable. The outcome variable is the HDDS, defined as the household's number of food groups consumed in the previous 24 hours. The definition of market participation can be the sales and income received by farmers. Households participating in the market are considered market participants and assigned a score of 1, otherwise 0.

In observational research like this, subject characteristics usually affect treatment selection. Usually, farmers make voluntary decisions to participate in the market based on their productive inputs and socio-demographic characteristics, resulting in self-selection bias. In this case, farmers' participation in the market cannot be randomly allocated. Where households are non-randomly treated, their choices for market participation can be influenced by their observed and unobserved characteristics that can correlate with the outcome variables. The missing counterfactual data is another major econometric challenge in impact assessment. Data

are missing because the outcomes can be observed only in one state, and the counterfactuals cannot be observed for each group (Wooldridge 2003).

Other studies (Kassie *et al*., 2011; Danso-Abbeam and Baiyegunhi, 2019) have used the two main econometric frameworks (instrumental variable (IV) and propensity scores approach) to account for confounding variables and the issue of counterfactuals. Propensity score approaches such as propensity score matching, regression adjustment, and inverse probability weighting only account for observed heterogeneity, while IV methods account for both observed and unobserved heterogeneity. This study depended on the instrumental variable Poisson regression model, which was used by Danso-Abbeam *et al.* (2021). The model uses the count outcome with the Poisson distribution of the error term to estimate the causal effect of participating in the market on nutrition security status.

The main interest of this study is to measure the average treatment effect on the treated (ATT). According to Takahashi and Barret (2014), ATT can be defined as the average difference in potential outcomes of smallholder farmers with or without participation in the market. According to Imbens and Wooldridge (2009) and Adolwa et al. (2019), the ATT can be expressed as;

$$ATT = E\left(Y_{1j} - Y_{0j} / T_j = 1\right) = E\left(Y_{1j} / T_j = 1\right) - E\left(Y_{0j} / T_j = 1\right) \qquad (1)$$

Where $E\{.\}$ denotes the expectation operator, Y_{1j} is the potential outcome for smallholder farmers who participate in the market, Y_{0j} is the possible outcome for smallholder farmers who do not participate in the market. T_j Represents the treatment indicator which takes the value 1 if smallholder farmers participate in the market and 0 otherwise. One critical challenge in estimating the ATT is unobserved counterfactual situations. Therefore, it is almost impossible to observe the potential outcomes of farmers who participated in the market had they not participated. Replacing this unobserved counterfactual with the potential outcomes of smallholder farmers who have not participated in the market is also not viable, as it is likely to result in biased estimates (Takahashi and Barret, 2014). The issue is addressed using the primary model, the endogenous Poisson treatment effect, as described by Terza (1998).

6.2.1. Endogenous treatment effect model for a count outcome – Poisson

As indicated above, the study is interested in whether smallholder farmers' market participation impacts their food and nutrition security status. Market participation by smallholder farmers is not exogenous; therefore, market participation is considered an endogenous binary-treatment variable T_j. T_j It is endogenous if treatment assignment is not random, but some unobservable covariates (variables) are affecting T_j that also affect the outcome variable Y_j. Since the HDDS (outcome variable) is a count event that takes the values, $Y_j = 0,1,2,.....Y_n$ and smallholder farmers decide whether to adopt a number of them or none, a second dummy S_j was defined to represent a sample selection rule. That is, smallholder farmers may not participate in the market. In this case, S_j it is missing for a proportion of the sample, and the selection rule is defined as $S_j = 1$ when Y_j it is observed and $S_j = 0$ when Y_j it is missing. Endogeneity and sample selection were solved using the count data model with endogenous treatment (Miranda, 2004).

The Poisson endogenous treatment effect model considers the case where the selection dummy S_j is assigned the value 0 when smallholder farmers did not receive any nutritional security status (Y_j is missing) and 1 when smallholder farmers did receive nutritional security status from market participation (Y_j is observed). The endogenous treatment and the selection dummies can be generated according to the continuous latent variables;

$$T_j^* = Z_i^{'} + \mu_j \qquad (2)$$

$$S_j^* = X_j^{'}\beta + \delta T_j + \varepsilon_j \qquad (3)$$

With $T_j = 1(T_j^* > 0), S_j = 1(S_j^* > 0)$ The outcome model, which follows a Poisson distribution, can be specified as;

$$Y_j = \left\{ \begin{matrix} 0 \\ \left\{ \mu^{Y_j} \exp(-\mu) \right\} / Y_j ! \end{matrix} \begin{matrix} if S=0 \\ if S=1 \end{matrix} \right\} \qquad (4)$$

Thus, $E(Y_j / X_j, T_j, \varepsilon_j) = \exp(X_j\beta + \delta T_j + \varepsilon_j \qquad (5)$

X_j denotes the vector of covariates used to model the count outcome, are the covariates for binary treatment and are the error terms for the outcome and treatment, respectively. The two

error terms are bivariate normal with a mean zero. The covariates X_j Z_j are exogenous; thus, they are unrelated to the error terms. Conditional, on ε_j μ_j is normal with mean $\varepsilon_{j\rho/\sigma}$ and variance $(1-\rho^2)$. In estimating the ATE and ATT, the endogenous treatment Poisson regression model is nested in a potential outcome model. The potential outcome model specifies what each farm household would obtain in each treatment level.

Table 6.1 represent the explanatory variable that affects market participation among smallholder farmers.

Table 6.1: A priori expectations for the explanatory variables used in the models

Variables names	**Variable type and measurement**	**Hypothesized effect on Market Participation**	**Hypothesized effect on household nutrition security**
Age of the household head	Age of the respondent head in years	±	±
Gender of household head	1= if the respondent is male, 0 otherwise	+	+
Marital status	1= if the respondent is married, 0 otherwise	±	±
Household size	The farm household's total family members	−	−
Education level of the household head	Years of education (continuous)	+	+
Ownership of livestock	1= if the respondent owned livestock, 0 otherwise	±	±
Access to market information	1= if respondents had received information on the market, 0 otherwise	+	+
Involvement in crop production	1= if respondents had been involved in crop production, 0 otherwise	+	+
Disability in the family	1= if there is a member in the family that lives with a disability, 0 otherwise	−	−
Access to agricultural assistance	1= if respondents had access to extension services, 0 otherwise	+	+
Family member with HIV	1= if there is a member in the family that is HIV positive, 0 otherwise	−	−
A family member worked on a farm	1= if there is a member that worked on a farm, 0 otherwise	+	+
Income	1= if there is a member that worked for a wage salary, 0 otherwise	+	+

Social grant	1= if there is a member in a family that received a social grant, 0 otherwise	±	±
Irrigation type	1= if the respondent had access to an irrigation system, 0 otherwise	±	±

Source: Own analysis

6.3. The study area, sampling, and data collection technique

The study area, sampling, and data collection technique are the same as described in chapter three

6.4. Results

6.4.1. Descriptive analysis of the results

The descriptive results showed that out of the total sample of 1520 smallholder farmers, 389 (representing 12.6%) of the smallholder farmers were market participants, while 1131 (representing 74.4%) had not participated in the market, as shown in Table 6.2. Farmers who participated in the market enjoyed higher HDDS than those who did not, with an average HDDS of approximately 2 per capita, and those who did not participate had an average of roughly 1.89 per capita, as shown in Table 6.3. This does not necessarily suggest that participation in markets can significantly improve rural farmers' household food and nutrition security due to the selection bias issue.

Table 6.2: Demographic characteristics of smallholder farmers in Limpopo and Mpumalanga province, South Africa.

Variable	Percentage (%)	Frequency
Farmers' participation in the market		
Market participant	12.6	389
Non-market participant	74.4	1131
Overall	100	1520

Source: own analysis

Table 6.3: The difference in HDDS between market participants and non-market participants

Variables	Mean	Standard deviation
Household Dietary Diversity (HDDS)		
Market participant	2.134	1.982
Non-market participant	1.982	1.218

Source: own analysis

6.4.1.1. Food Consumption Score of smallholder farmers

The proportion of smallholder farmers' food consumption scores before the study period is presented in Figure 6.1. In the overall population (n=1520), the acceptable food consumption score was 54%, followed by the borderline food consumption score at 30% and the poor food consumption score was the least at 16%. In the provinces, the acceptable food consumption score was 44% and 66% in Limpopo and Mpumalanga, respectively. 14% of the respondents for both provinces had a poor food consumption score. The borderline consumption score for Limpopo province was 42%, while it was 20% for Mpumalanga province.

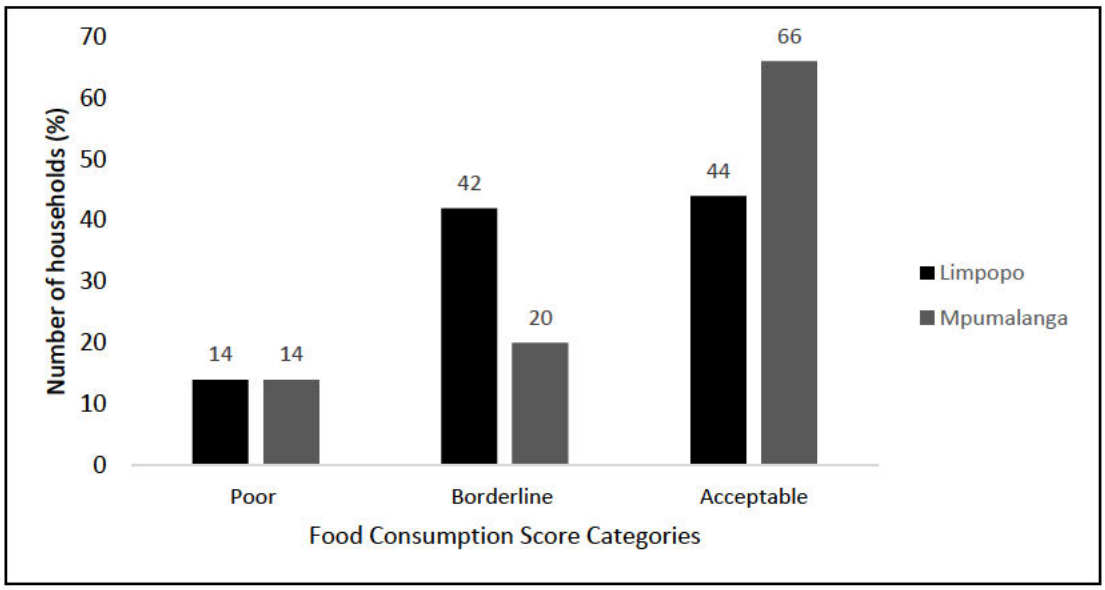

Figure 6.1: Food consumption score of smallholder farmers in Limpopo (n=911) and Mpumalanga (n=609) Provinces, South Africa.

6.4.1.2. Dietary diversity of smallholder farmers

Figure 6.2 show the dietary diversity of smallholder farmers in the Limpopo and Mpumalanga provinces before the study was conducted. In the overall sampled population (n=1520), 57% of smallholder farmers had the highest dietary diversity, followed by medium dietary diversity (25%), and the lowest dietary diversity was 18%. In the provinces, both Limpopo and Mpumalanga had 50% of the highest dietary diversity. The medium dietary diversity for Limpopo was 33%, and it was 35% for Mpumalanga province. Limpopo province had 17% of the lowest dietary diversity, while Mpumalanga had 15%.

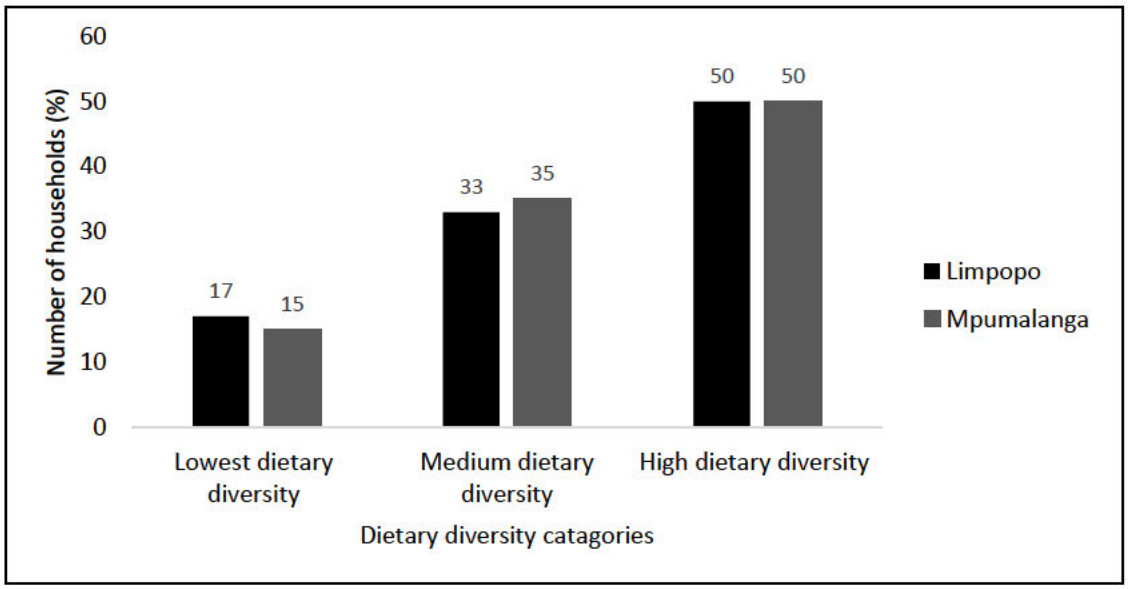

Figure 6.2: Dietary diversity of smallholder farmers in Limpopo (n=911) and Mpumalanga (n=609) Provinces, South Africa.

6.4.2. Determinants of market participation among smallholder farmers

The results in Table 6.4 presents the determinants of market participation among smallholder farmers in the Limpopo and Mpumalanga provinces of South Africa. The marginal analysis results showed that the gender of the household head had a positive statistically significant ($p < 0.05$) impact on market participation among smallholder farmers.

Table 6.4: Factors influencing market participation among smallholder farmers

Market participation	Probit			Marginal effect		
	Coeff	St.Err.	p-value	dy/dx	St.Err.	p-value
Household size	0.032	0.045	0.476	0.001	0.001	0.477
Gender of household head (male=1, 0 otherwise)	0.644	0.319	0.043**	0.015	0.008	0.053*
Age of household head	-0.004	0.008	0.599	-0.000	0.000	0.600
The educational	-0.258	0.426	0.546	-0.006	0.010	0.545

level of household head						
Marital status of household head (married =1, 0 otherwise)	-0.151	0.452	0.739	-0.004	0.011	0.739
Agricultural assistance	0.235	0.423	0.566	-0.002	0.011	0.543
Family member with HIV	-1.222	0.473	0.010**	-0.029	0.011	0.445
Social grant	1.184	0.335	0.000***	0.028	0.008	0.001***
Wealth index	1.021	0.163	0.000***	0.024	0.005	0.000***
Amount Harvested	0.000	0.001	0.785	-0.000	0.000	0.785
Constant	0.509	0.798	0.524			
Mean dependent var	0.649					
Pseudo r-squared	0.926					
Chi-square	1268.316					
Akaike crit. (AIC)	120.816					
Prob > chi2	0.000					
Bayesian crit. (BIC)	170.439					

Notes: Dependent variable is market participation; ***, **, * Indicate significance at 1%, 5%, and 10% levels, respectively—source: Own analysis.

Social grants had a positive and statistically significant ($p < 0.01$) impact on market participation among smallholder farmers. The results imply that households with social grants participated more in the market than those without social grants, as indicated by the marginal effect. The marginal effect results also showed that the wealth index had a positive and statistically significant impact on market participation among smallholder farmers.

6.4.3. The impact of determinants of market participation on the HHDS (nutritional status) of smallholder farmers – Poisson endogenous treatment effect model

The Wald Chi^2 (92.77, $p > 0.000$) indicates that the model is statistically significant at 1%, which suggests a good fit. The rho (ρ) was statistically significant at 1% (0.998, p >0.002). The significance of the rho *(ρ)* implies that unobserved characteristics of the smallholder farmers that influence their participation decisions in the market affect their nutritional status. The use of the Poisson endogenous treatment effect model to address the problem of endogeneity is, therefore, in order. The results showed that household size, agricultural

assistance, ownership of livestock, social grant, wealth index, access to market information, and involvement in crop production were all statistically significant, as shown in Table 6.5.

Table 6.5: Determinants of nutrition status using Poisson regression with endogenous treatment

Variables	Coef.	Std.Err.	P value
HDDS			
Age of the household head	-0.000	0.001	0.583
Gender of household head	-0.009	0.022	0.676
Households size	0.009	0.002	0.000***
The educational level of the household head	-0.047	0.054	0.391
Marital status	0.023	0.054	0.667
Access to agricultural assistance	-0.090	0.014	0.000***
Ownership of livestock	0.123	0.057	0.030**
A family member worked for a wage salary	0.009	0.043	0.838
Social grant	0.038	0.020	0.056*
WEALTH INDEX	0.058	0.024	0.015**
Access to market information	-0.038	0.018	0.031**
Involvement in crop production	0.199	0.058	0.001***
Family member with HIV	0.004	0.052	0.687
Market participation	0.084	0.029	-2.950
_cons	2.066	0.095	21.730
Market participation			
If a household received agricultural-related assistance	2.592	0.028	93.210
_constant	-0.931	0.015	-62.570
/athrho	3.430	0.374	9.170
/lnsigma	-17.326	0.107	-161.710
Wald Chi^2 (15)	92.77		
	0.000		
rho *(ρ)*	0.998	0.002	
sigma *(σ)*	0.000	0. 000	

Notes: Dependent variable is HDDS; ***, **, * Indicate significance at 1%, 5%, and 10% levels, respectively. Source: Authors' analysis.

Household size had a positive and significant impact on the nutrition status of smallholder farmers. This means an increase in household size led to increased household dietary diversity. The result showed an unexpected effect of agricultural assistance on HDDS, agricultural assistance had a negative impact on the HDDS, and it was statistically significant at 1%. Livestock ownership had a positive and statistically significant effect on the HDDS of smallholder farmers. The results showed that social grants had a positive and statistically significant (P>0.01) impact on the HDDS of smallholder farmers. Knowing a smallholder's

wealth index had a positive and significant impact. The results also showed that the involvement of smallholder farmers in crop production was statistically significant at 1% and positively impacted the HDDS of smallholder farmers. The coefficient on access to market information showed a positive effect on the HDDS and was significant at a 5% level.

6.4.3.1. Treatment effects on market participation of smallholder farmers

The main focus of this study was to assess the impact of market participation on the nutrition status of smallholder farmers in terms of HDDS. Descriptive statistics showed that the average per capita HDDS of smallholder farmers who participated in the market was higher than those who did not participate in the market. A simple considerable difference in the average per capita of HDDS between market participants and non-market participants in effect assessment is misleading as it involves bias and fails to consider the potential heterogeneity in the characteristics between the two groups. The evaluation from the endogenous Poisson regression model can also be inadequate though it accounts for endogeneity. This is because direct coefficients from the model cannot be considered as the Average treatment effect on the treated (ATT) since the issue of missing data (counterfactual scenario) has not been evaluated.

This study, therefore, turned to the results of the effects of participating in the market on the nutrition status of smallholder farmers in terms of HDDS using ATT and ATE, where the Poisson regression with endogenous treatment effects was used. The ATE and ATT were assessed after fitting the Poisson regression with endogenous treatment effects. As shown in Table 6.6, the estimated potential outcome means (ATE) of market participation on HDDS was approximately 0.747 and was statistically significant at 1%. The ATE estimate indicated that the sampled population's average smallholder farmers who participated in the market had improved nutritional status. Correspondingly, the conditional treatment effect, which measures the ATT of market participation on HDDS, was around 0.768 and statistically significant at 1%. Therefore, smallholder farmers who participated in the market had an average of about 0.768 more HDDS than they would have if they did not participate.

Table 6.6: Treatment effects on market participation of smallholder farmers

Treatment effects	**Coefficient**	**Std.Err.**	**P-value**
Poisson regression with treatment effects			
Average treatment (ATE)	0.747	0.267	0.003***
Average treatment effect on the treated (ATT)	0.768	0.255	0.004***

Notes: ***, **, * Indicate significance at 1%, 5%, and 10% levels; source: Authors' analysis.

6.4.4. The impact of determinants of market participation on the Food Consumption Score of smallholder farmers_ ordered, logistic regression model

The results in Table 6.7 indicate the impact of market participation on the food consumption score of smallholder farmers. The result showed that household size had a negative and significant impact on the food consumption score of smallholder farmers. Gender of household head, irrigation type, social grant, and amount harvested had a positive and significant effect on the food consumption score of smallholder farmers.

Table 6.7: Determinants of Food Consumption Scores using ordered logistic regression model

Variables	Coef.	Std.Err.	P value
Food Consumption Scores			
Age of household head	-0.036	0.081	0.654
Household size	-0.058	0.031	0.063*
Gender of household head	0.874	0.305	0.004***
The educational level of the household head	1.167	0.902	0.196
Irrigation type	0.947	0.501	0.059*
Marital status	1.073	0.676	0.112
Main economic activity	-0.853	0.326	0.123
Family member with HIV	-0.739	0.599	0.217
Distance to the market	0.943	0.618	0.127
Social grant	-0.805	0.242	0.001***
Amount harvested	0.001	0.000	0.068*
Cut 1	1.749	4.312	.b
Cut 2	3.470	4.316	.b
Cut 3	7.693	4.434	.b
Mean dependent var	1.365	SD dependent var	0.620
Pseudo r-squared	0.032	Number of obs	788.000
Chi-square	38.909	Prob > chi2	0.000
Akaike crit. (AIC)	1212.228	Bayesian crit. (BIC)	1286.940

Notes: Dependent variable is FCS; ***, **, * Indicate significance at 1%, 5%, and 10% levels, respectively. Source: Authors' analysis.

6.5 Discussion

Food consumption score and dietary diversity are the dominant topics in the scientific world of nutrition as they are catalysts towards improved nutrition sensitivity and specific programs by identifying nutrient inadequacies in households (Ambaw *et al*., 2021). The literature has shown that socio-demographic, knowledge, attitude, and household assets-related characteristics are some of the key factors associated with household food consumption scores (Daba *et al*., 2013; Ambaw *et al*., 2021). Unacceptable food consumption score is a central public health problem; thus, strengthening nutrition intervention is very important (Isaura *et*

al., 2018). The current study found that slightly more than half (54% and 57%) of smallholder farmers had acceptable food consumption scores and the highest dietary diversity, respectively. These results were in line with Fite *et al.* (2022), who found that more than half of the pregnant women in Haramaya District, eastern Ethiopia had acceptable food consumption scores. The study concluded that factors such as consumption of animal-source foods, attitude, wealth, and agricultural land possession were positively associated with acceptable food consumption scores.

Smallholder farmers mainly depend on family labour for production, so an increase in household size will lead to more land being cultivated and more diversity of crops will be produced, which can improve their nutritional status. Our results confirmed that household size positively impacted smallholder farmers' household dietary diversity. The results were substantiated by Mulenga *et al.* (2021), who reported that household size increases labour availability to produce enough agricultural output for home consumption and surplus for sale. The study also added that the revenue they obtain could be used to purchase more diverse food groups. However, the result of this study showed that household size had a negative impact on the food consumption score of smallholder farmers. The possible explanation might be that an increase in household size leads to household members competing for the little food they have and end up consuming less diverse food.

Agricultural assistance from the government, policymakers, and other stakeholders is supposed to improve smallholder farmers' production, marketing, and consumption, leading to more production of diverse crops and improving the nutritional status of smallholder farmers. However, in this study, agricultural assistance had a negative impact on the HDDS. The possible explanation for this might be that sometimes smallholder farmers do not receive enough or inadequate government assistance and end up utilizing whatever resources they have to produce only staple crops (De *et al.*, 2005). The few extension workers the government deploys to help farmers do not train them properly on sustainable crop production methods such as crop diversification. They sometimes provide farmers with sophisticated technology and inputs without any training. This results in farmers relying on their traditional techniques to produce staple crops. This result aligns with the study of Ojo *et al.* (2019), who found a negative relationship between agricultural extension and credit market participation among smallholder rice farmers in Southwest Nigeria. However, the result is a variance from the studies of Jari and Fraser (2012); Fischer and Qaim (2012); Sebatta (2014); Kyaw *et al.* (2018), which found a positive and significant relationship. These studies explained that having access

to agricultural assistance can provide information on market access and improved varieties that can improve farmers' knowledge of production. It can also help farmers with various seeds that will help them produce a diversity of crops for sale and consumption.

Livestock is an important production shifter because it enhances the capacity of a household to produce more, increasing the chances of a household's market participation (Pica-Ciamarra *et al*., 2011). The result of this study confirmed that ownership of livestock positively impacted the HDDs of smallholder farmers. Smallholder farmers with livestock can sell some of their livestock to buy nutritious foods and use their livestock sales to invest more in crop production. However, contrary to these findings, Kyaw *et al.* (2018) reported that if a household has livestock, the household members will need to share time and money with the livestock for feeding them and taking care of the livestock, in consequence, they will have less production surplus to sell in the market. The study further explained that farmers who own scarce land must compromise on crop production and focus on livestock breeding, which may negatively affect their marketed surplus.

Social grants have become an increasingly popular means of improving the welfare of underprivileged households in South Africa and beyond (Grinspun, 2016). The results of this study have proven that the social grant positively impacted the market participation, FCS, and HDDs of smallholder farmers. Social grants aim to alleviate poverty and improve human capital capacity. Many studies reported that social grants might increase rural households' productive capacity but may have an unintended positive or negative effect (Todd *et al*., 2010; Covarrubias *et al.*, 2012; Boone *et al.*, 2013; Sinyolo *et al*., 2017). The studies reported that social grants are disincentives for households to commercialize their farming activities. The households depend more on social grants and produce a less marketable surplus. This result in less dietary diversity since the social grant is not enough.

Smallholder farmers that know their resources and living standards tend to utilize what they have and produce effectively. Our results confirmed Knowing the wealth index positively impacted market participation and the nutrition status of smallholder farmers. The results also showed that the involvement of smallholder farmers in crop production positively impacted the HDDs of smallholder farmers. This was because smallholder farmers involved in crop production use the opportunity of market participation by being both sellers and buyers. They produce more crops to sell the surplus in the market and use the income earned to buy other food groups that they cannot produce. This result is in line with Mathenge *et al.* (2010);

Mulenga *et al*. (2021) reported that farmers involved in crop production have more comparative advantages in resource use, which can be shown in improved productivity through economies of scale.

The positive outcome of market information implies that farmers with access to market information are likely to sell their products and make a profit. The results showed that the market information helped farmers with the knowledge of the market. Farmers were able to get information on pricing strategies and information on the crops that were in demand. This result is similar to Kyaw *et al*. (2018), who concluded that access to market information would lead to increased productivity with a high marketable surplus.

Irrigation type and amount of crop harvested showed positive results on the FSC of smallholder farmers. This is because having access to an irrigation system makes smallholder farmers depend less on rain and be able to produce crops under unfavorable weather conditions. Contrary to this, Fanadzo *et al*. (2010); Post *et al.* (2012) reported that most smallholder farmers in rural areas have access to the irrigation system. These studies further noted that most smallholder farmers depend on rainfall for their production, which is why they have less diversity in their crop production

6.6. Conclusion and recommendations

The magnitude of undernutrition in developing countries remains high despite food and nutrition security improvements over the last few decades. The results showed that more than half of smallholder farmers had acceptable food consumption scores and the highest dietary diversity. Therefore, this study recommends that more specific nutrition programs be established to improve the nutritional status of smallholder farmers. The result also showed that agricultural assistance significantly impacted the HDDs of smallholder farmers. Agricultural assistance is more associated with the improvement of extension services which can lead to more production of diverse crops and more market participation.

Health extension workers need to do more nutrition programs and workshops in rural areas. These programs and workshops will provide nutrition education, creating awareness among smallholder farmers on diverse and balanced food items they should produce, sell and consume. The extension workers can also invite nutritional counselors to address food diversity's importance. The nutritional counselors will demonstrate and provide guidebooks on all the diverse and balanced food items required. The workshops will also be used to help smallholder farmers how they can improve their market participation. The extension workers need to

develop different and easy strategies for delivering market information to smallholder farmers. This will help smallholder farmers make production decisions that are in line with consumer demand.

6.7. References

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CHAPTER SEVEN

FACTORS AFFECTING CROP PRODUCTIVITY AMONG SMALLHOLDER FARMERS IN LIMPOPO AND MPUMALANGA PROVINCES, SOUTH AFRICA

7.1. Introduction

Economic development, food security, and poverty alleviation in developing countries are directly linked to the agricultural sector (Mugendi, 2013; Fedoroff, 2015). Agriculture is a vital sector for many developing countries. Regardless of its small contribution (2.2%) to South Africa's Gross Domestic Product (GDP), the sector is still essential for rural livelihoods and helps to increase employment growth by 5.2% (Statistics South Africa (stat SA), 2013). However, South Africa's agriculture mainly involves unprivileged smallholder farmers, and it is for subsistence (Food and Agriculture Organisation (FAO), 2015). Smallholder farmers suffer low income from agricultural production, and they continue to experience poverty, food insecurity, and climate uncertainties. South Africa has not been able to achieve self-sufficiency in food production due to many factors, such as the lack of mechanization and the small-scale nature of production (Obasi *et al.*, 2013). The country is among the countries in sub-Saharan Africa suffering significant food shortages as over 40% of the population is projected to be food insecure (FAO, 2015).

Smallholder farmers in South Africa are still trapped in low-productivity traditional technologies that have a negative impact on output and livelihoods (Obi and Seleka, 2011; Calzadilla *et al.*, 2014). Low agricultural productivity threatens the efforts of lessening poverty and improving food security. It also limits the ability of farmers to take on new opportunities in the worldwide food system (Turpie and Visser, 2013). By 2050, it is estimated that the global population will increase to 9 billion, and food demand is expected to rise by 60% (United Nations, 2017; Goldbatt, 2010). To provide enough food for this rapidly growing population under existing climate, social, and land changes, sustainable agricultural productivity should be utilized in food production (Goldbatt, 2010). Increasing demand for food can be met through improved productivity or cropland expansion. Crop productivity can be enhanced by using fertilizers, innovative irrigation, and adopting sustainable farming methods (Elferink and Schierhorn, 2016). This can help to improve crop yields from existing land through effective and efficient use of available resources and inputs.

Smallholder farmers can adopt sustainable agricultural practices to improve crop productivity; these include intercropping, crop rotation, use of crop cover, green and animal manure, rainwater harvesting, and minimum tillage (Myeni *et al.*, 2019). However, the adoption levels

of these practices by South African smallholder farmers are still minimal. The land remains underutilized as farmers cultivate small plots while possessing small land (1-2 hectares). Previous studies in South Africa and across the African continent indicated that socio-economic factors, farm characteristics, and agro-climatic characteristics were the main factors influencing crop productivity among smallholder farmers (Obasi *et al.,* 2013; Mango *et al*., 2017; Mekuriaw *et al.,* 2018; Myeni *et al.,* 2019). These factors include age, cropping patterns, years of farming experience, lack of access to credit, use of low-input technologies, lack of knowledge of high-input technologies and poor farm management skills, poor extension services, unavailability, and high cost. Therefore, factors influencing crop productivity vary with provinces and areas due to differences in cultural beliefs, natural resources, access to education, adequate information on sustainable farming methods, extension services, and infrastructure (Pretty *et al*., 2011; Mungai *et al*., 2016).

Given the extensive diversity of South African regions, understanding the constraints that influence crop productivity across the country is crucial to developing interventions to enhance crop productivity and adopt appropriate farming methods, not only in the study areas but also in other regions that face the same constraints. Resource utilization efficiency can be obtained at various levels to produce optimum food crops (Moses and Adebayo, 2006; Oluwatosin, 2006). This shows that smallholder farmers still have opportunities to improve production and productivity efficiency. Against this backdrop, the study examined agricultural production in South Africa with the main objective of determining and isolating the factors that affect farmers' productivity in the selected areas. The study described the effects of demographic and socio-economic characteristics on the agricultural productivity of smallholder farmers in the study areas.

7.2. Analytical framework

The quantitative data were analysed using STATA software (version 13). The descriptive statistics were performed to provide the key socio-economic characteristics of the sampled smallholders. It was performed to show mean averages and percentages of the different factors that affect the crop productivity of smallholder farmers. The Tobit regression model was employed to quantify the magnitude and direction of the factors influencing smallholder farmers' crop productivity. Many studies previously used the model (Ele, Omini, and Adinya, 2013; Kabiti *et al*., 2016; Rubhara and Mudhara, 2019; Rubhara *et al.,* 2020). The model answers both factors influencing the decision to be involved in crop production and the extent

of crop production, assuming that both decisions are affected by the same variables (Buke 2009). The Tobit model was appropriate for analyzing variables with lower and upper limits (McDonald and Moffitt 1980). In this case, the dependent variable, Crop Productivity, is lower censored at zero and upper censored at one as it can take values ranging between zero and continuous observation. Subsistence farmers who do not produce crops would have zero Crop productivity; on the other hand, farmers who produce crops would have crop productivity of one. The model estimates linear relationships since the dependent variable is censored from left to right (Tobin, 1958). The Tobit model fits the data well as it considers the qualitative difference between zero and continuous observations, unlike the ordinary least squares regression method (Bukenya, 2017; Oduniyi, 2018).

The Tobit model is defined as:

$$Y_i^* = \beta_0 + \beta X_i + \varepsilon_i \quad (1)$$

$$\begin{aligned} Y_i^* &= 1 \; if \;\; Y_i^* > 0 \\ Y_i^* &= 0 \; if \;\; Y_i^* \leq 0 \end{aligned} \quad (2)$$

$$Y_i^* = 0 \; if \;\; Y_i = 0 \quad (3)$$

Y_i^* It is the latent variable of the dependent variable, β is defined as the vector of parameters to be estimated, X_i is defined as a set of explanatory variables, and ε_i is the disturbance. The model errors ε_i are assumed to be independent, $N(0, \sigma^2)$ distributed, conditional on the X_i. The observed Y_i^* is defined as $1 \; if \;\; Y_i^* > 0$, and $0 \;\; if \;\; Y_i^* \leq 0$.

Explanatory variables used in the study

The decision of smallholder farmers to produce specific crops is influenced by different factors such as household characteristics, resource endowment, and information. Household characteristics include variables such as the age of the household head, gender, household size, marital status, and educational level. Household assets or resources include cattle, off-farm income, irrigation systems, and land. The level of access to information is captured by access to extension services. Table 7.1 summarizes the variables that were likely to affect the crop productivity of smallholder farmers.

Table 7. 1: Factors that are estimated to affect Crop productivity.

Variable name	variable definition	Variable type and measurement

Age	Age of the household head	In years (continuous)
Gender	Gender of household head	1= if the respondent is male, 0 otherwise
Marriage	Marriage status of the household head	1= if the respondent is married, 0 otherwise
Household size	Number of family members	Size of household (continuous)
Level of education	Education level of the household head	Years of education (continuous)
Yield	Yield harvested	In kilometers (continuous)
Land	Size of land cultivated	In Ha (continuous)
Involvement in crop production	Household head involved in crop production	1= if respondents had been involved in crop production, 0 otherwise
Irrigation	Access to irrigation scheme	1= if the respondent had access to an irrigation system, 0 otherwise
Family member with HIV	A family member that is living with HIV	1= if there is a member in the family that is HIV positive, 0 otherwise
A family member worked on a farm	A family member worked on a farm	1= if there is a member that worked on a farm, 0 otherwise
Disability in the family	Family member with a disability	1= if there is a member in the family that lives with a disability, 0 otherwise
Livestock	Ownership of livestock	1= if the respondent owned livestock, 0 otherwise
Social grant	Social grants received by households from the government	1= if there is a member in a family that received a social grant, 0 otherwise
Agricultural assistance	Access to extension service	1= if respondents had access to extension services, 0 otherwise

Source: own analysis

7.3. The study area, sampling, and data collection technique

The study area, sampling, and data collection technique are the same as in chapter three.

7.4. Results

7.4.1. Descriptive results

7.4.1.1. Demographic characteristics of smallholder farmers regarding crop productivity

In the sample of 1520 rural households, 386 were crop producers, and 1134 were non-crop producers (Table 7.2).

Table 7.2: Demographic characteristics of smallholder farmers in Limpopo and Mpumalanga province, South Africa.

		Crop producers	**Non-crop producers**	**Total**
Province name	Mpumalanga	176	433	609
	Limpopo	210	701	911

Total	386	1134	1520

Source: own analysis

Between crop producers and non-crop producers. The results showed that 74% of the crop producers knew about crop rotation, while 26% did not (Table 7.3). Of non-crop producers, 88% knew about crop rotation, while 12% did not. Regarding access to irrigation, 48% of crop producers had access, while 52% did not. Among non-crop producers, only 6% had access to irrigation, while 94% did not have access. Regarding agricultural inputs, 65% of crop producers had access, while 35% did not. Among non-crop producers, only 18% had access to agricultural inputs, while 82% did not have access. The results also showed that 22% of crop producers had access to mechanization, while 78% did not have access. Of non-crop producers, 12% had access to mechanization, while 88% did not.

Table 7.3: Demographic characteristics of smallholder farmers in Limpopo and Mpumalanga provinces, South Africa

Variables	**Crop producers (386)**		**Non-crop producers (1134)**		**Overall Freq**
	%	**Freq**	**%**	**Freq**	
Crop rotation					
Yes	74	286	88	1000	1286
No	26	100	12	134	234
Access to irrigation					
Yes	48	186	6	66	252
No	52	200	94	1068	1268
Access to inputs					
Yes	65	250	18	200	450
No	35	136	82	934	1070
Access to mechanization					
Yes	22	86	12	134	220
No	78	300	88	1000	1300

Source: own analysis

7.4.2. Determinants of crop productivity under smallholder farming using Tobit regression model.

Table 7.4 shows the results of the Tobit regression model used to determine the factors influencing smallholder farmers' crop productivity, revealing several interesting outcomes. Gender of the household head, irrigation system, involvement in crop production, and wealth index all positively influenced crop productivity ($p<0.01$). The results showed that access to agricultural assistance had a negative and significant impact on the crop productivity of smallholder farmers. This study has demonstrated unexpected effects on the impact of HIV on

the crop productivity of smallholder farmers. Having a family member with HIV was statistically significant and positively impacted the crop productivity of smallholder farmers.

Table 7. 4: Determinants of crop productivity under smallholder farming using the Tobit regression model.

Variables	**Coef.**	**Std.Err.**	***p*-Value**
Age of the household head	2.867	14.700	0.845
Household size	-79.950	91.045	0.380
Gender of the household head	3712.648	1101.649	0.001***
The educational level of the household head	907.609	3353.573	0.787
Marital status	-3972.112	4957.777	0.423
Crop number	-87.154	193.286	0.652
Irrigation system	11487.926	1967.006	0.000***
Access to agricultural assistance	-3417.430	807.491	0.000***
Involvement in crop production	9047.278	3212.759	0.005***
A family member worked on a farm	-1382.487	2250.941	0.539
Social grant	-1723.233	1296.330	0.184
WEALTH INDEX	-3875.732	1301.283	0.003***
Access to extension advises	609.984	908.477	0.502
Disability in the family	7078.643	5462.066	0.195
Family member with HIV	4225.499	2431.313	0.082*
Constant	-22800.000	4630.378	0.000***
var (e., harvesting)	70200000.000	3390000.000	. b
Mean dependent var	383.280	SD dependent var	6715.550
Pseudo r-squared	0.004	Number of obs	1424.000
Chi-square	73.845	Prob > chi2	0.000
Akaike crit. (AIC)	18863.616	Bayesian crit. (BIC)	18958.318

Notes: ***, **, * Indicate significance at 1%, 5%, and 10% levels, respectively—source: Authors' analysis.

7.5. Discussion

The gender of the household head positively influenced crop productivity among smallholder farmers. This implies that gender plays a vital role in crop production and agriculture. Vargas Hill and Vigneri (2011); Sebatta *et al*. (2014) explained that women and men often share the duties during crop production; women are more involved in the production side, while men are more likely to participate in the market.

The irrigation system is an essential production input in agriculture. It allows farmers to have water for their crops in the desired manner and helps to avoid dependency on rainfall. The result of this study has proven that since irrigation system positively influenced crop productivity. This is because farmers can access stored water at any time they want and grow

any crop. This result was in line with Oni et al. (2011); Sinyolo et al. (2014) reported that irrigation systems had a positive role in the welfare and food security of rural households. However, most studies reported that most smallholder farmers do not have access to irrigation systems, and those who have them perform poorly (Denison and Manona, 2007; Fanadzo *et al*., 2010; Post *et al.,* 2012). These studies reported that most smallholder farmers do not have adequate cropping systems, management practices, and irrigation applications, leading to them using any irrigation without looking at the crop type and growth stage.

The results showed that access to agricultural assistance had a negative impact on the crop productivity of smallholder farmers. The possible explanation for this might be that sometimes smallholder farmers do not receive enough or inadequate assistance from the government, and they end up using their traditional methods to produce crops that are not efficient. The few extension workers the government deploys to help farmers do not train them properly on sustainable crop production methods such as crop diversification. This result was substantiated by many studies conducted in rural areas (Aliber and Hall, 2012; Van Den Berg, 2013; Kruger and Gilles, 2014; Ojo *et al*., 2019). These studies reported that there is still poor performance of extension services which affects the production of smallholder farmers. They further explained that smallholder farmers are provided with sophisticated technologies without any training, affecting their productivity. On the contrary, Sasa (2009); Ackello-Ogutu (2011); Oni *et al*. (2011) found that access to extension services had a positive impact on productivity and income generation.

The involvement of smallholder farmers in crop production helps to reduce poverty, food insecurity, and unemployment. This study's result has proven that smallholder farmers' participation in crop production positively impacted crop productivity. This is because smallholder farmers involved in crop production can produce more for consumption and sell more to generate income. They can use all the opportunities they have to increase their productivity. This result was supported by Mathenge *et al*. (2010); Mulenga *et al.* (2021) reported that smallholder farmers involved in crop production could escape most of the unfavorable conditions they face, such as hunger, malnutrition, and unemployment. However, the wealth index of smallholder farmers had indicated a negative and significant impact. This is because some farmers do not know their resources and living standards; therefore, they tend to under-utilize what they have and produce ineffectively.

The impact of HIV on agriculture is essential, as it results in a decline in agricultural production. HIV affects the number of workers available for agricultural activities, leading to low production and productivity. This study has shown the opposite result on the impact of HIV on the crop productivity of smallholder farmers. The possible explanation for the consequences might be that family members with HIV follow their doctor's orders on medication dosage, resulting in them being healthy and able to work on the farm. They also eat healthy foods, which improves their nutrition status. On the contrary, Food and Agriculture Organization (FAO) (2010) reported that an increasing number of sick HIV-infected in rural areas threaten survival strategies and affect the crop productivity of smallholder farmers.

7.6. Conclusion and recommendations

The study's main aim was to assess the factors that influence the crop productivity of smallholder farmers. The descriptive results showed that most smallholder farmers do not have access to the irrigation system, mechanization, and agricultural inputs. The results also showed that most crop producers knew about crop rotation. The results from the Tobit regression model showed crop productivity of smallholder farmers in Mpumalanga and Limpopo Provinces was positively influenced by the gender of the household head, irrigation system, family member with HIV, and involvement in crop production. Access to agricultural assistance and the wealth index of smallholder farmers had a negative and significant impact on the crop productivity of smallholder farmers.

The limited agricultural assistance that farmers receive from the government is not surprising since many previous studies found the same results in past analyses of agriculture productivity in developing countries. Therefore, the government must strengthen the extension and advisory services to achieve its intended purpose. The crucial thing that the government needs to do is first to improve the skills of hired extension workers. Extension workers need to be trained or prepared on the conditions that smallholder farmers live and operate on to provide technologies and strategies that are tailor-made to farmers' production capabilities. They need to use more participatory approaches to deliver knowledge to smallholder farmers since most are uneducated. The problem of inefficiency of extension services can also be solved by adopting an alternative extension paradigm, such as having farmer field schools. In the farmer field schools, farmers can be organized into groups to be trained in large numbers simultaneously. In that way, farmers will be trained on essential modern technologies and how to use the resources they have sustainably. Furthermore, when farmers are organized into groups, it will

increase their visibility since they will appoint committee members responsible for receiving all the supporting services they get from the government.

7.7. References

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CHAPTER EIGHT

IMPACT OF CROP PRODUCTIVITY ON HOUSEHOLD FOOD AND NUTRITION SECURITY STATUS IN LIMPOPO AND MPUMALANGA PROVINCES, SOUTH AFRICA

8.1. Introduction

The agricultural sector is the most significant contributor to the economies and rural livelihoods of developing countries in Africa (Mwadalu and Mwangi, 2013). It accounts for 35% of the continent's GDP (Gross Domestic Product), 40% of export earnings, and 70% of employment (Nyange *et al.*, 2011). Furthermore, over 75% of the food consumed in the country is produced by small-scale farmers (Food and Agriculture Organization (FAO), 2015). An estimated 70% of South Africans who live in rural areas depend on agriculture and are engaged in smallholder subsistence farming. This stresses the importance of smallholder farmers and agriculture in South Africa. Although agriculture is the most critical sector of the economy in South Africa in terms of contribution to livelihoods, GDP, employment creation, and export earnings, the country is still facing the issue of malnutrition, hunger, and food insecurity, especially in rural areas. South Africa is considered to be food secure at the national level, while a considerable proportion (30-60%) of rural households are food insecure (Statistics South Africa (Stats SA), 2019). About 11.3% of families and 9.7% of individuals experienced hunger in 2018 (Stat SA, 2019).

South Africa faces many challenges that hinder one of the agricultural sector's objectives to attain food security. It is one of the developing countries where excessive population growth and the increased intensity of such environmental events as droughts, floods, extreme temperature variability, or rainfall usually threaten food security (Ahmed *et al.*, 2017). An increase in food demand due to population growth results in higher food prices and income inequalities, leading to low crop productivity (Prosekov and Ivanova, 2018; Causes of world hunger, 2019). Most smallholder farmers produce under pressure with limited resources and skills. Smallholder farmers in South Africa are still trapped in low-productivity traditional technologies that harm output and livelihoods (Obi and Seleka, 2011; Calzadilla *et al.*, 2014). Low agricultural productivity threatens the efforts of lessening poverty and improving food security.

The agricultural sector strategically improves crop productivity and achieves food security (Otsuka, 2013; Wegren and Elvestad, 2018). Crop productivity can be enhanced using fertilizers, innovative irrigation, and sustainable farming methods (Elferink and Schierhorn,

2016). This can help to improve crop yields and food provision from effective agricultural land use. However, due to many challenges, smallholder farmers cannot fully adopt the existing technology and knowledge. Most smallholder farmers are uneducated; they possess small lands, rely on low-input technologies, lack an understanding of high-input technologies, have poor farm management skills, and have poor extension services. The factors affecting crop productivity and food security of smallholder farmers differ in areas due to cultural beliefs, resources, educational status, relevant information on viable farming methods, extension services, and infrastructure (Pretty *et al*., 2011; Mungai *et al*., 2016).

Considering the extensive diversity of South African regions, understanding crop productivity's role in food security across the country is crucial to develop interventions to enhance crop productivity and adopt appropriate farming methods. Despite the importance of agricultural crop productivity in the food security strategies of many developing countries such as South Africa, limited empirical knowledge exists on the linkages between the two. Several studies have focused on analyzing factors determining crop productivity among smallholder farmers in various developing countries (Obasi *et al*., 2013; Mango *et al*., 2017; Mekuriaw *et al.,* 2018; Myeni *et al.,* 2019). On the one hand, the food security studies (Sinyolo *et al*., 2014; Musemwa *et al.,* 2015; Walsh and van Rooyen, 2015; Baiyegunhi *et al.,* 2016; Sinyolo and Mudhara, 2018) have not investigated the role of crop productivity. Therefore, there is a need for quantitative research linking crop productivity and poverty indicators such as food insecurity to offering empirical evidence of agricultural crop productivity's role in rural poverty reduction. Against this backdrop, the study attempts to investigate the impact of crop productivity on household food and nutrition security status in South Africa. The study aims to close the existing gap by investigating the linkage between crop productivity and food and nutrition security status among the smallholder farming households in the Limpopo and Mpumalanga provinces, South Africa.

8.2. Analytical framework

The study aimed to quantify crop productivity's impact on the food and nutrition security of smallholder farmers. In this study, crop productivity is defined as the ability of farmers to allocate the inputs they have to produce economic outputs efficiently. Food and nutrition security is defined as the state where all people at all times have physical, social, and economic access to food, which is consumed in sufficient quantity and quality to meet their dietary needs and food preferences. Farmers with high crop productivity are assumed to be

food and nutrition secure. The food security assessment employed the conventional measurement tools: the household food insecurity access scale (HFIAS), Food Consumption Score (FSC), and the household food dietary diversity score (HDDS). The HDDS indicates the variety of food and dietary diversity accessible to a household (Kennedy et al., 2011). The dietary diversity data is obtained through 24-hour recall questions about the food groups consumed by a household. The standard 12 food groupings identified by Swindale and Bilinsky (2006) were used. The 12 food groups are cereal, vegetables, meat, roots and tubers, poultry and eggs, fruits, fish and seafood, pulses/legumes/nuts, milk and milk products, oil/fats, sugar/honey, and miscellaneous (which includes spices, sauces, salt, and other condiments). The food referred to here excludes food consumed from outside the household, such as restaurants, social gatherings, or any other unusual events that would otherwise misrepresent regular food consumption at the household level. The HDDS in this study was used as an outcome/ dependent variable to show nutrition diversity among crop and non-crop producers.

The HFIAS measures the "access component of household food insecurity" based on information covering four weeks (Coates *et al.,* 2015). It builds on nine questions that focus on a household's food access anxiety and uncertainty and the quality and quantity of food consumed. Tables 7.1 and 7.2 show a brief survey instrument based on nine questions, which aimed to assess whether households have experienced problems with accessing food during the last 30 days. Questions were ordered in a way that they represent a generally increasing level of severity of food insecurity. They can be divided into three domains: anxiety (question 1), inadequate quality (questions 2–4), and insufficient intake (questions 5–9). Respondents were asked about the frequency, i.e., if the situation had never occurred or occurred rarely (once or twice in the past month), sometimes (three to ten times in the past month), or often (more than ten times in the past month).

Table 8.1: Household Food Insecurity Access Scale survey among smallholder farmers in the 2016/2017 season in Mpumalanga province.

Do You or Your Household Members Have the Following Problems with Ensuring Food Security Due to Financial Problems/ lack of resources:	**Last 30 days**			
	No	**Rarely (1 – 2 times)**	**Sometimes (3 – 10 times)**	**Often (more than 10 times)**
Worry about not having enough food	147	212	199	51
Do not eat your kinds of preferred food	110	225	216	58
Limit the diversity/quality of meals	102	230	211	66
Consume some foods that you do not want to eat	105	227	209	67

Limit has eaten food portions	161	227	179	41
Limit the number of meals	186	213	161	49
No food to eat of any kind in your household	353	139	95	21
Go to sleep at night hungry	465	85	37	22
Go a whole day and night without eating anything	496	60	30	20

Source: Own analysis

Table 8.2: Household Food Insecurity Access Scale survey among smallholder farmers in the 2016/2017 season in Limpopo province.

Do You or Your Household Members Have the Following Problems with Ensuring Food Security Due to Financial Problems/ lack of resources:	**Last 30 days**			
	No	**Rarely (1 – 2 times)**	**Sometimes (3 – 10 times)**	**Often (more than 10 times)**
Worry about not having enough food	231	276	305	98
Do not eat your kinds of preferred food	166	286	332	123
Limit the diversity/quality of meals	157	287	329	137
Consume some foods that you do not want to eat	157	285	325	141
Limit has eaten food portions	240	288	287	94
Limit the number of meals	266	268	270	104
No food to eat of any kind in your household	511	191	159	48
Go to sleep at night hungry	667	123	72	48
Go a whole day and night without eating anything	728	86	63	31

Source: Own analysis

For us to examine the impact of crop productivity on the food and nutrition security of smallholder farmers in some parts of Limpopo and Mpumalanga province in South Africa, we estimate the following equation with the smallholder farmer as the unit of analysis:

$$y_i = \beta_0 + \beta_1 \times CP_i + \beta_2 \mathrm{X}_i + \eta_i + \nu_i \qquad (1)$$

Where y_i is a measure of food security or nutritional status of smallholder farmer i; CP_i is a binary variable taking 1 if crop producers i had high crop productivity and 0 otherwise; X_i is a vector of household or farm level characteristics; η_i is a term capturing unobserved heterogeneity assumed to be unrelated to the explanatory variables vector X_i and applying to each smallholder farmer living in the same locality, and ν_i captures all the remaining variation with $\nu_i \sim IIDN(0,1)$.

If the vector X_i comprises all the factors assumed to affect crop productivity, including location-fixed effects, and is uncorrelated with the error ν_i, then an ordinary least squares (OLS) regression of Eq. (1) will yield consistent estimates. In that case, our coefficient of interest β_1, which measures the extent of crop productivity, can thus be regarded as the true impact of crop productivity on smallholder farm food and nutritional security status.

Smallholder farmers' crop productivity is affected by many unobserved factors, making it an endogenous variable, and failure to control for this endogeneity may result in biased and inconsistent estimates. The endogeneity bias of crop productivity occurs because some smallholder farmers have the skills and resources to increase their crop productivity while others do not. This selection bias will overstate the actual impact of crop productivity in a regression model specified in Eq. (1). Conversely, unprivileged smallholder farmers, might fail to increase crop productivity because they do not have enough agricultural inputs. In this instance, a failure to control for this kind of bias underestimates the supposed true benefit of crop productivity. Crop productivity (CP), a potentially endogenous variable, takes the following form:

$$CP_i^* = \alpha_0 + \alpha_1 Z_i + \alpha_2 X_i + \eta_2 + \varepsilon_i \qquad (2)$$

Where CP_i^* is the propensity to increase crop productivity. However, CP_i^* it is unobserved and what we observe instead is the following:

$$CP = \begin{cases} 1 \ \ if \ \ Crop \ productivity \ score > 0 \\ 0 \ \ otherwise \end{cases}$$

The vector Z_i comprises a set of variables that influence crop productivity, such as management and technical abilities of smallholder farmers and agricultural assistance from the government (Abdulai and Huffman, 2014; Manda *et al.*, 2016); η_2 is the unobserved heterogeneity parameter assumed to be uncorrelated with the vector of explanatory variables (X_i) and ε_i captures the remaining unobserved variation. The unobserved heterogeneity components' subscripts $\{1, 2\}$ (η) are equation indicators.

The standard approach in the economics literature to control for endogeneity bias is to estimate Eq. (1) with instrumental variables for crop productivity [Eq. (2)]. Instrumental variables are those variables highly correlated with the endogenous variable (crop productivity in this case) and not correlated with the unobserved factors that may affect the outcome variables (Angrist and Krueger 2001). However, as is well known, it isn't easy to obtain good instruments. To avoid the problems often associated with poor instruments, we jointly estimate Eqs. (1) and (2).

As stated previously, the endogeneity nature of crop productivity can significantly over or under-estimate the impact of crop productivity on food and nutrition security status. To control for this possibility, we jointly estimate Eqs. (1) and (2) within a Conditional (recursive) Mixed Process (CMP) framework introduced by Roodman (2011). The CMP was used by other previous studies (Makate *et al*., 2016; Alhassan *et al*., 2020; Melesse *et al*., 2021). The CMP controls for the selection bias that occurs because of the unobserved factors that affect our outcome variables by building from the seemingly unrelated regression framework and allowing for cross-equation correlation of the error terms. Allowing for the potential endogeneity of crop productivity in Eq. (1), we can express the joint, marginal likelihood as follows:

$$\int_{\eta_2}\int_{\eta_1}\left[\prod L_2\left(\eta_2\right)\prod L_1\left(\eta_1\right)\right] f\left(\eta_2,\eta_1\right) d\eta_2\eta_1 \qquad (3)$$

Where L_1 and L_2 are the conditional likelihood functions of Eqs. (1) and (2), respectively, $f\left(\eta_2,\eta_1\right)$ is the joint distribution of the unobserved heterogeneity components. In this case, the joint distribution of the unobserved effects $f\left(\eta_2,\eta_1\right)$ is assumed to be a two-dimensional normal distribution characterized as follows:

$$\begin{pmatrix}\eta_2\\ \eta_1\end{pmatrix} \sim N\left(\begin{bmatrix}0\\0\end{bmatrix},\begin{bmatrix}\sigma_2^2 & \\ \rho_{12}\sigma_2\sigma_1 & \sigma_1^2\end{bmatrix}\right) \qquad (4)$$

The complete specification or full model is jointly estimated via the conditional mixed process, CMP, which utilizes the Geweke, Hajivassiliou, and Keane (GHK) algorithm to consistently assess the likelihood function given in (Eq.3). The main reason for jointly estimating Eqs. (1) and (2) are to control for potential self-selection bias. Maitra (2004) stated that joint estimation indicates the possibility of non-zero covariance between the error terms of the two Eqs. (1) and

(2), i.e. $\text{cov}(\eta_2, \eta_1) \neq 0$. However, since we condition on the heterogeneity terms, Eqs. (1) and (2) become independent, making it easy to get the likelihood function in (3) above by simply multiplying the individual conditional likelihood functions of Eqs. (1) and (2) (Chamberlain *et al.,* 1975). Since finding appropriate instrumental variables is a huge challenge, the joint model (with correlated errors) allows us to derive selection-bias revised estimates for smallholder crop productivity and food and nutrition security status.

Variable description and statistics

The quantitative data were analyzed using STATA software (version 13). Descriptive statistics were performed to provide the key socio-economic characteristics of the sampled smallholders. It was performed to show mean averages and percentages of the different factors that affect the crop productivity of smallholder farmers. The crop productivity of smallholder farmers is influenced by factors that can be grouped as internal, external, and socio-demographic factors. Socio-demographic characteristics include variables such as the age of the household head, gender, household size, marital status, and educational level. Internal factors or Household assets include the number of cattle, off-farm income, irrigation system, and land. The level of access to information is captured by access to extension services which is the external factor. Table 8.3 summarizes the explanatory variables that were likely to affect the crop productivity of smallholder farmers.

Table 8.3: Factors that are estimated to affect Crop productivity.

Variable name	variable definition	Variable type and measurement
Age	Age of the household head	In years (continuous)
Gender	Gender of household head	1= if the respondent is male, 0 otherwise
Marriage	Marriage status of the household head	1= if the respondent is married, 0 otherwise
Household size	Number of family members	Size of household (continuous)
Level of education	Education level of the household head	Years of education (continuous)
Yield	Yield harvested	In kilometers (continuous)
Land	Size of land cultivated	In Ha (continuous)
Involvement in crop production	Household head involved in crop production	1= if respondents had been involved in crop production, 0 otherwise
Irrigation	Access to irrigation scheme	1= if the respondent had access to the irrigation system, 0 otherwise
Family member with HIV	A family member that is living with HIV	1= if there is a member in the family that is HIV positive, 0 otherwise
A family member worked on a farm	A family member worked on a farm	1= if there is a member that worked on a farm, 0 otherwise

Disability in the family	Family member with a disability	1= if there is a member in the family that lives with a disability, 0 otherwise
Livestock	Ownership of livestock	1= if the respondent owned livestock, 0 otherwise
Social grant	Social grants received by households from the government	1= if there is a member in a family that received a social grant, 0 otherwise
Agricultural assistance	Access to extension service	1= if respondents had access to extension services, 0 otherwise

Source: own analysis

8.3. The study area, sampling, and data collection technique

The study area, sampling, and data collection technique are the same as in chapter three.

8.4 Results

8.4.1 Descriptive results

8.4.1.1 Demographic characteristics of smallholder farmers regarding crop productivity

In the sample of 1520 rural households, 386 were crop producers, and 1134 were non-crop producers. The descriptive analysis revealed that 389 farmers participated in the market and 1131 did not (Table 8.4).

Table 8.4: Demographic characteristics of smallholder farmers in Limpopo and Mpumalanga province, South Africa.

		Crop producers	**Non-crop producers**	**Total**
Province name	Mpumalanga	176	433	609
	Limpopo	210	701	911
Total		386	1134	1520

Source: own analysis

Tables 8.5 show the demographic characteristics differences between crop and non-crop producers. The results showed that 74% of the crop producers knew about crop rotation, while 26% did not. Of non-crop producers, 88% knew about crop rotation, while 12% did not. Regarding access to irrigation, 48% of crop producers had access, while 52% did not. Among non-crop producers, only 6% had access to irrigation, while 94% did not have access. Regarding agricultural inputs, 65% of crop producers had access, while 35% did not. Among non-crop producers, only 18% had access to agricultural inputs, while 82% did not have access. The results also showed that 22% of crop producers had access to mechanization, while 78%

did not have access. Of non-crop producers, 12% had access to mechanization, while 88% did not.

Table 8.5: Demographic characteristics of smallholder farmers in Limpopo and Mpumalanga provinces, South Africa

Variables	**Crop producers (386)**		**Non-crop producers (1134)**		**Overall Freq**
	%	**Freq**	**%**	**Freq**	
			Crop rotation		
Yes	74	286	88	1000	1286
No	26	100	12	134	234
			Access to irrigation		
Yes	48	186	6	66	252
No	52	200	94	1068	1268
			Access to inputs		
Yes	65	250	18	200	450
No	35	136	82	934	1070
			Access to mechanization		
Yes	22	86	12	134	220
No	78	300	88	1000	1300

Source: own analysis

8.4.1.2. Occurrence of Food Insecurity by Household Characteristics Based on HFIAS Categories

The HFIAS, which was employed to determine households' access to food, revealed that of the overall (1520 sample size), 85% of the households were food insecure, and only 15% were food secure, indicating that the majority of the households were experiencing difficulties when it comes to food access. Regarding the HFIAS tool categories, 51% were severely or moderately severely food insecure, indicating severe challenges relating to access to food by those surveyed households.

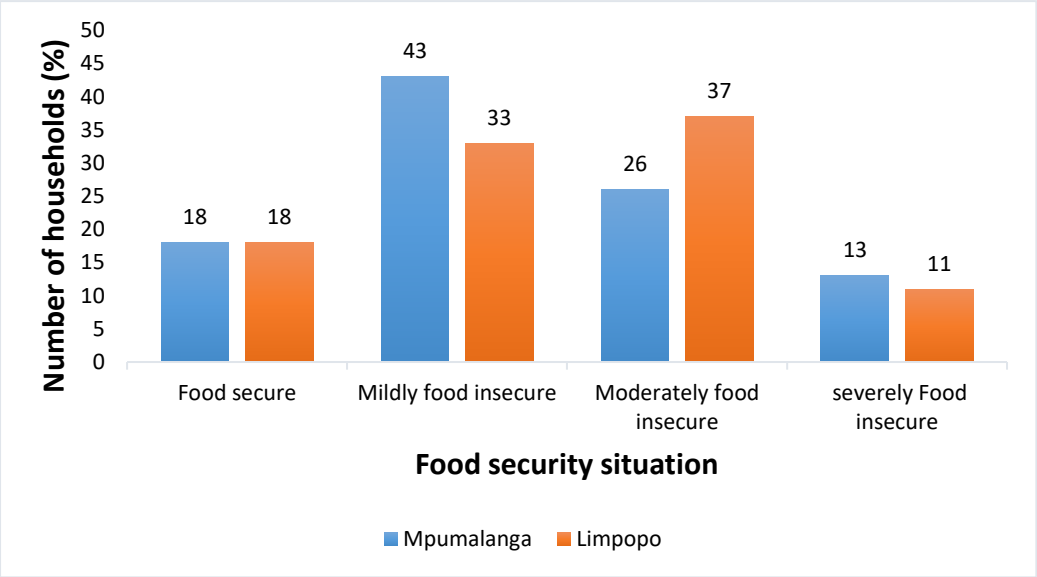

Figure 8. 1: The food insecurity situation of the smallholder farmers in the two provinces (Mpumalanga (n=609) and Limpopo (n=911)). Source: own analysis

Analysis of the food security situation for the two provinces revealed that the majority of farmers in Mpumalanga province were mildly food insecure (43%), while in Limpopo province, the majority of farmers were moderately food insecure (37%) (Figure 8.1). About 13% of farmers were severely food insecure in Mpumalanga and about 11% in Limpopo, indicating that some of these farmers experienced difficulties in accessing food.

8.4.1.3. Dietary diversity of smallholder farmers

Figure 8.2 show the dietary diversity of smallholder farmers in the Limpopo and Mpumalanga provinces before the study was conducted. In the overall sampled population (n=1520), 57% of smallholder farmers had the highest dietary diversity, followed by medium dietary diversity (25%), and the lowest was 18%. In the provinces, both Limpopo and Mpumalanga had 50% of the highest dietary diversity. The medium dietary diversity for Limpopo was 33%, and it was 35% for Mpumalanga province. Limpopo province had 17% of the lowest dietary diversity, while Mpumalanga had 15%.

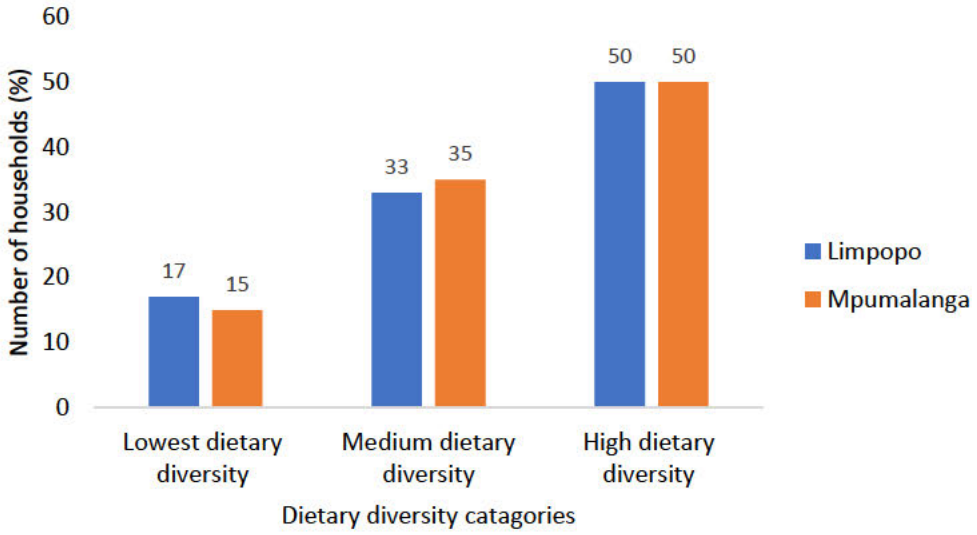

Figure 8.2: Dietary diversity of smallholder farmers in Limpopo (n=911) and Mpumalanga (n=609) Provinces, South Africa.

8.4.2 Impact of crop productivity on the HHDS (nutritional status) and HFAIS (food security) of smallholder farmers – Conditional Mixed Process (CMP) model

Table 8.6 presents the estimation results from the joint estimation of Eqs. (1) and (2). As mentioned earlier, a joint assessment of the system of equations allows us to control for endogeneity bias created by the selectivity bias of crop productivity in the equations for nutrition status (HDDS) and food security (HFIAS). The primary measure of selection bias is the reported atanhrho at the bottom of Table 8.6. The atanhrho value reported here is the arc-hyperbolic tangent of the rhos (ρ) to unbound them. A positive value of atanhrho indicates that some unobserved factors positively impact crop productivity and the primary outcome variable. In this study, the atanhrho_12 was significant and negative in the outcome equations. The negative value of atanhrho_12 indicates that no omitted variables were affecting the outcome variables.

Table 8.6: Determinants of crop productivity on nutritional status and food security using Conditional Mixed Process (CMP) model

	HHDS (nutritional status)			**HFAIS (food security)**		
Variables	**Coef.**	**Std.Err.**	**P-value**	**Coef.**	**Std.Err.**	**P-value**
Age	-0.002	0.002	0.412	-0.003	0.002	0.161
Household size	0.052	0.016	0.001***	0.071	0.013	0.000***
Social grant	-0.254	0.144	0.077*	-0.667	0.431	0.122
Agricultural assistance	-0.647	0.167	0.000***	-0.103	0.119	0.388
Ownership of livestock	0.187	0.476	0.694	-0.795	0.354	0.025**

The educational level of the household head	0.176	0.590	0.765	0.632	0.487	0.194
Government advice	-0.203	0.175	0.246	0.151	0.132	0.250
Harvest (kg)	-0.030	0.016	0.051**	-0.027	0.014	0.050**
Disability in the family	0.300	0.467	0.520	-1.658	0.785	0.035**
Economic activity	0.355	0.219	0.106	1.510	0.760	0.147
Gender	0.849	0.682	0.213	0.378	0.192	0.049**
Family member with HIV	0.029	0.407	0.943	0.645	0.302	0.465
/cut_2_1	-0.859	0.167	0.000			
/cut_2_2	1.663	0.172	0.000			
/atanhrho_12	-0.081	0.048	0.090			
rho_12	-0.080	-0.172	0.013			

Notes: ***, **, * Indicate significance at 1%, 5%, and 10% levels, respectively.

The general observation from the CMP model results in table 8.7 indicated that household size had a positive and significant impact on nutrition status (HDDS) and Food security (HFAIS). The results showed that social grants and agricultural assistance negatively and significantly affected smallholder farmers' nutrition status (HDDS). Livestock ownership had a negative and significant impact on the food security of smallholder farmers. The study found surprising results on the effects of harvest. The total harvest of smallholder farmers had a negative and significant impact on their nutrition status and food security. Disability in the family had a negative and significant ($P<0.05$) on the food security of smallholder farmers. The result showed that the gender of the household had a positive and significant ($P<0.05$) impact on the food security of smallholder farmers.

8.5 Discussion

The positive impact of household size on nutrition status and food security is attributed to the fact that smallholder farming mainly depends on family labour, so an increase in household size leads to increased crop productivity as work is shared on the farm. This result was substantiated by many other previous studies (Mango *et al.*, 2014; Osmani and Hossain, 2015; Kyaw *et al.,* 2018). These studies reported that an increase in household size could lead to more responsibilities shared on the farm, which could lead to high productivity and improve the food security of rural households.

The possible explanation for the negative impact of social grants is that some smallholder farmers that receive social grants do not want to be involved in crop production and do not purchase healthy food with their funds. In line with this result, Boone *et al.* (2013); Sinyolo *et*

al. (2017) explained that social grant is a disincentive for many households to participate in farming activities. Most households see social grants as their primary source of income and neglect farming. This led to less dietary diversity in their food since the social grant was insufficient to improve their nutrition.

Smallholder farmers with livestock tend to focus more on livestock production than crop production. This study has proven that ownership of livestock has a negative impact on food security. Most of the time, they do not want to sell livestock to buy healthy food, which leaves them susceptible to food insecurity. This result was in line with Kyaw *et al.* (2018), who reported that smallholder farmers usually have inadequate land for crop and livestock production, so they compromise crop production. This reduced crop production, resulting in hunger, malnutrition, and food insecurity.

In South Africa, the government has agricultural extension services to boost agricultural productivity, increase food security and improve rural livelihoods. However, in this study, the result showed that agricultural assistance from the government had a negative impact on the nutrition status (HDDS) of smallholder farmers. The possible explanation might be that there is a shortage of extension workers, and some of the hired ones do not have suitable skills in crop production and food security-related matters. Contrary to the result, Fischer and Qaim (2012); Sebatta (2014) found that agricultural extension positively impacted smallholder farmers' crop production, improving their food and nutrition security status. However, Aliber and Hall (2012); Kruger and Gilles (2014) confirmed the observed result; they reported the poor performance of extension service in many rural areas. The authors further explained that this is due to many factors, including administrative inefficiency, deficient program design, and weaknesses in information delivery systems.

Harvest in this study referred to the output/yield that smallholder farmers get during their crop production. The amount of harvest determines if farmers will be able to consume and sell. In this study, the result showed that harvest negatively affected the nutrition status and food security of smallholder farmers. This is because most smallholder farmers did not produce enough for consumption and selling. This caused them only to consume what they had and not be able to get income to buy other nutritious food groups. On the contrary, Liliane and Charles (2020) found that crop yields significantly reduced poverty and malnutrition. The study further explained that numerous factors influence crop yield in a specific area. The factors include agricultural practices, managerial decisions, diseases and pests, climatic conditions, soil

fertility, and topography. So, it is important to ensure that farmers understand all these factors before they commence crop production.

Having a disabled family member increases stress and affects other family members' mental and physical health. This affects their decision to be involved in crop production, and that affects their food security. National Home Sharing and Short Break Network (NHSN) (Undated) stated that having a family member with a disability is associated with the time, financial costs, and physical and emotional demands which affect education/training and work decisions.

It is crucial to address gender inequality to achieve sustainability in agriculture. A high level of inequality leads to lower crop productivity, poverty, and food insecurity. However, in this study, the result showed that the gender of the household positively impacted the food security of smallholder farmers. This showed that smallholder farmers were working together during production to increase crop productivity and improve food security. Sebetta (2014) stated that males are more likely to be involved in the decision to market the produce, while females are more involved in the production side. Vargas Hill and Vigneri (2011) also attest to this result; the study found that females are more likely to be involved in smallholder farming, while males grow cash crops to get income that will sustain the family needs.

8.6 Conclusion and recommendations

The study aimed to assess crop productivity's impact on household food and nutrition security status in South Africa. The descriptive results showed that most smallholder farmers do not have access to the irrigation system, mechanization, and agricultural inputs. The results from the CMP model showed that ownership of livestock, harvest, and disability in the family had a negative impact on the food security of smallholder farmers. At the same time, household size and gender positively impacted the food security of smallholder farmers. The results also showed that social grants, agricultural assistance, and harvest had a negative impact on the nutrition status of smallholder farmers. In contrast, household size positively impacted the nutrition status of smallholder farmers.

The results of the study showed that crop productivity determinants impacted the food security and nutrition status of smallholder farmers. An improvement in these determinants can lead to an improvement in food security and nutrition status. To increase the harvest that smallholders get, farmers must first be trained on how to manage their resources efficiently. They need to be trained on all the factors (farming methods, fertilizer application) that affect their yield so

that they can produce more. This can be done by employing extension workers. The government needs to hire skilled extension workers capable of training farmers. Extension workers need to be trained or prepared for the conditions that smallholder farmers live and operate in to provide technologies and strategies tailor-made to farmers' production capabilities. They need more workshops and training in rural areas to increase food security and nutrition status awareness. This will help farmers change their living style and improve their crop productivity. The workshops will also help farmers use the social grant as one of the incentives to be involved in crop production. They need to be taught how their social grant can allow them to acquire the inputs required for farming and what benefits they will receive from doing that. Also, the workshops can be used to train and teach smallholder farmers how to cope mentally and physically when they stay with a disabled person. Farmers can also be taught how to allocate their time effectively.

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CHAPTER NINE

CONCLUSION AND RECOMMENDATIONS

9.1. Summary

Improved crop productivity and market participation by smallholder farmers can increase production and productivity and thus contribute to household income, leading to improved food and nutrition security outcomes. Smallholder farmers can become both sellers and consumers when they participate in the market. Despite all the potential and opportunities that smallholder farmers have, they face several challenges that limit their potential and opportunities to access adequate quantity and quality food through their production, purchase, or equitable food distribution. The purpose of the study was to understand more about how crop productivity and market participation can impact the food and nutrition security of rural households in the selected rural areas of Limpopo and Mpumalanga provinces, South Africa. The specific objectives were to assess the intensity and determinants of market participation among smallholder farmers; analyze the impact of market participation on the food and nutrition security status of the smallholder farmers; analyze the factors affecting crop productivity among smallholder farmers, and determine the effect of crop productivity on household food and nutrition security status in the study areas.

Descriptive statistics, double-hurdle model, Household Food Insecurity Access Scale (HFIAS), extended ordered probit regression model, Household Dietary Diversity Score (HDDS), Food Consumption Score (FCS), Poisson endogenous treatment effect model, Tobit regression model, and Conditional Mixed Process (CMP) model were employed to achieve the objectives. The results from the study and literature showed that smallholder farmers are still faced with challenges that make their production and marketing system remain marginalized and unimproved. The results showed that institutional, technical, and socio-demographic factors influence smallholder farmers' crop productivity and market participation. This implies a need to improve these factors, which will spontaneously enhance the conditions that smallholder farmers operate and live.

The study hypothesized that crop productivity and market participation impact rural households' food and nutrition security. The hypothesis was accepted as different analyses done in this study showed that determinants of crop productivity and market participation had either positive or negative impacts on food and nutrition security. This showed that more

intervention is needed to improve, control, and monitor the environment that smallholder farmers are exposed to.

9.2. Conclusions

The results of the first hurdle suggested that market participation among smallholder farmers was influenced by the gender of the household head, family member working on the farm, wealth index, agricultural assistance, age of the household head, and family member with HIV. In contrast, the results of the second hurdle showed that the perceived intensity of market participation was influenced by marital status, educational level of the household, wealth index, access to agricultural assistance, household size, household age, and family member with HIV. On the other hand, the results from the Tobit regression model showed crop productivity of smallholder farmers was influenced by the gender of the household head, irrigation system, family member with HIV, involvement in crop production, access to agricultural assistance, and wealth index of smallholder farmers. This shows that there is still more improvement that is needed to address the impacts of these factors. It was notable that access to agricultural assistance had a negative impact on both market participation and crop productivity. This shows that smallholder farmers do not fully benefit from the extension services that the government provides. It can be concluded that smallholder farmers still rely more on their limited traditional methods to produce and sell their produce. They still do not have the resources and technologies that will help them improve their crop productivity and market participation.

The Household Food Insecurity Access Scale revealed that out of the total sample size, 85% of the households were food insecure, while 15% were food secure. This confirms what has been reported in the past years that most rural households are still food insecure and are faced with malnutrition. On the other hand, the study found that more than half of the smallholder farmers had acceptable food consumption scores and the highest dietary diversity. Most smallholder farmers face many challenges, such as population growth, inflation, and climate change. These challenges force smallholder farmers to produce more for consumption and more staple crops than diversifying.

The determinants of market participation that influenced smallholder farmers' food and nutrition security status include household size, having a family member with HIV, agricultural assistance, educational level of household head, ownership of livestock, age of household head, gender of household head, and having access to social grants. An improvement of these factors

can improve the market participation of smallholder farmers, which will, in turn, improve their food and nutrition security status. The study also determined the impact of crop productivity on households' food and nutrition security status in the study areas.

The results from the CMP model showed that ownership of livestock, harvest, and disability in the family, household size, and gender statistically influenced the food security of smallholder farmers. The results also showed that social grants, agricultural assistance, harvest, and household size significantly impacted the nutrition status of smallholder farmers. Most of these factors (social grant, agricultural assistance, ownership of livestock, total harvest, and disability in the family) had a negative influence on both nutrition status and food security. The influence of these factors showed that smallholder farmers do not produce enough crops to consume and sell the surplus. Smallholder farmers are still trapped in low-productivity traditional technologies, which adversely affect their food and nutrition security.

The results obtained in this study confirmed that smallholder farmers could not produce enough and generate their income to grow other crops or buy food items they cannot grow for their health and food security. It was then concluded that smallholder farmers do not sustainably produce their crops since they cannot produce enough crops to consume and continuously sell the surplus. It was also concluded that farmers do not understand the concept of food security. Most of their decisions to produce crops are based on resources, the conditions they live and operate in, and their traditional knowledge.

9.3. Recommendations and policy implications

Improvement of crop productivity and market participation can positively influence smallholder farmers' food and nutrition security. However, smallholder agriculture mainly depends on internal and external factors that can either have negative or positive impacts. Therefore, there is a need for unity between all the necessary stakeholders to support and develop smallholder agriculture. Policymakers need to make sure they revisit the existing policies and programs to identify the loopholes and address them. The government must ensure that all the hired extension workers are skillful in delivering the extension services adequately. Researchers must conduct thorough research to develop meaningful findings to influence the existing agricultural policies and programs. Moreover, smallholder farmers need to cooperate and allow developments in their environments.

The results showed that agricultural assistance was the common factor that had a negative impact on almost all the outcomes that were observed. It is recommended that the government

enforce the quality of extension and advisory services. More skilled extension workers need to be hired and trained in crop production and marketing so that they can be able to do their advisory duties properly. Extension workers need to develop technologies and developments that are tailor-made for farmers to cater to the conditions that smallholder farmers operate. Since most are illiterate, they need to use more participatory approaches to deliver messages to smallholder farmers efficiently. Since smallholder farmers exist in large numbers and have unique characteristics, extension workers can help to form cooperative groups where they will be quickly assisted.

It was also recommended that more workshops and training be conducted in rural areas to increase food and nutrition security awareness. Smallholder farmers need to be educated on the type of diverse food items they should produce, sell and consume. These workshops will also provide market information to smallholder farmers so that they can create appropriate and provide quality to meet consumers' needs. Additionally, the programs and workshops can be used to pull young educated people into the agricultural industry since they can easily understand and implement modern production and marketing techniques. It is certain that if the workshops, programs, and training are conducted adequately, they can raise awareness of agriculture's importance and improve rural livelihoods.

The results also showed that gender and social grant play a significant role in smallholders' crop production and marketing. It is recommended that government, policymakers, and other relevant stakeholders develop policies and programs that enforce equality among all gender identities in agriculture. More support and attention should be given to women's involvement in agriculture; they must be encouraged to produce more and participate in the market. Social grants can be used to acquire resources that can be useful during crop production and marketing. However, many rural households tend to depend on it and are reluctant to be involved in agriculture. It also recommended that the government re-look at the idea of giving cash to households since most of them misuse it. The government can offer vouchers that will specify the specific support an individual can get instead of money. Also, the social grant support should be supplemented with other programs intended to improve food security, such as agricultural infrastructure and education. Education can assist smallholder farmers in making wise decisions on how they spend resources. If all the recommendations are implemented and monitored, food insecurity, malnutrition, poverty, and unemployment in rural areas can be reduced or managed considerably.

9.4. Limitations of the study and suggestions for further research

The initial aim of the study was to use the primary data collected from different parts of rural areas in South Africa; however, the study ended up relying on secondary data due to the spread of the COVID 9 pandemic. Future studies can use primary and secondary data to compare the findings before and after the spread of COVID 9 to see how the food and nutrition security status of rural households was affected.

The data used in this was collected during the 2016/2017 season. Since then, smallholder farmers' production and marketing systems may have changed. Smallholder agriculture is dynamic and affected by many factors, so it is essential to research and frequently use the most recent findings. After cleaning and sorting out the available data, the study was limited to using only two provinces (Mpumalanga and Limpopo) out of nine provinces of South Africa. It was impossible to travel and conduct interviews in different provinces due to the rules and regulations of COVID-19. Therefore, future studies can perform the same research across all nine provinces of South Africa. The findings can be used to compare smallholder farmers' challenges and opportunities in their different working environments. The results will also be used to identify the area of improvement each province needs. The findings will also help develop a comprehensive report that will be submitted to policymakers, government, and other stakeholders for implementation.

APPENDIX A

agriculture, land reform & rural development

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Dear Dr Ngidi

RE: PERMISSION FOR USE OF SAVAC DATASETS

Thank you for your letter dated 29 January 2021, in which you request the Department of Agriculture, Land Reform and Rural Development (DALRRD) to **use theSAVAC datasets for PhDs, Masters and publication of papers.** Permissionis granted expressly for use in the Masters and PHD as listed in your letter. The data remains the property of the South African Vulnerability Assessment Committee (SAVAC) as the originator. Users are expected to respect the intellectual property rights of the SAVAC. It is therefore expected that the analysisand insights emanating from the use of this data will be shared with the SAVAC Chairperson.

Yours Faithfully,

[redacted]

MR M MAMADI

DIRECTOR: SUBSISTENCE FARMING

DATE: 25 Feb 2021

APPENDIX B: Food Security and nutrition survey 2016

Food Security and Nutrition **Survey 2016**

Unique No.

mm

d

2 0 1 6

ub Place name

D: Survey perio

esponse details

Dwelling Unit Number

Date actual Result Next Visit (Planned)

No. 1 d d m M y y y y Cc e d d m m y y y y

2

A4: Physical Dwelling

3

A5: Telephone number of enumerated household

A6:

Total number of persons in household A7: Questionnaire number of this household

B: Households at the selected dwelling unit

B1: Household number for this household

E2: FINAL RESULT CODE

ull details

E3: Con me ts and f for resu t cc des 2-11

B2: Total number of households at selected dwelling

C: Field staff

Survey Officer name Assignment Number

d d m m Y y Y y

DSC name Assignment Number

d d m m y y y

PQM name Assignment Number

d d m m y y y y

Questionnaire number: .....

The following information must be obtained for every person who is considered a member of the household. Only add personswho had stayed here for at least four nights on average per week for the last four weeks. ***Do not forget babies.***

If there are more than 10 persons in the household, use a second questionnaire.

INTERVIEW START TIME

		01	02	03	04	05	06	07	08	09	10
A	**First name and surname** ***First name:*** *Write down first name and surname of each member of the household, starting with the head or acting head. If more than one head take the oldest.*										
	Surname:										
B	Has .....stayed here (in this household) for at least four nights on average per week during the last four weeks?										
	1 = Yes	1	1	1	1	1	1	1	1	1	1
	2 = No ***If "No", End of interview***	2	2	2	2	2	2	2	2	2	2
C	**Is ... a male or a female?**										
	1 = Male	1	1	1	1	1	1	1	1	1	1
	2 = Female	2	2	2	2	2	2	2	2	2	2
D	**What is …?'s date of birth and age in completed years?**										
	Day of Birth: *Example of day 05*	d d	d d	d d	d d	d d	d d	d d	d d	d d	d d
	Month of birth: *Example of month 11*	m m	m m	m m	m m	m m	m m	m m	m m	m m	m m
	Year of birth: *Example of year 2007*	y y y	y y y y	y y y y	y y y y	y y y y	y y y y	y y y y	y y y y	y y y y	y y y y
	Age in years *Less than one year = 0*										

y

Questionnaire number: .....

			01	02	03	04	05	06	07	08	09	10
F	**Does the head reside in this household**		YesNo									
G		**name**										
	If no to F, provide the following; Code:gender 1=M; 2=F	**Age in years**										
		gender										
		education										
	Use code for education											

SECTION 1: HOUSEHOLD SPECIFIC CHARACTERISTICS

This section covers particulars of each person in the household

		1	02	03	04	05	06	07	08	09	10
1.2	**What is ……'s present marital status?** 1 = Legally married 2 = Living together like husband and wife 3 = Divorced 4 = Separated, but still legally married 5 = Widowed 6 = Single, but have been living together with someone as husband/wife before										

	7 = Single and have never been married/neverlived together as husband/wife before										
1.4	**Is an orphan?**										
	1 = Yes	1	1	1	1	1	1	1	1	1	1
	2 = No	2	2	2	2	2	2	2	2	2	2
		1				1	1	1	1	1	1
	Is A vulnerable child?	2	1	1	1	2	2	2	2	2	2
	1 = Yes		2	2	2						
	2 = No										

+ +

Questionnaire number: .....

EDUCATION

Ask for all household members. Read out: Now I am going to ask you questions related to education for each member of the household

	Ask for all household members above 5 yrs	01	02	03	04	05	06	07	08	09	10
1.4	**What is the highest level of education that** **…… has successfully completed?** *Diplomasor certificates must be of six months plus studyduration full-time (or equivalent) to be included* 98 = No schooling00 = Grade R/0 01 = Grade 1/ Sub A/Class 102 = Grade 2 / Sub B/Class 2 03 = Grade 3/Standard 1/ ABET 1(Kha Ri Gude,Sanli) 04 = Grade 4/ Standard 2 05 = Grade 5/ Standard 3/ ABET 206 = Grade 6/Standard 4 07 = Grade 7/Standard 5/ ABET 308 = Grade 8/Standard 6/Form 1 09 = Grade 9/Standard 7/Form 2/ ABET 410 = Grade 10/ Standard 8/ Form 3 11 = Grade 11/ Standard 9/ Form 4 12 = Grade 12/Standard 10/Form 5/Matric(No Exemption)										

	13 = Grade 12/Standard 10/Form 5/Matric (Exemption *) 14 = matric plus Diploma or degree										

	Ask for all household members aged 0-5	01	02	03	04	05	06	07	08	09	10
1.5	**Which of the following does the child currently attend?** 1 = Grade R 2 = Pre-school / nursery school/Grade 00/Grade 000 3 = Creche / educare centre / ECDs4 = Day-mother – out of home care 5 = None 6 = Do not know										

Questionnaire number: .....

Ask for all school going children

		01	02	03	04	05	06	07	08	09	10
1.6	**Does…. attend a school where food is givento the children?** 1 = Yes 2 = No *xxxxxx* 3 = Do not know *Go to Q2.1*	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

		01	02	03	04	05	06	07	08	09	10
1.7	**How many days in a week does …. eat the food provided at school?** *If yes, specify howregularly food is eaten.* 1 = number of times per week2 = Do not know										

SECTION 2: ECONOMIC ACTIVITY STATUS

Ask for all household members. Read out: Now I am going to ask you questions related to occupation for each member of the household

		01	02	03	04	05	06	07	08	09	10

Questionnaire number: .....

2.1	**What is your Economic activity Status?** 01=Subsistence farmers 02=Subsistence farmers 03=Commercial farmers 04=Parastatal employees 05=Formal sector private employees, 06=Formal sector public employees, 07=Self-employed outside agriculture,08=Unpaid family worker 09=Workers not elsewhere classified, based on employment status 10=Unemployed, 11=Inactive, those whose main current activity was not										

Questionnaire number: .....

ECONOMIC ACTIVITIES

Ask for all household members 15 years and older

		01	02	03	04	05	06	07	08	09	10
2.2	**During the last 12 months did ….. work for a wage, salary, commission or any payment in kind (including paid domestic work), even if itwas for only one hour?** *Examples: a regular job, contract, casual or piece work for pay, work in exchange for food or housing, paid domesticwork.* 1 = Yes 2 = No 3 = Do not know	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
2.3	**During the last 12 months did … run or do any kind of business, big or small, for yourself or with one or more partners, evenif it was for only one hour?** *Examples: Commercial farming, selling things, making thingsfor sale, construction, repairs, guarding cars, brewing beer, collecting wood or water for sale, hairdressing, etc.* 1 = Yes 2 = No	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

	3 = Do not know										
2.4	**During the last 12 months did do any** **work for which they were paid in some way besides cash?** *Examples: Commercial farming, production of agricultural produce to sell, help to sell things, make things for sale or exchange, doing the accounts, cleaning up for the business, etc.* 1 = Yes, ate food on site 2 = Yes, was given a food ration to take home 3 = Yes, was given non-food items 4 = Do not know	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

		01	02	03	04	05	06	07	08	09	10
2.5	**What is ……'s total salary/pay at his/her main job?** *Including overtime, allowances and bonus, before any tax or deductions. Give amount in whole figures, without any text or decimals.* If "NONE", "REFUSE" **or** "DO NOT KNOW write 999 000 000										
2.6	**Ask only if an amount is given in Q2.5**										
	Is this….										
	1 = Per week	1	1	1	1	1	1	1	1	1	1
	2 = Per month	2	2	2	2	2	2	2	2	2	2
	3 = Annually	3	3	3	3	3	3	3	3	3	3

SECTION 3: HEALTH AND GENERAL FUNCTIONING

Questionnaire number: .....

		01	02	03	04	05	06	07	08	09	10
3.1	**Has .....been unable to perform their usual duties (housework, employment) for 30 days or more during the past year due to illness?** *Read all the options* 01 = Yes										

Ask for all household members. Read out: Now I am going to ask you health-related questions for each member of the household

Questionnaire number: .....

		01		02		03		04		05		06		07		08		09		10	
3.2	**Has…been informed by a medical practitioner or nurse that he/she suffers from any if the following conditions?** *Read all the options*	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
	1 =Asthma	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
	2 = Diabetes	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
	3 = Cancer	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
	4 = HIV and AIDS	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
	5 = Hypertension/high blood pressure6 = Arthritis	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
	7 = Stroke	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
	8 = Heart attack / myocardial infection	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
	9 = Tuberculosis	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
	10 = Others (specify in the box)	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2

Questionnaire number: .....

Read out: I am now going to ask about the general functioning of persons within the household

SECTION 4: SOCIAL GRANTS AND SOCIAL RELIEF

Ask for all household members

Read out: I am now going to ask about the use of social grants and social relief

	01	02	03	04	05	06	07	08	09	10
4.1 Does anyone in this household receive a social grant, pension or social relief assistance from the Government?										
1 = Yes	1	1	1	1	1	1	1	1	1	1
2 = No *xxxxx*	2	2	2	2	2	2	2	2	2	2
3 = Do not know *xxxx*	3	3	3	3	3	3	3	3	3	3

+

4.2	*If "Yes" in Q4.1a* **Does … receive a(n) ?** *Answer for each person* *who qualified for the grant and NOT for the personwho applied on behalf of/physically receives the money. Someone who used to work for the Government and receive a pension do* ***not get*** *anold age grant* *Read all the options* 1 = Old-age grant 2 = Disability grant 3 = Child support grant 4 = Care dependency grant5 = Foster child grant 6 = War veterans grant7 = Grant-in-aid																				
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2

4.3 Does the household receive any social relief of distress ? Code: 1=Yes; 2=No ______

Questionnaire number: .....

SECTION 5: ANTHROPOMETRY: the following measurements should be recorded for all children under 5 years of age and the person who cares for them

	01	02	03	04	05	06	07	08	09		10
5.1	**Is any female in the household pregnant?**	1	1	1	1	1	1	1	1	1	1
	1 = Yes	2	2	2	2	2	2	2	2	2	2
	2 = No	3	3	3	3	3	3	3	3	3	3
5.2	**Is the person older than 0 months and under 5 years of age (<60 months) at home?**	1	1	1	1	1	1	1	1	1	1
		2	2	2	2	2	2	2	2	2	2
	1 = Yes 2 = No										

Measure weight of (household member name). Measure twice with a digital scale. Measurements are recorded in kilograms with two decimals.

Weight measurement 1

Weight measurement 2

5.3 **M**easure height of children who are 0 – 5 years (household member name). Measure twice with stadiometer in centimeter (cm).

Height measurement 1

5.4 Height measurement 2

5.5 Mid-upper arm circumference (MUAC) for the children under 5: Measure twice with narrow tape in centimeters (cm). Measures (4-5) should only be done to children under the age of 5(60 months).

MUAC Reading 1 (force entry)

MUAC Reading 2 (force entry)

5.6 Last entry on the Road to Health booklet of children under 5 years of age

Questionnaire number: .....

	Date of entry										
	Age of the child in months										
	Weight of the child in kg, 2 decimal places										
5.7	How many meals did this child eat yesterday?										
5.8	Does this child breastfeed? 1=Yes 2=No	1	1	1	1	1	1	1	1	1	1
		2	2	2	2	2	2	2	2	2	2
5.9	Did this child breast feed yesterday? 1=Yes	1	1	1	1	1	1	1	1	1	1
	2=No	2	2	2	2	2	2	2	2	2	2
5.10	Is this child under exclusive breast feeding?	1	1	1	1	1	1	1	1	1	1
		2	2	2	2	2	2	2	2	2	2

Questionnaire number: .....

SECTION 6: GENERAL HOUSEHOLD INFORMATION AND SERVICE DELIVERY

Ask a responsible person in the household to answer on behalf of the household.

HOUSING ***Ask all households***

6.1 Indicate the type of main dwelling that the household occupies	**Main Dwelling**	**Other Dwelling**
01 = Dwelling/house or brick/concrete block structure on a separate stand or yard or on farm 02 = Traditional dwelling/hut/structure made of traditional materials 03 = Dwelling/house/flat/room in backyard04 = Informal dwelling/shack in backyard 05 = Informal dwelling/shack not in backyard, e.g. inan informal/squatter settlement or on farm 06 = Room/flatlet on a property or a larger dwelling/servants' quarters/granny flat 07 = Caravan/tent 08 = Other (specify)		

6.2 What is the main material used for the walls and the roof of the main dwelling?	**Walls**	**Roof**
01 = Bricks 02 = Cement block/concrete03 = Corrugated iron/zinc 04 = Wood 05 = Plastic 06 = Cardboard 07 = Mud and cement mix08 = Wattle and daub 09 = Tile		

10 = Mud 11 = Thatching/grass 12 = Asbestos 13 = other (specify)		

Questionnaire number: .....

WATER - ***Ask all households***

SANITATION - ***Ask all households***

6.3 What is the household's main source of water for washing and bathing

01 = Piped (tap) water in dwelling/house
02 = Piped (tap) water in yard
03 = Borehole in yard
04 = Rain-water tank in yard
05 = Neighbour's tap
06 = Public/communal tap
07 = Water-carrier/tanker
08 = Borehole outside yard
09 = Flowing water/stream/river

13 = Other (specify)

Ask if Water is not in dwelling, or in yard.

6.5 How far is the water source from the dwelling or yard (200m is equal to the length of two football/soccer fields)?

6.10

What type of toilet facility does this household use?

1 = Flush toilet connected to a public sewerage system

2 = Flush toilet connected to a septic tank

3 = Chemical toilet

4 = Pit latrine/toilet with ventilation pipe

5 = Pit latrine/toilet without ventilation pipe

6 = Bucket toilet

7 = None

8 = Other (specify)

11 = Well

12 = Spring

ENERGY - ***Ask all households***

Does thishousehold have access to/use electricity?

Questionnaire number: ……

1 = Yes 1

2 = No 2

3 = Do not know 3

Is the toilet facility in the dwelling, in the yard or outside the yard?

1

2 = 201 - 500 metres 2

3 = 5

01 metres - 1 kilometre 3

4 4 = More than 1 kilometre

5 = Do not know

What is the main source of energy/fuel for cooking in thishousehold? 5

water is not from a pipe or a tap.

Ask if

6.6 **Did you use piped or tap water at any time in the past while li in this community, but have stopped as a result of the systemving breaking down?**

01 = Electricity from mains

02 = Electricity from generator03 = Gas

1 = Yes

04 = Paraffin 1

05 = Wood

06 = Coal

07 = Candles

08 = Animal dung 09 = Solar energy 10 = Other, (specify)11 = None

Questionnaire number: .....

Ask all households

6.4 What is the household's main source of drinkingwater?

01 = Piped (tap) water in dwelling/house02 = Piped (tap) water in yard

03 = Borehole in yard

04 = Rain-water tank in yard05 = Neighbour's tap

06 = Public/communal tap 07 = Water-carrier/tanker 08 = Borehole outside yard

09 = Flowing water/stream/river10 = Stagnant water/dam/pool 11 = Well

12 = Spring

13 = Other (specify)

6.7 Is the water from the main source of drinking water before any treatment …..

Read all the options

	Yes	No
1 = S a f e to drink?	1	2
2 = C l e a r (has no colour / free of mud)?	1	2
3 = G o o d in taste?	1	2
4 = F r e e from bad smells?	1	2

6.8 Do household members treat the water used for drinking? *This may include boiling, adding chlorine or other chemicals, filtering.*

1 = Yes, always 1

2 = Yes, sometimes 2

3 = No, never 3

6.9 Does the household pay for water?

1 = Yes 1

2 = No 2

6.11

1 = In dwelling 1

2 = In yard 2

3 = Outside yard 3

Questionnaire number: .....

Questionnaire number: .....

Questionnaire number: .....

SECTION 7: HOUSEHOLD FOOD SECURITY

7.1	**In the past four weeks, did you worry that your household would not have enough food??** 1 = Never 2 = Rarely (1 – 2 times a month) 3 = Sometimes (3 – 10 times a month) 4 = Often (more than 10 times a month)	No:___
7.2	**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?** 1 = Never 2 = Rarely (1 – 2 times a month) 3 = Sometimes (3 – 10 times a month) 4 = Often (more than 10 times a month)	
7.3	**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?** 1 = Never 2 = Rarely (1 – 2 times a month) 3 = Sometimes (3 – 10 times a month) 4 = Often (more than 10 times a month)	
7.4	**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?** 1 = Never 2 = Rarely (1 – 2 times a month) 3 = Sometimes (3 – 10 times a month) 4 = Often (more than 10 times a month)	
7.5	**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?** 1 = Never 2 = Rarely (1 – 2 times a month) 3 = Sometimes (3 – 10 times a month) 4 = Often (more than 10 times a month)	No: ___
7.6	**In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?** 1 = Never 2 = Rarely (1 – 2 times a month) 3 = Sometimes (3 – 10 times a month) 4 = Often (more than 10 times a month)	No: ___
7.7	**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 = Never 2 = Rarely (1 – 2 times a month) 3 = Sometimes (3 – 10 times a month) 4 = Often (more than 10 times a month)	No: ___
7.8	**In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?** 1 = Never 2 = Rarely (1 – 2 times a month) 3 = Sometimes (3 – 10 times a month) 4 = Often (more than 10 times a month)	No: ___

Questionnaire number: .....

7.9	**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?** 1 = Never 2 = Rarely (1 – 2 times a month) 3 = Sometimes (3 – 10 times a month) 4 = Often (more than 10 times a month)	
7.11	How many times in a typical day do adults eat?	No____
7.12	How many times in a typical day do children under 5 years eat?	No____

7.

Household Hunger Scale questions		
	7.14a In the past [4 weeks/30 days], was there ever no food to eat of any kind in your house because of lack of resources to get food? 1 = Yes 2=No (if No skip to 7.15a)	**7.14b How often did this happen in the past [4 weeks/30 days]?** 1= Rarely (1–2 times) 2= Sometimes (3–10 times) 3 = Often (more than 10 times)
7.13	**7.15a In the past [4 weeks/30 days], did you or any household member go to sleep at night hungry because there was not enough food?** 1 = Yes 2=No (if No skip to 7.16a)	**7.15b How often did this happen in the past [4 weeks/30 days]?** 1= Rarely (1–2 times) 2= Sometimes (3–10 times) 3 = Often (more than 10 times)
	16a In the past [4 weeks/30 days], did you or any household member go a whole day and night without eating anything at all because there was not enough food? 1 = Yes 2=No	**7.16b How often did this happen in the past [4 weeks/30 days]?** 1= Rarely (1–2 times) 2= Sometimes (3–10 times) 3 = Often (more than 10 times)

Questionnaire number: ……

8.1 ***Ask about the food consumption of householdmembers***	**Did household members eat this food yesterday?**	**Did any child 6-23 months old eat this food yesterday?**	How often is this food group usually eaten in the household? Think of the past year, and then fill in the number of times: either per week OR permonth OR per year.	Where was the food obtained from (source)?
				Produced (e.g. from own garden) / In kind/donations/ event / Bought (name bank/school feeding) / Gift/food
01 = Cereals: maize, rice, wheat, sorghum, millet, and any other foods made from cereals such as porridge, bread and	- Other fruit (e.g. oranges, banana, apple, pear etc.),including wild/indigenous fruits?	Yes - tick	Yes - tick Per week Per month Per year	
02 = White roots and tubers - Potatoes, white sweet potatoand cassava	- Organ meat (liver, kidney, heart or other organ meatsor blood-based foods)			
03 = Orange-flesh vegetables: Pumpkin, carrot, butternutor sweet potato	- Meat (e.g. beef, goat, sheep, poultry, pork, fish, insects			
–Dark green leafy vegetables, including wild/indigenous vegetables	- Eggs from any animal			
– Other vegetables (tomato, onion, green beans, gem squash, eggplant, including wild/indigenous vegetables	- Fish and seafood (fresh, tinned or dried and shellfish)			
- Orange-coloured fruit (e.g. ripe mango, apricot, spanspek, papaya, dried peach and 100% fruit juice madefrom these)?	- Dried beans, peas, lentils, nuts, seeds or foods madefrom these (e.g. peanut butter)?			
	- Milk and milk products (e.g. yoghurt, maas cheese)			

store)

- Oils and fats(e.g. sunflower, rama, lard, butter addedto food or used for cooking
- Sweets (e.g. sugar, honey, sweetened juices or fizzydrinks, sugary foods such as chocolate, cookies, cakes)
- Spices (e.g. pepper and salt), condiments (e.g.tomato sauce), coffee, tea, alcoholic beverages

Questionnaire number: .....

Section 9: Months of Adequate Household Food Provisioning (MAHFP) for Measurement of Household Food Access

9.0	Months of hunger experiences		
9.1	In the past 12 months, were there months in which you did not have enough food to meet your family's needs? [1=Yes, 0=No]		
9.2	If yes, which were the months (in the past 12 months) in which you did not have enough food to meet your family'sneeds?		
ABC **DEF** **GHI** **J** **KL**	January FebruaryMarch April May June July August SeptemberOctober November December ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	A…….. B…….. C…….. D…….. E…….. F……..☐ ☐ G……..☐ ☐ H……..☐ ☐ I……..☐ ☐ J…….. K…….. L……..	

Questionnaire number: .....

9.3 How does the household cope with major income shocks (e.g. drought, death of a breadwinner, job loss, etc.) (Please tick where appropriate)			
Sell livestock	Y N	Take on additional work	Y N
Sell other assets	Y N	Reduce spending	Y N
Use own cash savings	Y N	Reduce food consumption	Y N
Borrow money from relatives	Y N	Reduce or stop debt repayments	Y N
Borrow money from stokvel	Y N	Other: Please specify	Y N
Receive help from friends or relatives	Y N		

Questionnaire number: .....

SECTION 9B: CONSUMPTION COPING STRATEGIES INDEX

	Behaviours: In the past 7days, if there have been times when you did not have enough food or money to buy food, how many days has your household had to: Yes orno	Number of days out of the past seven (use numbers 0 – 7 to answernumber of days Use NA for not applicable
a. Rely on less preferred and less expensive foods?		
b. Borrow food, or rely on help from a friend or relative?		
c. Purchase food on credit?		
d. Gather wild food, hunt, or harvest immature crops?		
e. Consume seed stock held for next season?		
f. Send household members to eat elsewhere?		
g. Send household members to beg?		
h. Limit portion size at meal times?		
i. Restrict consumption by adults in order for small children to eat?		
j. Feed working members of HH at the expense of non-working members?		
k. Reduce number of meals eaten in a day?		
l. Skip entire days without eating?		

Questionnaire number: ……

SECTION 10: Food and Non Food Expenditure: I will know ask about household food and non-food expenditure for last 12 months

0. Where do you normally get thisitem? **Codes** *1…supermarket* *2…small shop/restaurant/takeaway* *3..Informal market / street vendors 4...Own production* *5…Food aid* *6…Remittances*		1.Since March 2012 to this day, did the household spend money onthe following food items?**Codes** *1…yes* *2…No* **go to nextitem**	2. If yes, how frequent were these purchased?Code *1…daily 2…weekly 3…monthly* *4…. quarterly 5…annually* *6…other (specify)*	3. Number of purchases per period? number of times P= Number of Purchase M=Number of Months		4. How much money was normally spent per eachpurchase?	5. Quantity bought of this itemPer purchase in Kgs
Item	*Code*			**P**	**M**	*Rand*	
01 Mealie meal, maize products							
02 Rice							
03 Millet							
04 Sorghum							
05 Wheat, wheat flour, etc							

06 Vegetables, Tomato,							xxxxx
07 Sugar, tea, coffee, etc							xxxxx
08 Salt, Spices, etc							xxxxx
09 Cooking oil, margarine, butter,							xxxxx
10 Cassava, sweet potatoes, Irish potatoes (root and tubers)							
11 Beans, peas (Pulses)							
12 Fish							
13 Meat							
14 Milk, milk products, etc							
15 Fruits							
16 Yam							
17 Bread							
18 Other (specify							

Questionnaire number: ……

SECTION 10B:

Non- Food Expenditure

1. Did the household spend money on the following items in the past 12 months? **Code4** *1…yes* *2…No* **go to next item**		*2.* *If* yes, how frequent were these purchased *Codes* *1…daily* *2…weekly* *3…monthly* *4….quarterly* *5…annually* *6…other (specify)*	3. Number of purchases per period?	4. How much money is normally spent per each purchase?
01 Electricity (bills, light bulbs,				
02 Batteries				
03 Firewood				
04 Charcoal				
05 Petrol / diesel				

1. Did the household spend money on the following items in the past 12 months? **Code** *1…yes* *2…No* **go to next item**		2. If yes, how frequent were these purchased*Codes* *1…daily* *2…weekly* *3…monthly* *4….quarterly* *5…annually* *6…other (specify)*	3. Number of purchases per period? Put the number of times	4. How much money is normally spent per each purchase?
Item				
17 Writing materials				
18 Father's clothes				
19 Mother's clothes				
20 Children's clothes				
21 Clothes and shoes				
22 Pots				
23 Plates, spoons,				
24 Cups				
25 Baskets				
26 Loan repayment				
27 Remittances				
28 Gifts				
29 Religious Offerings				
30Wedding ceremony				
31 Funeral expenses				
32 Dowry (lobola etc)				
33 Entertainment				

06 Kerosine				
07 Candles, matches, etc				
08 Security				
09 Telephone (calls, handsets,				
10 Transport				
11 General body hygiene				
12 Make up and hair dressing				
13 Shaving, nail cleaning, etc				
14 School fees				
15 Uniform				
16 Pocket money				

Questionnaire number: .....

	Section 10: HOUSEHOLD LIVELIHOODS AGRICULTURAL ACTIVITIES ***Ask all households***		
10.1	**Has the household been involved in the production of any kind of food or agricultural products during the past twelve months? (e.g. livestock, crops, poultry,food gardening, forestry, fish, etc.)** 1 = Yes 2 = No	1 2	
10.2	**What kind of food production/agricultural activities is thehousehold involved in?** *Read all the options* 01 = Livestock production (cattle, goats, sheep, pigs, etc.) 02 = Poultry production (chickens, ducks, geese, guinea fowl, etc.)03 = Grains and food crops (maize, wheat, beans, sorghum, millet, Groundnuts etc.) 04 = Industrial crops (e.g. tea, coffee, cotton, sugar, tobacco)05 = Fruit and vegetable production 06 = Fodder, grazing/pasture or grass for animals07 = Fish farming/aquaculture 08 = Forestry 09 = Game farming10 = Other	Yes 1 1 1 1 1 1 1 1 1 1	No 2 2 2 2 2 2 2 2 2 2
10.3	**Why do you grow farm produce or keep livestock for the household in the past year?** 1 = As a main source of food for the household	1	

	2 = As the main source of income/earning a living	2
	3 = As an extra source of income	3
	4 = As an extra source of food for the household	4
	5 = As a leisure activity or hobby e.g. gardening	5
10.4	**Did your household sell any of its produce or livestock in the last year?**	
	1 = Yes	1
	2 = No	2

10.5	Do you store any foods for later use? **1=yes 2=no**	If yes, what foods?
10.5b	If yes, how do you store your food? Tick appropriate	1=Refrigerate 2=Drying 3=Fermenting 4=Pickling 4=Dry salting 5=Smoking 6=Sealing 7=Cellaring 8=Other (specify)
10.6	Do you process any foods? **1=yes 2=no**	If yes, what foods?

Questionnaire number: .....

	How many of the following does the	**…ber**
10.7	**If produce is sold, to whom does your household sell most of its produce?** *Read all the options* 1 = Local buyers from this district 2 = Buyers from neighboring cities and towns 3 = Formal markets in South Africa 4 = Export agencies in international buyers. 5 = Other	1 2 3 4 5

		Yes	No
10.8	**Has your household received any of the following kinds of agricultural related assistance from the government during the past 12 months?** *Read all the options*		
	1 = Training	1	2
	2 = Advice from government extension officers	1	2
	3 = Grants (money that does not have to be paid back)	1	2
	4 = Loans (money that has to be paid back)	1	2
	5 = Inputs (seed, fertilizer, etc.) as part of a loan	1	2
	6 = Inputs (seed, fertilizer, etc.) for free	1	2
	7 = Dipping and vaccination services for livestock from State veterinarian or other Department	1	2
	8 = Other (specify)	1	2
	Go to Q10.9 if households answered yes to any of the categories above, else go to Q10.10		

10.9	**Did your household find this agriculture-related assistance:**	
	1 = Very useful	1
	2 = Somewhat useful	2
	3 = Not useful	3

10.10	**Did your household receive agriculture-related assistance from any other entity than government?**	
	1 = Yes	1
	2 = No	2

Con…stry)/pastures/industrial crops. Otherwise, go to Q10.14

		Yes	No
10.12	**Where does the household practice its crop planting activities?** *Read all the options*		
	1 = Farm land (communal or private)	1	2
	2 = Backyard garden (can include, vegetables, fruits, grains)	1	2
	3 = School garden (can include, vegetables, fruits, grains)	1	2
	4 = Communal garden (more than one household involved, caninclude vegetables, fruits, grains)	1	2
	5 = On verges of roads and unused public/municipal land	1	2
	6 = Other		

Questionnaire number: ……

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Questionnaire number: .....

10.13	**Approximately how big is the land that the household uses for production? Estimate total area if more than one piece.** 1 = Less than 500m² (approximately one soccer field) 2 = 500m² to 9 999m² (between one soccer field and one hectare) 3 = 1 but less than 2 hectares 4 = 2 but less than 5 hectares 5 = 5 but less than 10 hectares 6 = 10 but less than 20 hectares 7 = 20 or more hectares 8 = Do not know	

10.14	**On what basis does this household have access to the land used for crop production? If more than one kind of tenure system applies for different pieces of land, give an answer for the biggest piece.** 1 = Owns the land 2 = Rents the land 3 = Sharecropping 4 = Tribal authority5 = State land 6 = Other (specify) 7 = Do not know	

10.15	**If the household receives an income from remittances, please specify approximately how much they receive per month?** *If no income received from remittances write 0.*	
10.16	**If the household receives an income from pensions (do not include income from old age grants), please specify approximately how much they receive per month?** *If no income received from pensions, write 0.*	
10.17	**What was the total household expenditure in the last month?** *Include money spent on food, clothing, transport, rent and rates, alcohol and tobacco, school fees, entertainment and any other expenses.*	

Questionnaire number: .....

10.18	**How many of the following does the household own?** 01 = Bed with mattress 02 = Sofa Set 03 = Table (dining/desk) 04 = Pay TV (M-Net / DSTV / Top TV) Subscription 05 = Radio-working condition 06 = Mobile Phone 07 = Tape or CD/DVD 08 = Television 09 = Motor vehicle 10 = Refrigerator 11 = Washing machine 12 = E lectric Stove / Gas Stove	Number 01 = 02 = 03 = 04 = 05 = 06 = 07 = 08 = 09 = 10 = 01 = 11 = 12=

Questionnaire number: ……

Questionnaire number: .....

SECTION 12: CROPS PRODUCED in the 2013/14 season (X month 2013 to this month 2014)

12.1	Crops grown	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12

Questionnaire number: .....

Crops planted and harvested	Total area	Total	Price per	Did the household consume this crop?	Was any sold?	Income	Was this processed in any way?	How much was stored for home consumption?	Was the crop irrigated?	If irrigated, what kind of irrigation? • buckets form a river, treadle • pump, flood irrigation • irrigation scheme, municipal	If irrigated, what is the water source?	Did you use any inputs? Improved seeds? Fertilizer? Manure?	Is mechanized farming used? Tractor? Harvester?

12.2			
	Do you apply crop rotation? Y/N	**1=Yes 2=No**	**Why?**
	Is there un-used land? Why?	**1=Yes 2=No**	**Why?**
	Is there follow land? Why?	**1=Yes 2=No**	**Why?**
	Do you have access to water?	**1=Yes 2=No**	**Why?**
	Do you use it for irrigation?	**1=Yes 2=No**	**Why?**
	Do you have enough water?	**1=Yes 2=No**	**Why?**
	What are you not growing andwould like to?		
	Have you had poor success with acrop? Why?	**1=Yes 2=No**	**Why?**

Thank the respondent!

INTERVIEW END TIME