SOCIAL-ECONOMIC DETERMINANTS OF FOOD SECURITY AMONG SMALLHOLDER FARMERS IN BURERA DISTRICT, RWANDA

VINCENT NSABUWERA

MASTER OF SCIENCE

(Agriculture and Applied Economics)

JOMO KENYATTA UNIVERSITY OF

AGRICULTURE AND TECHNOLOGY

2018

Social-Economic Determinants of Food Security among Smallholder Farmers in Burera District, Rwanda

Vincent Nsabuwera

A thesis submitted in partial fulfilment for the Degree of Master of Science in Agriculture and Applied Economics in the Jomo Kenyatta University of Agriculture and Technology

2018

DECLARATION

This thesis is my original work and has not been presented for a degree in any other University

Signature …… Date ……..

Vincent Nsabuwera

This thesis has been submitted for examination with my approval as University Supervisor

Signature …… Date ……..

Dr. Eucabeth Majiwa, PhD

JKUAT, Kenya

Signature …… Date ……..

Dr. Patrick Mulyungi, PhD

JKUAT, Kenya

DEDICATION

This thesis is dedicated to my beloved wife Eugenie Musabyimana Bazimenyera, and my children Nsabuwera Rukundo Beni Fidele, Nsabuwera Kwizera Eddy Louange and Nsabuwera Hirwa Enzo Marie-Jean. Your patience, relentless encouragement and prayers throughout this course showed me your incomparable love.

ACKNOWLEDGMENT

Several individuals have helped me immensely during the completion of this thesis. Acknowledging each and every one would be impossible but it would be amiss if I don't mention a few of them without whose support and help it would have been difficult for me to complete this heavy task.

I wish to express my profound sense of gratitude and indebtedness to my Supervisors, Dr. Eucabeth Majiwa and Dr. Patrick Mulyungi, Your tireless guidance, friendly attitude, sustained interest and invaluable advices were always a source of inspiration and encouragement for me to complete this research work.

I owe gratitude also to Prof. David Mburu, Dean of the Faculty of Agriculture and Resource Economics of Jomo Kenyatta University of Agriculture and Technology (JKUAT) for all the encouragement and wise advice he continuously provided throughout this course and research work.

My gratitude is also extended to the leadership of Partners in Health (PIH) where I worked as Director of Food Security and Livelihood Program. Dr Peter Drobac, Dr Bethany Hedt, Dr Manzi Anatole, to mention a few, your encouragement and mentorship not only made me a good operational researcher in the domain of food security but also a profound inspiration to investigate, document, advocate and act for the betterment of the rural livelihood conditions in Rwanda.

I place on record of my acknowledgment my brothers, relatives, colleagues and friends for all your encouragement and moral support you provided me. Alphonse Hishamunda, Tharcisse Munyampirwa, Fidele Rwamuhizi and Jean Claude Ndolimana, your regular check in on my progress and moral support have been instrumental in completing this work. Particularly, Ernest Uwimana, Lambert Niyigaba, Norbert Muhaturukundo, Gaspard Ntabakirabose, Francine Uwamahoro, Eric Ntaganira and Eric Ruvuna, you

have been invaluable colleagues and encouraging friends at my side during this long journey.

Finally, I am very grateful to my beloved wife and children for always being on my side. Your patience, prayers and support helped me to keep forward during the time of this course and research work.

To all unmentioned, you always have your place in my heart and memories.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

AHM	Agricultural household models
CFSVA	Comprehensive Food Security and Vulnerability Analysis
CIP	Crop Intensification Program
DFID	Department for International Development
EICV	Enquete Integrale des Conditions de vies des Menages au Rwanda (Rwanda Integrated Household Survey)
EDPRS	Rwanda's Economic Development and Poverty Reduction Strategy.
FAD	Food Availability Decline
FED	Food Entitlement Decline
FAO	United Nations Food and Agriculture Organization
FRW	Rwandan Franc
GDP	Gross Domestic Product
GoR	Government of Rwanda
HFIAS	Household Food Insecurity Access Scale
IFAD	International Fund for Agriculture Development
IFC	International Finance Corporation

MINAGRI	Rwanda Ministry of Agriculture
MLM	Multinomial Logistic Regression
NFSNSP	National Food Security and Nutrition Strategic Plan
NISR	National Institute of Statistics of Rwanda
PSTA	Plan Strategic de Transformation Agricole (Strategic Plan for Agricultural Transformation)
SHF	Smallholder Farmer
SSA	Sub-Saharan Africa
UNDP	United Nations Development Program
WFP	World Food Program

DEFINITION OF KEY CONCEPTS

Farmer: The Business Dictionary defines a farmer as an individual whose primary job junction involves livestock and/or agriculture. This definition is simplified by Oxford Dictionaries as a person who owns or manages a farm.

Food Accessibility: household level food access is ensured when the household has sufficient resources to obtain appropriate foods for their nutritious diet (InWEnt,2010). Accessibility refers to ability of the household members to acquire food and it depends on the household level resources – capital, labour, and knowledge. Food accessibility at household level is a function of the physical environment, social environment and policy environment which determine the ability of the household to generate sufficient income which, together with own production, can be used to meet food needs (InWent, 2010).

Food Availability: this concept refers to the physical existence of food at the household level, be it from own production or from the market. At national level, food availability is a combination of domestic food production, commercial food imports and food aid (InWent, 2010).

Food Security: The 1996 World Food Summit defined food security as a situation that exists "*when all people at all times have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*" (FAO,1996). This commonly accepted definition of

food security comprises both the physical aspects (availability and access), nutritional aspects (use and utilization) and temporal aspect (stability) of food. To remove confusion, many scholars later preferred to refer to this 1996 FAO's definition as "Food and Nutrition Security" (InWent, 2010).

Food Use and Utilization: The use of food refers to the decision making (both at individual and household level) concerning what type of food is to be purchased, prepared and consumed, and how the food is allocated within the household members. Food utilization on the other hand refers to the ability of the human body to take food and convert it into energy and nutrients used to either undertake daily activities, or stored energy. This biological utilization of food requires not only an adequate diet, but also a healthy physical environment, including safe drinking water and adequate sanitary facilities (to avoid diseases etc). (InWent, 2010).

Household: The Cambridge Dictionary defines a household as a group of people, often a family, who live together.

Smallholder subsistence farming: smallholder subsistence agriculture refers mainly to rural producers in most developing countries who farm on a small piece of land using mainly family labour for production purposely for household consumption (Morton, 2007). According to Rwanda Ministry of Agriculture (MINAGRI, 2009), small-holder farmers are the marginal and sub-marginal farm households that own and/or cultivate less than 2.0 hectare of land.

ABSTRACT

The agricultural sector is the backbone of the Rwandan economy, contributing 33% of the GDP. It has recorded steady increases in the last decade. While Rwanda is classified as food secure at macro level, about half of the households in Rwanda still face seasonal difficulties in accessing adequate food, meaning that they are at high risk of becoming food insecure in terms of food availability and accessibility. Most of the households at risk are typically rural households who mainly depend on agricultural daily labour for their livelihoods and mostly live on their own farm production. The objective of this study was to investigate the Socio-economic determinants of food security among the mixed smallholder farmers in Burera district of Rwanda. Data were collected from 378 smallholder farmers 'households selected by using a Multi-Stage Random Sampling technique. Household food security status was assessed and categorized using internationally validated HFIAS tool. To analyse the effect of socio-economic determinants of household food security status of the sampled smallholder farmers, Multinomial Logit Model was used. The results revealed that only 6.3% of the sampled smallholder farmers' households could be classified as food secure, 15.6% of the households were found to be mildly food insecure, while 34.7% were moderately food insecure and 43.4% were found to be severely food insecure, which implies that a majority of the smallholder farmers in the study area live in food insecurity situation. The study also revealed that 77.7% of the respondents were operating on farm size less than one hectare. About 54.2% of the respondent households had at least one medium to large livestock (cow, goat, sheep or pig) that helped them to produce organic manure, with only 15.87% having cows in their households. The study revealed that 42.9% of the respondents earned on farm income range of 200,000-300,000Frw. About 72% of the respondents did not have access to financial facility while 92% of the respondents did not receive any training in agricultural practices or a home visit from an extension agent within the previous one-year period. Only 25% of the respondents had ever used mineral fertilizers in the previous two agricultural seasons. The Multinomial Logit model odds ratios revealed that farm size, on-farm income and gender (women headed households) were found to influence positively the probability of a household to be in the category of food secure or better off food insecurity level (mild or moderate) when compared to severe food insecurity status. On the other hand, family size, poor access to financial facilities, agricultural trainings and extension services, as well as low education level of the household head had a negative effect on the probability of a household to be in better off category of food security status when compared to the severe food insecurity. Based on the findings, the study recommends to strengthen the implementation of the land use consolidation policy among the smallholder farmers, which would ease efficient exploitation of consolidate land capital units as well as easy access to subsidized fertilizers and agricultural extension assistance. The study further recommends policy actions aimed at more income generation and optimal exploitation of the available surplus labour among the smallholder farmers. This could be through development of rural based agro-processing enterprises. Efforts to increase awareness on women

empowerment and financial literacy among the smallholder farmers are also recommended.

Keywords: Food security, HFIAS, smallholder farmers, Multinomial logit model, Rwanda.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Across the World, in 2013 there were approximately 2.5 billion people who lived directly from agricultural production systems, either as full or part-time farmers, or as members of farming households that supported farming activities (IFAD, 2013). Out of that number, 80% were classified as smallholder farmers, managing the world estimated 500 million small farms and providing over 80 % of the food consumed in a large part of the developing world, contributing significantly to poverty reduction and food security (IFAD, 2013). Smallholder farmers are characterized by producing food and non-food products on a small scale, with limited external inputs. The Food and Agriculture Organization (FAO) has set a 2-hectare (ha) threshold as a broad measure of a small farm (FAO, 2010). According to IFAD (2013), the majority of smallholder farmers live in rural areas. The contributions of smallholder farmers on the world's food security, economy and poverty reduction thus remain considerable. Smallholder farmers are a pillar to food security since they provide up to 80% of food supply in Asian and Sub-Saharan Africa with 70% of Africa's food supply coming from smallholder farmers (IFAD, 2013).

Rwanda's economy still depends mainly on agricultural sector, contributing 33% of GDP and employing about 80% of the workforce, and 90% of them being smallholder subsistence farmers (NISR, 2014). Agricultural sector in Rwanda is dominated by smallholder subsistence farming which is practiced on an average farm size of less than one hectare per household (IFDC, 2014). The sector continues to be characterized by very low levels of inputs use. Without optimal agricultural inputs such as land, labour and capital, there is limited crop production since such inputs are essential in increasing agricultural productivity thus resulting to increased food output and enhanced food security. Thus, raising productivity levels of smallholder farmers represents a vital role

to economic growth and poverty reduction in Rwanda. The Government of Rwanda has introduced several projects and programs to improve agriculture and boost food production in the country such as CIP, PSTA I, II and III, land use consolidation policy, one cow per family amongst others. Because of these interventions, there has been an increase in the use of inputs including agrochemicals, though the average use remains still far below the Government targets. In 2009, compared to other countries, it was estimated that over the previous decade, only 12 percent of farming population had used improved seed varieties and 5.2 percent of households had used approximately 4 kg of fertilizer per hectare (MINAGRI, 2009) which was still below the estimated average use of fertilizer in the Sub Saharan Africa (SSA) standing at 9 to 11 kg per hectare (MINAGRI 2009). Due to the above mentioned programs initiated by the Government of Rwanda, the rate of fertilizer application in CIP areas has reached an annual average of 29 kg/ha/year in 2011-2012 compared to a national average of 4.2 kg/ha/year from 1998-2005 and in 2013 the Ministry of Agriculture of Rwanda (MINAGRI) set a target average rate of fertilizer use of 45 kg/ha by 2017 (MINAGRI, 2013). Access to improved seeds, increased areas under irrigation, radical terraces protected against erosion, distribution of livestock through programs such as Girinka among others are some of the other proposed measures targeted at increasing Rwanda's agricultural productivity and production for a number of crops, thus increasing the farmers' income and reducing rural poverty considerably.

Despite the considerable contribution in the global, regional and national food production, smallholder farmers comprise the majority of the world's undernourished population, and most of those living in absolute poverty (IFAD, 2013). Smallholder farmers are often relegated to infertile soils and to decreasing plot sizes (De Schutter, 2011). In many parts of the world, smallholder farmers particularly in densely populated areas are struggling to maintain food self-sufficiency, mainly due to declining land size (per capita land) which leads to fragmentation,, thus threatening the ability of the remaining land to provide adequate livelihoods (Jayne & Muyanga, 2012).

The 2015 FAO's State of Food Insecurity in the world indicated that there were still over 795 million people, or one in nine worldwide and one in four within Sub-Saharan Africa who did not have enough to eat in 2015, while 70% of them live in rural areas and depend directly or indirectly on agriculture for their living (FAO, 2015).

In Rwanda, despite all the efforts the Government has put in place to boost Agriculture, the level of food insecurity remains high, with minimal reduction on annual basis, from 51% of households having difficulties in accessing adequate food in 2012 to 49% in 2015, especially in the rural households depending mainly on agricultural daily labour and their own agricultural production (WFP, 2012; 2016). As indicated in the Fig.1.1, in 2016 Rwanda was ranked among the countries with serious Global Hunger Index, with a score of 27.4 (IFPRI, 2016).

Existing literature indicates that socio- economic characteristics of small holder farmers have been noted to significantly determine the level of farm productivity and subsequent household food security levels. Such factors include lack of natural resources, low income levels, small farm sizes, low level of education of the small holder farmers (Oni, 2010).In Rwanda, the status of food insecurity and the socio-economic factors that affect food security in many areas have not been well investigated.

Thus, this study assesses the status of food security at household level and the social–economic determining factors that affect household food security among small-holder farmers in Burera district of Rwanda.

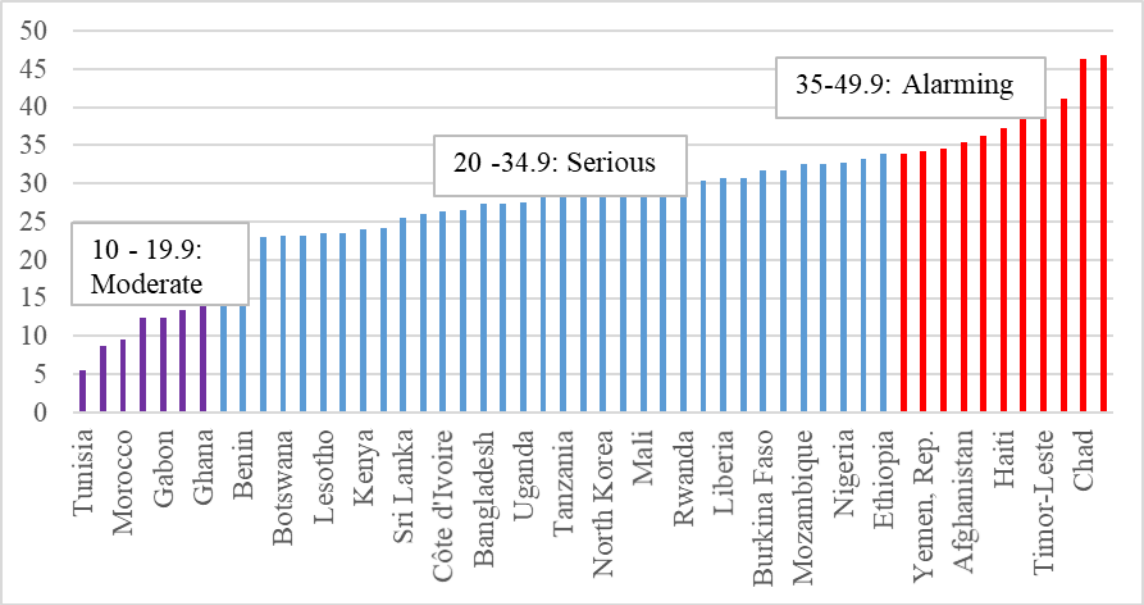

Figure 1.1: Global Hunger Index Scores by rank (IFPRI, 2016)

1.2 Statement of the problem

Rwanda's economy is largely agrarian with more than 80% of Rwanda's population depending on farming, 95% of whom are smallholder farmers (FAO, 2015). Despite the importance of agriculture, most food insecure households are those depending mainly on agricultural production, implying that this segment of the Rwandan population is vulnerable to food insecurity (WFP, 2016).

While a number of studies exist in the literature that depict the food insecurity status in Africa and in Rwanda (WFP, 2012&2016; De Schutter, 2011; Jayne & Muyanga, 2012), none so far has focused on the influence of social economic factors towards food security amongst the small holder farmers. Some of these studies cited low income generation, small farm size, lack of inputs, lack of resources, limited access to credit, low level of technical skills and inadequate training on modern farming practices as the

common characteristics of smallholder farmers. However, none of these studies have exhaustively analysed the direct link of socioeconomic factors to food security of the smallholder farmers, especially in Rwanda. Thus, this study fills the above gap and may likely provide information to the policy makers so as to bridge the food insecurity gap.

1.3 Objectives of the study

1.3.1 General objective

The main objective of this study was to assess the status of food security and explore the socio-economic determinants of food security among the smallholder mixed farmers in Rwanda.

1.3.2 Specific objectives

The specific objectives of the study were:

1. To assess the status of food security at household level among the smallholder farmers of Burera District.
2. To determine the effect of household resource and demographic characteristics on food security status of the smallholder farmers of Burera District.

1.4 Research hypothesis

This study examined the following hypotheses:

Hypothesis 1:

H_0: Food insecurity does not exist among small holder farmers in Burera District

H_1: Food insecurity exists among small holder farmers in Burera District

Hypothesis 2

H_0: Resource and demographic factors have no significant effect on food security status among small holder households

H_1: Resource and demographic factors have a significant effect on food security status among smallholder farmer households.

1.5 Justification and significance of the study

Food insecurity is a global challenge and is of great concern, especially in SSA where majority of the countries suffer from extreme hunger and poverty (FAO, 2015). A study carried out on the cost of hunger in Rwanda indicated that an estimated 503.6 billion Rwandan Francs (FRW) were lost in the year 2012 because of child under-nutrition which translated to an equivalent of 11.5% of Rwanda's GDP (NEPAD, WFP and UNECA, 2012). The same study found that 49.2 % of adults in Rwanda suffered from stunted growth when they were children, which represented more than 3 million people of working age who were not able to achieve their potential because of undernourishment. The Government of Rwanda in its National Food Security and Nutrition Strategic Plan (NFSNSP) 2013-2018 recognized that the major cause of the high level chronic malnutrition in children in Rwanda was due to inadequate quantity and quality of food consumed at the household level (GoR, 2013). Given that 72 % of the Rwandan rural households rely on agricultural production to sustain their livelihoods (WFP, 2016), majority of those households (95%) own very small plots of land averaging less than 2ha with the predominant farming system in the country being smallholder subsistence farming.

The 2015 Rwanda Comprehensive Food Security and Vulnerability Analysis and Nutrition Survey (CFSVAN) done by World Food Programme classified Rwanda as overall food secure at macro-level and commended the considerable increase of food production in Rwanda. However, the same study reported that about 49% of Rwandan

households still face seasonal difficulties in accessing adequate food, 14% of them having constant problems all year round (WFP, 2016). Thus, there is dearth need for research on issues that affect food security at micro level which are directly linked with insufficient food production under smallholder subsistence farming. This research will contribute in bridging the knowledge gap by investigating the key factors determining food security among the smallholder farmers in Rwanda. Such determining factors would provide vital information to policy makers which would help them in designing agricultural and food security policies as well as livelihood programs which may not only benefit the smallholder farmers but also those households already facing chronic food insecurity. The results would also be useful in spelling out strategies that would help improve rural household food security, especially through the combined multi-sectorial efforts of tackling extreme poverty in rural Rwanda.

1.6 Scope of the study

1.6.1 Context scope of the study

This study assessed the socio-economic determinants of food security among smallholder farmers in the context of a developing economy, with a special focus on subsistence farming in Rwanda. Food security is defined as a situation that exists "*when all people at all times have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*"(FAO,1996). From this universal definition, food security is normally assessed through four dimensions namely: food availability, food accessibility, food use and utilization, and food stability (InWent, 2010). This study took only into consideration the first two dimensions of food security i.e. food availability and accessibility which are directly associated with agricultural production and demand at household level. The other two dimensions were beyond the scope of this study.

1.6.2 Geographical scope of the study

Research for this study was carried out in Burera District in Northern Province of Rwanda, which is one of the predominantly rural districts of the country. Burera district has rich fertile soils with rain all year round, hence making the area one of the greatest potential for agricultural farming in Rwanda. Burera district was also selected for this study based on the previous reports (WFP, 2009 & 2012) that profiled the region to be vulnerable to food insecurity and chronic malnutrition despite the district being an agricultural region. Burera district was also profiled in the third Integrated Household Survey (EICV3) of 2010/2011 which ranked Burera as second district with the largest household size, with average family size of five (5) members per household. The district is characterized by high levels of family land partitioning with mean size of farm land of 0.39 ha per household, which is below the national average farm land size of 0.59ha per household, leading to typical small-scale farming (NISR, 2011). Within Burera district, data were collected in Butaro sector which also represents the highest populated sector in the district (NISR, 2011).

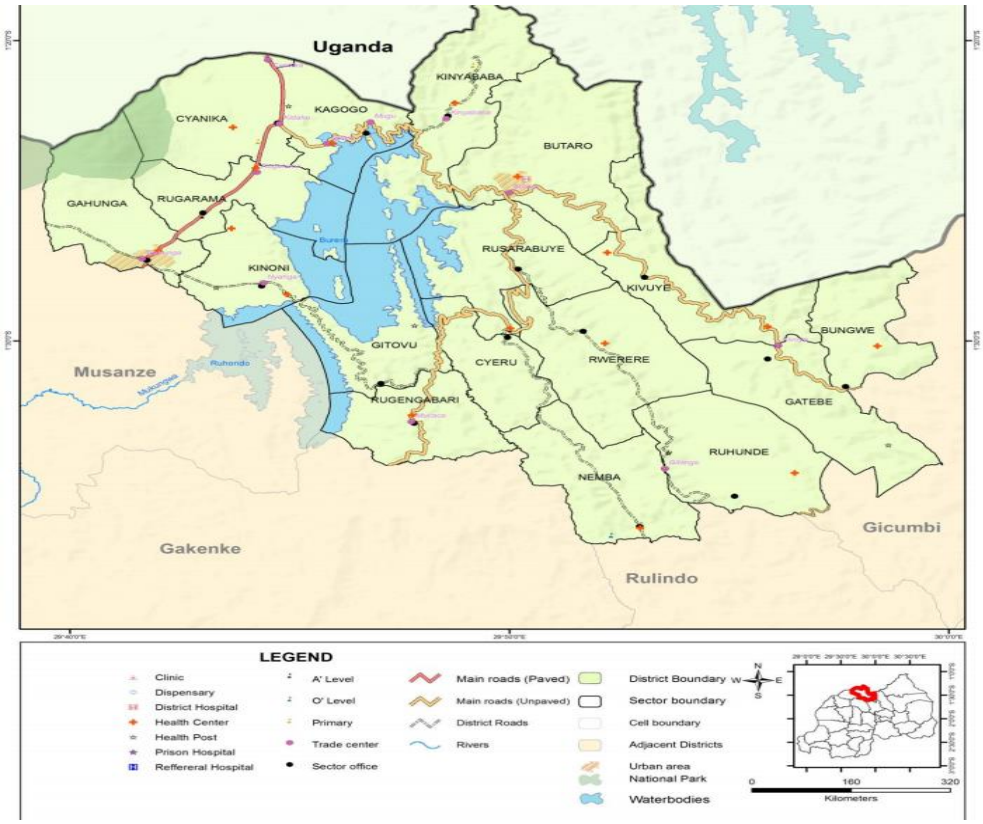

Figure 1.2: Administrative map of Burera District. (Source: Rwanda 4th Population and Housing Census, 2012)

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter on literature review is subdivided into six main sections. Section 2.1 reviews the theories relevant to the present study, while section 2.2 presents the conceptual framework of the research. Section 2.3 reviews the previous empirical studies on demographic, resource and institutional factors of household food security. Section 2.4 reviews the literature regarding household food security indicators and measurement while section 2.5 presents the empirical studies that have assessed food security at household level using HFIAS measurement tool. Lastly, section 2.6 presents the literature gaps regarding the socio-economic determinants of food security in relation to the smallholder farmers.

2.2 Theoretical Framework

A number of theories exist in the food security literature and their applicability help to assess household food security and its determinants. For the purpose of the current study, only the theories that dealt with food availability, ability to access food as well as those that talked about any determinants of food security were considered. These include Food Availability Decline (FAD), Food Endowment and Entitlement Theory (FED) and Robert Malthus's Population Theory. FAD explains the impacts of land degradation, lack of productive resources and population pressure on the availability of household food since disruption of agricultural production leads to the decline in food availability in the household (Degafe, 2002). To examine the main hindrances for the agricultural production, which in turn lead to decline in food availability, FAD model can be used. FED (Food Entitlement Theory) focuses on an individual/ household's purchasing power which gives him or her access to food, thus it can be used to analyse the

household food access. The Malthus Population Theory defines the relationship between food production, food supply and population growth.

2.2.1 Food Availability Decline (FAD) Theory

The Food Availability Decline Approach has been a dominant explanatory framework for food insecurity. As stated by Sarracino (2010), the FAD approach points out the insufficient production and availability of food as the main causes of food insecurity which leads to extreme cases of famine and starvation. Under FAD theory, food availability is defined as when all people have sufficient quantities of food available on a consistent basis, with the food available being determined by the amount of food produced (FAO, 2008). The FAD theory focuses on the question of why people are food insecure. The answer to this question is that it is because of the insufficient food supply. Because of insufficient food supply, the prices go up and people who are not able to bear such an increase consume less calories. FAD theory states that anything that disrupts food production can cause food insecurity since it might cause a food supply decline below the subsistence needs of the population of a given region. This theory is necessary to prevent food insecurity. To conclude, this approach conceived famine as shortages of food supplies per capita, favoured by natural factors such drought, floods and the calamities that affect negatively the crops yield, or demographic factors such as gender, age or educational level among others (Hummel et al., 2004).One of the major criticisms of the FAD approach is that it focuses on collective supply rather than the capacity of a household to have access to food. Yaro (2004) confirmed that this approach does not explain how individuals/farmers have access to food. The gaps left by the FAD approach led to the emergence of the entitlement theory.

2.2.2 Endowment and Entitlement Theory

The FAD approach did not offer adequate explanations to the paradox of why in the presence of abundant food, still a significant number of people remain food insecure. As cited by Sarracino (2010) , Amartya Sen explained that to study food security, one

needs to go beyond looking at food availability and take into consideration the general economy and also the political and social environments which make it possible for people to have access to food (Sen,1981). Therefore, the entitlement approach emerged to consider a broader sense of food security other than production and agricultural expansion which are the concerns of the FAD approach.

According to Amartya Sen who is the pioneer of the entitlement approach, a famine can occur without a decline in the food production. He also observed that FAD does not centre its attention on who suffers during a famine (Sarracino, 2010). The basic question of entitlement approach is *"why we still have famines while food production is still enough"?* To answer this question, based on his personal experience in India, Sen argues that famine is caused by lack of access to food. Hence to solve the issue of famine, the entitlement approach becomes handy. Sen divided entitlement approach into two categories: endowment set and the entitlement set. To produce food, a farmer needs a set of resources known as endowments such as land, labour, fertilizers, capital, education and farmers' skills among others. The entitlement set refers to the products obtained from using the resources into the production process which usually depends on the combination of resources or endowments set that a farmer chooses. The endowment set refers to the inputs whereas the entitlement set represents the outputs. The connection between the inputs and outputs is known as the entitlement mapping. For example, the relationship between the amount of resources employed on a farm and the output realized from production. Then to transform these endowments into production requires knowledge, technology, skills and experience (Sarracino, 2010). Briefly, to satisfy one's entitlement to food, the endowments should be put into production or one's income in an employment should provide a means of access to food. This has been described as interdependence because there are people who are not directly linked to food production (like in sectors such as industry and services) but they have access to food since they are able to use their incomes to buy food (Sen, 1999; Sarracino, 2010). The entitlement approach focuses on an individual's' purchasing power which gives him or her access to food. Sen interprets access to food in the following statement: "Food is not distributed in

the economy through charity or some system of automatic sharing. The ability to acquire food has to be assessed. What we have to concentrate on is not the total food production in the economy but the entitlement that each person enjoys: the commodities over which she can establish her or his ownership and command" (Sarracino, 2010).

2.2.3 The Malthusian Theory or Population-Driven Theory

Thomas Robert Malthus (1798) came up with the theory of population, published in "An Essay on the principle of Population". According to Malthus, population tends to increase faster than the supply of food available for its needs. Whenever a relative gain occurs in food production over population growth, a higher rate of population increase is stimulated. On the other hand, if the population size increases higher than food production, the growth could only be checked by natural disasters such as famine, disease or war among others.

Malthus argues that high fertility and population growth lead to ecological problems in terms of over cultivation, excess use of fertilizers, deforestation and desert, or soil degradation among others. These practices lead to food insecurity (Sarracino, 2010). Malthus' idea of food supply became widely popular when he talked about food insecurity and hunger. Malthus stated that food insecurity and hunger are caused by lack of food supply because the growth of population creates more food demand. Malthus thus proposed instrumental policies to control the population growth including female education and promoting easy access to contraception.

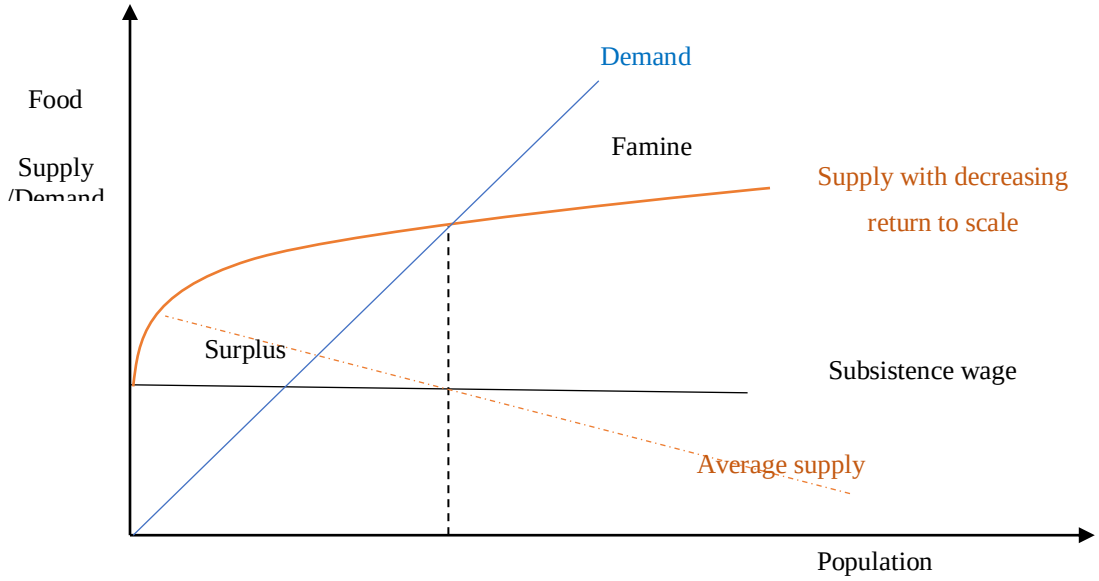

Figure 2.1: The Malthusian Population Theory (Source: Sarracino, 2010)

2.2.4. Review of the application of FAD and FED Theories

A number of studies exist in the literature that have used the FAD and FED theories to explain the food security situation in some countries. As noted by Akinyoade et al., (2014), persistent food crisis in the Horn of Africa is majorly caused by food availability declines' (FAD) resulting from prolonged drought within the context of climate change. The authors clearly observe that the first pillar of food security (i.e. food availability) has collapsed in the Horn of Africa, the result being that large groups of starving and severely undernourished people have started to move from their homes in search of food. However, in such dire circumstances, the authors state that it is also very common to find another section of the population insulated from the famine due to their purchasing power to buy food even at highly inflated prices. This also illustrates the theory of Amartya Sen (1981) who proposed to look at famine in a new light with the theory of the failure of exchange entitlements (FED).

Meskerem and Degefa (2015) also examined the household food security status and its determinants in Oromia region, Ethiopia using the FAD and FED theories. This study examined the effect of economic factors such as on-farm, off-farm income, farm size, number of farm oxen available, and types of farm inputs to draw conclusions on their impacts on food security. Farm size was found to have a positive impact on food security with higher food security being experienced in households with large farm sizes compared with those who owned small farm size. They found also a positive relationship between the number of oxen owned by a household and food security status. There are many other studies on rural households' food security that applied the entitlement theory (FED) by analysing the effect of assets related to farming such as land ownership, access to government support programs, social grants and conditional or unconditional cash transfers, aid and remittances among others (Akinboade et al., 2016; Musemwa et al., 2015). Household income has been by large considered as a major factor influencing household food security as it determines the household purchasing power for both food and other physical assets needed for farming activities (Akinboade & Adeyefa, 2017). Bashir et al. (2012) also found that in Punjab region of Pakistan, the households with ownership to land and livestock were associated with less food insecurity levels. Boukary et al. (2016) applied the approach of principal component analysis and structural modelling using cross sectional data from Niger and found that safety nets and higher asset index were positively correlated with higher food security.

From these theories highlighted above, the existing relationship between different factors and food security will be reviewed in the conceptual framework below (Fig.2.2)

2.3 Conceptual Framework of smallholder farmers household food security

In economics, factors of production such as natural resources, raw materials and other inputs are used in the production process to produce the outputs. The utilized amounts of the various inputs determine the quantity of output, a relationship that is referred to as the production function. This section explores the factors influencing household food availability and accessibility and hence determine the household food security. The

conceptual framework guiding this study is shown in Fig.2.2. Drawing on existing literature, we postulate that household food security is directly influenced by resource factors and socio-demographic characteristics of the household, while institutional factors play as intervening or moderating factors. Regarding resource factors, farm size, on-farm labour availability and on-farm income are analysed. The demographic factors such as age of the household head, gender of household head, education level and size of the household are taken into account and lastly, institutional factors including access to financial facilities (savings and credits) and access to agricultural trainings and extension services are examined. These factors have been documented in the literature review to have direct effect on household food security and the outcome of the study will provide an understanding of whether the smallholder farmers' households in Burera district are food secure or not. The relationship between household food security and determining factors are briefly explained as follows.

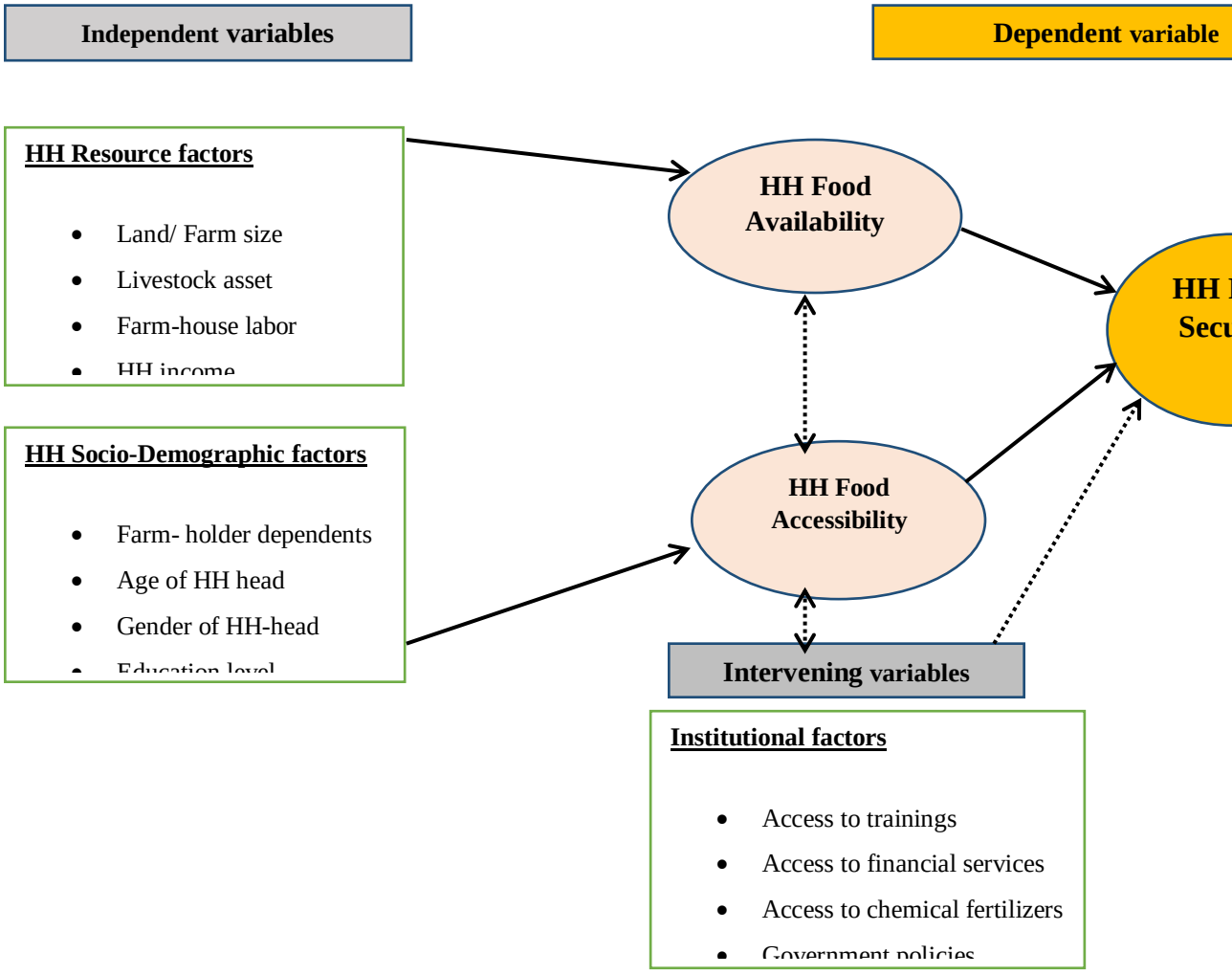

Figure 2.2. The conceptual framework of smallholder farmers' food security at household level.

Source: Author's own construct.

2.4 Empirical review of the determinants of household food security

2.4.1. Demographic factors and household food security

Demographic characteristics that determine household food security including gender, age, educational level and household size have been widely documented in literature as highlighted in the paragraphs below.

Examining the literature on gender, many studies have shown that the gender of the household head has an effect on household food security levels. According to FAO (2012), women comprise an average of 43% of the agricultural labour force of developing countries up to almost 50% in Eastern and Southern Asia and Sub-Saharan Africa. Further, the same report suggests that if women farmers have the same access to productive resources as men, then yield from women farms would likely increase by 20 to 30 %. Also FAO (1998) recognized that women produce between 60 and 80 percent of the food in sub-Saharan African countries and were responsible for a half of the World's food production. There are however contradicting findings in literature arguing that women –headed households are more prone to food deficit. For example, Chomba (2011) found that male -headed households were more likely to grow different crops compared to women-headed household, making the male-headed household to be more food secure compared to the female-headed ones in Kalulushi District of Zambia. These findings confirmed those of Allen and Thompson (1990) who had concluded in their study that female headed households were significantly more likely to be in poverty than the male headed households. In contrast, Kennedy and Peters (1992) using data from Kenya and Malawi found that although many female-headed households were poorer than their male counterparts, there was an impression that food security and nutritional status of individual members in the household was significantly better in the household headed by women. The rational of this significant difference in welfare of the household members within female-headed household compared to male-headed households was attributed to the fact that a higher proportion of women's income is spent on food compared to the income of their male counterparts. FAO (2011) also reported that

compared to men's spending pattern, women spent more on basic food supply while men spent more on assets acquisition.

Some studies that exist in the literature have also indicated that the age of the household head remains one of the key determinants of food security. Bashir and Schilizzi (2013) found a negative relationship between the age of the household head and food security in Pakistan, while Jemal and Kyung-Ryang (2012) found that the age of the household head was strongly and positively affecting food security in rural Ethiopia. Abu and Soom (2016) found that the probability of households being food secure or food insecure in rural areas of Benue State in Nigeria was determined by age. Result from this study revealed that the coefficient of age was negative and significant at 5 % which meant that food security declined with increase in age of the household head. The negative and significant effects of age of the household heads decreased the probability of households' to be food secure. Agboola (2004) in his study on an economic analysis of household food insecurity and coping strategies in Osun state of Nigeria reported that age was negatively and significantly affecting food security.

Examining the effect of education of the household head as well as other households' members on the overall household food security, the literature also indicates that there is a relationship between education level of the household and food security level. For example, the results of the study conducted by Bashir at al. (2012) showed that education levels affected positively the level of household food security in Punjab District of Pakistan. Similar results were also found by Mutisya et al. (2016) in their study on the effect of education on household food security in Kenya. De Muro and Burchi (2007) in their study on education for rural people as a neglected key to food security found that education was negatively associated with food insecurity, that is the greater the educational level, the lower the average of food insecurity. In the contrast, Nyako (2013) in his study on the relationship between educational attainment and food security found a negative correlation between the level of education and food security status among households in Nigeria.

The role of household size in impacting food security has been documented in several studies as well. Adebayo (2012) studied the effects of family size on household food security in Osuna state of Nigeria and found that as the number of family members increased, the household food security decreased. A study conducted by Bashir et al. (2013) also revealed that household size had a negative impact on food security. Ojeleye et al. (2014) found a negative relationship as well between household size and food security in their study conducted in Kaduna state of Nigeria. Similarly, Oni et al. (2010) found household size to be statistically significant and influenced the probability of being food secure. Similarly, Djangma (2016) found that the size of the household was significant and negatively affected food security in the Eastern and Northern regions of Ghana. The study on the determinants of food security among the rural farming households in Kwara state of Nigeria by Omotesho et al. (2010) also revealed that one third of the sampled rural farming households were food insecure and household size affected positively food security in the study area.

2.4.2. Resources Factors/ Economic Factors

Economic factors have a significant role in helping or limiting a household to be food secure through production or purchase from the market. The extent to which a household obtains cash income matters a lot in improving agricultural activities and food production. Economic factors such as total income, number of employed people in the household and farm-size will be analysed.

For example, a study carried by Saidu (2013) in Gombe State of Nigeria found a positive relationship between total income and food security. The author concluded that the higher the level of income the more food secure is the household. Djangmah (2016) did a comparative analysis of food security status of farming households in Eastern and Northern Regions of Ghana using a logistic model, and the results revealed that monthly households' income positively and significantly affected households' food security of the farming households. Mannaf and Uddin (2012) conducted a study on the socio-economic factors influencing food security status of maize growing farmers in selected

areas of Bogra district of Bangladesh, and they found that monthly on-farm income affected positively household food security, since as the income of the household head increased food security status also improved. Abdullah (2015) in his study on determinants of household food security and copping strategies in Borana Zone of Ethiopia revealed that off-farm income significantly and positively affected food security status of the households, which meant that farmers engaged in off-farm activities had a better chance of attaining food security. Reis (2011) in his study on food insecurity and the relationship between household income in Brazil found that household per capita income decreased with the intensity of food insecurity. The author also compared the per capita income of a food secure household with the per capita income of a food insecure household and found that the average household per capita income of a food secure household was more than twice that of food insecure households, and more than four times higher when compared to households under severe food insecurity. Oni et al. (2010) also found that the total income in farming was statistically significant and influenced the probability of being food secure in the study area of Limpopo District of South Africa. The study suggested that there was need to create an enabling environment for smallholder farmers to improve their levels of productivity through appropriate government policies and strategies.

Examining the relationship between farm size and food security reveals a positive correlation between farm size and household food security levels. For example, the results of a study conducted by Abdulla (2015) in Bule-Hora District of Borana zone in Ethiopia showed that farm size positively affected food security status of households i.e. the larger the farm size, the better food secure status of the household. Aidoo et al. (2013) also found that farm size positively influenced household food security in the Sekyere-Afram Plains of Ghana: - a household with a larger farm size was found to be food secure compared with households with smaller farm sizes. Maharjan and Khatri-Chhetri (2006) examined household food security in rural areas of Nepal and found that the average farm size of food secure household was almost double that of food insecure household. Another study on the assessment of the contribution of smallholder

irrigation to household food security in comparison to dry land farming in Vhembe district of Limpopo Province in South Africa conducted by Oni et al. (2011) found that farm size was negatively and significantly influencing food security.

2.4.3 Institutional Factors

The institutional factors that influence household food security include access to financial services, namely access to credits, as well as access to agricultural extension services which deliver trainings to farmers. Access to bank facilities including credits and loans can also have an influence on the household food security. An assessment of the impact of access to credit on income and food security in Malawi conducted by IFPRI (1998) showed that access to formal credit positively and significantly affected food security of the Credit Program members compared to their non-credit member counterparts. Similarly, the study conducted by Abdul-Jalil (2015) in Karaga district of Ghana revealed that the higher the amount of credit obtained from the formal source, the more food secured was the farmer household. The study of Pankomera et al. (2009) also found a positive relationship between access to credit and food security in Malawi, where the household with better access to credit was more likely to be food secure. On the contrary, Ojeleye (2015) in his study on farm household and community food security in Kaduna State of Nigeria found that consumer credit was significant at 10% level and negatively influenced food security status. The reasons for negative association between food security and credit were due to credit not being used for the purpose for which they were intended for.

Concerning access to training, the importance of agricultural extension services and trainings on farmers production and hence food security is extensively documented in the literature. Agricultural extension services mainly involve the passing of agricultural information to the farmers such as on new agricultural practices. Kipkurgat and Tuigong (2015) reviewed the impact of agricultural extension on food security among small scale farmers in Wareng District, Kenya and found that whenever the extension officers visited the small scale farmers frequently, their production shot up for that year.

According to the authors, the results indicated that extension services impact the agricultural production and thus have an impact on the food security of the residents. However, Stewart et al. (2016) in their meta-analysis of literature on effects of training, innovation and new technology on African smallholder farmers' economic outcomes and food security were not able to identify any evidence of the effects of training interventions on smallholder farmers' food security. Albeit this conclusion, the authors of this meta-analysis of literature are in agreement with Waddington et al. (2014) who conducted a systematic review focusing on the impact of farmer field schools (FFS) on farming practices and farmer outcomes, which concluded that FFS had a positive impact on agricultural yields and improved the farmers' income among other impacts.

2.5 Food availability and accessibility as primordial indicators of household food security.

Food availability at household level is the first entry-level indicator of household food security (Coates et al., 2006). According to Khan and Gill (2009) food availability is when sufficient quantities of food are available at all times to a household and all individuals of that particular household. Hence, a household that does not have sufficient food available at their disposal is classified as food insecure and turns to be more vulnerable to hunger, and malnutrition. The food availability indicator reflects the supply side and hence is affected by all the drivers and determinants that have an impact on the domestic supply of food and the ability to supply it from the market (Barret and Lentz, 2009). There may be prevalence of food insecurity and hunger for some of the rural households due to the fact that they do not produce sufficient food or do not have the purchasing power to afford their food needs (Omotesho et al., 2010). Therefore, another key indicator of the household food security is the "food access", which in order to be realized, not only the domestic and local food availability must be realized, but households must also have access to the necessary resources to acquire food, namely sufficient income to purchase food from market if own production is not enough (FAO, 2003). Jacobs (2009) indicated that household food security depends mainly on

household income and wealth status which may allow these households to access food. For instance, a low-income household is more likely to experience food shortages than a wealthier household because the latter household will have purchasing power than the former household (Jacobs, 2009).

2.6 Measuring Household Food Security through HFIAS tool

The appropriate measurement of food security is critical for efficient targeting of food and economic aid; supporting early famine warnings, global monitoring systems and development programs; and informing government policy across many sectors (Jones et al., 2013). However, measuring food security is still a complicated task, due to multiple approaches and diverse tools used throughout history and in multi-cultural contexts. The selection of food security measurement method depends on the selection of food security definition (Alinovi et al., 2009). Food security metrics may focus on food availability, access, utilization, stability of food security over time, or a combination of these domains. Depending on the purpose, metrics may focus on national level, regional, household or individual level data. Based on the compendium of Jones et al. (2013), the currently available food security metrics were grouped into four categories: The first category relates to the tools that provide national-level estimates of food security, the second category is tools aimed at informing the global monitoring and early warning systems; the third is tools that assess household food access and acquisition; and last category comprises the tools that measure food consumption and utilization

For the purpose of this study, the tools that measure the household level food availability and accessibility remain the focus since these two dimensions of food security predetermine the quantity and quality of food which is physically and potentially ready to be consumed and utilized by the individual members of the household. According to Jones et al. (2013), household-level measures of food security are much more concerned with food security dynamics between and within households, and since they rely on data from household surveys, they are able to more accurately capture the “access” component of food security than measures that rely on nationally aggregated data. Food

access refers to the physical and economic access to food, however many of the tools commonly used to measure food access actually measure food acquisition or food consumption, yet those two concepts are a bit different although they are commonly used interchangeably in referring to food access (Jones et al., 2013).

Evidence of rising amounts of hunger in the United States in the early 1980s motivated the development of the "Household Food Security Survey Module" (HFSSM), which consisted of an eighteen (18) question survey module that asked families to report their subjective experiences in 4 domains of food insecurity as follows: (1) anxiety about household food supplies; (2) perceptions about the quality and quantity of accessible food; (3) perceptions about adult food intake; and (4) perceptions about food intake by children (Jones et al., 2013). The empirical research that employed adaptations of HFSSM tool in low-and middle-income countries came up with an adapted "Household Food Insecurity Access Scale" (HFIAS), which is a set of nine (9) generic questions (Appendix1) developed to represent universal domains of the access component of household food security (Coates et al., 2006). Since its development, the HFIAS has been widely used as a monitoring tool in the evaluation frameworks of the USAID funded food security programs (Jones et al., 2013). Food security measured by HFIAS has been shown to be positively associated with household wealth, dietary adequacy, household per capita income, household assets and dietary diversity (Becquey et al., 2010; Knueppel et al., 2010; Maes et al., 2008; Faber, 2009).

In conclusion, HFIAS tool has been internationally tested and validated to be a direct, experience-based approach to measuring household food security, while most of other tools used have been classified as indirect proxies or "second generation" indicators (Barret, 2002). This set of nine questions asked on a recall period of last 30 days generate a score from 0 to 27 that is designed to reflect a single statistical dimension of food security, with the aim of providing programs a simple tool for targeting, monitoring and evaluating efforts. Since its development, the HFIAS has been widely used and

validated across many countries in the world, including Tanzania, one of the East African countries with similar cultural context to Rwanda (Knueppel, 2010).

2.7 Empirical review of assessments of food security at household level using HFIAS tool.

There are many empirical studies in literature that have assessed food security at household level. This section of literature review highlights only some examples of these studies that specifically used the HFIAS as measurement tool. One of this kind is the study conducted Knueppel et al. (2008) who carried out the validation of HFIAS in rural Tanzania. The purpose of the study was to test the validity and internal consistency of the HFIAS in measuring household food insecurity in rural Tanzania and to determine the socio-economic characteristics associated with household food insecurity. The results showed that, approximately 20.7% of the households were categorized as food-secure, 8.4% as mildly food insecure, 22.8% as moderately food-secure and 48.1% as severely food-insecure. Cronobach Alpha (α) was used to measure the internal consistency (reliability) of the scale and it was found to be 0.90 which indicated a high level of internal consistency of the scale. Food security was positively associated with maternal education, husband's education and household wealth status, while it was negatively associated with maternal age and household size. Thus, the HFIAS tool was found to be valid and reliable in measuring household food insecurity among poor households in Tanzania. Becquey et al. (2007) also conducted a study to assess the performance of HFIAS and the index-member's dietary diversity score (IDDS) in approximating the adequacy of urban food security in 1056 households in Ouagadougou capital of Burkina Faso. The survey unit of the study was the household which was defined as a group of persons sharing housing and meals, managing a common budget and led by a head of household. The findings of the study indicated that both HFIAS and IDDS measurement tools performed well in measuring urban households' food insecurity, that is, both tools could be used in monitoring and evaluating food security. Salarkia et al. (2014) as well carried out a study to assess the validity and application of

the HFIAS in measuring household food insecurity in the urban area of Varamin city of Iran. The study conducted a survey on 400 households and used HFIAS to measure the household food security. The study found that 21% of households were classified as food secure, while 46.5% were classified as mildly food insecure, 25.0% as moderately food insecure and 7.5%were classified as severely food insecure. Similarly, Gebreyesus et al. (2015) studied the applicability of HFIAS to measure food insecurity in Urban and rural households of Ethiopia using a community-based cross-sectional study design with a repeat survey after seven days of the first administration in order to determine the reproducibility of the household food insecurity assessment tool (HFIAS). A total of 1,516 households were studied across the two rounds of data collection. The findings of the study indicated that the participants responses to the 9 questions of HFIAS were mostly affirmative responses for items showing mild to moderate forms of food insecurity, such as worry about food, inability to eat preferred foods, eating limited variety of food items and eating smaller or fewer meals a day. The study also found a significant and positive dose-response trend ($P<0.01$) between household wealth status and levels of food security among the rural and urban households. Particularly, an inverse but significant dose-response trend between household food insecurity level and wealth status was observed in urban sample. A dose-response trend was also observed between food insecurity levels and food intake. For instance, the likelihood of the previous day's consumption of milk among food secure households was 39.8% compared with 11.6% for severely food insecure households, while previous day's consumption of eggs was 10.2% among food secure as compared to 2.1% for severely food insecure households. The same study found that the HFIAS tool exhibited a good internal consistency, with Cronbach's alpha values of 0.76 and 0.73 respectively for rounds 1 and 2. This study concluded that the HFIAS is a simple and valid tool to measure the access component of household food insecurity.

2.8 Critique of existing literature and research gaps

Across the surveyed literature, it is particularly observed that food security has improved in the recent past within countries which have been able to increase their agricultural production and exports. Considering the world average per capita availability of food for direct human consumption, FAO states that in principle there is sufficient global aggregate food consumption for nearly every one to be well-fed (FAO, 2012). However, that relationship has not been verified in Rwanda while its agriculture sector has historically been the backbone of the economy and the overall production has been increasing over the past two decades. In addition to its contribution to GDP, agriculture sector in Rwanda generates about 90% of employment, 70% of export revenues and 90% of national food needed (IPAR, 2009).Unfortunately, food insecurity has remained high especially in rural areas (WFP, 2012). It is therefore imperative to identify the factors that affect food security at household level among the smallholder farmers who constitute the majority of rural households in Rwanda.

Additionally, throughout the review of the existing literature, there was no other empirical research found that has ever assessed the effect of resource and socio-demographic factors on food security of smallholder farmers in Rwanda. Thus, to the best of my knowledge, the conceptual framework of this study has never been applied for any other study in Rwanda. By applying it, this study hopes to elicit and clarify many issues that impede the achievement of food security in Rwanda in general and in particular among smallholder rural farmers and make recommendations on how food security can be improved in Rwanda. The lack of appropriate literature in the context of Rwanda calls for more studies on agricultural production and food security within the country. Hence this study attempted to bridge the knowledge gap about the socio-economic determinant of food security among smallholder farmers in Rwanda.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the research methodology of the study. The section 3.1outlines the research design, sections 3.2 and 3.3 present the target population, sampling techniques and sample size calculation. The section 3.4 presents data collection tools and procedure, while the section 3.5 outlines the data processing and analytical tools used for hypotheses testing.

3.2 Research Design

The study design was a cross sectional survey, using both quantitative and qualitative data collection approaches. The quantitative data were collected on resource, demographic variables and institutional (moderating) variables, while qualitative approach (combining opinions inquiry and observations) was used to properly record the respondents' household experience with food insecurity and possible reasons.

3.3 Target population and sampling techniques.

This research focused on smallholder farmers' households of Burera District, within the administrative sector of Butaro. A Multi-Stage Random Sampling technique was used. In the first stage, Northern Province was purposively selected based on the data from the 2012 WFP's comprehensive food security and vulnerability analysis report which had ranked the Northern Province as the most vulnerable province in terms of food insecurity and chronic malnutrition (WFP, 2012). In the second stage, Burera district was considered due to the high rate of households with food insecurity among all the districts of Northern Province (WFP, 2012). Butaro sector of Burera district was selected on third stage due to its highest population density (NISR, 2013). A Simple Random Sampling technique was used to select a sample from the estimated 6917 households of

Butaro sector (NISR, 2013). In the EICV3 of 2011, it was estimated that 91.3% of the total households in Burera district were living on farm size of less than 0.9ha of land, with a mean of 0.39ha (NISR, 2011). From this profile of the district, this study assumed that all the households of Butaro sector would meet the category of smallholder farmers whose benchmark is set at below 2ha of land.

3.4 Sample size calculation

A sample is a small representation of a large population selected from the latter in such a way that they are representative of the universe (Saravanavel, 2013).

The sample size of this study was computed using Yamane's scientific formula as shown below:

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the sample size, N is the population size and e is the level of precision or the sampling error.

Population size was 6917 households. Therefore, the sample selected in the population was computed based on the formula as follows:

$$n = \frac{6917}{1+6917\,(0.05)^2} = 378$$

3.5 Data collection tools and procedures

A closed ended questionnaire was used to collect data for study. Its adoption was based on the ease of use, cost effectiveness and rapidity in data collection. The questionnaire was administered directly to the respondents. This tool provided the primary data, while secondary data were sourced through review of journals and reports. The set of nine

questions of the HFIAS measurement tool (Appendix1) which categorizes households into four levels of food security (i.e. food secure, mildly food insecure, moderately food insecure and severely food insecure) were included in the questionnaire (Appendix2) .

Pilot testing

The instrument for data collection was first piloted on 19 respondents who constituted a 5% of the calculated sample size of 378. The pilot sub sample was obtained from non-respondents of main sample of this study. The purpose of the pilot testing was to confirm clarity of the questions asked and determine the reliability of the data collection instrument.

Duration of the study

The primary data used in this study were collected through household interviews conducted between 05th November to 02nd December 2016.

3.6 Data processing and analysis

The data collected were coded, entered and tabulated in MS Access before analysis. Microsoft-Excel and Statistical Package for Social Sciences (SPSS) software were used to analyse the data.

3.6.1 Analytical tools and hypotheses testing

Descriptive Statistics were used to describe the profile of respondents with regards to social- demographic characteristics of the respondent smallholder farmers' households. Descriptive statistics were also used for food security status categorization of households.

Inferential statistics were used to assess the strength of the relationship between independent (causal) variables and dependent (effect) variable. The relationship between household food security status categories and its determinants were studied through

multinomial logistic regression model and the impact of each explanatory variable on the dependent variable was analysed using significance P-values.

Hypothesis testing was also performed to assess if premises were actually true or false for the data set. Maximum Likelihood Ratio test was applied to estimate the parameters of the logistic regression model, Wald statistic test was also used to test the significance of the determinants of food security to be able to reject or accept the null hypotheses.

3.6.2 Model Specification

The multinomial logit model (MLM) was used to analyse the socio-economic determinants of household food security among mixed small holder farmers in Burera district. The model was preferred because it enables the analysis of more than two categories of the dependent variable, contrary to the binary probit and logit models which are limited to a maximum of two categories (Agresti, 2007). Given the results of this study, it was possible for the households to be divided into four categories: those who were in the category of food secure, those who were in the category of mildly food insecure, those who were in the category of moderately food insecure and those who were in the category of severely food insecure.

Their categories and codes used in the regression are presented in Table 3.1

Table 3.1: Dependent variable categories

Household Food Security Status	**Code**
Food Secure (FI)	1
Mildly Food Insecure (MFI_1)	2
Moderately Food Insecure MFI_2)	3
Severely Food Insure (SFI)	4

The MLM model was expressed as follows:

$$p(y = j / x) = \exp(x\,\beta\,j) / \left[1 + \sum_{h=1}^{j} \exp(x\beta_h)\right] \qquad (1)$$

where, y denotes the dependent variable taking the values {1,2,……J} for J>0 and x denotes a set of independent variables. In this study y represents household food security status while x represents the set of demographic, productive resources and institutional factors. The question was how changes in these factors affect the response probabilities p(y=j/x).

The empirical specification for examining the influence of the explanatory variables (Xi) on the household food security (Y) was given as follows:

$$Y_{i=1\ldots j} = B_0 + B_1 AgHH + B_2 Gen + B_3 Edu + B_4 FMS + B_5 FS + B_6 OFI + B_7 FHL + B_8 AFF + B_9 ATE + B_{10} Fert + B_{11} LO + \varepsilon_i$$

X_1= Age of the household head (AgHH)

X_2=Gender of the household head (1 if male, 0 if female)

X_3= level of education (Years of schooling)

X_4= Family size (FMS)

X_5= Farm size (FS)

X_6= On-farm income (onFI)

X_7= Family house labour (FHL)

X_8= Access to financial facility (AFF)

X_9=Access to agricultural trainings and extension services (ATE)

X_{10}= use of mineral fertilizers (Fert)

X_{11}= Livestock ownership (LO)

Where, $B_0$is a constant term, B_i is the parameters to be estimated, i=1…….11dnd ε_i= error term

The analysis of the model used three performance measures:

1) P-value: this is a significance statistic test. It is normally tested at a threshold value of 1%, 5% and 10%. If the p-value is less than the threshold value, the null hypothesis is rejected and the alternative hypothesis accepted. For our model, we tested at 1%, 5% and 10% level of threshold. Therefore, if the p-value was less than 1%, 5% and 10% we concluded that the hypothesis was statistically significant.
2) B-value: the beta coefficients show the effect of the independent variables on the dependent variable. A positive coefficient for β indicates a positive relationship while a negative coefficient indicates a negative relationship. For our analysis, a positive β value showed that the independent variable was more likely to impact the dependent variable to be in a given better off category with respect to the reference/base category and a negative β value showed that the independent variable was less likely to impact the dependent variable category under consideration with respect to the reference category. If β=0, the particular category and the reference category are equally likely to be impacted by the independent variable.
3) Exponential Beta Value: this value gives the odds ratio for the independent variables. It is an exponentiation of the coefficients (B_i). The odds ratio shows the change in odds of the dependent variable being in a particular category

compared to the reference category. An odds ratio greater than 1 indicates that the probability of the outcome falling in the comparison group relative to the probability of the outcome falling in the referent group increases as the variable increases. An odds ratio less than 1 indicates that the probability of the outcome falling in the comparison group relative to the probability of the outcome falling in the referent group decreases as the variable increases, thus it is less likely to fall in the comparison group.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter analyses the data collected from the sampled smallholder farmers in Butaro sector, Burera District. Based on the study objectives, the results and their interpretations are presented under the following sections: Section 4.1 provides the descriptive statistics thus providing the profile of sampled respondents based on the salient demographic, economic and institutional factors which in the conceptual framework of the study were hypothesized to influence the household food security status of the smallholder farmers (Figure 2.3). Section 4.2 categorizes the sampled smallholder farmers' households per different levels of experienced food insecurity. Section 4.3 presents the diagnostic tests for econometric problems including the correlation and multi-collinearity tests. Section 4.4 presents the results of multinomial logistic regression models, assessing the effect of each of the hypothesized demographic and resource factors on food security status of the smallholder farmers.

4.2 Descriptive analysis: socio-demographic and resource characteristics of the respondents.

The first step of this study analysis focused on describing the profile of the respondent smallholder farmers sampled. The socio-demographic and resource characteristics of the respondents are presented in the sections below.

4.2.1 Socio-demographic profile of respondent smallholder farmers

The results in Table 4.1 provide a summary of the socio-demographic characteristics of the respondents. Out of the 378 smallholder farmers' households sampled, 48.7% had a family size of less than 4.5 members, while 51.3% had 5 and more family members. The average family size among respondents was found to be 5 members. The dependence ratio was greater than one for 26.5% of respondent households. Most of the sampled households (73%) were male headed with 27% of the households being female headed. Regarding the marital status of the household head, it was found that 90.2% were married with 1.9% being single males and 7.9% single females. It was also found that 52.9% of sampled household heads had never attended school, while43.1% had only primary school level of education and 3.9% had a secondary level of education. Looking at all the household members' education level, 67.5% of the sampled households had at least one family member who attended primary school level and only 6.6% had a member who had attained the secondary school level of education.

Table 4.1: Households Socio-demographic characteristics of the sampled smallholder farmers in Burera District

Variable		Frequency 378	Percent %
	Family Size*		
	Less than 5 members	184	48.7
	Between 5 and 8 members	183	48.4
	More than 8 members	11	2.9
Household Dependency ratio**			
	≤1	278	73.5
	>1	100	26.5
	Education level of the household head		
	Never attended school	200	52.9
	Attended primary level	163	43.1
	Attended secondary level	13	3.4
	Attended university level	2	0.5
Summed education level of household members			
	No member attended school	93	24.6
	At least one member attended Primary	255	67.5
	At least one member attended secondary	25	6.6
	At least one member attended vocational training	5	1.3
	At least one member attended university	0	0
	Gender of the household head		
	Female	102	27.0
	Male	276	73.0
Marital status of the Household head			
	Couple (Husband &wife)	341	90.2
	Adult male, Single	7	1.9
	Adult female, Single	30	7.9
	Child headed (<18 years)		
Age of the Household head			
	18-45years	216	57.1
	46-65years	114	30.2
	66-75years	29	7.7
	76 and more	19	5.0

*Note: *The mean number of family members was 4.5**The household dependency ratio is equal to (n<16 years + n>65years)/n (16–65 years). 0=no dependants, 1=as many dependants as non-dependants, >1= more dependants than non-dependants.*

(a) Family size and farm-holder dependents

The current study found that close to half (48.7%) of the sampled smallholder farmer households had less than five (5) members with average family size of 4.5. Findings were consistent with the 2010/2011 EICV3 (NISR, 2011) which had indicated that the mean number of household members in Burera district was 5 persons per family with the national average of 4.8 members per household. This remarkable difference from 2011 to 2016 might be attributed to the mind-set change as more sensitization on family planning has been carried out across the country to be able to decelerate the population growth in Rwanda. Similar trends of decreasing family size were also observed nation-wide, as the EICV4 of 2013/2014 (NISR, 2015) revealed that the national mean of household members had reduced from 4.8 in 2010 to 4.6 in 2013. The 2017 Rwanda demographics profile done by Index Mundi also confirmed that the average number of births per woman decreased from 5.6 in 2005 to 4.5 in 2016. .

The average family size among the sampled smallholder farmers of Burera district was lower compared to the general trend observed among smallholder farmers across the globe. Comparing the economic lives of smallholder farmers across nine countries, FAO found that the average family size of smallholder farmers is generally large. In countries like Kenya and Bangladesh, the average is 7 members from which at least 2 members are of age less than 14 years (Rapsomanikis, 2015).

The results also indicated that lesser number of households had a high dependency ratio of more than one (1). This means implies that the majority of the smallholder farmers' households in Burera district had a balanced ratio between the sum of children and elderly people considered as dependents and the household members in active age who were the providers of the family. However, this was different from other districts of the country, like Eastern province where the proportion of households with higher dependency ratio (over one) was found to be up to 46% in Kayonza district (Nsabuwera et al., 2015).

(b) Gender of the household head

Regarding gender of the household head, the results indicated that majority of sampled households were male-headed with an average of 73% while 27% were female headed households. This finding was not surprising in the Rwandan context with paternal culture, given that the household would be only headed by female if she is a widow or separated. The trend of marital status of the household head was as expected, with the majority being married.

In the past few years, due to the tragic history of genocide which left many orphans, it was also common to find cases of child- headed households country wide (the elder child looking after his siblings being below 18 years old), however this case was not found in the sampled respondents, which is a good sign that the Rwandan society is maturing and recovering from the genocide aftermath.

(c) Education level of the sampled smallholder farmers

Education level among the smallholder farmers of Burera district was found to be very low, with majority of household heads being illiterate, while at household level the trends is a bit changing, with more members having primary school level of education. This reflects the reality of the Rwandan rural settings where most of the households live on the subsistence farming and engaging children in farming to provide labour at the expense of schooling. However, the trend is currently changing with the education policy enforcement which stipulates that every child in the schooling age should attend school since there is free access to nine (9) years of basic education (MINEDUC, 2008). Nonetheless, other countries have shown higher trends of education level of smallholder farmers, like the Caribbean countries where the FAO's data of 1999 showed that 50-55% of smallholder farmers had achieved primary level and 20 % had completed secondary level of education (Graham, 2012).

(d) Age of the household head

The study found that 57.1% of smallholders' household heads were aged between 18 and 45 years old, while 30.2% were aged between 46 and 65 years, with only 12.7% being aged beyond 65 years. The mean age of the household heads was found to be 44.8 years. The fact that majority of the household heads were in the early active age (below 45 years) aligns with the national demographics which state that 51.8% of Rwandan population are between 15 and 55 years old (Index Mundi, 2017). It also aligns with the EICV3 findings which stated that in 2010/2011, in Burera district majority of population (81%) were young, aged below 40 years old.

4.1.2 Resource characteristics of the smallholder mixed farmers in Burera district

The Table 4.2 presents the resource characteristics of the sampled smallholder farmers.

(a) Farm size

Examining the farm size, the results indicated that majority of the smallholder farmers in Burera district operate on small plots of land, with 77.7% of the respondents having less than 1hectare (ha) of land.

The findings of this study confirmed what the 2010/2011 Rwanda's integrated household survey (EICV3) had found out while profiling Burera district. The EICV3 report stated that over 80% of Burera population lived on agriculture and 91.3% of households operated on land less than 0.9ha, with a mean of 0.39ha (NISR, 2011). The small size of land has been the main characteristics of smallholder farmers across the World. This finding confirms the findings of Rapsomanikis (2015) who assessed the economic lives of smallholder farmers with household data from 9 countries, and found that on average small-scale holders in majority of the developing countries have farm holdings of less than 2 hectares. The author found the average size of smallholder farms in Bangladesh and Vietnam to be 0.24 and 0.32ha respectively while in Kenya and Ethiopia it was 0.47ha and 0.9ha respectively. It is only in Latin American countries,

where the smallholder farmers were found to have an average farm size of between 2 and 5 hectares. The average small size of farms on which the smallholder farmers of Burera district operate and live on was hypothesized in this study to be a predictor of household food insecurity.

Table 4.2: Resource characteristics of the sampled small-holder farmers in Burera District

Variable	Frequency *378*	Percent *%*
Farm size (ha)		
≤ 0.5 ha	103	27.2
Between 0.5 and 1ha	191	50.5
More than 1ha	84	22.2
On Farm Income (FRW/ annum)		
≤200,000	156	41.3
Between 200,000 and 300,000	162	42.9
Above 300,000	60	15.9
Livestock ownership		
Own at least one livestock (cow, goat, sheep or pig)	145	38.6
Own at least one cow	60	15.9
No livestock	173	45.5
Onfarm labour availability		
Less than 3 active members	284	75.1
Between 3 and 4 active members	83	22
More than 4 active members	11	2.9

(b) On-farm income

Regarding the average annual income from farming activities, 41.3% of the respondents were found to earn less than 200.000 FRW (less than 250 USD), 42.9% earned between 200.000 and 300.000 FRW (250-400 USD), while only 15.9% earned above 300.000 FRW (400 USD). Translating the estimated annual revenues from farming activities to daily rate, the results imply that majority of the smallholder farmers (84.2%) in Burera

district would be living on income below the internationally set poverty line of 1.25 USD/day (World bank, 2005), which has been adjusted to 1.9 USD/day considering Power Purchasing Party Exchange rates of 2011 (World Bank, 2014). That means that majority of the smallholder farmers in Burera district are classified as poor. The findings of the study on the ranges of annual income for these smallholder farmers align with the findings of the 2013/2014 EICV4 (NISR, 2015) which stated that about 39.1% of the Rwandan population are identified as poor with a national poverty line of 159,375 FRW (227.6 USD[1]),. In 2011/2012, EICV3 had set a threshold of poverty line at 118,000 FRW (194 USD) per year (NISR, 2011). This EICV3 had identified Burera district as the first among districts in the range of 40-55% of population identified as poor (NISR, 2011).

Similar trends of low income from the farming activities for smallholder farmers leading them to be classified as poor are recognized across many countries. In Bolivia, up to 83% of smallholder farmers are classified as poor with the national poverty average of about 61%. In Ethiopia, poverty headcount ratio of smallholders is 48%, and in Vietnam more than a half of the smallholder farmers are poor (Rapsomanikis, 2015). Although there is correlation between land size and on-farm annual income obtained, the land productivity factor is equally important, hence the smallholder farmers of Burera district should optimize their land productivity to increase their earnings. For instance, it has been shown that a smallholder farmer in Bangladesh operating on 0.24 ha of land can generate about 2.9US$ per person per day which is very different from their counterpart smallholder farmers in African countries (Rapsomanikis, 2015).

To cope with the low revenues of farming activities, the respondent smallholder farmers of this study confirmed that they live on diversified income sources. Only 39%

confirmed that they solely live on farming activities on their land, while 55% combined farming on their own farms with casual jobs (either working on others' farms or other daily paying jobs) while 6% combined farming with small businesses and crafts. Thus, boosting revenues of smallholder farmers should combine improving the farmers 'capital assets (land and livestock) and the skills-mix which give rise to diverse sets of opportunities in the rural non-farm sector. Kenya is a typical example, where smallholder farmers combine their farming activities with off-farm jobs to earn a gross income of about 2,527 USD per year (about 1.4 USD per day per person) in a family of average size of 5 members (Rapsomanikis , 2015).

(c) Livestock assets

The study found that 54.5% of the sampled smallholder farmers owned at least one livestock (either a cow, goat, sheep or pig) with only 15.87% having cows in their households. The importance of livestock assets in the smallholder mixed crop farming cannot be reemphasized since they are not only a source of organic manure, but they are also a quick means of liquid cash when disposed, thus providing an economic security against frequent failure (Njarui et al, 2016). The findings are slightly different from the EICV3 which had stated that in Burera district 78.5% of all households were raising some type of livestock in 2010/2011 while the national proportion was 68.2% (NISR, 2011). However, the findings could be consistent since only medium to large livestock were counted in this study (only those with cows, sheep, goats and pigs) while the EICV had counted even small animals such as chicken and rabbits. The findings of the study align with the proportions reported in EICV4 (NISR 2015) which stated that in the Northern Province 31.5% of households' reared sheep; 37.6 % reared goats and 28.1% reared pigs. The big difference is on cattle rearing where EICV4 reports that in Northern Province 57.8% of households' reared cattle, while the findings of this study were 15.8% among the smallholder farmers. However, given the high levels of poverty among the sampled smallholder farmers, it is also likely that the 15.8% of the cattle owned

could be from the overall 6.8% share of the Northern Province from the "One Cow Per family" Policy as reported by EICV4 (NISR,2015).

(d) Family labour

About the availability of labour resource factor, 31.2 % of the sampled households had only one member in active age who could be relied on to supply family labour, 45.8% had 2 active members while 23% had more than 2 active members catering for the household. This means that 75.1% of the households could only rely on the household head or his wife since not many other family members were available to support in on-farm activities. Given that 57.7% of the sampled household heads were aged below 45 years, and considering that the legal age of marriage is set at 21 years in Rwanda, the study results indicate that most of the households sampled were having young children of less than 16 years and considered to be still in schooling age. The current findings show that majority of the sampled smallholder farmers' households have a limited number of on-farm labour (with 75.1% having less than 3 active members). On the other hand, the WFP in its Rwanda Comprehensive Food Security and Vulnerability Analysis (CFSVA) had reported that rural households with few adult household members tend to be food insecure (WFP, 2012 &2015). Nonetheless, after analysing the data from 9 countries, Rapsomanikis (2015) concluded that that the number of family workers does not tell the whole story since the smallholder farmers typically exploit very low capital to labour ratios, using more labour than capital resources (like land) to produce food. The author found for instance that in Kenya, Bolivia and Albania, the family labour amounted to 2, 2.5 and 3.2 persons per day and per hectare respectively, which implied an over-use of family labour, which is inconsistent with the profit-maximization principle.

4.1.3 Access to institutional support for the smallholder farmers in Burera District

Access to agricultural extension services and financial services were assessed as factors that influence farm productivity and capital investment. The results presented in Table

4.3 show that only 8% of the respondents had received agricultural training or extension assistance within the one-year period from the date of interview. The main extension service provider cited by trained respondents (58.6%) was the sector agronomist/ veterinary who normally oversaw more than 6000 households that comprise the administrative sector boundary. Financial literacy among the smallholder farmers and access to financial facilities are also very limited. Only 28% of the respondents had some mechanisms of saving and access to loans with 20% using informal savings and lending groups of neighbours (IBIMINA), while only 8% were using the formal saving and credit cooperative (SACCO) available at sector level. It was also found that none of the respondents had ever acquired a loan from any bank. The limited access to extension services spanned to the limited level of using improved farming techniques such as mineral fertilizers availed as Government subsidies. Only 25% respondents had used mineral fertilizers at least in the previous two agricultural seasons preceding the time of interview, that is either during season A of September 2015 or Season B of March 2016. Another stimulating factor to easily access extension services in rural areas is being a member of agricultural cooperative, where extension officers can easily reach the cooperative members at their gatherings and bank loans can be provided using group guarantee. Although 44% of the respondents indicated that they were members of a cooperative, only 6% were members of a registered cooperative that supported agricultural production activities. 8% of the respondents were found to be members of informal savings and lending groups (IBIMINA) in their neighbourhood, and 30% were members of informal unregistered cooperatives of social assistance, mainly exchanging labour during the planting season.

The findings on access to financial and agricultural extension services confirm the general trend across the world. In 2014, IFC reported that while agriculture remains a key economic activity in Africa employing about 55% of the population, only approximately 1% of the banks' lending goes to the agricultural sector. Furthermore, only 4.7% of adults in rural areas in developing countries globally access a loan from a formal financial institution with only 5.9% having a bank account (IFC, 2014). Although

the 2016 Rwanda FinScope report indicated that 89% of adult population in Rwanda were financially included (through formal and informal financial services), 72% of them were found to use informal group saving and rotational money lending mechanisms, and Burera district accounts for 87% of its adult population using informal financial mechanisms.

The current study results on access to finance among the smallholder farmers align with the findings reported in Zambia's 2015 FinScope report which stated that among smallholder farmers, only 16.9% of farmers used formal services and 23.3% used informal services which include informal rotating savings schemes, structured saving groups and or informal credit providers (Corps, 2016).

Table 4.3: Access to institutional facilities for the sampled smallholder farmers in Burera District

Variable	**Frequency** ***378***	**Percent** ***%***
Access to financial facility (loans, saving)		
No	273	72
Yes	105	28
Used mechanisms of saving and borrowing money		
Informal saving groups (Ibimina)	73	19.3
SACCO	32	8.5
MFI/ Bank	0	0
Received agriculture training /extension assistance in last year		
No	349	92
Yes	29	8
Belonging to agricultural Cooperative		
No	212	56
Yes	166	44
Use of mineral fertilizers		
Did not use fertilize in last 2 seasons	283	75
Did use fertilizer in last two seasons	95	25

Source: Data from the current study survey.

Regarding access to agricultural trainings and extension services, it was not surprising to find very limited access given that in Rwanda, the decentralized public extension services depend solely on one sector agronomist and veterinary officer. These officers plan for agriculture seasons, ensure inputs are delivered in the sector, attend trainings and then supervise the running of the agricultural season cycle from planting to harvesting. Given that the rural administrative sector has between 5.000 and 9.000 households, most of them depending on agricultural livelihood, it is understandable that one agronomist and one veterinary officer will not be able to reach all the smallholder farmers households in the locality. At the best, these two extension agents will only attend to few large-scale farmers and cooperative lands where they manage to report on their performance, both in terms of land use consolidation and production.

The limited access to extension services could be linked to the low technology adoption such as level of use of chemical fertilizers, despite the Government efforts to boost use of fertilizers, including offering subsidies. The 2015 Rwanda Poverty profile drawn from EICV4 indicated that nationwide, purchase of chemical fertilizers was at 36.4% accounting for all small and large-scale farmers (NISR, 2014). Thus, the low level of fertilizer users (25%) conforms to the national trend.

4.2 Food security status of the smallholder farmers of Burera District

The first objective of this study was to assess the smallholder farmers' status of food insecurity and therefore categorize each household according to the household food insecurity access score.

The results in Table 4.4 indicate the three domains of food insecurity experienced by the respondent households during the previous 30 days from the day of interview. Such experiences are related to anxiety and uncertainty about food; household experience with the quality of food (limited varieties and unmet preferences) and the experience with insufficient food intake (quantity of food consumed). About the anxiety and uncertainty about food, 58% of the respondent smallholder farmers had been worried for some time

or so often about access to enough food; 45% felt they had eaten so often the kinds of food they did not prefer because of lack of resources; 60% experienced so often a situation of eating few kinds of food (limited varieties) while 62% confirmed that it happened so often to eat kinds of food that they should not eat but due to limited means, they had to. However very few (10%) expressed that it has sometimes happened to miss food at all in their households, though still 28% experienced a situation of sometimes going to sleep feeling hungry because there was not enough food. Other 5% expressed that it rarely happened to go a whole day and night without eating anything.

The results in Table 4.5 show that out of 378 smallholders farmers' households interviewed, only 24 households (6.3%) were found to be in the category of food secure, 59 were mildly food insecure (15.6%), while 131 were moderately food insecure (34.7%) and 164 were severely food insecure (43.4%). The results showed that there is a big proportion of smallholder farmers living in a situation of food insecurity, with only 6.3% of the sample not being worried about food availability and access. The mildly and moderately food insecure households representing 50.3% are sometimes considered as marginally food secure households with transitional food security status given that at normal harvests they become fully food secure and may face transitory food insecurity if the harvest is poor (WFP,2012). In the contrast, the severely food insecure households are those that face food deficit all year long and are in a situation of almost chronic food insecurity.

Table 4.4: Assessment of smallholder farmers experience with food insecurity situations

	Variable (HFIAS Questions)	Frequency of Occurrence			
		Never	**Rarely**	**Sometimes**	**So often**
1	Did you worry that your household would not have enough food?	98 (26)	60(16)	156 (41)	64(17)
2	Were you or any household member not able to eat the kinds of food you preferred because of lack of resources?	55 (15)	51 (14)	102 (27)	170(45)
3	Did you or any household member eat just a few kinds of food day after day due to lack of resources?	71 (19)	12 (03)	69 (18)	226(60)
4	Did you or any household member eat food that you preferred not to eat because of lack of resources to obtain other types of food?	40 (11)	22 (06)	80 (21)	236(62)
5	Did you or any household member eat a smaller meal than you felt you needed because there was not enough food?	90 (24)	40 (11)	81 (21)	167(44)
6	Did you or any household member eat fewer meals in a day because there was not enough food?	171(45)	78 (21)	103 (27)	26(07)
7	Was there ever no food at all in your household because there were not enough resources to get more?	304 (80)	36 (10)	37 (10)	1 (00)
8	Did you or any household member go to sleep at night hungry because there was not enough food?	38 (10)	213 (56)	104 (28)	23 (06)
9	Did you or any household member go a whole day without eating anything because there was not enough food?	358 (95)	18 (05)	2 (01)	- (00)

The numbers in () are percentages

Source: Field survey data

Table 4.5: Food security status of sampled Smallholder farmers of Burera District

Food security Status	Frequency	Percent	Cumulative %
1. Food Secure	24	6.3	6.3
2. Mildly Food Insecure	59	15.6	22.0
3. Moderately Food Insecure	131	34.7	56.6
4. Severely food Insecure	164	43.4	100.0
Total	378	100.0	

Source: Field survey

The results showed that, as we move from food secure category to severely food insecure category, the level or percentage of households' increases. This indicates that in the study area, even though many efforts have been done by the Government of Rwanda to attain universal food security, the number of households who were severely food insecure was still high and therefore it called for redefining of strategies for immediate interventions to address extreme rural poverty. The findings were consistent with those of the WFP's Rwanda 2015 comprehensive food security and vulnerability analysis (WFP, 2015) which reported that 48% of Rwandan households had difficulties in accessing food at some point in the previous year of the survey. The same report stated that this situation of household food insecurity happened despite the fact that food was generally available in markets and infrastructures allowing food to move across the country were well developed. Using a different categorization method of food security index, The 2015 WFP assessment classified Rwandan households in general as 40% being food secure and 40.2% of the households as marginally food secure which means that they were living with stress in their coping strategies to food insecurity. Other 16.8 and 2.6% were classified as moderately food insecure and severely food insecure

respectively, meaning that their livelihood coping strategies to food insecurity were in crisis and emergency status. Despite the differences in classifications, we assume that the majority of sampled smallholder farmers fall in the category of marginally food secure and hence live with some sort of stress of coping with food accessibility as defined by WFP. According to the answers provided to the 9 HFIAS questions (Table 4.4), only 5% of the respondents lived under food crisis and emergency situations since they positively responded to (rarely) have spent a whole day without eating at all.

The very low proportions of food secure households among the smallholder farmers conform with the WFP studies (WFP, 2012 &2015) which found that food insecurity is prominent in the low-income agricultural communities which represent the most common form of livelihood in Rwanda. The same studies also observed that when compared to food secure households, food insecure households have less livestock, less agricultural land, fewer adult household members, grow fewer crops and mostly consume more of their own production. This has been demonstrated by the logistic regression of this study, which showed that livestock asset and land size significantly affected the status of the household food security of the smallholder farmers.

The trends of food insecurity among smallholder farmers of Burera district as identified in this study using HFIAS tool are consistent with findings of similar studies across rural areas of Africa. For example, Sakyi (2012) examined the determinants of food accessibility of rural households in the Limpopo province of South Africa using the HFIAS tool and found that 53% were severely food insecure. Astemir (2014) in his study of determinants of food security in rural farm households in Ethiopia also found that about 10.16% of households were food secure, 11.07% were mildly food insecure, while 22.76% were moderately food insecure and 56.01% were severely food insecure. On the other hand, food security trends among the smallholder farmers of Burera as observed in the current study were different from the findings of Cho et al. (2016) who assessed the household food security through crop diversification in Magway region of Myanmar. They found that 31.25% of the households were food secure, 35% of the

households were mildly food insecure, 25% of the households were moderately food insecure and 8.75% of the households were severely food insecure. The study concluded that majority of the sampled farmers were in the category of mildly food insecure followed by households that were food secure, a trend which is different from the present study. The dissimilarities could be explained by the differences in social and economic context of the two countries.

4.3 Econometric analysis of the determinants of household food security

The second objective of this study was to determine the effect of resource factors combined with the socio-demographic factors on the food security status of the smallholder farmers 'households. Resource factors considered included the farm size, on-farm income per annum, livestock assets, and farm-house labour availability (the number of physically active members of the household, within legally accepted age limit for labour provision). In Rwanda, the labour law stipulates that children can only be considered for labour from the age of 16 years, while the retirement age is set at 65 years (MIFOTRA, 2009), though this doesn't limit children or elders from providing farm labour informally. Demographic variables factored in the analysis included age, gender and education of the household head and family size or farm-holder dependents. Institutional mechanisms were also factored in as intervening variables such as availability and access of agricultural trainings and extension services, access to subsidized fertilizers, as well as access to financial services for capital saving and equity loans acquisition.

Before carrying out the multinomial logistic regression of the above parameters to find association odds ratios, diagnostic tests were performed to assess correlation and potential multi-collinearity among the hypothesized parameters.

4.3.1 Multi-collinearity diagnostic test

In order to diagnose the multi-collinearity among the explanatory variables of the present study, the, results of Pearson Bivariate correlation matrix, VIFs and tolerance are given in the Table 4.6. Table 4.7shows the result of variance inflation factor. It is seen from the table that the values of VIFs for all the explanatory variables are less than 5 meaning that multi-collinearity is not a problem. It can be also seen that the values of tolerance are greater than 0.01 meaning that the regressors in question are not correlated.

Assumption 10 of the classical linear regression model (CLRM) is that there should be no multi-collinearity among the regressors included in the regression model (Gujarati, 2004). Estimating a model in the presence of multi-collinearity results in indeterminate regression coefficients (i.e. coefficients with less precision or accuracy) and their standard errors are infinite. In this section, we take a critical look at this assumption. Multi-collinearity was checked by Pearson bivariate correlation matrix, tolerance statistics and variance inflation factor (VIF). As Djangmah (2016) suggested, a tolerance value of less than 0.01 indicates serious collinearity problems and any of the VIF whose value exceeds 5 (the cut-off point) is the cause of multi-collinearity. Multi-collinearity problem arises when some or all the explanatory variables are highly correlated, which reduces the precision of estimation. Multi-collinearity occurs due to poor sampling method, model misspecification, overfitting of a model as well as improper use of dummy variables (Gujarati, 2004). Pearson bivariate correlation matrix of the explanatory variables, variance inflation factors (VIFs) and tolerance are some of the statistical techniques that have been provided for detecting multi-collinearity among categorical variables. For the purpose of the present study these three techniques were employed. Even though these techniques have the same purpose of testing multi-collinearity, they differ in the levels in which they are used. Pearson Bivariate correlation matrix is used to help detect high multi-collinearity between predictors (X_i and X_j, $i \neq j$) while VIFs are used to investigate potential multi-collinearity problems. Another way of detecting the multi-collinearity is to take the inverse of VIF named as

tolerance. When the variable's tolerance ($1-R^2$) is smaller than 0.01, it indicates that the variable under consideration is almost a perfect linear combination of the independent variables already in the equation and it should not be added to the regression equation. Also, when a low tolerance value is accompanied by large standard errors and non-significance, multicollinearity may be an issue.

$VIF\hat{\beta} = \frac{1}{1-R_j^2}$ where R_j^2 is the coefficient of determination obtained when X_j is

regressed on the remaining ρ-1 predictors. The VIF of each predictor in the model measures the combined effect of the dependencies among the predictors on the variance of that predictor. Multi-collinearity is confirmed if any of the VIFs exceeds 10.

Examining if the variables are correlated, correlation analysis was performed, which is a measure of the degree of relationship between the independent variables under consideration. It gives an idea about the degree and direction of the relationship between the two variables under consideration. The results of the Pearson's correlation matrix in the Table 4.6 revealed that none of the bivariate correlation between any two regressors exceeded 0.8 meaning that multi-collinearity was not a problem and thus all the regressors were included in the model.

Table 4.6(a): Correlation matrix of the variables in the model

		Gender of the household head	Education of the household head	On Farm Income	Farm size	Training in Agriculture	Access to financial services	Family Size	Farm house labour
Gender of the household head	Pearson Correlation	1							
	Sig. (2-tailed)								
	N	378							
Education level of the household head	Pearson Correlation	.036	1						
	Sig. (2-tailed)	.480							
	N	378	378						
On Farm Income	Pearson Correlation	-.016	.047	1					
	Sig. (2-tailed)	.757	.360						
	N	378	378	378					
Farm size	Pearson Correlation	-.061	-.027	-.126*	1				
	Sig. (2-tailed)	.240	.604	.014					
	N	378	378	378	378				

Table 4.6 (b): Correlation matrix of the variables in the model

		Gender of the household head	Education of the household head	On Farm Income	Farm size	Training in Agriculture	Access to financial services	Family Size	Farm houselabour
Training in Agriculture	Pearson Correlation	.041	.017	.033	-.121*	1			
	Sig. (2-tailed)	.428	.735	.522	.019				
	N	378	378	378	378	378			
Access to financial services	Pearson Correlation	-.022	.128*	.039	.087	-.023	1		
	Sig. (2-tailed)	.667	.013	.453	.093	.650			
	N	378	378	378	378	378	378		
Family Size1	Pearson Correlation	.009	.023	.031	-.062	.041	.012	1	
	Sig. (2-tailed)	.869	.659	.547	.229	.424	.815		
	N	378	378	378	378	378	378	378	
Farm House Labour	Pearson Correlation	.039	-.037	.034	-.057	-.001	.021	.392**	1
	Sig. (2-tailed)	.449	.478	.509	.267	.983	.680	.000	
	N	378	378	378	378	378	378	378	378

Note: *. Correlation is significant at the 0.05 level (2-tailed); **. Correlation is significant at the 0.01 level (2-tailed).

Table 4.7: Collinearity diagnosis tests

	Collinearity Statistics	
Model	**Tolerance**	**VIF**
Use of fertilizers	.178	5.606
Livestock Asset	.922	1.084
Farm House Labour	.773	1.293
Age of the household head	.834	1.199
Gender of the household head	.979	1.021
Education of the household head	.920	1.087
On Farm Income	.945	1.058
Farm size	.934	1.071
Access to financial facility	.958	1.043
Training in Agriculture	.176	5.679
Family Size	.771	1.297

Note: Dependent Variable is Food Security Status1

Source: Field survey data

4.3.2 Multinomial logistic regression

Based on the procedures of the multinomial logistic model, the model fitting information and maximum likelihood parameter estimates for the model were computed as shown in Table 4.8 and Table 4.9. The coefficients (βi) of the independent variables in the model were studied and assessed with respect to a priori expectations of the signs and the statistical significance of the coefficients. The results of the logistic regression model are presented in the Table 4.10.

58

Table 4.8: Econometric Model Fitting

Model fitting information						
	Model Fitting Criteria	Likelihood Ratio Tests			Pseudo R Square	
Model	-2 Log Likelihood	Chi-Square	df	Sig.	Cox and Snell	0.838
Intercept Only	882.936				Nagelkerke	0.923
Final	194.129	688.808	33	0.000	McFadden	0.763

Table 4.8 describes the model fitting information. In the multinomial logistic regression model, dependent variable is status of household food security and independent variables are: age of the household head, gender of household head, education, family size, farm size, livestock asset, on farm income, farm house labour, fertilizer use, and access to financial facility and access to training. The first model is called null model (model with intercept only) and the second model is alternative model (model which includes all the independent variables). To compare the difference between these two models, there is a need to make a statement of the hypothesis to be tested:

H_0: Socio-economic factors have no significant effect on household food security

H_1: There is a significant effect of socio-economic factors on household food security.

The results showed that the significance value or p-value (0.000)s less than 0.05. It means that the null hypothesis was rejected and the alternative hypothesis accepted which implies that socio-economic factors had a significant effect on household food security.

Table 4.9: Likelihood ratio

	Model Fitting Criteria	Likelihood Ratio Tests	
	-2 Log Likelihood of Reduced Model	Chi-Square	Significance
Intercept	1.941E2	0.000	
Age of the household head (AgHH)	718.547	524.418	0.000
Education level of the household head(Educ)	2.036E2	9.472	0.024
Onfarm income (OnFI)	2.490E2	54.872	0.000
Farm size(FS)	1.954E2	1.244	0.742
Family size(FMS)	1.973E2	3.126	0.373
Farm –house labour(FHL)	1.947E2	0.604	0.896
Access to trainings (AT)	1.976E2	3.473	0.324
Access to financial facilities (AFF)	2.074E2	13.317	0.004
Gender of the household head(GEN)	2.177E2	23.547	0.000
Use of fertilizers (TFert)	196.015	1.886	0.596
Livestock assets(LA)	2.038E2	9.644	0.022

Source: Field Survey data

The results of the likelihood ratio test revealed that among eleven (11) independent variables, six (6) variables namely age of the household head, education level, gender of the household head, on farm income, livestock asset and access to financial facility had a significant impact or positively associated with the status of household food security at 5% significance level (p-value<0.005).This implies that the null hypothesis is rejected and the alternative hypothesis is accepted, meaning that more than one of the considered socioeconomic factors significantly influence household food security.

Table 4.10: Multinomial logistic regression Estimates with eleven (11) independent variables

Food Security Status1[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Food Secure	Intercept	-18.894	812.584	0.001	1	0.981	-	-	-
	AgHH	-2.696**	1.123	5.758	1	0.016	0.068	0.007	0.610
	Educ	0.081	0.648	0.016	1	0.900	1.085	0.305	3.860
	OnFI	5.278***	1.543	11.696	1	0.001	5.956	9.517	40.345
	FS	-0.082	0.589	0.020	1	0.889	0.921	0.290	2.920
	FMS	-1.825	1.189	2.357	1	0.125	0.161	0.016	1.657
	FHL	-0.646	0.956	0.457	1	0.499	0.524	0.080	3.413
	[TA=0]	8.891	812.579	0.000	1	0.991	7263.775	0.000	-
	[TA=1]	0.000	_	_	0	_	_	_	_
	[AFF=0]	-2.757**	0.954	8.342	1	0.004	0.064	0.010	0.412
	[AFF=1]	0.000	-	-	0	-	-	-	-
	[Gen=0]	0.971	0.973	0.998	1	0.318	2.642	0.393	17.771
	[Gen=1]	0.000	-	-	0	-	-	-	-
	[TFert=0]	1.721	0.000	-	1	-	5.593	5.593	5.593
	[TFert=1]	0.000	-	-	0	-	-	-	-
	[LA=0]	0.000	-	-	0	-	-	-	-
	[LA=1]	1.824*	0.944	3.732	1	0.053	6.195	0.974	39.402
Mildly Food Insecure	Intercept	-170.936	720.827	0.056	1	0.813	-	-	-
	AgHH	52.960	236.984	0.050	1	0.823	1.000	1.903	5.259
	Educ	-3.825**	1.560	6.010	1	0.014	0.022	0.001	0.464
	OnFI	1.205*	0.723	2.779	1	0.095	3.337	0.809	13.762
	FS	0.052	0.644	0.006	1	0.936	1.053	0.298	3.721
	FMS	0.042	0.872	0.002	1	0.961	1.043	0.189	5.759
	FHL	0.378	1.053	0.129	1	0.720	1.459	0.185	11.491
	[TA=0]	-25.535	3666.589	.000	1	0.994	8.133	0.000	-
	[TA=1]	0.000	-	-	0	-	-	-	-
	[AFF=0]	0.698	1.053	0.439	1	0.508	2.009	0.255	15.828
	[AFF=1]	0.000	-	-	0	-	-	-	-
	[Gen=0]	17.301	106.210	0.027	1	0.871	3.264	1.282	8.309
	[Gen=1]	0.000	-	-	0	-	-	-	-
	[TFert=0]	25.985	3666.590	.000	1	.994	1.92	0.000	-
	[TFert=1]	0.000	-	-	0	-	-	-	-
	[LA=0]	-2.750*	1.470	3.496	1	.062	.064	.004	1.142
	[LA=1]	0.000	-	-	0	-	-	-	-
Moderately Food Insecure	Intercept	-42.228	355.440	0.014	1	0.905	-	-	-
	AgHH	21.349	177.716	.014	1	0.904	1.869	9.989	3.498
	Educ	-0.618	0.435	2.023	1	0.155	0.539	0.230	1.263
	OnFI	0.285	0.347	0.674	1	0.412	1.330	0.673	2.628

FS	-0.304	0.341	0.795	1	0.373	0.738	0.378	1.439
FMS	-0.287	0.437	0.432	1	0.511	0.750	0.318	1.767
FHL	0.051	0.444	0.013	1	0.909	1.052	0.440	2.513
[TA=0]	-11.387	125.863	0.008	1	0.928	1.134	8.307	1.547
[TA=1]	0.000	-	-	0	-	-	-	-
[AFF=0]	-0.276	0.526	0.275	1	0.600	0.759	0.271	2.128
[AFF=1]	0.000	-	-	0	-	-	-	-
[Gen=0]	0.340	0.486	0.490	1	0.484	1.405	0.542	3.640
[Gen=1]	0.000	-	-	0	-	-	-	-
[TFert=0]	10.500	125.867	.007	1	0.934	36330.182	2.643	4.993
[TFert=1]	0.000	-	-	0	-	-	-	-
[LA=0]	-0.179	0.455	0.155	1	0.693	0.836	0.343	2.039
[LA=1]	0.000	-	-	0	-	-	-	-

Source: Field data analysis

Note: Number of observations: 378, Wald Chi^2 (33): 688.808; Prob=0.0000; Pseudo R^2: 0.923; Log pseudolikelihood: 506.768 ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level. Reference category: Severely food insecure

In the above econometric model, the dependent variable has four categories which are: food secure, mildly food insecure, moderately food insecure and severely food insecure as presented in Table 4.10. The model has a pseudo R^2 of 0.923 which means that 92.3% of the variation in the dependent variable is due to the variations in the independent variables.

The results of this first multinomial logistic regression model with initially estimated 11 independent variables assessed on the different categories of household food security status, with severe food insecurity being a reference category, showed that 5 predictors out of 11 were statistically significant in influencing household food security status with probability of a household being in better off category compared to severe food insecurity. Age of the household head (AgHH), on farm income (ONFI) and access to financial facility (AFF_0) had a significant P-value at 1% ($P<0.01$) while household livestock asset (LA_1) has a significant P-value at 10% ($P<0.1$). All of these 4 factors influence the probability of a household to be in the category of food secure compared to the category of severely food insecure. In the second category, education (EDU,

P<0.01); on farm income (OnFI, P<0.1) and livestock asset (LA_0, P<0.1) significantly influenced the probability of a household to be in the category of mildly food insecure compared to the category of severely food insecure. None of the predictors were significant in influencing the moderately food insecure category in comparison to severely food insecure. In this first testing of the model with a combination of 11 predictors, independent variables like family size, farm size, gender, on farm house labour, access to trainings and extension services, as well as use of fertilizers, did not have any significant influence on household food security status.

4.3.2.1. Adapted model with eight independent variables

Given that the first model did not show any significant predictor when comparing moderately food insecure category to severe food insecurity, more exercises of combining the independent variables in the model were performed to find out a more balanced spread of predictors across the three-better off food security status categories when compared to severe food insecurity. The final MLM adopted was the one combining: gender and education of household head; family size; farm size, on-farm house labour, on farm income, access to financial facilities and access to trainings and extension services. While age of household head was permitting the rise of R^2 up to 80-90%, meaning that considered independent variables would affect the dependent variable at higher probability, very few predictors from the conceptual framework would make a significant influence. Thus, reducing to eight parameters showed more significant behaviour. Tables 4.11; Table 4.12 and Table 4.13 show the final model fitting information, likelihood test and final parameter estimates.

Table 4.11: Econometric Model Fitting

	Model fitting information (2)						Goodness-of-Fit			
	Model Fitting Criteria			Likelihood Ratio Tests			Model	Chi-Square	df	Sig.
Model	AIC	BIC	-2 Log Likelihood	Chi-Square	df	Sig.	Pearson	452.573	519	0.984
Intercept Only	666.563	678.368	660.563							
							Deviance	392.499	519	1.000
Final	585.752	715.603	519.752	140.811	30	.000				

Source: Field data analysis

Table 4.12: Likelihood Ratio Tests

	Model Fitting Criteria			Likelihood Ratio Tests		
Effect	AIC of Reduced Model	BIC of Reduced Model	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	585.752	715.603	5.198E2[a]	0.000	0	-
Onfarm income (ONFI)	660.683	778.729	600.683	80.931	3	0.000
Family size (FMS)	588.908	706.954	528.908	9.156	3	0.027
Farm house labour(FHL)	582.092	700.139	522.092	2.341	3	0.505
Farm size (FS)	584.568	702.615	524.568	4.817	3	0.186
Gender of HH (GEN)	592.854	710.901	532.854	13.102	3	0.004
Access to financial facilities (AFF)	592.845	710.892	532.845	13.093	3	0.004
Access to Agri trainings (AGT)	584.743	702.790	524.743	4.991	3	0.172
Education (EDU)	573.038	667.475	525.038	5.286	9	0.809

Source: Field data analysis

Table 4.13: Multinomial logistic regression Estimates

Food Security Status		Coeff.	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Food Secure	Intercept	-26.643	3.344	63.463	1	0.000	-	-	-
	EDU	0.399	0.551	0.525	1	0.469	1.491	0.506	4.393
	ONFI	4.753***	1.108	18.412	1	0.000	1.907	13.222	1016.079
	FS	-0.239	0.473	0.255	1	0.614	0.787	0.311	1.991
	FMS	-2.176*	0.870	6.262	1	0.012	0.113	0.021	0.624
	FHL	0.471	0.720	0.427	1	0.513	1.601	0.390	6.568
	[GEN=0]	0.702	0.741	0.899	1	0.343	2.018	0.473	8.617
	[GEN=1]	0.000[b]	-	-	0	-	-	-	-
	[AFF=0]	-2.298***	0.699	10.806	1	0.001	0.100	0.026	0.395
	[AFF=1]	0.000[b]	-	-	0	-	-	-	-
	[AGT=0]	16.106	0.000	-	1	-	1.292	1.292	1.292
	[AGT=1]	0.000[b]	-	-	0	-	-	-	-
Mildly Food Insecure	Intercept	-0.910	1.071	0.722	1	0.396	-	-	-
	EDU	-1.076***	0.316	11.560	1	0.001	0.341	0.183	0.634
	ONFI	-0.264	0.256	1.065	1	0.302	0.768	0.465	1.268
	FS	0.481**	0.240	4.016	1	0.045	1.617	1.011	2.589
	FMS	0.383	0.311	1.519	1	0.218	1.466	0.798	2.695
	FHL	-0.309	0.342	0.820	1	0.365	0.734	0.376	1.434
	[GEN=0]	0.950***	0.335	8.028	1	0.005	2.586	1.340	4.988
	[GEN=1]	0.000[b]	-	-	0	-	-	-	-
	[AFF=0]	-.053	0.379	0.020	1	0.889	0.948	0.451	1.995
	[AFF=1]	0.000[b]	-	-	0	-	-	-	-
	[AGT=0]	-0.595	0.646	0.850	1	0.356	0.551	0.156	1.954
	[AGT=1]	0.000[b]	-	-	0	-	-	-	-
Moderately Food Insecure	Intercept	1.037	0.801	1.675	1	0.196			
	EDU	-0.572***	0.213	7.195	1	0.007	0.565	0.372	0.857
	ONFI	0.015	0.184	.007	1	0.934	1.015	0.708	1.456
	FS	0.185	0.180	1.055	1	0.304	1.204	0.845	1.714
	FMS	0.039	0.243	.025	1	0.874	1.039	0.645	1.675
	HFL	-0.301	0.262	1.323	1	0.250	0.740	0.443	1.236
	[GEN=0]	-0.120	0.287	0.175	1	0.676	0.887	0.505	1.557
	[GEN=1]	0.000[b]	-	-	0	-	-	-	-
	[AFF=0]	-0.230	0.281	0.667	1	0.414	0.795	0.458	1.379
	[AFF=1]	0.000[b]	-	-	0	-	-	-	-
	[AGT=0]	-0.839*	0.453	3.438	1	.064	.432	.178	1.049

[AGT=1]	0.000[b]	-	-	0	-	-	-	-

Note: Number of observations: 378, Wald Chi^2 (24): 152.01; Prob=0.0000; Pseudo R^2: 0.370; Log pseudolikelihood: 506.768 ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level. Reference category: Severely food insecure; (b) = the parameter set to zero because it is redundant.

As presented in the above Table 4.13, this second model has a pseudo R^2 of 0.370 which means that only 37% of the variation in the dependent variable is due to the variations in the independent variables.

The results of this final MLM for the different categories of household food security show that on farm income (ONFI), family size (FMS) and not having access to financial facility (AFF_0) significantly ($P<0.1$) influence the probability of a household to be in the category of food secure compared to the category of severely food insecure. Education (EDU), farm size (FS) and gender (GEN) significantly ($P<0.05$) influence the probability of a household to be in the category of mildly food insecure compared to the category of severely food insecure. On the other hand, education (EDU) and agricultural training (AGT_0) significantly ($P<0.01$ and $P<0.1$ respectively) influence the probability of a household to be in the category of moderately food insecure compared to the category of severely food insecure.

4.3.3. Factors influencing household food security status of smallholder farmers in Burera District.

From the above multinomial logistic regression (Tables 4.10 and 4.13), it can be observed that the hypothesized demographic and resource factors have an effect on the household food security status of the smallholder farmers in the following manner:

4.3.3.1. Resource factors

(a) On- farm income

Despite the low levels of observed on-farm income from the smallholder farmers of Burera District, the inferential statistic results of this study showed that at 1% level of significance, on farm income positively influenced the probability of a household to be food secure by 90.7% compared to severely food insecure. A unit increase in on farm income will increase the probability of household to be food secure by 1.907. This means that the higher the household on farm income, the higher is the probability that the household would be food secure other things being constant. This is because on farm income will increase the purchasing power of a household and therefore enables a household head to have access to available food from the market thus increasing the probability of that household to be food secure. On farm income will again help farmers to purchase farm inputs for next planting season.

The results of this study are consistent with the study of Mannaf and Uddin (2012) on the socio-economic factors influencing food security status of maize growing households in selected areas of Bogra district, Bangladesh. The authors found that monthly on farm income was positively associated with food security at 5% significance level. This scenario is true since, most farmers plant crops for two main purposes i.e. for household consumption and selling. On farm income depends on the quantity of the produce sold and its market price. In this context if a farmer gets income from his produce he can have access to other food commodities available at the market and therefore increasing the level of food security. Thus, one of the policy implications is that increase of on farm income is one of the key factor that possibly help to increase the level of household food security, especially in the rural areas where poverty and malnutrition is most common. Even though on farm income is a positive and significant factor of household food security, it can be noted that in order to help farmers to gain from the farming business, post-harvest handling and marketing information is needed

by the farmers so that they avoid selling their produce at low prices during the harvesting period while they purchase the same food at higher prices during the off-season. Another point to be emphasized on is that farming activities in Rwanda and in the mountainous Burera district in particular, are only seasonal and depend on rainy seasons since irrigation facilities are scanty. Burera district climatic conditions differ from the rest of the districts due to its higher altitude hence high humidity which makes the district ideal for three agricultural seasons in contrast to most of other districts in the country which only have two agricultural seasons and a dry period of between 3-4 months (from end of May to beginning/end September). Thus, Burera district farmers can plant in 3 seasons, the season of June –September being dedicated to planting Irish potatoes in the valleys and hillsides. However, even if the agro-climatic conditions in Burera district provide opportunities for the farmers to be busy all year round with 3 consecutive seasons, men in general tend to only work on few activities which require more physical efforts (like tilling and fertilizer application) and then leave the big part of crop cycle activities to women (like sowing and thinning process up to harvesting). Therefore, it would be important to strategically identify potential off-farm employment opportunities which should keep the household members busy during the break periods when they are not engaged in any farming activities.

Similar observation was also noticed in the WFP's comprehensive food security and vulnerability analysis (WFP, 2015) which stated that women are more often engaged in agricultural production and agricultural labour, while it was more common for men to work as unskilled labourers (non-agricultural), skilled labourers, salaried employees or work in their own business. This means that in rural areas where off-farm employment is scarce, there is a lost opportunity of engaging idle labour, thus aggravating household food insecurity since even the little income of the household earned is drained out.

(b) Farm size

Farm size in this study referred to the land area under crop production during the period of the survey. It is expected to influence positively household food security. The

households who have larger farm sizes are assumed to produce more food which gives a better chance for the household to be food secure. The results of the present study show that, having an odds ratio of 1.617 while holding all other things constant, farm size increased by 61.7 % the probability of a household to be classified as mildly food insecure compared to severely food insecurity at 5% significance level. Thus, an additional hectare owned by a household increases the probability of a household to be mildly food insecure by 61.7% compared to being severely food insecure. Large farm size allows households to adopt practices such as soil conservation through crop rotation which enhances land productivity. This is in line with the findings of Abdulla (2015) who found that farm size had a significant and positive effect on the household food security status in Borana zone of Ethiopia. Thus, an increase in land size of one hectare would lead to better food security state of the household. Similarly, Omotesho et al. (2006) using a binary logistic regression model found that farm size affected positively household food security status in Kwara State of Nigeria. Despite the positive association between food security and farm size, the fact is that almost all the smallholder farmers surveyed operated on very small plots of land of less than a hectare. Thus, government efforts and those of relevant stakeholders should be geared towards assisting farmers to increase productivity from the small plot sizes. Increasing off-farm income generating and employment opportunities in the rural area of Burera district would also help to reduce food insecurity in Burera District by allowing the farmers to diversify their livelihoods, thus coping with the pressing situation of food insecurity.

(c) Livestock asset

In the first ML Model run with 11 predictors initially hypothesized to influence food security status of the smallholder farmer's household, livestock showed to be significant at 10% in influencing the probability of a household to be in the category of food secure compared to the category of severe food insecurity. This is a normal expectation, given that livestock not only provides manure and thus better productivity of crops, but it is also a source of income to the household, usually maintained as a "saving account" in the sense that it can be sold in the hardships to secure the family (Njarui et al., 2016).

However, when the model was modified removing age of the household head, livestock asset did not have any significant influence in the subsequent predictors' combinations.

***(d)* On farm house labour**

On farm house labour did not show any significant influence in the model. This could be attributed to the fact that there is enough farm labour compared to the capital asset (available farm size), and this spanned across all households independently of their food security status category. That is, there was no significant difference in distribution of on-farm house labour across the 4 categories of food security status.

4.3.3.2. Demographic factors

(a) Family size

The current study found that high family size decreases the probability of a household to be food secure by 88.7 % when compared to severe food insecurity category. This is explained by the negative correlation between family size and household food security, which means that when the family size increases by one member, the probability of the household to be food secure decreases by 88.7%. This is due to the fact that the family members tend to share the available food and an increase in family size would lead to overstretching of the household food share. These findings confirm the Malthusian Theory of Population which emphasizes on the existing relationship between population growth and food production. Malthus stated that population trend follows a geometric progression while food production follows an arithmetic progression. Therefore, the growing number of population and family size are the challenges for the household food security since there is an inverse relationship between food security and family size. This study concurs with the study of Adebayo (2012) which found family size to be negatively and significantly affecting the household food security in Osun State of Nigeria. Similarly, Mannaf and Uddin (2012) found a significant and negative relationship between family size and household food security among the maize growers

in Bogra district of Bangladesh. Shisanya and Hendriks (2011) also reported that family size decreases the probability of a household to be food secure. These authers further explained that the inverse relationship between family size and household food security indicates that as the number of household members increase, the more people are consuming from the same resources, thus the household members may not be able to have enough food which increases the probability of the household to be food insecure.

(b) Gender of the household head

Gender is a relevant factor of food security among households. The current study found that the households headed by females were more likely to be in the category of mildly food insecure compared to severely food insecurity. Having an odds ratio of more than one i.e. 2.586, after controlling other regressors, households headed by female increase the probability of being in the category of mildly food insecure compared to the category of severe food insecurity and this result was significant at 1% significance level. Similar results were found by Shisanya and Hendriks (2011) who reported that households headed by females are more likely to be in the category of mildly food insecure compared to severely food insecure. The results of this study were against the findings of Mohammadi –Nasrabadi et al. (2011) who found that households headed by females were more likely to be severely food insecure. Ndobo and Sekhampu (2013) also found that female headed households had a lower probability of being food secure as compared to households headed by men. Nonetheless, the findings of the current study can be explained based on the Rwandan culture, given that women are the most engaged in farming activities compared to men who tend to be more engaged with the activities outside the farm. However, the off-farm income generating activities in rural areas of Rwanda are scarce, which makes the men idler than the females and that may have an effect on household food security. Therefore, a household headed by a female who bears at the same time the responsibility of making decisions for the household, will likely be more food secure compared to the households headed by the males.

(c) Educational Level

The results from the present study revealed that education level of household head negatively influenced the probability of household to be in the category of mildly food insecure by 65.9% compared to the category of severe food insecurity. These findings were contrary to the expectation that, education should impact positively the household food security status. It was expected that the higher the educational level of a household head, the more food secure the household should be, with assumption that more educated household heads would easily and quickly adopt better farming techniques and better family resources management (Nyako, 2013; Negash & Alemu, 2013; FAO, 2007). The results of the present study were also in contrast with the findings of Abdullah et al. (2017) who reported that education was positively influencing the household food security status, that is, the more educated household head the more food secure the household, which was also initially expected for the current study as well.

The negative correlation sign of education coefficient in this study could be interpreted as follows: in such a study setting as rural Burera district where the smallholder farmers are operating on very small plots of land, the majority having less than 1 ha, there is already a surplus of family labour ready to work on farming activities when compared to the available capital asset to exploit which is land. Therefore, in such a situation, an increase in education of the household head by one additional level of schooling would reduce the probability to continue to work on farm since they would be looking for any potential off-farm income generating activities outside the farm setting. Unfortunately, in such a rural context, the off-farm job opportunities are very scarce and that extra manpower which is not engaged in farming activities remains idle at the shopping centres, consuming more than what they produce and draining out the household resources hence leading the household into worse situation of food insecurity. Would there have been more off-farm opportunities, such households with more educated heads would acquire more income and be more food secure.

In contrast, the education level of all members of the household did not have any significant association with the food security status when run in the econometric model. This might be due to the fact that the only difference comes to the primary education of children which has increased, but still those are considered as dependents, not yet in the active age (less than 16 years old) of contributing to farm labour. The introduction of free 12-year basic education policy in Rwanda is still new not more than 10 years of implementation, thus mass increase of primary level education for children has not yet reached its long-term impact on household food security. In future, when those children are grown and start seeking more on farm trainings and off-farm jobs, the positive effect of summed education level of household members on food security status could likely be detected.

(d)Age of the household head

In the first initial model with 11 predictors, age of the household head was found to negatively influence the probability of a household to be in the category of food secure by 93.2% when compared to the category of severe food insecurity. That means that any increase by one level range of age (from 18 years to 45; and from 46 to 65 and so on) will decrease the probability of being food secure by 93.2%. This finding may be true, given that as the household head gets older, the physical energy to work on farm decreases and even chances of being employed in off-farm income generating activities also decrease.

However, in that first model with 11 explanatory variables, age of the household head was inhibiting the effect of other factors that only a few could be identified to significantly influence the food security status. Even the 4 factors identified to be significant were not spread across all categories of food security status. When age was removed, the model became more balanced. This phenomenon of aberrant behaviour for age factor needs further investigations to understand it better. The findings in the first model were however in tandem with those of Bashir et al. (2013) who found a negative relationship between the age of the household head and food security in Pakistan.

Similarly, Abu and Soom (2016) found that the probability of households being food secure or food insecure in rural areas of Benue in Nigeria was determined by age. Result from that study revealed that the coefficient of age was found to be negative and significant at 5 % which means that food security declines with increase in age of the household head. The negative and significant effects of age of the household heads decrease the probability of households to be food secure. In contrast, Jemal and Kyung (2012) found that age of the household head was strongly and positively affecting food security in rural Ethiopia.

4.3.3.3. Institutional factors

(a) Access to financial facility

The ability to get access to financial facility has a positive and significant impact on household food security. The results of this study revealed that household heads with no access to financial facility decreased the probability of the household to be in the category of food secure by 90% compared to the category of severely food insecure in the study area which was in complete agreement with the prior expectation. This might be due to the fact that households with the opportunity to get financial facility (savings and loans) would build their farm production capacity through the purchase of agricultural inputs and cover other related agricultural costs that occur in the crop production process. The present findings are in line with the findings of Abdul-Jalil (2015) which revealed that lack of access to financial facility was negative and statistically significant at 1% implying that if a household head does not have access to financial facility; it will lead to a decrease in food security. Similarly, the findings of Kuwornu et al. (2011) reported that households in Central Region of Ghana that received financial facility increased their probability of being in the category of food secure compared to those who were in the category of severely food insecure households. Further, Pankomera et al. (2009) found a positive relationship between access to credit and food security which means that a household with better access to credit were more likely to be food secure This indicates that households that received

financial facility were likely to be food secure compared to those that did not have access to financial facility. Therefore, access to financial facility should be a vital area to be addressed by policy makers in order to achieve household food security.

(b) Access to agricultural trainings and extension services

Agricultural training received by household members as well as home visits of extension agents enhance the capacity to understand the various practices involved in crop production and encourage adoption of technologies that boost production. It is therefore hypothesized that a trained farmer has a positive influence on food security status of his household than a non-trained household head. The results of the present study showed that the non-trained households decreased the probability of being in the category of moderately food insecure by 56.8%comparedto severely food insecure category. In other words, households that had not received any training were less likely to be in a better category of moderately food insecure when compared to the severe food insecurity category. The findings of this study were in line with Kipkurgat and Tuigong (2015) who examined the impact of agricultural extension on household food security in Wareng District of Kenya and found that agricultural extension was important since it helped farmers to access information about good or new agricultural practices although quantifying the contribution of extension services to food security was not always possible.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This last chapter aims to provide the summary of the study findings, conclusion as well as possible policy recommendations based on the study results. The chapter is subdivided into three sections. Section 5.1 presents the summary of findings, section 5.2 presents the conclusion and lastly, section 5.3 outlines the key policy recommendations.

5.1. Summary

The economy of Rwanda is mainly agrarian, with the agricultural sector contributing about 33% of GDP and employing about 80% of the work force (NISR, 2014). Approximately 90% of the farming households in Rwanda are classified as smallholder subsistence farmers (NISR, 2015). Although the country is classified as food secure at macro level, about half of Rwandan households face seasonal difficulties in accessing adequate food, which sets them at high risks of food insecurity (WFP, 2012 &2015). Most of those households at risk are typically rural households whose majority are smallholder farmers. The aim of this study was to investigate the Socio-economic determinants of food security among the mixed smallholder farmers who constitute the big proportion of Rwandan households. The small holder farmers make an important contribution to the national economy and thus maintaining the food security status of the country. Burera district was selected as case study, representing the typical rural livelihood with optimal environmental conditions for small-scale agricultural production (good weather all year long and good soil type). The rationale behind this study was to understand why smallholder farmer households remain food insecure despite the many efforts of the Government of Rwanda to boost agriculture production across the country. To achieve the main objective, the study started by describing the social –demographic and resource characteristics of the smallholder farmers in Burera district followed by an assessment of the status of food security at household level among the smallholder

farmers of Burera district, and finally by examining the effect of resources factors and household demographic characteristics on food security status of the smallholder farmers 'households. A sample of 378 smallholder farmers was selected through multi-stage random sampling, and a questionnaire administered to the household heads. The following were the key findings of the study.

5.1.1. Socio-economic characteristics of the respondent smallholder farmers.

Out of the 378 smallholder farmers' households sampled, close to half (48.7%) had a family size of less than 5 members, while 51.3% had 5 and more family members. The mean of family size among respondents was 4.5 members. The dependence ratio was over one for 26.5% of respondent households. Most of the sampled households (73%) were male headed; only 27% were female headed. Regarding the marital status of the household head, it was found that 90.2% were couples, 1.9% were headed by single adult males while 7.9% were headed by single adult females. It was also found that 52.9% of sampled household heads had never attended school, while 43.1% had only been in primary school, while only 3.9% had reached high school level of education. Looking at all the household members' education level, 67.5% of the sampled households had at least one family member who attended primary school level and only 6.6% had a member who ever reached high school level of education. About the age of the household head, the study found that 57.7% of smallholders' household heads were aged between 18 and 45 years of age, while 30.2% were aged between 46 and 65 years and only 12.7% were aged beyond 65 years of age. The mean age of the household heads was found to be 44.8 years. Regarding farm size, the results indicated that majority of the smallholder farmers in Burera district operated on small plots of land, with77.7% of the respondents having less than 1ha of land, 50.5% owning between 0.5 and 1 ha, while 27.2 % lived on less than 0.5 ha of land. On livestock assets, about 54.2% of the sampled smallholder farmers owned at least one large to medium size animal (either cow, goat, sheep or pig) with only 15.87% having cows in their households. For the average annual income from the farming activities, 41.3% of respondents earned less than 200.000 FRW (less than 250 USD), 42.9% earn between

200.000 and 300.000 FRW (250 to 400 USD), while only 15.9% earned above 300.000 FRW (400 USD). Regarding the availability of labour resource factor, 31.2 % of the sampled households had only one member in the active age who could be relied on to supply labour, 45.8% had 2 active members while 23% had more than 2 active members catering for the household labour. On agricultural training and extension, only 8% of the respondents had received agricultural training or extension assistance within the one-year period from the date of interview. Financial literacy among the smallholder farmers and access to financial facilities were also found to be very limited with only 28% of the respondents having some mechanisms of saving and accessing to loans; among them 20% were using informal savings and lending groups of neighbours (IBIMINA), while only 8% were using the formal Saving and Credit Cooperative (SACCO) available at sector level. None of the respondents had ever acquired a loan from any bank. On fertilizer use, only 25% respondents had used mineral fertilizers at least in the previous two agricultural seasons preceding the time of interview.

5.1.2. Household food security status among the respondent smallholder farmers

The results showed that out of 378 smallholder farmers 'households interviewed, only 24 households representing 6.3% were found to be in the category of food secure, 59 were mildly food insecure (15.6%), while 131 were moderately food insecure (34.7%) while 164 were severely food insecure (43.4%). The results showed that there is a big proportion of smallholder farmers living in a situation of food insecurity, with only 6.3% of the sample not being worried about food availability and access.

About the stated anxiety and uncertainty about food, as well as household experience with the quality of food (limited varieties and unmet preferences) and the experience with insufficient food intake (quantity of food consumed), 58% of the respondent smallholder farmers had been worried for some time or so often about access to enough food. 45% felt they had eaten so often the kinds of food they did not prefer because of lack of resources; 60% experienced so often a situation of eating few kinds of food (limited varieties) while 62% confirmed that it happened so often to eat kinds of food

that they should not eat but due to limited means they had to. Very few (10%) expressed that it had sometimes happened to miss food at all in their households, although 28% had experienced a situation of sometimes going to sleep feeling hungry because there was not enough food. Of all the respondents, 5% of the households expressed that they rarely happened to go a whole day and night without eating anything.

5.1.3. Effect of resource and demographic factors on food security status.

Based on the household food security status obtained from HFIAS analysis, the multinomial logit model was applied by regressing the eleven predictors namely gender, education and age of the household head, on farm income, farm size, livestock assets, family size, farm house labour, use of fertilizers, access to financial facility and access to agricultural trainings and extension services. Before regressing, the diagnosis of the multicollinearity was prior analysed through the application of correlation matrix, Variance Inflation Factor and tolerance statistics. The results showed that there was no multicollinearity among the set variables. Due to its higher proportion in the model, severe food insecurity category was set as a reference category. The inferential analysis of the first multinomial logit model with 11 predictors revealed that age of the household head, on farm income, access to financial facility ($P<0.01$) and household livestock asset ($P<0.1$) significantly influenced the probability of a household to be in the category of food secure compared to the category of severely food insecure. Education was found to significantly ($P<0.01$) influence the probability of a household to be in the category of mildly food insecure compared to the category of severely food insecure while on farm income and livestock asset significantly ($P<0.1$) influenced the probability of a household to be in the category of mildly food insecure compared to a household in the category of severely food insecure. None of the predictors were significant in the model of the moderately food insecure in comparison to severely food insecure.

Given that the first model did not show any significant predictor when comparing moderately food insecure category to severe food insecurity, more exercises of combining the independent variables in the model were performed to find out a more

balanced spread of predictors across the three better food security status categories when compared to severe food insecurity. The final MLM adopted comprised 8 predictors i.e. gender and education of household head; family size; farm size, on-farm house labour, on farm income, access to financial facilities and access to trainings and extension services. The results of this final MLM showed that on farm income, family size and access to financial facility significantly ($P<0.1$) influenced the probability of a household to be in the category of food secure compared to the category of severely food insecure. Education, farm size and gender were found to influence ($P<0.05$) the probability of a household to be in the category of mildly food insecure compared to the category of severely food insecure. Education ($P<0.01$) and agricultural training ($P<0.1$) were found to significantly influence the probability of a household to be in the category of moderately food insecure compared to the category of severely food insecure.

The study also found that there was enough farm labour at household level among the smallholder farmers, which might be even more than required when comparing the labour per capital ratio. Majority of the smallholder farmers 'households were found to have 2 and more members working on a daily basis on a piece of land less than 1 hector. Thus, on farm labour constitutes extra resource invested in the smallholder farming, in contrast of the rational profit maximization, although it might not be called irrational behaviour, rather lack of alternate options. The extra- labour among the smallholder farmers of Burera is also linked to the large family size, though the study found the average to be slightly lower compared to the national average family size, and there has been decrease of family size in Burera district over the last 7 years, comparing EICV3 and EICV4 (NISR, 2011; NISR,2015) and the findings of the current study. Extra-labour not fully exploited could lead to idle manpower, consuming without producing as it is unavoidable to be fed on daily basis at household level without their contribution to the household food and income.

5.2. Limitations of the study

While the current study has several strengths including the use of a considerable sample size from the study area, as well as using internationally validated food security measurement tool, there are however some limitations which should be considered while interpreting the study. First, the geographic focus of the study is one of the notable since this study focused on the smallholder mixed farmers of Burera District only and not the whole of Rwanda. Thus extrapolating the results of the study to all the smallholder farmers of Rwanda would require further investigations from other agro-climatic zones of the country. Second, there are also several tools and different approaches used internationally to measure household food security status. This study used the 30 days experience-based household food security measurement tool, the Household Food Insecurity Access Scale Score (HFIAS), which has been validated and used across many countries including the Easter African Region, in Tanzania and Burundi which have similar conditions as Rwanda (Knueppel et al., 2010). Any other study that could be conducted in the same study area but using a different food security measurement tool and different categorization approach of food security status, could come up with results that might be different from the results of the current study. For instance , the current study results could not align with the 2015 Rwanda Comprehensive Food Security and Vulnerability Analysis (WFP, 2015) which used the food consumption score (FCS) and food security index (FSI) in categorizing the food security status. The results and interpretation of that WFP study were different with the current study, mainly due to the use of different measurement tools and approaches.

5.3. Conclusion

The current study examined the food security status of the smallholder farmers of Burera District and investigated on the socioeconomic characteristics that may have an influence on household food security. The overall goal was to bridge the knowledge gap as to why at micro level this biggest proportion of the Rwandan households suffer from food insecurity while at macro level the country is classified as food secure and

generally food is available at local markets. The study revealed that a number of resource and demographic factors significantly influence the household food security of the smallholder farmers.

In brief, the study rejected the null hypotheses which stated that there was no food insecurity situation among the smallholder farmers of Burera District (H01) and that resource and demographic factors did not affect the food security status of the smallholder farmers in Burera district (H02).).On-farm income and farm size were found to be resource factors that consistently affect the household food security status among the smallholder farmers, while family size, gender and education of the household head were the demographic factors that significantly affected the food security status. Institutional factors such as access to financial services and access trainings to extension services were also found to significantly influence the food security status.

The fact that family size was found to be negatively associated with the household food security status also confirmed the Malthusian theory of population growth. Both food availability decline and food entitlement theories were also confirmed by the limited resource factors as farm size, on farm income and limited access to institutional services which showed to be significantly affecting the food security status at household level.

5.4. Policy implications

Based on the findings of this study, the Government of Rwanda policy makers and Development Partners should take into consideration the above highlighted resource and demographic factors that are significantly affecting their household level food security when devising support projects and programs targeting smallholder farmers.

First, given the very small partitioned plots of lands owned by the smallholder farmers, there is need to strengthen the implementation of the land use consolidation policy whereby adjacent plots are put together to form an optimal land capital unit for exploitation. By putting adjacent smallholder farms together, it will become easy to

access subsidized fertilizers under crop intensification program. It will also become easy for agricultural extension agents to provide advices and assistance.

Second, given the smallholder farmers low access to agricultural extension services and given the information acquired that there exist only one agronomist and one veterinary at sector level who are in charge of assisting all the farmers in the sector, the Government of Rwanda should consider restructuring and reorganizing the agricultural extension service delivery.

Third, it has been widely documented that small pieces of land, to be optimal, should be planted with rapid growing crops which are harvested in the very short periods, thus generating quick revenues to the smallholder, but also allowing the smallholder to cope with the long seasons in between two harvests of staple crops. Thus, value chains of horticultural crops (vegetables and on farm fruit trees) could be emphasized.

Fourth, given that income acquired from the smallholder farms are very low, and the fact that but many adult members of the smallholder farmers' households tend to abandon farming activities, there is a need to diversify household income sources with more on-farm and off-farm enterprises (such as agro-processing) to leverage the available surplus labour and hence ensure increased ability to acquire food (access) at household level.

Fifth, more efforts should be put in rural women empowerment. This study proved that women –headed households have higher probabilities of becoming food secure. Thus, this should encourage for more sensitization of men and women in the study area and across Rwanda, so that men let their wives to take up responsibilities of managing the household. It is not easy to changecultural behaviours, but the comparative advantages should be weighted.

Last but not least, further advocacy is needed to improve the financial literacy and access to financial services in remote rural areas**.** This study proved that not accessing financial services negatively affected the household food security status. Thus, more

sensitization and promotion of financial literacy among the smallholder farmers should go hand in hand with efforts to avail more banks and non-bank financial services, ensuring that smallholder farmers have opportunity to save money for inputs purchase, but also to be able to acquire small loans to smoothly invest and run agricultural season. Therefore, efforts to make adapted loan conditions and saving incentives should be created.

5.5. Recommendations for future researches

The current study focused on household food security in Burera district only and the socioeconomic factors that determine food security. Thus, this study makes the following recommendations for further research:

First, future research should focus on the factors of production and productivity measurement for the smallholder mixed farmers across Rwanda. There is a literature gap on productivity of small scale farms and their contributions to national food security and economy and this gap was beyond the scope of this study.

Second, further research should aim at investigating and harmonizing the different food security measurement tools and customize its application to the Rwandan context, both at macro and micro levels. Given that using different food security measurement tools and different classification methods generate very different and incomparable results, it is imperative to compare the dozens of internationally validated tools in order to reach a common ground of food security classification in Rwanda.

REFERENCES

Abdul-Jalil, M-A. (2015). *Determinants of access to credit and its impact on household food security in Karaga district of the Northern region of Ghana*. UnPublished PhD Theses, Ghana: Kwame Nkrumah University of Science and Technology.

Abu, G.A., Soom,A. (2016). Analysis of factors affecting food security in rural and urban farming households of Benue State, Nigeria. *International Journal of Food and Agricultural Economics*. *4*(1), 55-68.

Adebayo, O.O. (2012). Effects of family size on household food security in Osun State, Nigeria. *Asian Economic and Social Society*, *2*(2), 136-141.

Abdulla, A.M. (2015). Determinants of household food security and coping strategies: The case of Bule-Hora District, Borana Zone, Ethiopia. *Ethiopian Journal of Food Science and Technology*, *3*(3), 30-44.

Agboola, C. (2004). *An economic analysis of household food insecurity and coping strategies in Osun state of Nigeria*. Unpublished Thesis, Oyo State, Nigeria: University of Ibadan.

Agresti, A. (2007*).* *Categorical Data Analysis*. (2nd ed.). Hoboken, New Jersey John Wiley &Sons, Inc.,

Aidoo, R., Mensah, J.O., & Tuffour, T. (2013). Determinants of Household Food Security in the Sekyere-Afram Plains District of Ghana. *European Scientific Journal, 3*, 23 -41.

Akinboade, O.A., & Adeyefa, S.A. (2018). An analysis of variance of food security by its main determinants among the urban poor in the City of Tshwane, South Africa. *Social Indicators Research, 137*(1), 61–82.

Akinboade, O.A., Mokwena, M.P., & Adeyefa, S.A. (2016). Determinants of food insecurity among the Urban Poor in the city of Tshwane, South Africa. *Social Indicators Research, 4*(2), 101-114.

Akinyoade, A., Klaver, W., Soeters, S.R., & Foeken, D.W.J. (2014). *Digging deeper: inside Africa's agricultural, food and nutrition dynamics.* Netherlands: African Studies Centre, Leiden University.

Allen, J.E., & Thompson, A. (1990). Rural Poverty among Racial and Ethnic Minorities. *American Journal of Agricultural Economics, 72,* 1161–168.

Alinovi, L., Mane, E. & Romano, D. (2009). Measuring household resilience to food insecurity: Application to Palestinian households. Working Paper, EC-FAO Food Security Programme, Rome: FAO.

Astemir, H.Y. (2014). *Determinants of Food Security in Rural Farm Households in Ethiopia.* Unpublished Published Thesis, The Hague, Netherlands: Institute of Social Studies,.

Barrett, C. (2002). Food security and food assistance programs.. Handbook of agricultural economics, in: B. L. Gardner & G. C. Rausser (ed.), *Handbook of Agricultural Economics, 2*(40), 2103-2190.

Barret, C. & Lentz, E. (2009). *Food insecurity. In the International Studies Compendium Project.* Oxford, UK. Wiley-Blackwell Publishing.

Bashir, M.K. , Schilizzi, S. & Pandit, R. (2012). *The Determinants of rural household food security in the Punjab, Pakistan*: An econometric analysis. Working

Paper 1203, School of Agricultural and Resource Economics, University of Western Australia, Crawley, Australia.

Bashir, M.K. & Schilizzi, S. (2013). Is food security measurement sensitive to its definition and measurement method? *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources*, 8, 21-32.

Bashir, M.K. & Schilizzi, S. (2013). Determinants of rural household food security: a comparative analysis of African and Asian studies. *Journal of the Science of Food and Agriculture, 93*(6), 1251-8.

Becker, G.S. (1994). *Human capital: A theoretical and empirical analysis, with special reference to education* (3rd Ed.)., Chicago, IL: University of Chicago Press.

Bhutta, Z. A., Lartey, A. & Black,R.E.(2013). Evidence based interventions for improving maternal and child nutrition: what can can be done and at what cost? Lancet Maternal and Child Nutrition & Interventions Review Groups. *Lancet 382* (9890), 452-477.

Becquey, E., Martin-Prevel, Y., Traissac, P., Dembélé, B., Bambara, A. & Delpeuch, F.(2010). The household food insecurity access scale and an index-member dietary diversity score contribute valid and complementary information on household food insecurity in an urban west-African setting. *Journal of Nutrition, 140,* 2233-40.

Bickel, G., Nord, M., Price,C.,Hamilton, W., & Cook, J. (2000). *Guide to Measuring Household Food Security*, (Revised 2000). Alexandria VA: U.S. Department of Agriculture, Food and Nutrition Service.

Bonti-Ankomah, S. (2001). Addressing food security in South Africa. The National Institute for Economic Policy. Paper presented at the South African Regional and Poverty Network (SARPN) conference on Land Reform and Poverty

Alleviation in Southern Africa. The National Institute for Economic Policy. Pretoria: South Africa, 4-5 June 2001.

Boukary, A.G. Diaw, A. & Wunscher, T. A. . (2016). Factors affecting rural households' resilience to food insecurity in Niger. *Sustainability, 8*(3), 181.

Brown, J.L., Shepard, D., Martin,T., & Orwat, J.(2007). *The economic cost of domestic hunger. Estimated Annual Burden to the United States*. Gaithersburg, USA Sodexho,Inc.

Burns, R.B. & Burns, R.A. (2008). *Business research methods and statistics using SPSS,* London: Sage Publications Ltd.

Chambers, R & Conway, G. (1991). Sustainable Rural Livelihoods: Practical Concepts for the 21st Century. Institute of Development Studies, IDS Discussion Paper 296. Brighton, UK.

Cho, A., Tun Oo, A., &Speelman, S. (2016). *Assessment of Household Food Security through Crop Diversification in Natmauk Township, Magway Region, Myanmar. Conference on International Research on Food Security*, Natural Resource Management and Rural Development organised by the University of Natural Resources and Life Sciences (BOKU Vienna) , September 18-21, 2016, Austria .

Chomba, P. C. (2011). *Gender and household food security: A case for Kalulushi District, Zambia.* UnPublished MSc Thesis, Hague, Netherlands: International Institute of Social Studies.

Chinweoke U.I. (2015). Measuring household food security status in Taraba State, Nigeria: Comparing Key Indicators. Stellenbosch University, Retrieved from: http://scholar.sun.ac.za/handle/10019.1/96765.

Coates, J., Frongillo, E.A, Rogers, BL, Webb, P, Wilde, PE & Houser, R.. (2006). Commonalities in the experience of household food insecurity across cultures: what are measures missing? *J Nutr. 136,* S1438–48.

Coates, J. , Swindale, A., & Bilinsky, P.(2007). *Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide, Version 2*, /Academy for Educational Development, Washington, DC: Food and Nutrition Technical Assistance (FANTA).

Coleman-Jensen, A., Gregory,C., & Singh, A. (2012). *Household food security in the United States in 2011.Economic Research Service, Economic Research Report* N°173. USDA, Washington, DC:; USDA.

Cook, J., & Jeng, K. (2009). *Child food insecurity: The economic impact on our nation. A report on research on the impact of food insecurity and hunger on child health, growth and development* commissioned by Feeding America and The ConAgra Foods Foundation. Chicago: Feeding America.

Degefa, T. (2002). *Household Seasonal Food Insecurity in Oromiya Zone, Ethiopia: Causes. Social Science Research Report Series, No.26,* Ethiopia, Addis Ababa: OSSREA.

Deitchler, M., Ballard,T., Swindale,A. & Coates, J. (2010). *Validation of a measure of household hunger for cross-cultural use*. Food and Nutrtion Technical Assistance II Project (FANTA-2), FHI 360, Washington, DC: FANTA.

De Muro, P., & Burchi, F. (2007). Education for Rural People: A Neglected Key To Food Security, Working Paper n° 78, Dipartmento Di Economia, 'Roma Tre: University 'Roma Tre'.

De Schutter, J. (2011). The Green Rush: The Global Race for Farmland and the Rights of Land Users. *Harvard International Law Journal, 52,* 503-559.

Djangmah, G.M. (2016). *Comparative Analysis of Food Security Status of Farming Households in Eastern and Northern Regions of Ghana.* Unpublished MSc Thesis, Montreal: McGill University.

Eduards, S (2008). *Activity -Based Costing. Topic Gateway Series No1*., London: The Chartered Institute of Management Accountants.

Elm, V.E., Altman, D.G., Egger, M., Pocock, S.J, Gotzsche, P.C., Vandenbroucke, J.P., & STROBE Initiative (2007). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet, 370*, 1453–57.

Faber, M. (2009). Dietary viversity in relation to other household food security indicators. *International Journal of Food Safety, Nutrition and Public Health, 2*,1-15.

Faber, M, Witten, C, & Drimie, S. (2011). Community-based agricultural interventions in the context of food and nutrition security in South Africa. *South Africa Journal of Clinical Nutrition*, *24*(1), 21-30.

Falconor, J. , & Arnold J.E.M (1991). *Household food security and forestry: An analysis of socioeconomic issues. Community Forestry Note1*, Rome: FAO.

FAO (1996). *Rome declaration on world food security and world food summit*, Rome: FAO.

FAO (1998). Women and Sustainable Food Security. Retrieved from: http://www.fao.org/docrep/x0171e/x0171e02.htm#P83_10385

FAO (2002). Measurement and assessment of food deprivation and undernutrition. Summary of proceedings, International Scientific Symposium, Rome, 26–28 June 2002.

FAO (2003). *Trade Reforms and Food Security: conceptualizing the Linkages: Food Security: Concepts and Measurement*. Food and Agriculture Organization of the United Nations, Rome: FAO.

FAO (2004). *State of Food Insecurity in the World*. Rome: FAO.

FAO (2007). Food security data and definitions. Food and Agriculture Organization of the United Nations. Retrieved from: http://www.fao.org/economic/ess/ess-fs/fs-data/ess-fadata/en

FAO (2007). Education for Rural People and Food Security. A Cross Country Analysis. Food and Agriculture Organization of the United States, Rome: FAO.

FAO (2008). *The State of Food Insecurity in the World 2008. High food prices and food security- threats and opportunities*. Rome: FAO.

FAO (2010). *The State of Food Insecurity in the World: Addressing food insecurity in protracted crises.* Rome: FAO.

FAO (2011*). Gender differences in assets. ESA Working Paper N°11-12. Agricultural Development Economics Division*, Rome: FAO.

FAO (2012). *Smallholders and Family farmers. Sustainability Pathways Factsheet*. Rome: FAO.

FAO (2012). World Agriculture towards 2030/2050: The 2012 Revision. ESA Working Paper No.12-03, Agricultural Development Economics Division, Food and Agriculture Organization of the United Nations, Rome, Italy. Retrieved from: www.fao.org/economic/esa

FAO (2015). The State of Food Insecurity in the World 2015. The FAO Hunger Map 2015. Retrieved from: http://www.fao.org/hunger/en/

FAO (2015). The State of Food Insecurity in the World 2015. Glossary of selected terms Retrieved from: http://www.fao.org/hunger/glossary/en/

FAO, IFAD ,WFP (2014). The State of Food Insecurity in the World 2014. *Strengthening the enabling environment for food security and nutrition.* Rome: FAO.

FAO, IFAD,WFP (2015). The State of Food Insecurity in the World 2015. *Meeting the 2015 international hunger targets: taking stock of uneven progress*. Rome: FAO.

Faridi, R., & Wadood, S.N. (2010). An Econometric Assessment of Household Food Security in Bangladesh. *The Bangladesh Development Studies, XXXIII*(3), 34- 45.

FEG Consulting, Save the Children (2008). The practitioners guide to the household economy approach, regional hunger and vulnerability program. FEG Consulting and Save the Children, Johannesburg.

Feleke, S., Kilmer, R. L., & Gladwin, C. (2005). Determinants of food security in Southern Ethiopia. *Agricultural Economics*, *33*, 351–363.

Fiedler, JL., Carletto, C., & Dupriez, O. (2012). Still waiting for Godot? Improving Household Consumption and Expenditures Surveys (HCES) to enable more evidence-based nutrition policies. *Food Nutr Bull*. *33*(3, Suppl) S242–51.

AFR, (2016). *FINSCOPE. Financial Inclusion in Rwanda 2016*. Access to Finance Rwanda (AFR), Kigali, Rwanda.

Frongillo, E.A. (1999). Validation of measures of food insecurity and hunger. *Journal of Nutrition*. *129*(2), 506S–509S.

Gebreyesus, S., Lunde, T., Mariam, D. H, & Lindtjorn, B. (2015). Is the adapted Household Food Insecurity Access Scale (HFIAS) developed internationally to measure food insecurity valid in urban and rural households of Ethiopia? *BMC Nutrition* 2015, 1:2.

GoR(2007). *Vision 2020 Umurenge. An Integrated Local Development Program to Accelerate Poverty Eradication Rural Growth and Social Protection*. EDPRS Flagship Program Document., Kigali: Government of Rwanda.

GoR (2013). *National Food and Nutrition Strategic Plan, 2013-2018.* Mininstry of Local Government (MINALOC); Ministry of Health (MOH) and Ministry of Agriculture (MINAGRI). Kigali, Rwanda Retrieved from: http://www.moh.gov. rw/file admin/templates/policies/National_Food_and_Nutrition_Strategic_Plan_2013-2018-18_scanned.pdf (Last accessed March 2015)

Graham, B. (2012*). Profile of the small-scale farming in the Caribbean. Workshop on Small-Scale Farming in the Caribbean.* The Hunger Free Latin America and the Caribbean Initiative (HFLACI), Food and Agriculture Organization for the United States (FAO), Rome, Italy. Retrieved from: www.fao.org/3/a-au343e.pdf

Gujrati, D.N. (2004). *Basic Econometrics*, (4th ed.). NewYork: The McGraw-Hill Companies, Inc.

Haen, H., Klasen, S., & Quaim, M. (2011). What do we really know? Metrics for food insecurity and under-nutrition. *Food Policy, 36*, 760-769.

Hailu, A. , &. Nigatu, R. (2007). Correlates of household food security in densely populated areas of southern Ethiopia: Does the household structure matter? *Studies on Home and Community Science*., *1*(2), 85-91.

Hart, T. (2009). Exploring definitions of food insecurity and vulnerabilty: Time to refocus assessments, *Agrekon*, *48*(4), 362-383.

Headey, D., & Ecker, O (2012). Improving the measurement of food security. IFPRI Discussion Paper No. 01225, Poverty, Health, and Nutrition Division; Development Strategy and Governance Division. International Food Policy Researh Institute (IFPRI).

Hendriks, S .L. (2005). The challenges facing empirical estimation of household food (in)security in South Africa. *Development Southern Africa*, *22*(1), 103-123.

Herman, PM, Avery, DJ, Schemp, CS, & Walsh, ME. (2009). Are cost-inclusive evaluations worth the effort? *Evaluation and program Planning*, *32*(1), 55-61.

HKI(2010). Homestead food production model contributes to improved household food security, nutrition and female empowerment: Experience from scaling-up programmes in Asia (Bangladesh, Cambodia, Nepal and Philippines). *Nutrition Bulletin*, 8 (1), 13- 21.

HLPE (2012). Climate change and food security. A report by the High Level Panel of Experts on Food Security and Nutrition. HELPE Report No3, Committee on World Food Security (CFS), Rome: FAO.

Hoddinott, J., & Yohannes, Y. (2002). *Dietary diversity as a food security indicator*. Food consumption and nutrition division discussion paper, No. 136. IFPRI, Washingon, DC: IFPRI.

Horton, S.,Shekar,M.,McDonald,C., Mahal, A., & Krystene Brooks,J. (2010). *Scaling up nutrition: What will it cost? Directions in Development; human development*. World Bank, Washington DC: World Bank.

Hummel, D., Hertler, C., Niemann, S., & Janowicz, A. (2004). Supply Systems as Subjects of Social-Ecological Research: Food and Water. Demons Working Paper 2. Frankfurt, Germany.

IFAD (2013). *Smallholders, food security, and the environment*. International Fund for Agricultural Development (IFAD). Rome, Italy: IFAD.

IFC (2014). *Access to finance for smallholder farmers. Learning from the experiences of microfinance institutions in Latin America*. International Finance Corporation (IFC), World Bank Group, Washington DC: IFC.

IFDC (2014). Rwanda Fertilizer Assessment. In support of The African Fertilizer and Agribusiness Partnership. IFDC, Alabama, USA.

IFPRI (1998). *Impact of access to credit on income and food security in Malawi.* FCND Discussion Paper No.46, Food Consumption and Nutrition Division. International Food Policy Research Institute, Washington, D.C: IFPRI.

IFPRI (2016). 2016 Global Hunger Index. Getting to Zero Hunger. International Food Policy Research Institute; Concern Worldwide; Washington, D.C: IFPRI.

Jacobs, P.T. (2009). The he status of household food security targets in South Africa. *Agrekon, 48*(4)

Jayne, T.S., & Muyanga, M. (2012). Land constraints in Kenya's densely populated rural areas: Implications for food policy and institutional reform. *Food Security, 4*(3), 399-421.

Jemal, A. & Kyung-Ryang, K. (2012). Determinants of Household Food Security in Rural Ethiopia: An Empirical Analysis. *Journal of Rural Development, 2*, 1-29.

Jones, A.D., Ngure, F.M., Pelto, G., &Young, S.L. (2013). What are we assessing when we measure food security? A compendium and review of current metrics. *Advances in Nutrition*. *4*(5), 481–505.

InWEnt (2010). Achieving Food and NutritionSecurity. Actions to Meet the Global Challenge. A Training Course Reader. InWEnt –Internationale Weiterbildung gGmbHCapacity Building International, Feldafing, Germany.

IPAR (2009). *Rwandan Agriculture Sector Situational Analysis. An IPAR Sector Review.* Institute of Policy Analysis and Research. Kigali: IPAR.

Kuwornu, J.K.M., Suleyman, D., & Amegashie, D.P.K. (2011). Analysis of food security status of farming households in the Forest Belt of the Central Region of Ghana. *Russian Journal of Agricultural and Socio-Economic Sciences*, *1*(13), 26-42.

Kennedy, E. & Peters, P. (1992). Household food security and child nutrition: the interaction of income and gender of household head. *World Development, 20*(8), 1077-1085.

Khan, R.E. & Gill, A.R. (2009). *Determinants of Food Security in Rural Areas of Pakistan. MPRA Munich Personal RePEc Archive, MPRA Paper No. 17146.* Presented at the National Conference on Socio-Economic Stability in Pakistan, February 16-17, 2009. Sarhad University of Science and Technology Peshawer, Pakistan. Retrieved from: http://mpra.ub.uni-muenchen.de/17146/.

King, J. (2014). Value for investment: A practical evaluation theory. Aukland: Julian King & Associates. Retrieved from: www.julianking.co.nz.

Kipkurgat, T. &Tuigong, D. (2015). Impact of Agricultural Extension on Food Security among small scale farmers in Wareng District, Kenya. *International Journal of Agricultural Extension and Rural Development Studies, 2*(1), 18-21.

Knueppel, D., Demment, M, & Kaiser L. (2010). Validation of the household food insecurity access scale in rural Tanzania. *Public Health Nutrition*. *13*(3), 360–7.

Levin, C. (1993). *On Food Consumption Survey: A commentary. Data need for Food Policy in Developing Countries*. New Direction for Household Survey. Washington DC: IFPRI.

Levine, S. & Chastre,C. (2004). *Missing the Point. An analysis of food security interventions in the Great Lakes.* Network Paper, Humanitarina Practice Network (HPN), , London: Overseas Development Institute.

Levy, S., Barahona, C. & Chinsinga, B. (2004). Food Security, Social Protection, Growth And Poverty Reduction Synergies: The Starter Pack Programme In Malawi. ODI, *Natural Resource Perspectives*, Number 95, September 2004.

LIFT Project (2009). *Livelihood & Food Security Conceptual Framework.* FHI 360, Washington, DC: LIFT Project.

Maes, K.C., Hadley, C., Tesfaye, F., Shifferaw, S. & Tesfaye, Y.A (2009). Food insecurity among volunteer AIDS Caregivers in Addis Ababa, Ethiopia was highly prevalent but buffered from the 2008 food crisis. *Journal of Nutrition*. *139*(9), 1758-64.

Maharjan, K.L., & Khatri-Chhetri, A. (2006). Household Food Security in Rural Areas of Nepal: Relationship between Socio-economic Characteristics and Food Security Status. International Association of Agricultural Economists, Annual Meeting, August 12-18, 2006, Queensland, Australia .

Mannaf, M., & Uddin, M.T. (2012). Socio-economic factors influencing food security status of maize growing households in selected areas of Bogra District. *Bangladesh Journal of Agricultural Economics*, *35*(2), 177-187.

Malthus, T. (1798). *An Essay on the Principle of Population.* London: Printed for J. Johnson.

Martinez, R., & Fernandez, A. (2007). *Model for analyzing the social and economic impact of child undernutrition in Latin America*. Serie Manuales - CEPAL No.52., CEPAL, Social Development Division, , Santiago, Chile: United Nations.

Maxwel, D. , Watkins, B., Wheeler, R. & Greg, C. (2003). *The Coping Strategy Index: a tool for rapidly measuring food security and the impact of food aid programmes in emergencies.*International workshop on food security in complex emergencies., Rome: FAO.

Maxwell, D., & Caldwell, R. (2003). *The coping strategies index: field methods manual.*, Nairobi: CARE and WFP.

Maxwell, S. (2003). *The evolution of thinking about food security, in : Devereux S & Maxwell S (eds.). Food security in Sub-Saharan Africa*. Pietermaritzburg: University of Natal Press.

Maxwell, S., & Frankenberger, T.R (1992). *Household Food Secuirty: Concepts, Indicators, Measurements. A Technical Review.*, New York: UNICEF.

Mercy -Corps, A. (2017). A 2016 Zambia Ecosystem Review & Strategic Perspective on Digital Financial Services for Smallholder Farmers. A white paper prepared by Mercy Corps Agrifin. Accelerate Program for the Master Card Foundation.

Meskerem, A., & Degefa, T. (2015). Household Food security status and its determinants in Girar Jarso Woreda, North Shewa Zone of Oromia Region, Ethiopia. *Journal of Sustainable Development in Africa,* 17(7), 118-137,

MIFOTRA (2009*). Law regulating labour in Rwanda, N°13/2009 of 27/05/2009. Official Gazette of the Republic of Rwanda,* Year 48 n° special of 27 May 2009. Kigali: MIFOTRA.

MINAGRI (2009). *Strategic Plan for the Transformation of Agriculture in Rwanda - Phase2 (PSTAII).* Kigali: Ministry of Agriculture and Animal Resources.

MINAGRI (2013). *Strategic Plan for the Transformation of Agriculture in Rwanda – Phase3 (PSTAIII).* Kigali Ministry of Agriculture and Animal Resources

MINAGRI (2013). *Crop assessment 2013B season. 2013B crop growing condition, harvested areas, crop yield, crop production and food security*. Final Report. Mininstry of Agriculture and Animal Resources, Kigali: Ministry of Agriculture and Animal Resources.

MINEDUC (2008). Nine Years Basic Education Implementation. Fast track strategies. Kigali: MINEDUC.

Mohammadi-Nasrabadi, F., Omidvar, N., Hushiar-Rad, A., & Mehrabi, Y.(2011). Validity of an adapted Household Food Insecurity Access Scale in urban households in Iran. *Public Health Nutrition 15*(1), 1-9 .

Mohammadi-Nasrabadi, F., Omidvar,N., Khshfetrat, M.R. & Kolahdooz, F.(2014). Household food insecurity in the Islamic Republic of Iran: a systematic review and meta-analysis. *Eastern Mediterranean Health Journal, 20* (11).

Morton, J.F. (2007). The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academic Sciences, 104*(50), 19680–19685.

Muhammad, S. A. (2013). *An Empirical Analysis of Households' Food Security in Gombe State, Nigeria*. Nigeria: Ahmadu Bello Unversity Zaria.

Musemwa, L.; Muchenje, V.; Mushunje ,A. ; Aghdasi, F. & Zhou, L. (2015). Household food insecurity in the poorest province of South Africa: level, causes and coping strategies. *Springer Link, Food Sec*. *7*, 647.

Mutisya, M. Ngware, M.W. Kabiru, C.W., & Kandala, N.B. (2016). The effect of education on household food security in two informal urban settlements in Kenya: a longitudinal analysis. *Springerlink/ Food S*ec, *8,* 743-756.

Ndobo, F., Sekhampu, T.J. (2013). Determinants of Vulnerability to Food Insecurity in a South African Township: A Gender Analysis. *Mediterranean Journal of Social Sciences* , 4(14), 14-31

Negash, T., & Alemu ,S. (2013). Determinants and coping strategies of household food insecurity in rural areas of Tigray: The case of rural Adwa Woreda. *Ethiopian Journal of Agricultural Sciences, 23,* 1-2.

Negash, T., Reda,S.A. (2015). Determinants and coping strategies of household food insecurity. Evidence from Agro Pastoralists of Afar Region (Zone Two). *Journal of Poverty, Investment and Development*, *12,* 2015.

NEPAD , WFP, UNECA (2012). The Cost of Hunger in Rwanda. Social and Economic Impacts of Child Undernutrition in Rwanda. Implications on National Development and Vision 2020. The New Partnership for Africa's Development (NEPAD), World Food Program (WFP) and United Nations Economic Commission for Africa (UNECA).

NISR (2010). *Rwanda Demographic Health Survey 2010, Final Report*., Kigali: National Institute of Statistics of Rwanda (NISR).

NISR (2011). *The Third Integrated Household Living Conditions Survey* (EICV3), Main Indicators Report. Kigali: National Institute of Statistics of Rwanda (NISR).

NISR (2014). *Fourth Population and Housing Census, Rwanda, 2012. Thematic Report*: Population size, structure and distribution. Kigali: National Institute of Statistics of Rwanda (NISR).

NISR (2015). *The Fourth Integrated Household Living Conditions Survey (EICV4), Main Indicators Report*. National Institute of Statistics of Rwanda (NISR) , Kigali National Institute of Statistics of Rwanda (NISR)..

Njarui, DMG., Gichangi, EM, Gatheru, M,, Nyambati, EM, Ondiko, CN, Njunie, MN, Ndungu-Magiroi, KW., …& Ayako, W.(2016). A comparative analysis of livestock farming in smallholder mixed crop-livestock systems in Kenya: 1. Livestock inventory and management. *Livestock Research for Rural Development*, 28(4).

Nsabuwera, V. Hedt-Gauthier B, Khogali M, Edginton M, Hinderaker SG, Nisingizwe MP, Tihabyona Jde D, … &, Drobac P.(2015). Making progress towards food security: Evidence from an intervention in three rural districts of Rwanda. *Public Health Nutrition*, *19*(7), 1296–1304.

Nyako, A.M. (2013). *The relationship between educational attainment and food security in Nigeria.* Unpublished PhD Thesis, Washington DC: Georgetown University.

Ojeleye, O.A; Saleh, M.K., & Oyewole, S.O. (2014). Non-Farm Income and Food Security Status of Small Scale Farming Households in Nigeria. *Research Journal of Agriculture and Forestry Science*, *2*(12), 1-7.

Ojeleye, O.A. (2015). *Analysis of farm household and community food security in Kaduna State, Nigeria*. Published Thesis, Retrieved from: http://kubanni.abu.edu.ng/ jspui/handle/123456789/7015

Omotesho, O.A., Adeumi, M.O., Muhammad-Lawal, A., & Ayinde, O.E. (2006). Determinants of food security among the rural farming households in Kwara State, Nigeria. *African Journal of General Agriculture, 2*(1), pp.7-15.

Omotesho,O.A., Adewumi, M.O., & Fadimula, K.S. (2010). Food security and poverty of the rural households in Kwara State, Nigeria. *Libyan Agriculture Research Center Journal International*, *1*(1), 56-59.

Oni S.A., Maliwichi L.L., & Obadire O.S. (2010). Socio-economic Factors Affecting Farming and Household Food Security: A Case of Thulamela Local Municipality in Vhembe District of Limpopo Province, South Africa. *African Journal of Agricultural Research, 5*(17), 2289-2296.

Oni, S.A., Maliwichi, L.L. & Obadire, O.S. (2011). Assessing the contribution of smallholder irrigation to household food security, in comparison to dryland farming in Vhembe district of Limpopo province, South Africa. *African Journal of Agricultural Research, 6*(10), 2188-2197.

Persaud, N. (2007). Is cost analysis underutilized in decision making? *Journal of Multidisciplinary Evaluation*, *2*(2), 81-82.

Pigali, P., Stamoulis, K., & Stringer, R (2005). Eradicating extreme poverty and hunger: Towards a coherent policy agenda. Global Forum on AGriculture: Policy Coherence for Development; 30 November -1 December 2005, Paris, France.

Pankomera, P.,Houssou, N. , & Zeller, M. (2009). Household food security in Malawi: Measurements, determinants, and policy review. Conference Paper, *Tropentag, October,* 6-8.

Ramirez, R. (2002). The Effectiveness of Small-Scale Agriculture Interventions on Household Food Security: A review of the literature (Phase 1, Part 2). Report prepared for Partners in Rural Development.

Rapsomanikis, G. (2015). *The economic lives of smallholder farmers. An analysis based on household data from nine countries*. Rome: FAO.

Rashid, D.A., Smith, L., & Rahman, T. (2006). *Determinants of dietary quality: evidence from Bangladesh.* American Agricultural Economics Association Annual Meeting; 2006 July 23–26; Long Beach: American Agricultural Economics Association.

Reily, F., Mock, N., Cogill, B., Bailey, L., & Kenefick, E. (1999). *Food security indicators and framework for use in the monitoring and evaluation of food aid programmes*. Food Security and Nutrition Monitoring Project (IMPACT), Washington, DC: United State Agency for International Development.

Reis, M. (2011). Food insecurity and the relationship between household income and children's health and nutrition in Brazil. *Health Economics, 21*(4), 405-27.

Ruel, M.T (2002). *Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs. Discussion paper no. 140.* Washington DC: International Food Policy Research Institute (IFPRI).

REMA (2011). *State of Environment and Outlook Report 2011*., Kigali: Rwanda Environmental Management Authority.

Saidu, A.M. (2010). An Empirical Analysis of Households' Food Security in Gombe State, Nigeria. Retrieved from: http://kubanni.abu.edu.ng/jspui/handle/ 123456789/1711.

Sakyi, P. (2012). *Determinants of food accessibility of rural households in the Limpopo Province, South Africa*. Unpublished Master Thesis, Belgium: Ghent University.

Salami, A., Kamara, A.B., & Brixiova, Z. (2010). Smallholder subsistence agriculture in East Africa: Trends, Constraints and Opportunities. Working Paper Series No. 105. Tunis: African Development Bank.

Salarkia, N., Abdollahi, M., Amini, M., & Neyestani, T.R. (2013). *An adapted Household Food Insecurity Access Scale is a valid tool as a proxy measure of food access for use in urban Iran.* Iran: Springer.

Saravanavel, P. (2013). *Research Methodology*, New Delhi: Kitab Mahal Publisher.

Sarracino, F. (2010). *Explaining famines: A critical review of main approaches and further causal factors*. NAF-IRN Natural Resources, Agricultural Development and Food Security International Research Network. NAF International Working Paper Series, Paper no.10/02.

Sekhampu, T. (2013). Determination of the Factors Affecting the Food Security Status of Households in Bophelong, South Africa. *International Business and Economics Research Journal*, *12*(5), 543-550

Sen, A. (1981). *Poverty and Famines. An Essay on Entitlement and Deprivation*. ILO: Clarendon Press, Oxford.

Shisanya, S., & Hendriks, S. (2011). The contribution of community gardens to food security in the Maphephetheni uplands. Special Issue: Food security in

southern Africa: Responses to the problem of hunger. *Development Southern Africa, 28*(4), 2011.

Simon, G-A. (2012). *Food Security: Definition, Four Dimensions, History. Basic readings as an introduction to Food Security for students,* Rome: FAO.

Singh, I., Squire,L., & Strauss, J. (1986) *Agricultural Household Models: Extensions, applications, and policy.* Baltimore: Johns Hopkins University Press.

Sinikiwekuwenyi, Kabuya, F.I. & Masuku, M.B.(2014). Determinants of Rural Households' Food Security in Shiselweni Region, Swaziland: Implications for Agricultural Policy. *Journal of Agriculture and Veterinary Science*, *7*(11), 44-50

Smith, L, & Subandoro, A (2007*). Measuring food security using household expenditure surveys. Food Security in Practice Series.* Washington, DC: International Food Policy Research Institute.

Staatz, J.M , D'Agostino, V.C., & Sundberg, S. (1990). Measuring food security in Africa: Conceptual, empirical, and policy issues. *American Journal of Agricultural Economics*, *72*(5), 1311-1317.

Strauss, J. (1983). *Socioeconomic determinants of food consumption and production in rural Sierra Leone*. Sierra Leone: Application of an agricultural household model with several commodities.

Stewart, R., Langer, L., Da Silva, N.R. & Muchiri, E. (2016). *Effects of training, innovation and new technology on African smallholder farmers' economic outcomes and food security.* 3ie Systematic Review Summary 6, Agriculture. London: International Initiative for Impact Evaluation.

Swindale, A. , & Bilinsky, P, (2006). Development of a universally applicable Household Food Insecurity Measurement Tool: process, current status and outstanding issues. *Journal of nutrition, 136* (5S),1449S-1452S.

The Common Financial Management Group (2006). *Introduction to Cost-Benefit Analysis and Alternative Evaluation Methodologies*. Commmonwealth of Australia: Department of Finance and Administration.

The Republic of Rwanda (2013). Economic Development and Poverty Reduction Strategy 2013-2018. Shaping our development. Retreived from: http://www.minecofin.gov.rw/fileadmin/General/EDPRS_2/EDPRS_2_FINAL1.pdf

The World Bank (2005). *The Bangladesh Integrated Nutrition Project. Effectiveness and Lessons. The World Bank Bangladesh Development Series*.South Asia Human Development Unit. Dhaka The World Bank Office.

Tsegay, G. (2009). *Determinants of Food Security in Rural Households of the Tigray Region, Ethiopia*. Unpublished Master Thesis, Addis Ababa: Addis Ababa University.

UN Millennium Project (2005). *Investing in Development: A Practical Plan to Achieve the Millennium Development Goals*. New York: UN Millennium Project.

UNDP (2014). *Inclusive dialogue on the Post 2015 Development Agenda-" Helping to strengthen capacities and build effective institutions*. Rwanda: UNDP.

UNECA, WFP , NEPAD (2012). *The Cost of Hunger in Rwanda. Social and Economic Impacts of Child Undernutrition in Rwanda.* Implications on National Development and Vision 2020. Geneva: UNECA, WFP , NEPAD

USDA Economic Research Service (2011). Food Security in the United States: Definitions of Hunger and Food Security. Retreived from: http://www.ers.usda.gov/briefing/foodsecurity/labels.htm.

Verpoorten, M. (2001). *Imperfect markets: a case study in Senegal. Discussions Paper Series (DPS) 01.20, Center for Economic Studies*, Katholieke: Katholieke Universiteit Leuven.

Vision 2020 Umurenge Program-VUP (2011). Annual Report 2009/10. VUP, Rwanda Local Development Support Fund,Kigali, Rwanda. Retrieved from: http://www.unicef.org/rwanda/RWA_resources_vision2020umurenge.pdf . Last accessessed on 16th December 201

Waddington, H., Snilstveit, B., Hombrados, J., Vojtkova, M., Phillips, D., Davies, P., & White, H. (2014). Farmer field schools: findings from a systematic review of 500 studies. London: International Initiative for Impact Evaluation.

Waddington, H., Snilstveit, B., Hombrados, J., Vojtkova, M., Phillips, D., Davies, P., & White, H. (2014). *Farmer Field Schools for Improving Farming Practices and Farmer Outcomes: A Systematic Review*. Campbell Systematic Reviews 2014:6. Oslo, Norway: The Campbell Collaboration (C2),.

Webb, P. (2011). *Achieving Food and Nutrition Security: Lessons Learned from the Integrated Food Security Programme (IFSP),* Mulanje, Malawi. Boston: Feinstein International Center, Tufts University.

WEBB, P., Coates, J, Frongillo, EA, Rogers, BL, Swindale, A, & Bilinsky, P.(2006). Measuring household food insecurity: Why it is so important yet so difficult to do. *Journal of Nutrition, 136* (5), 1404-1408.

Wenhold, F., Faber, M., Averbeke, W.van., Oelofse, A., Jaarsveld, V. van, Rensburg, WS.J. van, Heerden, I. & van Slabbert, R. (2007). Linking smallholder

subsistence agriculture and water to household food security and nutrition. *Water South Africa*, *33*(3), 321-336.

WFP (2005). *Emergency Food Security Assessment Handbook. United Nations World Food Programme* (WFP), Emergency Needs Assessment Branch (ODAN). Rome: WFP.

WFP (2007*). Food consumption analysis: Calculation and use of the Food Consumption Score in food consumption and food security analysis.* Technical Guidance Sheet (draft). Rome: WFP..

WFP (2009). *Hunger and Markets. World Hunger Series,* Rome: WFP.

WFP (2009). *Rwanda Comprehensive Food Security and Vulnerability Analysis and Nutrition Survey.* Rome: WFP.

WFP (2012). *Comprehensive Food Security and Vulnerability Analyisis and Nutrition Survey, Rwanda Report.* Rome, WFP.

WFP (2016). *Rwanda 2015 Comprehensive food security and vulnerability analysis.* Rome: WFP.

Wiesmann, D., Bassett, L., Benson, T., &Hoddinott, J. (2009). Validation of the World Food Programme's food consumption score and alternative indicators of household food security. IFPRI Discussion Paper 00870, Poverty, Health, and Nutrition Division.

World Bank (2014). *Purchasing Power Parities and Real Expenditures of the World Economies.* Summary of Results and Findings of the 2011 International Comparison Program (ICP 2011), Washington DC: The World Bank.

Yaro J. A. (2004). Theorizing food insecurity: building a livelihood vulnerability framework for researching food insecurity. *Norwegian Journal of Geography*, *58*(1), 23-31.

Yates, B.T.(2015). *Cost-Benefit and Cost-Effectiveness Analyses in Evaluation Research*. In: James D(editor-in-chief), International Encyclopedia of the Social & Behavioral Sciences, (2nd ed.), Vol 5. Oxford: Elsevier.

APPENDICES

Appendix I: Household Food Insecurity Access Scale Score (HFIAS) as a measurement of food access

The HFIAS is a nine-question tool developed and validated by the Food and Nutrition Technical Assistance (FANTA) to assess household food insecurity, and looks at three key domains experienced in households during the previous month:

1. Stated anxiety & uncertainty about food
2. Household experience with quality of food (variety & preferences)
3. Insufficient household food intake (quantity)

The 9 questions are as follow, referring to the past 30 days:

Q1-Did you worry that your household would not have enough food?

Q2-Were you or any household member not able to eat the kinds of food you preferred because of lack of resources?

Q3-Did you or any household member eats just a few kinds of food day after day due to lack of resources?

Q4-Did you or any household member eat food that you preferred not to eat because of lack of resources to obtain other types of food?

Q5-Did you or any household member eat a smaller meal than you felt you needed because there was not enough food?

Q6- Did you or any household member eat fewer meals in a day because there was not enough food?

Q7- Was there ever no food at all in your household because there were not enough resources to get more?

Q8-Did you or any household member go to sleep at night hungry because there was not enough food?

Q9-Did you or any household member go a whole day without eating anything because there was not enough food?

Each question's score depends on how frequent the household has lived with that situation in the past 30 days: never happened= 0, rarely (once or twice) = 1, sometimes (3-10 times) = 2, or often (more than 10 times) = 3. A total score for the household ranges on a scale from 0 to 27.A higher HFIAS score is indicative of poorer access to food and greater household food insecurity.

Prevalence of food insecurity is further categorizedas follows:

1. Food secure: if[(Q1=0 or Q1=1) and all other questions =0

2. Mildly food insecure: if [(Q1=2 or Q1=3 or Q2=1 or Q2=2 or Q2=3 or Q3=1 or Q4=1) and Q5, Q6, Q7, Q8, Q9=0]

3. Moderately food insecure: if [(Q3=2 or Q3=3 or Q4a=2, Q4=3 or Q5=1 or Q5=2 or Q6=1 or Q6=2) and

Q7=0 and Q8=0 and Q9=0]

4. Severely Food Insecure if [Q5=3 or Q6=3 or Q7=1 or Q7=2 or Q7=3 or Q8=1 or Q8=2 or Q8=3 or Q9=1 or Q9=2 or Q9=3]

AppendixII: Household Questionnaire – Household Food Security Assessment

0. <u>Household Identification</u>

Name of Household Head:

Village:

Cell:

Sector: Butaro

District: Burera

Date of data collection:

<u>Section 1: Household Demographics</u>

Names of respondent &(relationship to the HH Head if different):

……..

SN	Household member-Names	Age	Gender M=0 F=1	Relation to Household Head Husband=0 Spouse=1 Child=2	Education level No school=0 Primary=1 Secondary=2 Arts/crafts=3 University=4	Does Off-farm job? No=0 Yes=1

				Sibling=3 Other=4		
1						
2						
3						
4						
5						
6						
7						
8						
How many family members?						
What ubudehe category does your household belong to? (Possible values: 1-4) Doesn't know =0						
What is your marital status (Head of Household)?					1 = Single 3 = Separated 4 = Widowed	

Section2: Agriculture related questions

1. How big is your cultivable land? (1) Less than 500 sq. meters
   (2) 500 – 1000 sq. meters
   (3) 1000- 2000 sq. meters
   (4) Between 2000 sq. meters-1ha
   (5) More than 1 ha
2. What are the major crops grown in this household (tick)? Cassava__ Maize__Beans__ Bananas___ Irish potatoes___ Sweet potatoes___ Peas___ Soya___ wheat___ Rice___ Corocasia___Imboga___ Other___

3. How much yield do you get from the following crops? (Based on local unit of measurement, try to inquire about how many Kg/ are)
   Cassava____ Maize_____Beans____ Bananas_____ Irish potatoes_____ Sweet potatoes_____ Peas_____ Soya_____ wheat_____ Rice_____ Corocasia____

4. a) Do you have any livestock? Yes(1) No (0) ☐

   b) What kind and how many?

Animal	**How many?**	**Is it yours? Yes(1) No (0)**
Cow		
Goat		
Sheep		
Pig		
Rabbit		
Hens		

5. Have you ever used any chemical fertilizer in the last 2 seasons? (0) No / Yes (1) ☐
6. a) Have you had any training in agriculture and livestock rearing in the last 2 years? Yes(1) No(0)
   b) Training in what?..... ☐

   c) Who gave you the training? ☐
      (1)Supporter organization/ NGO
      (2)Sector Agronomist/Veterinary
      (3)Other:…….. ☐
7. a)Do you belong to any cooperative/ association? Yes (1) No (0) ☐
   b) If yes, what is the purpose of the cooperative? (1)Saving/crdit ___(2) Agriculture___ (3)Livestock exchange_____(4)Business/ commerce____(5) Social Support group____ (6)other___

Section 3: Questions related to food availability

8. Is the yield you get from your farm enough for your household until the next harvesting season?

- o It does not last more than a month (1)
- o Lasts 1-2 months (2) ☐
- o Lasts 2-3 months (3)
- o Last until next harvest (4)
- o Lasts more than 3 months (5)

9. Where do you get most of the food you consume in this household?
   (1) Farm produce ____
   (2) Buy from Market_____
   (3) Supported by others (neigbours, relatives)____

Section4: Income & financial literacy related questions

10. What are the sources of monetary income in this household?
    (1) Farming ___
    (2) Retailing business____
    (3) Rearing livestock___
    (4) Monthly Salary from job___
    (5) off farm Casual work/Salary per day____
    (6) Gucainshuro(working in fields of neighbours)___
    (7) From crafting___ (which ones?.....

11. Is there anyone in this household trained in specific crafts/profession? Yes(1)/ No(0)
    If yes, what kind of craft?
        (1) Construction/Masonry
        (2) Carpentry
        (3) Tailoring/sewing
        (4) Cooking
        (5) Hair dressing
        (6) Shoes repairing
        (7) Pottery
        (8) Other…….

12. What is the total daily income from different members of the household? <500 Frw ___ 500-1000 Frw___ 1000-2000 Frw___ > 2000 Frw___

13. Do you have any system of saving money? Yes=1 No=0
    If yes, by which system do you save?

    (1)Use informal saving group/ association (Ibimina)

    (2)Through formal SACCO (saving & Credits Cooperative)

    (3)Through MIF/ Bank

    (4)Through lending other people/ neigbours with small interest

    (5)Other……
    ……

14. Do you or anyone in this household have a bank account? Yes (1)/ No (0) . If yes, [How many have accounts]……

15. If you save, like how much do you manage to save per month?.....FRW

Section 5: Household Food Insecurity Access Scale (HFIAS) [2]

16. . In the past four weeks, did you worry that your household would not have enough food?

    0 = No (skip to following question)) 1=Yes ….|___|

---

[2]Cfr "**Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide" By** Jennifer Coates, Anne Swindale ,Paula Bilinsky, (FANTA, August 2007) P 13-14

- If Yes, How often did this happen? ….|___|

  1 = rarely (once or twice in the past four weeks)

  2 = Sometimes (three to ten times in the past four weeks)

  3 = Often (more than ten times in the past four weeks)

17. In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?

    0 = No (skip to following question) 1=Yes ….|___|

    If yes, How often did this happen? ….|___|

    1 = rarely (once or twice in the past four weeks)

    2 = Sometimes (three to ten times in the past four weeks)

    3 = Often (more than ten times in the past four weeks)

18. In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?

    0 = No (skip to following question) 1=Yes ….|___|

    If yes, How often did this happen? ….|___|

    1 = rarely (once or twice in the past four weeks)

    2 = Sometimes (three to ten times in the past four weeks)

    3 = Often (more than ten times in the past four weeks)

19. In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?

0 = No (skip to following question) 1=Yes ….|___|

If yes, How often did this happen? ….|___|

1 = rarely (once or twice in the past four weeks)

2 = Sometimes (three to ten times in the past four weeks)

3 = Often (more than ten times in the past four weeks)

20. In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?

0 = No (skip to Q3) 1=Yes ….|___|

If yes, How often did this happen? ….|___|

1 = rarely (once or twice in the past four weeks)

2 = Sometimes (three to ten times in the past four weeks)

3 = Often (more than ten times in the past four weeks)

21. 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?

0 = No (skip to following question) 1=Yes ….|___|

If yes, How often did this happen? ….|___|

1 = rarely (once or twice in the past four weeks)

2 = Sometimes (three to ten times in the past four weeks)

3 = Often (more than ten times in the past four weeks)

22. 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?

    0 = No (skip to following question) 1=Yes ….|___|

    If yes, How often did this happen? ….|___|

    1 = rarely (once or twice in the past four weeks)

    2 = Sometimes (three to ten times in the past four weeks)

    3 = Often (more than ten times in the past four weeks)

23. In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?

    0 = No (skip to following question) 1=Yes ….|___|

    If yes, How often did this happen? ….|___|

    1 = rarely (once or twice in the past four weeks)

    2 = Sometimes (three to ten times in the past four weeks)

    3 = Often (more than ten times in the past four weeks)

24. In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?

    0 = No (skip to following question) 1=Yes ….|___|

    If yes, How often did this happen? ….|___|

    1 = rarely (once or twice in the past four weeks)

    2 = Sometimes (three to ten times in the past four weeks)

3 = Often (more than ten times in the past four weeks)