WOMEN EMPOWERMENT, TECHNICAL EFFICIENCY AND MARKET PARTICIPATION: A STUDY OF SMALLHOLDER RICE FARMERS IN KILOMBERO DISTRICT, TANZANIA

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A Dissertation Submitted in Partial Fulfillment of Requirements for the Degree of Doctor of Philosophy (Economics) of the University of Dar es Salaam

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by the University of Dar es Salaam a dissertation titled, **"Women Empowerment, Technical Efficiency and Market Participation: A Study of Smallholder Rice Farmers in Kilombero District, Tanzania"** in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Economics of the University of Dar es Salaam.

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DECLARATION

AND

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I, **Esther Leah Achandi,** declare that this thesis is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

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DEDICATION

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LIST OF ABBREVIATIONS

ACDI	Agricultural Cooperative Development International
ACGD	African Centre for Gender Development
AGRA	Alliance for Green Revolution of Africa
AFSP	Accelerated Food Security Project
ANOVA	Analysis of variance
ASDP	Agricultural Sector Development Programme
ASDS	Agricultural Sector Development Strategy
AU	African Union
BRN	Big Results Now
CAADP	Comprehensive Africa Agriculture Development Programme
CET	Common External Tarrif
CREW (T)	Credit for Women in Tanzania
DAI	Development Alternatives Incorporated
DE	Domains Empowerment

EAAPP	East African Agricultural Productivity Programme
EAC	East African Community
ESRF	Economic and Social Research Foundation
FAO	Food and Agricultural Organization
FGD	Focus Group Discussions
FTF	Feed the Future
FYDP	Five Year Development Plans
GAD	Gender and Development
GDP	Gross Domestic Product
GEI	Gender Equity Index
GPI	Gender Parity Index
Ha	Hectares
HDI	Human Development Index
IFPRI	International Food Policy Research Institute

ILO	International Labour Organization
JICA	Japan International Cooperation Agency
MDG	Millennium Development Goal
MTF	Medium Term Expenditure Framework
NAIVS	National Agricultural Inputs Voucher System
NARS	National Agricultural Research Systems
NBS	National Bureau of Statistics
NIE	New Institutional Economics
NRDS	National Rice Sector Development Strategy
OAU	Organization of African Union
OECD	Organisation for Economic Co-operation and Development
OPHI	Oxford Poverty and Human Development Inititaive
OLS	Ordinary Least Squares
PRIDE	Promotion of Rural Initiatives and Development Enterprises

SADC	Southern African Development Community
SAGCOT	Southern Agricultural Growth Corridor of Tanzania
SARO	Semi Aromatic Rice
SRI	System of Rice Intensification
SSA	Sub Saharan Afric
TAWLA	Tanzanian Women Lawyers Association
TAFSIP	Tanzania Agriculture and Food Security Investment Plan
TE	Technical Efficiency
UNECA	United Nations Economic Commission for Africa
UN General Assembly	United Nations General Assembly
UN Women	United Nations Entity for Gender Equality and the Empowerment of Women
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
URT	United Republic of Tanzania

USAID	United States Agency for International Development
VAT	Value Added Tax
VOCA	Volunteers in Overseas Cooperative Assistance
WDF	Women Development Fund
WEAI	Women Empowerment in Agriculture Index
WID	Women In Development
WLAC	Women's Legal Aid Center

ABSTRACT

This study examines women empowerment, technical efficiency and market participation by smallholder rice farmers in Kilombero using the Women Empowerment in Agriculture Index (WEAI). For the study site, the overall WEAI is estimated at 0.54 and the determinants of women empowerment for female headed households are; age of the household head, education level, group membership, condition of dwelling and distance from the nearest major town, all of which have a positive association with women empowerment while monthly income has a negative association. For the male headed households, age of the husband and number of male children both have an association with women empowerment. The study also analyzes technical efficiency of production using the stochastic frontier analysis. Findings indicate mean technical efficiency scores of 0.50 and 0.66 for female and male headed households respectively.The factors that affect technical efficiency are empowerment of the women; gender, primary occupation, group membership and education level of household head and, fertilizer use in production. In examining market participation, a double hurdle model is used with findings indicating that being a male household head, group membership of household head, hiring labour, empowerment of the woman and ownership of modern equipment have a positive effect on the decision while, irrigation and customary land ownership have a negative effect on the decision to market. Plot size, education, age squared, ownership of modern equipment have a positive effect on quantity marketed while age has a negative effect on quantity marketed.

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CHAPTER ONE

INTRODUCTION

1.1 Background

Agriculture is the mainstay of the Tanzanian economy contributing 29.8 percent to GDP for the period 2012 to 2016 (National Bureau of Statistics, 2016a), employing 69.9 percent of women and 64 percent of the male population (NBS, 2017); is dominated by food production- Chauvin et al. (2012) suggests that 85 percent of land area cultivated annually is under food crops; the sector suffers low productivity (Amani, 2005; Leyaro et al., 2014) and, ASDP II notes that the sector's growth rate over the past decade has mainly been driven by area increment rather than by productivity increase (URT, 2015) and, agricultural production is dominated by smallholder farmers (Amani, 2005; Casey, 2013).

The Government of Tanzania initially adopted the Agricultural Sector Development Programme (ASDP) in 2006 in order to operationalize the Agricultural Sector Development Strategy (ASDS) (URT, 2006). It also further adopted the ASDP II which envisages an agricultural sector in the year 2025 that is modernized, commercial, market-oriented, highly productive and profitable, resilient, utilizing natural resources in an sustainable manner, ensuring food security throughout the country, expanding its export to regional and international markets and contributing to improved livelihood in rural and urban area of the country (URT, 2015).

Rice has been identified as a strategic crop in the country and has made its way into both the policy agenda and discourse. In terms of policy, Tanzania adopted the National Development Vision 2025 with a series of Five Year Development Plans (FYDP) with the first beginning in 2011/2012 and ending in 2015/2016 upholding the theme of, "Unleashing Latent Growth Potential". In 2009, the government also specifically adopted the National Rice Sector Development Strategy (NRDS) targeting the rice sub-sector (URT, 2009). The NRDS highlights key features of the sub-sector, indicates the challenges and opportunities within the sub-sector, gives priority areas and approaches and, vision, scope and strategies for the rice sub sector. Moreover, to harmonize implementation of the NRDS with the national development agenda, the NRDS defined intervention strategies, which were to be implemented in three-year periods, a timeframe synchronized with the Government Medium Term Expenditure Framework (MTF) (URT, 2009).

There is deliberate government effort to enhance growth and development which can result in empowerment of the populace; empowerment is a personal concept and has been defined by several scholars; Alsop et al. (2006) describe empowerment as "a group's or individual's capacity to make effective choices, that is, to make choices and then to transform those choices into desired actions and outcomes". Narayan (2002) gives a definition of empowerment as "the expansion of assets and capabilities of poor people to participate in, negotiate with, influence, control, and hold accountable institutions that affect their lives" and she stresses four main elements of empowerment namely access to information, inclusion and participation, accountability, and local organizational capacity. It is however important to note that in defining empowerment, focusing on individual choice can be limiting, especially when looking at culture where community and mutuality are valued contexts. Narayan's definition stands out as broader capturing the relationship between people and institutions.

In examining empowerment in rice production systems it is critical to assess the ability to make decisions but also keep in mind the material and social resources needed to execute those decisions. Mahmud et al. (2012) argue that a crucial element of empowerment relates to access to and control of material, human, and social resources. Women empowerment in particular can be extended to several dimensions to cover social, cultural and economic spheres of human life and interaction. However, it has been noted that women empowerment is not a static state but rather a progression from one known state to another (Wiklander, 2010).

In spite of existing government efforts and policies to have an inclusive development framework for both men and women in development, there still exists gaps that need to be addressed if women empowerment is to be achieved in Tanzania; one such area is in the traditional land tenure system which is critical to access and control over land, a key resource in agricultural production. Generally land belongs to the Government; however land ownership falls under jurisdiction of the respective villages/districts and is governed by the Village Act No.5 of 1999 which on the whole recognizes customary rights. About 69.3 per cent of total land ownership is under customary law, 15.7 per cent is bought while only 5.6 percent is under official land titling (NBS, 2013a). Equal rights of men and women to inherit land has remained the most contentious issue due to local gendered customary practices of inheritance and land tenure (mostly patrilineal) which are still important in many areas of Tanzania (Dancer and Sulle, 2015). Dancer (2015) indicates that the inheritance law was not changed as part of the 1990s land law reforms thus leading to inconsistencies between land, marriage and inheritance laws on issues of gender equality. Such inconsistencies impede efforts to empower women in agricultural production both in terms of their productivity and ability to participate in meaningful commodity market.

The existing policies in place provide a yardstick against which efforts to empower women can be assessed but also provide an opportunity to assess the benefits of such empowerment. Empowering women is likely to result in increased technical efficiency and the results can be much better when women have control over output as Elson (1995) in Agarwal and Herring (2013) point out that when weeding technology was introduced for maize, yields in women's plots increased by 56 percent in cases where women controlled output but only by 1 percent when women did not control the output. Seymour (2017) studies women empowerment in Bangladesh and reports gains in technical efficiency of the household as a result of reduction in gender disparities between men and women within the household, Rahman (2010) have also argued that female agricultural labor contributes significantly to productivity as well as technical efficiency although gender bias exists in the agricultural labor markets with remunerative employment of labor skewed in favor of men, since female labor is engaged only when the male labor supply is exhausted. The gender gap in agriculture has been estimated to impose a cost to the economy and UN Women et al. (2015) using conservative estimates argues that if policy makers address the gender gap in agriculture effectively, annual crop output could increase by 2.1 percent; potential gross gain to GDP would be $105 million (0.46 percent of GDP); the gain in GDP by closing the gender gap would lift as many as 80000 people out of poverty in Tanzania.

Although it has been noted that female agricultural labor contributes significantly to both productivity and technical efficiency, increasing productivity and technical efficiency is not an end in itself. Farmers need access to markets if they are to reap the gains from productivity and efficiency increase. In fact, studies have observed that increased productivity can result in market participation for example Rios et al. (2009) suggest that, controlling for differences in market access and the underlying determinants of market participation, households with higher productivity have greater participation in agricultural markets; Rios et al. (2008) argue that for cereals, productivity investments can help boost market participation. Nonetheless, there exists a gender gap in crop marketing and Chan (2010) observes that on male-owned farms, female family members do much of the work, yet receive little of the income from crop sales and have little say in how that income is spent and, within supply chains, sustainability certification schemes are less likely to benefit women than men.

1.2. Statement of the Problem

In spite of the targeted policies in place geared towards enhancing women empowerment and productivity improvement in the agricultural sector in general, and rice subsector in particular, to date the examination of women empowerment, technical efficiency of production and market participation with regard to smallholder farming systems in Tanzania has not been given sufficient attention in literature.

A number of studies have examined women empowerment with links to different elements of the economy such as credit schemes (Makombe et al. 1999), women's enterprenuership, non market work, time use and women's access to land (Ellis et al., 2007), women's economic empowerment (Fox, 2016) and women's participation in politics and the public sector (Strachan, 2015). These studies highlight how women have faired in these areas and the gaps that need to be addressed.

Nonetheless, for the Tanzanian economy that has been largely termed as agrarian, micro-level studies covering women empowerment remain very scarce, moreso for specific priority crops such as within the rice sub-sector. Moreover, although studies have been conducted examining technical efficiency and market participation within the agricultural sector, the possible relationship between intrahousehold women empowerment and technical efficiency and, its relationship with market participation for the rice sub-sector remain largely grey areas in terms of studies covering Tanzania.

This study seeks to contribute to the body of micro economic knowledge that examines women empowerment and its determinants and examines technical efficiency and market participation for smallholder rice farmers in Tanzania.

1.3 Research Questions

In examining the effect of women empowerment on technical efficiency and market participation, I ask the following questions in the context of rice based smallholder farming systems;

a. What is the existing level of intra-household women empowerment of smallholder rice farmers and what factors affect intra-household women empowerment?
b. How technically efficient are smallholder rice farmers, and what are the determinants of their technical efficiency?
c. What factors affect market participation by smallholder rice farmers?

1.4. Objectives of the study

The general objective of the study is to estimate the level of women empowerment and its determinants, examine technical efficiency of production and, examine market participation by smallholder rice farmers in Kilombero district.

1.4.1 Specific objectives

I. Estimate the level of intrahousehold women empowerment and its determinants

II. Estimate technical efficiency of production for households and establish the determinants of technical efficiency.

III. Analyze determinants of market participation by smallholder farmers.

1.5. Justification and Contribution of the study

This study demonstrates the existing level of women empowerment and its determinants; examines technical efficiency of farmers and its determinants and, assesses the determinants of market participation by smallholder farmers. Although there are studies which give evidence of disempowerment of women in Asia, and in African countries such as Uganda and selected sub sectors in Kenya, such studies in Tanzania remain scarce especially for priority crops such as rice; this is an area that the study seeks to contribute to.

With regard to methodology, agricultural sector specific attempts at estimating women empowerment in Tanzania have been limited and therefore the study seeks to add to this body of knowledge specifically for smallholder rice farming communities. The study adopts the women empowerment in agriculture index and additionally assesses technical efficiency of production and market participation. Techical efficiency and market participation are key aspects that can highlight profitability of the agricultural sector.

The study examines empowerment by disaggregating achievements made by men and women and uncovers that indeed, men too report disempowerment which shows that power centers contributing to intrahousehold women disempowerment can emanate from both within and without the household, thus imposing a binding empowerment constraint to the men as well.

Moreover in the examining technical efficiency, the study applies the three step procedure suggested by Henningsen and Henning (2009) with the unrestricted frontier, minimum distance estimation and, a final stage restricted frontier. The restriction is via imposing monotonicity, a process meant to ensure estimation of a theoretically consistent model. Very few studies addressing technical efficiency have applied this method although its novelty has been cited as the theoretical consistency of estimation to ensure meaningful interpretation of results on the determinants of technical efficiency.

1.6. Scope of the Study

The study covers the district of Kilombero in Tanzania focusing on smallholder rice farmers in Mbingu, Mkula, Mang'ula A, Njage and Msolwa Ujamaa. We use data generated from a survey covering targeting households within each selected village. Villages were purposively selected with a focus on villages growing more rice in terms of acreage but also villages within which AfricaRice, the research sponsors had some ongoing activities. Kilombero was thus purposively sampled due to the rice programs by the research sponsor AfricaRice as well as other development partners that it already serves as host to. The study selected dual adult households i.e. those with a primary male and primary female respondent (strictly a spouse) and female headed households. Within each household, the household heads were interviewed to gain information on household characteristics and, on household members except information pertaining to the primary female respondents, where the female respondent gave her own account. Questions were then administerd about household rice farming and marketing activities specifically with regard to sale of rice produce. Additionally respondents participated in two separate focus group discussions- one for the men and the other for the women so as to provide information on existence of extension services, infrastructure and social networks within the village.

To estimate intrahoushold women empowerment, the study used the women empowerment in agricultural index and, to assess the determinants of women empowerment, the ordinal logit analysis was adopted. In estimating technical efficiency of production for households and establishing the determinants of technical efficiency, the study used the stochastic frontier analysis and lastly, for market participation, the study used the double hurdle model.

1.7 Outline of the Dissertation

The rest of the dissertation is organized as follows; Chapter two gives a description of the Tanzanian economy (performance and policies) with a focus on agriculture, the rice subsector and, a brief on empowerment technical efficiency and market participation. Policies adopted to pursue women empowerment with key achievements and gaps that need to be filled are also discussed in this chapter. Chapter three gives a background of perspectives on empowerment, progress in discourse and its relationship to the household; a household decision making model is also reviewed and the Women Empowerment in Agriculture Index (WEAI) developed by Alkire et al. (2012) is adopted within the context of smallholder rice farming households in Kilombero. Chapter Four delves into technical efficiency of smallholder rice farmers using the Stochastic Frontier Analysis and specifically adopting the three step procedure proposed by Henningsen and Henning (2009) with the unrestricted frontier, minimum distance estimation and, a final stage restricted frontier. In Chapter Five, market participation of the household is examined beginning with a review of perspectives on smallholder farming including participation of smallholder farmers in agricultural markets, the importance of markets and, the double hurdle model for the determinants of market participation. Chapter Six gives the conclusion, policy implications, limitations of the study and highlights areas for further research.

CHAPTER TWO

TANZANIA: OVERVIEW OF THE ECONOMY, THE RICE SUB SECTOR AND EMPOWERMENT ISSUES

2. 1 Introduction

This chapter is a review of key features of the Tanzanian economy, progress as assessed by a few domestic and internationally comparable indicators, the agricultural sector evolution, policy perspectives for its development and, the rice sub sector. A detailed discussion of the rice sub-sector is done since it is the focus of the study. A brief account is given of empowerment focusing on efforts that Tanzania has put in adopting both international and national policies targeting empowerment of women. The chapter further highlights some of the achievements made so far and the gaps that remain to be addressed. The last part of the chapter highlights possible interconnectedness of women empowerment to technical efficiency and market participation.

2.2 The Tanzanian Economy

The United Republic of Tanzania was formed in 1964 by the union of mainland Tanzanyika which had received its independence in 1961 and Zanzibar that gained independence in 1963 (Mbogoni, 2013); it had a population of 45 million according to the 2012 population census (NBS, 2012) and 48.8 million in 2015 (NBS, 2016a). The Tanzanian economy has largely been classified as agrarian with agriculture accounting for more than one quarter of the GDP and providing 85 percent of exports (ESRF, 2009). Agriculture, forestry and fisheries sector employs 69.9 percent of women and 64 percent of the male population (NBS, 2017). The Tanzanian economy grew at an average of 6.8 percent during the period 2010-2015 (NBS, 2016a) reporting agriculture's contribution to GDP averaging 29.8 percent for the period 2012 to 2016 (NBS, 2016). Additionally as at December 2017, twelve month headline inflation was reported as 4.0 percent and, 5.0 percent in December 2016 with the decline largely attributed to food inflation given that wholesale prices of all major food crops have been lower than those of the corresponding month in 2016 (URT, 2018).

A number of international development indicators have been used to score Tanzania and it has ranked as follows; World Bank (2017) world development indicators shows GDP growth rate between 2014-2015 as 7 percent with a 3.7 percent per capita growth rate within the same period; the Human Development indicators (Human Development Report 2016) which summarizes progress in three basic dimensions of human development namely i) a long and healthy life, ii) access to knowledge and, iii) a decent standard of living; assessing how countries have fared against the 2030 Agenda for sustainable development goals, Tanzania attained a Human Development Index (HDI) value of 0.531 thus ranking 151 out of the 188 countries for which HDI was reported. Notably though, the country attained an increase in the HDI of 43.4 percent between 1990 and 2015. Furthermore, according to the Inclusive Development Index

(IDI) 2018, of the World Economic Forum System Initiative which identifies 15 areas of structural economic policy and institutional strength that have the potential to contribute simultaneously to higher growth and wider social participation in the process and benefits of such growth, Tanzania is classified as slowly advancing in the category of emerging economies with an overall score of 3.43 and ranking 48th out of 74 countries for the countries in its category (Samans et al., 2018).

2.3 Evolution of Policy Perspectives and the Agricultural Sector

Due to the importance of, and potential that agriculture has in the Tanzanian economy, the government has taken considerable steps in instituting policies and implementing programmes to promote the sector. Tanzania initially followed Arusha Declaration policies which were inconsistent with both market-led economies and technological developments at the time across the globe; moreover, the late 1980s and throughout the 1990s, saw the implementation of the structural adjustment policies. These different pursuits left the country no clear direction in terms of policy (URT, 1999). Therefore the Arusha Declaration and Structural adjustment policies were replaced with Tanzania's development vision 2025 which was laid out with the objective of raising the general standard of living of Tanzanians to the level of a typical medium-income developing country by 2025 (URT, 1999) and identified three priority areas as, i) ensuring basic food security, ii) improving income levels and iii) increasing export earnings; agriculture was identified as one of the priority sectors for achieving these goals (URT, 2001). Practical steps to achieve Vision 2025 saw a number of specific policies instituted; for example, the Agricultural Sector Development Programme (ASDP) in 2006 in order to operationalize the Agricultural Sector Development Strategy (ASDS) whose objective was to achieve a sustained agricultural growth rate of 5 percent per annum primarily through the transformation from subsistence to commercial agriculture. Government also further adopted the ASDP II with an aim of attaining a modernized, commercial, market-oriented, highly productive and profitable, resilient agricultural sector utilizing natural resources in a sustainable manner, securing food security throughout the country, with a capacity to penetrate the export markets and contribute to improved livelihood in rural and urban areas of the country (URT, 2015).

The interest in agriculture is notably due to its strong linkages to the rest of the economy; agriculture contributed 29.8 percent of the GDP or the period 2012 to 2016 (NBS, 2016), is a major component of the countries' traditional export (NBS, 2016), provides 95 percent of the countries' food requirement (URT, 2009; Leyaro et al.,2014), employs 69.9 and 64 percent of the female and male population respectively (NBS, 2017), is directly linked to inflation levels since food contributes about 51 per cent of the consumption basket in Tanzania (Adam et al.,2012) and Kweka et al.(2003) observe that the combined household income multiplier is highest for agriculture with World Bank (2000) arguing that agriculture's growth multiplier was higher than those for other sectors and felt in both rural and urban areas.

2.4 The Rice Sub setor in Tanzania: Production, Consumption and Marketing

Within Tanzania's agricultural sector, rice has been identified as a priority crop (URT, 2009). Noticeably, paddy/rice is the second most important commercial and food crop after maize in Tanzania (Ronald et al., 2014), the second widely grown cereal in Tanzania (Mghase et al., 2010) and, the most irrigated crop in Tanzania (Therkildsen, 2011). Tanzania stands to gain from the Eastern Africa regional bloc in terms of the existing and potential rice market given that it is the second largest rice producer in Eastern Africa after Madagascar (Lazaro, 2014; Kolleh et al., 2017). Additionally, there exists an attractive market for rice within Tanzania itself for domestic producers; rice in comparison to other cereals such as maize commands a higher market price; Weliwita et al. (2011) observes that local production cannot meet the domestic demand for rice and as such some rice is imported annually making it more expensive than maize and its consumption is mainly by the urban middle income class. Further opportunity exists for the local rice farmers given the higher quality of the locally produced rice compared to the imported rice as evidenced by consumer preference [Achandi and Mujawamariya (2016) observe that consumers prefer traditional aromatic varieties] and market prices; the price of the locally produced rice is higher than the market price of the imported rice (Minot, 2010). On the consumption side, Van Oort et al. (2008) compute annual rice consumption per capita at 23kg and, rice is becoming an increasingly popular food across Sub-Saharan Africa because of urbanization (Onyango, 2014; AfricaRice, 2011). Moreover, Cockx et al. (2017) in studying food consumption and urbanization among rural urban migrants note that in Tanzania, urban residents on average consume more than double the amount of rice. This attractiveness of rice consumption for the urban dwellers has been attributed to its convenience of storage, preparation and cooking (Seck et al., 2013) and with increasing urbanization, its consumption is likely to increase as anticipated in Reardon et al. (2015).

Nonetheless, rice growing in Tanzania is an activity mainly undertaken by the smallholder farmers accounting for over 90 percent of all rice production (SAGCOT, 2010) with average land holding of 0.5 to 3.9 ha each (URT, 2009) and producing rice in the regions of Morogoro, Shinyanga, Tabora, Mwanza and Mbeya. Rice has been recognized among other staples to have potential in terms of driving up food security and incomes of farmers and as thus the policy attention it has been accorded (URT, 2009).

Tanzania adopted the National Development Vision 2025 with a series of Five Year Development Plans (FYDP) and to establish a strong and effective system to oversee, monitor and evaluate the implementation of the FYDP I the government introduced the Big Results Now (BRN) with rice featuring among the three crops prioritized therein (URT, 2013) to ensure food availability, reduce poverty among rural households and gradually shift to a more commercialized and modernized production system. The rice sub-sector has further enjoyed a boost with Tanzania benefiting from membership to the Eastern Africa Agricultural Productivity Program (EAAPP) within which it serves as the regional rice center of excellence with funding from a World Bank loan (World Bank, 2009). Additionally, Tanzania is a member of the

Coalition for African Rice Development (CARD) initiative supported jointly by Japan International Cooperation Agency (JICA) and Alliance for Green Revolution of Africa (AGRA); and under the CARD, Tanzania and other beneficiary countries developed the National Rice Sector Development Strategy (NRDS) with each country making commitments and strategies to double domestic rice production by 2018 (JICA/AGRA, 2008). URT (2009) in the NRDS acknowledges that women form 60 – 80 percent of the agricultural labour force in the rural areas and also identifies key challenges to rice sector development specifically focusing on the production and postharvest produce management. The NRDS also developed a strategy to confront rice sector specific challenges through addressing bottlenecks in production, supply of inputs and marketing.

Challenges to the rice sub sector are however not limited to the production side but also scattered along the value chain to include the marketing side thus affecting profitability of rice farming. For example, although Tanzania is the second largest producer of rice within the East African region (World Bank, 2009), rice traders in Tanzania (some traders also double as producers) have not been able to fully exploit the potential of the rice market within the region. The East Africa Community member states maintain a Common External Tarrif (CET) for rice imports from lower cost producers in countries outside the EAC region at 75 percent percent advalorem common external tariff on rice to protect local rice farmers; a few concessions were made such as for Kenya that has a special trading agreement with Pakistan which imports Kenyan tea

(Vitale et al., 2013; Konandreas et al., 2015). Zanzibar on the other hand depends mainly on rice imports for consumption and as such imposes a 12.5 percent tariff although Kenya, Rwanda, mainland Tanzania, and Uganda all maintain the CET. In spite of the existence of a CET, Minot (2010) observes that imported rice is still considered inferior and is therefore cheaper than domestically produced rice on the market. Furthermore, smuggling of rice imports from Zanzibar into mainland (Therkildsen, 2011) poses a threat to suppliers of locally produced rice by exposing it to competition from subsidized rice and the dumping of rice imports in transit to other countries onto the Tanzania market which further depresses price of domestically produced rice. This scenario is worsened by the practice of mixing of rice on the market; (some mixing is done during postharvest management (Nkuba et al., 2016) but some mixing is unscruptulously done by combining domestic aromatic rice with imports (Lazaro, 2014) which is then sold as domestically produced aromatic rice for a gain in the market as domestically produced aromatic rice. Due to lack of standardized measures to ensure quality of rice except for percentage of breakage, long grain imported rice is mixed with domestically produced aromatic rice and sold at a higher price than the price of imported rice. In this way the market for rice faces distortions which result in losses for farmers and traders. Moreover, in spite of the good quality of Tanzanian rice, Ayoki (2012) observes that the mixing of rice which is re-exported is compromising the market for Tanzanian rice exports across neighboring markets, for example, Tanzania middle men tend to mix the three rice grades and label them as first grade rice. At the customs office, this rice grade is classified under high tax category and Rwandan importers pay a high tax for it. At the time of selling it, the traders discover that it is not grade 1 rice and as such has to be sold at lower prices on the market because of its lower quality.

Furtherstill, an examination of rice trade in the country amidst all the policies intended to improve the sector finds that farmers in the country are cash poor thus often prone to “distress” sales to cover for immediate cash needs; have limited structures for storage of rice. Rice marketing is thus dominated by middlemen and traders leaving little room for the farmers (Kilima, 2006). Moreover with the domestic rice market liberalization in 2007, traders seemed to have attained greater market power while farmers’ benefits from protection tumbled (Barreiro-Hurle, 2012).

In addressing some of the challenges within the sub-sector, the government in partnership with development partners has undertaken efforts to incorporate key development issues such as gender, environment, and nutritional development efforts in a bid to improve smallholder farmer productivity and profitability within the maize and rice value chains in Morogoro (Kilombero and Mvomero Districts), Dodoma (Kongwa district), and Manyara (Kiteto District). Such efforts include the NAFAKA Staples Value Chain Activity (ACDI/VOCA, 2014). The government has further instituted initiatives such as the Tanzania Agriculture and Food Security Investment Plan (TAFSIP) which provides a detailed and budgeted national sectoral plan developed through an inclusive Comprehensive Africa Agriculture Development Programme (CAADP) process and highlights investment priority areas such as rural infrastructure, market access and trade among others (URT, 2011; Gabagambi & Damian, 2013); SAGCOT corridor offers a flagship initiative for achieving the goals of TAFSIP through private-sector engagements and bears the objective of fostering inclusive, commercially successful agribusinesses that will benefit the region's small-scale farmers, and in so doing, improve food security, reduce rural poverty and ensure environmental sustainability (SAGCOT, 2011); improving the enabling environment e.g. reviewing lifting crop cess (Nyange et al., 2014), and waiving VAT on agricultural equipment (Grow Africa, 2013). Another example of a government program to boost agricultural production and productivity is the Voucher System (NAIVS) who's scaling up was sponsored jointly under the World Bank's Accelerated Food Security Project (AFSP) in 2009 targeting smallholder maize and rice farmers (World Bank, 2014). The project augurs well with Government's longer-term objective of promoting adoption and efficient use of critical productivity enhancing inputs.

2.5 Empowerment, Technical Efficiency and Market Participation: General Perspectives

2.5.1 Empowerment: A brief review of key issues pertaining to agriculture

There has been deliberate government effort to empower smallholder farmers and incorporate gender issues while at it. Empowerment however has not been equally achieved by men and women in agriculture thus there exists a gender gap (UN Women et al., 2015). It has been reiterated that women's rights are rights too (Salaam, 1979) and Tanzania has signed and ratified or acceded to a number of international and regional human rights instruments such as The

Universal Declaration of Human Rights (Hannum, 1995; UN General Assembly, 1948); International Covenant on Economic, Social and Cultural Rights (UN Economic and Social Council, 2009); International Convention on the Elimination of All Forms of Racial Discrimination (UN General Assembly, 1965; Kombo et al., 2013); Convention on the Elimination of All Forms of Discrimination Against Women and its Optional Protocol (UN General Assembly, 1979); The African Charter on Human and Peoples' Rights (OAU, 1981); Convention Governing the Specific Aspects of Refugee Problems in Africa (OAU, 1969)

The formal legal framework protecting women's rights to property in Tanzania is strong within the existing legislation (Duncan, 2014). The constitution of the United Republic of Tanzania, 1977 upholds women's rights in all socio-economic and political spheres. Notable clauses such as Article 9 of the Constitution accords the same opportunities to all citizens; Article 12 declares that all human beings are born free and are all equal (URT, 1977); law of marriage Act also provides for the woman within a legally recognized marriage to have the same right as has a man to acquire, hold and dispose off property, whether movable or immovable, and the same right to contract, the same right to sue and the same liability to be sued in contract or in tort or otherwise (Law of Marriage Act, 1971).

Additional actions have also been undertaken at the national level, for example, government incorporated within its National Development Vision 2025 a goal of attaining gender equality and the empowerment of women in all socio-economic, political relations, and culture by the year 2025 (URT, 1999; Luukkanen et al., 2015); government developed the Sub-program for women/gender advancement with core areas highlighted as, enhancement of women's legal capacity; economic empowerment of women and poverty eradication; women's political empowerment in decision-making and enhancement of women's access to education, training and employment (URT, 2005) and also provided safe atmosphere for women's rights activism carried out by several women's rights advocacy groups such as Gender Land Taskforce, Tanzanian Women Lawyers Association (TAWLA), Women's Legal Aid Center (WLAC) among others (Pedersen and Haule, 2013). Within the legal framework, with regard to resource ownership and use, in agricultural production land is a critical resource. The ownership and use of land in Tanzania is governed by the land Act, 1999 (URT, 1999). According to the Land Act of 1999, the State holds the title to all land in Tanzania. The President, through the Commissioner of Lands, has authority to grant a right of occupancy for up to 99 years. Notably, land is divided into i) general land ii) village land and iii) reserve land.

The Village Land Act governs village land, (which includes communal village land, which cannot be used for individual occupation; land occupied or used by an individual/family/group of persons under customary law; and land that can be allocated by the Village Council for communal or individual occupation). Under the Village Land Act, the Village Council is legally responsible for the management of village land as a trustee managing property on behalf of the beneficiaries, the villagers. However, a Village Council is not allowed to allocate land or grant a customary right of occupancy without prior approval of the Village Assembly. The Village Land Act upholds customary rules on land, but provides that the customary rule or any action dependent on the rules shall be void to the extent to which it denies women, children or persons with disability lawful access to ownership, occupation or use of any customary land (Village Land Act, 1999).

The Land Act No.2 of 2002 established Land Tribunals whose composition required not less than 43 percent women (URT, 2002). The Land Act No. 4 of 1999 was amended in 2004, to make land economically valuable and allow for mortgaging in order to access financial resources for investment (URT, 2004) and, this was noted as a gender aware reform (Knight, 2010). In operationalizing the framework for women empowerment, the National Gender Machinery was instituted to coordinate the implementation of the Beijing Platform for Action (1995) and the Beijing + 5 Political Declaration and Outcome Document (URT, 2005). The machinery also collaborates with sub-regional and regional mechanisms such as those of the Southern African Development Community (SADC), the East African Community and African Union, the United Nations Economic Commission for Africa (UNECA) and the African Centre for Gender Development (ACGD) Ellis et al. (2007).

Within the agricultural sector, the government has worked in close partnership with development partners to empower women engaging in agriculture using programs such as the Women Development Fund (WDF), which is supported by the government through the National Gender

Machinery and complimented by the local councils (URT, 1993) and provides credit to women in all the 114 Local Councils. There are also other funds, established by development partners such as; CREW Tanzania, (Makombe et al., 1999).

With the targeted efforts, Tanzania has made strides towards the empowerment of women and indeed achieved the SADC's 2005 and the 1995 Beijing Platform for Action's target of 30 per cent women's parliamentary representation (Yoon, 2011). Additionally, a 2012 Gender Diagnostic Study carried out for the Ministry of Community Development, Gender and Children in Tanzania indicated that at the time 29 percent of female public sector workers were in leadership positions.

Albeit the machinery in place and noticeable achievements at the macro level there still exists gaps impeding the achievement of similar stellar results within the micro level such as specific to the agricultural sector. In spite of the key role that women play, they are still over represented in the agricultural sector when compared to men (Fox, 2016) and yet their productivity within the sector remains very low and there exists a gender gap[1] between men and women (UN Women et al., 2015); women experience limited access to land (Odeny, 2013; Moyo, 2017), extension services (Due et al.,1997; Mbo'o-Tchouawou and Colverson, 2014; Lyimo-Macha and Ntengua,

[1] Agricultural productivity is defined as the value of output per hectare- the difference in this measure between male and female farmers constitutes the unconditional gender gap (UN Women et al., 2015).

2002), complementary agricultural inputs (Mukasa and Salami, 2015); are marginalized and have very limited decision making power (Kweka, 1998; Lyimo-Macha and Ntengua, 2002); are still less likely to hire male labour (especially male labour) for their agricultural plots yet Mukasa and Salami (2015) in a study on Nigeria, Uganda and Tanzania argue that family members working on farm and hired male workers are more productive than other types of labor inputs. Moreover, female farm managers within Tanzania were generally described as less educated, have fewer household members; are older than all the other farm managers and, invest in lower value crops (UN Women et al. 2015). For a key resource such as land, according to the gender score card computed by African Union Commission (2015), in this gender dimensions, the country scores poorly with just 2 out of 10 in the African gender scorecard, indicating persistent inequality in access to and ownership of land.

Generally ILO (2016) observes that women are over-represented in agricultural occupation, with relatively low productivity and rewards; moreover, in Southern Asia and sub-Saharan Africa, over 60 per cent of all working women remain in agriculture, often concentrated in time-intensive and labour-intensive activities, which are unpaid or poorly remunerated. ILO (2016) further highlights the gender bias arguing that women are more likely than men to work short hours, whether voluntarily or against their choice (thus finding themselves in "time-related underemployment). Additionally, Chen (2008) in examining women and employment in Africa observes that women tend to work fewer hours per day in paid work but longer hours per day in unpaid household or care work. Specific to the Tanzanian case, Leavens (2011) confirms that women represent a substantial portion of the agricultural workforce in Tanzania and Yahya, & Xiaohui (2014) observes that women's ability to contribute to agricultural production is largely constrained by their limited control of productive physical and human capital. The HDI which reflects gender inequalities in achievement in the three dimensions of the HDI: health, education and command over economic resources further highlight that for Tanzania the achievement between male and female is 0.937 with males attaining 0.546 while females attained 0.512 and Tanzania is therefore classified as a group 3 country comprising countries with medium equality in HDI achievements between women and men.

Aside from the gender gap highlighted and in spite of the existing laws, the existance of the customary law alongside the constitution poses a challenge for actual implementation of the provisions of the law in a way that would fully grant women access and control over land to as much an extent as enjoyed by the men. Pedersen & Haule (2013) acknowledge that indeed Tanzania has within its legislation instituted a framework that abolishes discriminatory practices against women and includes women within the state backed village authorities that govern land allocation and ownership. However, they do highlight the gap between the legal framework and what is happening on the ground, primarily due to customs. This difference has resulted in ambiguity that often leads to a less favorable position for women. An example of the ambiguity in land use has been discussed by Dancer (2017) who identify the various modes of land acquisition in Tanzania as i) inheriting land through lineal descent, a will religious or religious norms, ii) village governments allocating village land to their citizens (both women and men), iii) individuals or married couples ‘self-acquiring’ their interests in land through purchase, lease or by making permanent improvements to the land through clearance and cultivation on the basis of adverse possession. Dancer (2017) cautions that control over land varies across these modes of acquisition and individuals have a large measure of control over land they acquire for themselves, and spouses have shared rights in jointly acquired matrimonial property. Additionally, the extent to which women have access and control over land depends on the nature of the communities; Leavens (2011) observes that 80 percent of Tanzania‘s communities are patrilineal and the customary land tenure common in these communities favor male heirs, and do not bequeath land to the widow upon a man‘s death. Additionally, most women have usufruct rights to land and therefore face many challenges in enforcing property rights in Tanzania (Moyo, 2017) thus limiting development of their agricultural activities. Besides under customary law, there are three “tiers” of inheritance by descendants from the lineage i) First degree heirs (firstborn son from the first house) ii) second degree heirs (all the other sons) iii) third degree heirs (daughters). As per the local customary law, if a deceased man has no lineal relatives, his brothers, paternal uncles and aunts, and wife are considered heirs but, no share of the deceased’s estate goes to a widow so long as survivors include relatives of the deceased’s clan.

In other cases, women are able to inherit and use land but still unable to dispose it off such as the case of Ephraim Bernado vs Holaria Pastory (1990) highlighted in Pedersen & Haule (2013); this limits their ability to make use of such resources to acquire credit or betterstill to gain alternative investments and improve production. The problem is compounded by the fact that this system is dominant across the country given that women form 52 percent of labourforce in crop production as per the recent study by Palacios-Lopez et al. (2017) [who sought to correct popular belief that women contribute 60-80 percent of the labourforce in crop production] and are mainly employed in the rural agricultural sector and Moyo (2017) notes that statutory land tenure is predominant in the urban areas while the rural agricultural areas are predominantly under customary land tenureship.

A number of studies highlight the benefits of women empowerment which goes beyond the agricultural sector. Farré (2012) observes that expanding woman's opportunities in areas such as health, education, earnings, rights, and political participation - drives down gender inequality and accelerates development. Importantly, women empowerment has been reported to have a positive effect on the family welfare through channels such as nutrition, education and health among others. For example in Bangladesh, greater empowerment of women (measured by attitudes toward abuse, decision making power, and mobility) and maternal endowments such as education and height were associated with greater dietary diversity scores and reduced child stunting (Bhagowalia et al. 2012). Hatlebakk & Gurung (2016) conducted a family survey in

Nepal to investigate whether female empowerment leads to more education particularly for girls using the relative economic power of the male and female side of the extended family as an instrument for female empowerment; they found a positive association between female empowerment and children's literacy levels. Calvi, et al (2017) in a study in India on the effect of women empowerment on health conclude that women empowerment measured as women's control of substantial household resources improves their and their children's health. Moreover Ross et al. (2015) in a study on women empowerment in Ghana found that while empowering women is a goal within itself to achieve gender equality, their results indicate that women empowerment can lead to achieving other development goals through its effect on women's health status, such as gains in human capital formation and improved agricultural productivity.

2.5.2 Technical efficiency of smallholder farmers

Technical efficiency of production is an issue that has been of interest to scholars; farm households are said to be poorer than other households (Lokina et al., 2011). Efficient use of their scarce resources is therefore very important. A number of studies on the Tanzanian agricultural sector such as Kangile (2015), Kidane et al. (2013) and Msuya & Ashimogo (2005) highlight the existence of inefficiencies in utilization of capacity for agricultural production. Specific to the rice subsector even with rice considered a priority crop, Ringo et al. (2012) argue that Tanzanian rice productivity remains lower than most neighbouring countries and is one of the lowest in the world.

A number of issues have been highlighted as contributing to the such inefficiency; Kidane and Ngeh (2015) attribute inefficiency to household characteristics (age, primary educational attainment, household size, farm size and household health), Muange et al. (2015) cite social networks and, Baha et al. (2013) highlight lack of productive resources such as land, extension, insecticide. Moreover specific observations have been made attributing the lack of control over key productive resources such as land and credit to reduction in productivity of women (Ishengoma, 2004). For the rice sub sector, within which women have been cited as playing a key role in production (URT, 2009), empowering women can lead to gains in technical efficiency even as noted by Seymour (2017) in a study in Bangladesh who found that reduced gender disparities within households (measured in terms of the empowerment gap between spouses) are associated with higher levels of technical efficiency.

2.5.3 Market Participation by small holder farmers

Nonetheless, increasing technical efficiency per se is not sufficient in improving welfare outcomes for farming households. Avenues for market exchange of output produced are a pathway to income generation for smallholder farmers; Lerman (2006) in assessing changes in land use and their impact on rural incomes in countries of the former Soviet Union found market participation resulted in higher family incomes - both directly due to increased production, and indirectly as a result of additional revenue from sales. Furthermore, market access and market participation avail farmers with the opportunity to reap the benefits of increased efficiency in production, which includes increased agricultural based economic growth and enhanced rural incomes. A study by Rios et al. (2009) analyzing the correlation between farm productivity and market participation using comparable household data from Tanzania, Vietnam and Guatemala concluded that increases in agricultural marketing may be productivity-enhancing over time. In addition, market participation increases household welfare by enabling the household produce commodities for which it has a comparative advantage while sourcing other necessary commodities from the market by trading the commodity it produces (Barrett, 2008). Moreover, marketing activities such as processing, transportation and selling provide avenues of employment for smallholder farmers willing to exit the farming sector (Jari and Fraser, 2009). Additionally, with regard to the empowering reach of market participation, Lenjiso et al. (2016) note that in market participating households there is dependency between husbands and wives, and a woman's bargaining position is also stronger.

The preceding discussion highlights the key issues pertaining to women empowerment, technical efficiency and market participation. Women empowerment fosters the expansion of women's ability to make choices in relation to household production and their own participation in agricultural activities. The expansion of these choices provides avenues for enhancement of technical efficiency of production and the resultant increase in output can be exchanged in the market to improve household income and welfare.

2.8 Conclusion

In conclusion, the Tanzania economy is largely agrarian and rice has been identified as a strategic crop which can be used to boost incomes of farmers and food security. Tanzania has a comparative advantage and is the second largest producer of rice in the Eastern Africa region and stands to gain from exploiting the existing market in the trading bloc. Women play an important role in agricultural production and in rice production as well; they however still face challenges in accessing productive resources such as land. Tanzania has instituted several policies in place to address challenges faced by farmers in general and female farmers in particular through a legal framework and by ratifying international agreements. With this policy direction, Tanzania has made noticeable achievements in empowering women but there still remains gaps which need to be addressed especially in light of the existing cultural norms and societal customs with regard to women and specifically at the micro level of the economy such as within the agricultural sector. Addressing these gaps can have an effect on agricultural production and market participation since women play an important role in agricultural production. Moreover, specifically empowering women has been noted to have a positive effect on other household welfare outcomes such as child nutrition, girl child education and gains in human capital formation.

CHAPTER THREE

WOMEN EMPOWERMENT: ACHIEVEMENT AND DETERMINANTS

3.1 Introduction

The chapter seeks to i) estimate the level of intra-household women empowerment and, ii) identify the determinants of intra-household women empowerment. The first objective of this chapter is addressed using the recently developed Women Empowerment in Agriculture Index (WEAI) which measures women empowerment in 5 different domains (production, resources, income, leadership and time) and gender parity between the primary male and primary female members to assess intra-household women's achievements in empowerment in the 5 domains. The second objective of this chapter is addressed by applying the ordinal logit analysis within which ordinal scales use numbers to indicate rank ordering on a single attribute (Long, 2014) which in this case is the level of empowerment attained by the females in their respective households.

Within this chapter, the evolution of women empowerment as a concept is explored together with how it found its way into mainstream development agenda; a review of some studies that define women empowerment and place it within society's context is done. In reviewing the context, focus is laid on the household as the basic unit of analysis and thus the chapter examines household decision making which forms a basis for power play within the household. Analysis of household decision making has also evolved over time and so have the models for household decision making in order to capture the dynamics of decision making process within the household, the progress in the models for analysis is also discussed. The chapter further reviews literature on the possible determinants of women empowerment.

A few studies have been undertaken on Tanzania to examine women empowerment and its determinants (Kandus and Waiganjo, 2015; Jeckoniah, 2013; Losindilo et al., 2010 and Kato and Kratzer, 2013) studies specific to the rice sub sector which has been given priority in policy and support both by government and development partners remain scarce and this is a gap the chapter seeks to address.

Results from analysis are presented starting with descriptive results for the variables used, the women empowerment in agriculture index and, the ordinal logit analysis results indicating the determinants of women empowerment.

3.2 Women empowerment: A review of historical Perspectives and concepts

Empowerment is a term that has been adopted in development literature and has been widely used. Women empowerment specifically came to light during the 1970s with concerns about women's problems raised by studies such as Rubin (1975) in Rubin (2009); Oakley (1972) in Oakley (2015) and highlighted through work by scholars such as Boserup (1970) in Jacoby (1972). Following evidence based research such as reviewed in Boserup (2017) and international recognition through the international women's year, women's concerns entered the public debate

(Jahan and Schwartz, 1975). This was followed by declaration of the decade for women 1976-1985, a period during which women's issues could be debated at the national, regional and international levels (Tinker and Jaquette, 1987; Ghodsee, 2010), women empowerment found its way into mainstream development agenda in 1995 at the fourth World conference in Beijing (Pietilä and Peoc'h, 2007). Signatories to the Beijing Platform for action pledged to advance women's empowerment (UN, 1995). At the dawning of the new millennium, women empowerment made it to the list of development goals of the new millennium (UN, 2000) as goal number three, and with the Sustainable Development Goals, (UN, 2015) it is Goal number 5 geared at achieving gender equality and empowering all women and girls.

From the second half of the 1970s upto the new millennium, a critical time when women empowerment made its way into the international development dialogue, much of Africa was faced with post colonial adjustments and economic stagnation even as Heidhues & Obare (2011) note that the economies slowed down in the 1970s and stagnated in the 1980s thus necesitating the stabilization and structural adjustment policies of the IMF and the World Bank which lasted between 1980-1999. Discourse on key issues about women empowerment took place during the period with a Copenhagen conference in 1980 and a conference in Nairobi in 1985 (Tinker & Jaquette, 1987). Additionally, the opening up of discussions on women's issues required crossing the cold war geopolitical divide between the East and the West. Although a number of African states had chosen a non-allignment policy in terms of the cold war, having the women empowerment dialogue during that period left many African nations at a cross-roads in terms of policy pursuit; the season was characterized by postcolonial, neo-colonial, structural adjustment clamor. With the dawn of the new millennium came the MDGs and adoption of poverty reduction strategies for many African countries while the women empowerment dialogue entered its BPA+ 5 assessment period. A clear African agenda on the women empowerment discourse came decades after the UN decade for women as the African Union declared the African Women Decade for 2010-2020 with a goal of enhancing the implementation of African Union countries' commitments related to gender equality and women's empowerment and to support activities resulting in tangible positive change for African women at all levels Olowu (2011). So in general, Africa's progress in the dialogue on women's issues has not been at par with the rest of the world due to a number of reasons and it appears to have been a late starter in this particular development dialogue.

In pursuit of economic development, some terms have been coined to highlight the importance of acknowledging the role of women in the process. The Women In Development (WID) approach developed in the 1970s by The Women's Committee of the Society for International Development under influence of Esther Boserup (Moser, 1993) calls for greater attention to women in development policy and practice, against the traditional view that men are the producers and household heads, and emphasizes the need to integrate women into the development process. Examining statistics, Rathgeber (1990) and Välimaa (2004) argue that women had fared less well- in terms of development interventions; WID accepted existing social structure and did not examine why women had fared less well from development strategies (Jacka, 2006).

During the period of its application, WID largely focused on work while ignoring the reproductive side of women's lives (Tasli, 2007). Following the realization of the downside of WID approach, the GAD (or Gender and Development) approach was developed in the 1980s and has its theoretical underpinnings in socialist feminism and links production to reproduction relations thus looking at a woman's life holistically (Jaquette, 1982). Moreover Oakley (1972) and Rubin (1975) raised concern that women’s problems had been viewed in terms of their sex (biological difference from men) rather than their socially constructed relations (gender). It is this socially constructed basis of differences between men and women and, the need to challenge existing gender roles and relations that GAD as an ideology focuses on (Connelly et al., 2000).

By definition, women empowerment is a process by which women become able to organize themselves to increase their own self-reliance, to assert their independent right to make choices and to control resources which will assist in challenging and eliminating their own subordination (Malhotra and Schuler, 2005). Sultana (2012) defines women's subordination as a situation, where a power relationship exists and men dominate women. Subordination though, is not without a number of downsides; Sultana (2012) indicates that subordination destroys women’s self respect, self confidence and self esteem and sets limits on their aspirations. Additionally, aside from the limitations that subordination sets on women, Corbett (2009) cautions that women who bow down to patriarchal rules are not necessarily guaranteed happiness and may suffer dominance and victimization. Subordination shows the existence of unjust and unequal power relations across gender in society and absolutely goes against the UN (1948) universal declaration of human rights which states that, “All human beings are born free and equal in dignity and rights”. It is this unequal and unjust power relations problem that women empowerment seeks to address. Caroline Moser defines women's empowerment through the lens of self-reliance and building internal strength; to her, women empowerment is the capacity of women to increase their own self-reliance and internal strength. She develops a framework based on her concepts of gender roles and gender needs, and policy approaches to gender and development planning (Moser, 1993).

In order to understand the concept of women empowerment, examining the interaction of women with men and the society that they live in provides a more objective picture. Indeed this view is supported by Mason (2003) who argues that studies on women empowerment need to focus on the rights, obligations and resources granted to females versus males under different gender systems rather than on the characteristics of individual women. Women empowerment is thus a phenomenon that can suitably be placed within a context (Porter, 2013) and at best has its roots within the household as a basic unit of society; Maholtra and Schuler (2005) suggest that the household is central to gender relations, and they review several studies at the household level of data collection and analysis. Infact the household is a basic unit of analysis of the behaviour of society and it is within this complex unit that women empowerment begins (Kato and Kratzer, 2013). Domestic decision making power is thus an important dimension of empowerment (Chien, et al., 2012; Anderson et al., 2017).

3.3 Household Decision Making: A review of models for analysis

A number of models for analysis of decision making within the household have been developed and these we review within our analysis of women empowerment. The Samuelson's (1956) consensus model exhibits the conditions under which family behaviour can be rationalized as the outcome of maximizing a single utility function. The model depicts a two-member family consisting of a husband and a wife each of whom has an individual utility function that depends on individual's private consumption of goods (Lundberg and Pollak, 1996). The individuals by consensus agree to maximize a social welfare function of their individual utilities, subject to a joint budget constraint that pools the income received by the two family members (Rode, 2011). Their aggregate expenditure pattern can then be analyzed as though the family were a single agent maximizing a utility function (Lundberg and Pollak 2007). The model however did not indicate how consensus is reached (Dauphin and Network., 2001). Becker (1991-1992) altruist model sought to address this shortcoming and argues that the household with a single set of preferences combines time, goods purchased in the market and goods produced at home to produce commodities that generate utility for the household (Lundberg and Pollak, 2007). The altruist model assumes that there exists a welfare function within which all resources are pooled together – capital, labour, land and information (Beninger & Laisney, 2002). This has however been criticized due to its restrictive nature given that allocation within the household may be conflictual (Sen, 1984) and also due to the fact that models for marriage and divorce require agents to be able to compare their expected utility within marriage and outside marriage. A key shortfall of the above common preference models is the aggregation of preferences (Hildenbrand, 1994) thus the expected utility of the husband and wife cannot be recovered from the social welfare function that generates labour supply, consumption, fertility etc (Lundburg & Pollak, 1996). Additionally, the consensus and unitary models assume that that the distribution of income or assets or other measures of bargaining power within the household (holding all else constant) does not affect outcomes (Doss, 2013). It has however been proven that distribution of bargaining power or assets within the household does affect both individual and household outcomes (Schmidt, 2012; Djebbari, 2005 and Wang, 2014).

Another set of models of family behaviour are the cooperative bargaining models that recognize the existence of two or more individuals with distinct preferences (Vermeulen, 2002; Pollak, 2003) in determining family consumption. In a typical bargaining model of marriage, the family consists of a husband and wife with each having their own utility function that depends on consumption of private goods (Lundberg and Pollak, 1996). If agreement is not reached, the payoff received is a threat point which is essentially utilities associated with a default outcome of divorce or a non-cooperative equilibrium within marriage. Lundberg & Pollak (1993) propose an alternative Nash bargaining model in marriages within which the relevant threat point for the Nash bargaining solution should be not divorce, but an “uncooperative marriage” with spouses reverting to a “division of labor based on socially recognized and sanctioned gender roles.” In the noncooperative marriage, the husband treats the level of public good chosen by his wife as fixed and chooses quantities of his private good and the public good that he supplies so as to maximize his own utility, subject to his budget constraint. Similarly, the wife treats the quantity of the public good supplied by her husband as fixed and chooses the level of her private good and the public good that she supplies to maximize her own utility, subject to her budget constraint leading to a pair of reaction functions that determine a Cournot-Nash equilibrium in which the public goods contributions are inefficiently low. An important characteristic of this noncooperative equilibrium, which serves as the threat point in the separate spheres model, is that the husband's utility depends upon the resources of his wife through his consumption of "her" public good and vice versa. This is not to say that there are no female or child headed households, but rather for some empirical analysis some studies have adopted the two- decision maker scenario out of its simplicity. There have been variants of the family with the female headed households, child headed households as well as the elderly male only or female only adult households. In the female headed household, the woman provides the public good and private good from which she and the household members under her care derive utility subject to her budget constraint. The dual adult (male headed households) and the female headed households introduce a gender dimension to decision making within the household. While in the male headed household both the husband and wife provide a public good and private goods from which utility can be derived, for the female headed households, only the female provides goods from which utility is derived and therefore the household outcomes might be lower than in comparable male headed households. Arias and Palloni (1996) observe that female heads take on the dual role of economic providers and family nurturers without, in most instances, the direct assistance of males or the support of traditional kinship and family networks. An example has been given in an analysis of improved maize technology adoption in Ghana, Doss and Morris (2000) find that while women farmers are less likely to adopt improved varieties of maize and fertilizer, the gender differences in adoption are explained by gender-linked differences in access to complementary inputs. However, in female headed households, women are less likely to adopt improved varieties, even after controlling for these other factors. Thus, women farmers in male headed households are able to bargain within their household to obtain some of the unobservable factors that are needed to adopt these technologies. Female headed households are not able to do so. This last example gives a case that we would like to explore in our study- having the male/female adult households and the female headed households within a framework. Female headed households can be classified as *de jure* female headed households or the *de facto* female headed households (Horrell and Krishnan, 2007; Hossain and Huda, 1995). Within the *de jure* female headed households, the men are completely absent due to separation, divorce or death while for the *de facto* female headed households, the men are temporarily absent (Moser, 1993).

In our study, we consider the dual adult male headed households and the *de jure* female headed households.

3.4 Determinants of women empowerment

Morrisson and Jütting (2005) in measuring different aspects of constraints imposed on women by social institutions argue that social institutions are, the most important single factor determining women's participation in economic activities outside the household. While social norms can be a limiting factor to women empowerment, some studies suggest mechanisms that women are using to address the limitations imposed on them by social norms through collective action in social groups. Collective action is defined as the provision of public goods (and other collective consumption) through the collaboration of two or more individuals (Evans and Nambiar, 2013).

Credit programs have widely received acclaim in empowering women; Bali Swain and Wallentin (2009) argue that credit programs lead to a greater value for women in household decision making process but also improve other aspects of women empowerment such as access to financial and economic resources, social networks, greater bargaining power within the household and freedom of mobility. Results show that most of the females who accessed microcredit become socioeconomically empowered through acquiring self-esteem, business skills, confidence level, decision making power, etc.

Personal and household characteristics have also been found to affect women empowerment in addition to the community characteristics and social context. For example Wiklander (2010) uses household level data to investigate the determinants of women's empowerment and the presence of gender-related constraints within the household in rural India. Her definition of women empowerment includes mobility, voice, decision making in the family, property rights and freedom from domestic abuse. Her finding is that women empowerment is determined by age, education (both men's and women's), income, district and village, age at marriage, whether a women ever had a stillbirth, the number of sons in the household, husband's presence in the household. She thus concluded that social norms and intra-household gender-related constraints greatly influence women's possibility of being empowered.

Trommlerová et al. (2015) use custom-made household-level information and advanced econometric techniques that correct for endogeneity to examine what empowers individuals in the Gambia to change their own lives and affect changes in their communities. They find that age, gender, marital status, nationality, economic activity, and health are important determinants of empowerment at both communal and individual level.

The importance of marital status has also been highlighted in Kamal and Zunaid (2006) in predicting agency in Bangladesh. Allendorf (2007) finds that women's place in the family structure is the most influential source of empowerment in Nepal: the odds ratio for being the wife of the household head (rather than a daughter-in-law or sister in-law) is not only significantly larger than all the others, but also many times the size of the others. In the cases of widows and abandoned women generally there is no male member to control or govern their families; eventually their involvement in economic activities raised their level of empowerment significantly. Largely what underlies the importance of marital status in affecting women empowerment is patriarchy, which is defined as the male domination both in public and private spheres (Sultana, 2012); thus the absence of a man within the household leaves room for reflection of a level of women empowerment within those households a result observed by Jan and Akhtar (2008).

Some studies have looked at empowerment from a human capital point of view arguing that in developing countries addressing human capital needs can therefore result in empowerment. Bandiera et al (2014) examine how high youth unemployment, early marriage and childbearing interact to limit human capital investment and enforce dependence on men by evaluating a policy intervention attempting to jump-start adolescent women's empowerment in Uganda. Their finding is that the intervention relaxes the human capital constraints that adolescent girls face by simultaneously providing them vocational training and information on sex, reproduction and marriage. They therefore suggest that women's economic and social empowerment can be jump-started through the combined provision of hard and soft skills, in the form of vocational and life skills, and is not necessarily held back by binding constraints arising from social norms or low aspirations. Additionally, returns to human capital may increase men's incentives to share power with women (Doepke and Tertilt, 2008) although Mitra (2007) cautions that high educational attainment alone will not promote gender empowerment unless the social and cultural fabric of a country or state ensures equality of women in all areas of life.

Resource ownership has been known to foster empowerment of women particularly ownership of land. Allendorf (2007) indicates evidence of a positive correlation between land ownership and women's say in household decision making in a study of households where women held land titles in Nepal and, Mason and Smith (2003) in five Asian countries (Pakistan, India, Malaysia, Thailand and the Philippines). Land ownership also affects other dimensions of empowerment such as reduced domestic violence against women in intrahousehold violence against women (Panda and Agarwal, 2005). Nonetheless uncertainty of land tenure continues to prohibit women's decision making on the use of land in positions such as landlords. Moreover under joint ownership especially of land under customary ownership, upon death of the husband, separation or divorce it becomes hard for the woman to exercise rights of ownership over the land given the restrictions imposed by that mode of ownership (Meinzen-Dick et al, (2009). The situation is exacerbated by the gap between law and practice which leaves the land issue in balance moreso, amongst communities in Sub Saharan Africa where property rights concerning land are defined by customary laws which are typically mediated at the community level and usually are patrilineal (Knox et al., 2007).

Education has also been cited as a key determinant of women empowerment; Parveen and Leonhäuser (2004) in a study on Bangladesh deduce that while formal and nonformal education, information media exposure and spatial mobility positively affect women’s empowerment, traditional socio-cultural norms have a strong negative effect on women empowerment. Jejeebhoy and Sathra (2001) in studying three regions in India and Punjab, Pakistan argue that education and work status predict empowerment in all three sites but only secondary education mattered. Arguments have nonetheless arisen indicating that education is only a necessary and not a sufficient investment in the pursuit of gender equality and improvement of women’s well-being. In addition, only secondary or higher levels of schooling lead to improved options, opportunities, and outcomes for women for example in support of this argument Kamal and Zunaid (2006) in a studying education and women empowerment in Bangladesh find that secondary education is important in explaining women empowerment.

Specific studies have looked at women’s empowerment in Tanzania; Jeckoniah (2013) in exploring the linkage between women’s participation in onion value chain development activities and their empowerment uses a composite women empowerment index in Simanjiro. The study argues that empowerment increases with education attainment, age at first marriage and women's income. Although Jeckoniah (2013) argues that education attainment is an important influence on women empowerment, teenage education has had mixed signals for example in a study looking at women's participation in social, political and economic activities in Mainland

Tanzania, Losindilo et al (2010) reviews factors that affect women's participation in those three spheres mentioned. The finding indicate that place of residence, age group and region of residence are significant while education and religion are insignificant factors in hindering women from participation.

In Tanzania, it has also been argued that micro credit contributes to empowerment of women. In a study exploring the impact of microfinance on female entrepreneurs, Kato and Kratzer (2013) suggest that there exists a significant difference between the women members of MFIs and non-members in the dependant variables related to women empowerment; therefore women members of MFIs have more control over savings and income generated from the business, greater role in decision-making, greater self-efficacy and self-esteem, and greater freedom of mobility and increased activities outside home. Cooper (2014) explores the effects of microfinance on the success of female entrepreneurs in Tanzania. An analysis of the impact microfinance policies on three measures of entrepreneurial success – average monthly net income, months of business operation, and the presence of employees outside of the household shows that microfinance has a positive effect on entrepreneurs. Gogadi (2011) confirms the important role played by micro finance in empowering women in a study focusing on PRIDE and more important, shows the pathway through which it affects women empowerment. Specifically, the study reviews services offered by PRIDE in empowering women and identifies the factors hindering PRIDE in empowering women economically. Findings indicate that services offered by PRIDE (T) help to empower women economically through improved entrepreneurship skills, services also contribute to reduction of poverty and lead to job creation. Microfinance institutions also provide an avenue for collective action by women which further enhances the range of areas where they can bargain thus resulting in empowerment. Collective action is indeed confirmed by a cross section of studies such as Baden (2013) who looks at women's collective action in Ethiopia, Mali and Tanzania and concludes that improved empowerment outcomes are associated with membership to collective action groups. Moreover, women in collective action groups have more decision-making power over the use of credit.

Culture does play a key role in affecting women empowerment even as earlier indicated; in a study of social cultural factors affecting Maasai women's participation in decision making in Longido district, Kandus and Waiganjo (2015) finds that Maasai women's participation in decision making is limited by social cultural factors like social identity, social acceptance, social roles and limiting cultural practices. But what do we mean by culture? Geertz (1973) defines culture as a set of control mechanisms for governing of behaviour. Culture therefore shapes the attitude of society towards women and Sardenberg (2012) argues that in some cultures to be a woman is to be passive, subservient, and servile and therefore the passive, subservient woman, becomes the stereotype of these cultures. Tanzania is not immune to the effect that culture has on women empowerment, Ellis et al. (2007) highlights the issue following interviews with Tanzanian women entrepreneurs who indicated the reluctance of husbands to allow their wives to engage in business activity, and time constraints due to competing domestic responsibilities.

Moreover they also observed that cultural attitudes affect access to finance, ability to attend trainings and access to business development services. The women therefore often remain tied to small-scale and informal activities that are flexible to reconcile with their domestic obligations. Ellis et al. (2007) highlights other pathways through which culture affects empowerment as minimisation, naturalisation, and cultural sexism which allow the complexity of inequality to be overlooked.

Employment plays a key role in women empowerment and Tanzania has shown a high rate of women's labour force participation (Heintz and Valodia 2008b). Nonetheless, Chen (2008) observes that women are overrepresented in the informal sector, which is characterized by poor wages, insecure working conditions. Moreover, joining the informal sector has been classified as moving in the wrong direction, from more productive to less productive activities, including, most notably, informality' (McMillan & Rodrik, 2014) in the context of economic growth. Notwithstanding, Foster et al. (2012) in a study in solid waste management in Zambia and Tanzania conclude that whilst there is evidence of a traditional gendered division of labour, with notions of 'men's work' and 'women's work', such work in the informal economy, offers women opportunities to improve their lives.

In conclusion, literature shows that women empowerment is a concept that has attracted worldwide attention given the various countries where studies have been carried out; and has been defined and redefined showing that it is a dynamic concept and not static through time. Moreover, its determinants are also just as diverse as the context within which it is studied and can be significant or insignificant depending on the culture, region, institutions and both men’s and women's individual characteristics such as age, education amongst several others. Overall, factors that relax the human capital constraint on women such as education (both formal and informal) and those that relax her resource constraint such as credit access, employment income all grant women a better position within the household bargaining structure thus empowering her. Existing social institutions also play a key role due to the definition of gender roles it gives within the community thus determining how women interact within this gendered context. In conclusion, women empowerment is a multidimensional process and so are its determinants.

3.5 Models and Estimation Procedure

3.5.1 Estimating the Women Empowerment in Agriculture Index (WEAI)

By 1995, with the Beijing Platform for Action, a strong case had been shown for a comprehensive investigation of gender inequality in economic and social arrangements throughout the world; a step that would entail analyses and empirical research. Initially two gender indices were developed; i) the Human Development Index was adjusted to build the Gender-related Development Index (Bardhan and Klasen, 1999) by adding disaggregation of the indicators by sex, ii) the Gender Empowerment Measure departed from these initial indices by focusing on indicators related specifically to women's empowerment issues (Bardhan and Klasen, 1999). The empowerment index does not attempt to measure women's progress in well-being, but, rather, their roles as agents in society. Other gender indices have since been developed such as the Gender Equity Index (GEI) (Social Watch, 2007) which measures the gap between women and men in education, the economy and political empowerment, the gender equality index (Plantenga et al., 2009) all meant to expand on the theoretical positions and conceptual frameworks of the initial gender indices.

Notwithstanding such milestones in development of gender indices, most of those developed have little coverage of the agricultural sector. Moreover, the multi dimensional nature of empowerment makes it difficult to measure (Akter et al., 2017). Additionally, many agriculture-related indicators remain gender-blind a situation that calls for a measurement and monitoring tool which can assess the impact of agricultural interventions on empowerment of women within the agricultural sector (Malhotra and Schuler 2005).

The U. S Agency for International Development (USAID) makes an attempt under monitoring of the Feed the Future hunger and food security initiative to develop an index that tracks adjustment in women's empowerment levels resulting from the initiative. Through researchers at the USAID, IFPRI and Oxford Poverty and Human Development Inititaive (OPHI) the women empowerment in Agricultural Index was constructed. Alkire et al. (2012) develop the Women empowerment in Agriculture Index (WEAI), a survey-based index designed to measure the empowerment, agency, and inclusion of women in the agricultural sector. In developing the index, Alkire et al. (2012) posit that the index can be used or adapted to assess the level of women empowerment within each household and gender parity in agriculture, to identify key areas in which empowerment needs to be strengthened, and to track progress made in empowering women over time.

The WEAI is constructed using a list of variables following the methodology of multidimensional poverty Alkire-Foster (Alkire and Foster, 2011) where each person is identified as deprived or not deprived using available information for household members. It lays focus on variables that the farm household makes decisions about and thus enables the understanding of women empowerment within each household.

The index looks at women empowerment using two sub-indices, the first being the five domains of empowerment in agriculture (5DE) and the second measures gender parity in empowerment within the household (GPI). Women and men self-assess their achievements for each domain; this is important because empowerment has been looked at as bearing an element of human agency and as such, Malhotra and Schuler (2005; pp.6) suggests that "…a fundamental shift in perceptions, or "inner transformation," is essential to the formulation of choices."

3.5.1.1 Computing the Women's Empowerment in Agriculture Index

Table 1: Five Domains of Empowerment in the Women Empowerment in Agriculture Index

Domain	Indicator	Weight
Production	Input in productive decisions	1/10
	Autonomy in production	1/10
Resources	Ownership of assets	1/15
	Purchase, sale, or transfer of assets	1/15
	Access to and decisions about credit	1/15
Income	Control over use of income	1/5
Leadership	Group member	1/10
	Speaking in public	1/10
Time	Work load	1/10
	Leisure	1/10

Source: Alkire et al 2012

In the study the WEAI is constructed using 5 domains and ten indicators for those domains. The second sub index of the WEAI is Gender Parity Index which indicates gender parity in empowerment within the household (Gender Parity Index). It shows the inequality in the 5 Domains Empowerment (5DE) between the primary adult male and female within each household-could be husband and wife usually but in absence of such a setting one can look at the primary male and female decision maker in the household irrespective of their relationship to each other (Sraboni et al.,2013).

With reference to Table 1, the weighted sum of achievements in the indicators are summed up and at a cut off of 80 percent, those below this threshold are considered disempowered while those attaining 80 percent and above are considered empowered. This criteria is adopted from Alkire et al. (2012) who suggest that such an achievement can be compared to an individual being considered as empowered in the 5DE if he or she has adequate achievements in four of the five domains, enjoys adequacy in some combination of the weighted indicators that sum to 80 percent or more, or has an adequacy score of 80 or greater.

We further adopt the following definitions of key components in estimation of the WEAI from Alkire et al. (2012);

With H_p the disempowerment head count ratio, $H_{p=}\frac{q}{n}$ where q is the number of disempowered individuals and n is the total population and, the intensity of disempowerment A_p. Inadequacy score of disempowered individuals is;

$A_{p=}\frac{\sum_{i=1}^{q} c_i(k)}{q}$ where $c_i(k)$ is the censored inadequacy score of individual i and q is the number of disempowered individuals.

The five domains of disempowerment measured as M_0 is calculated as;

$\boldsymbol{M_0 = H_p \times A_p}$ ……………………………………………………………….. 1

From the above disempowerment index, the 5DE can be obtained as;

$\boldsymbol{5DE = 1 - M_0}$……………………………………………………………….. 2

Therefore, the $5DE = H_e + (H_p \times A_e)$ where H_e is the empowered head count ratio same as $(1 - H_p)$ and, A_e is the average adequacy score of disempowered individuals also equal to $(1 - A_p)$.

The 5DE is built based on the disempowerment index M_0, it can be also calculated as;

$5DE = H_e + H_p(A_e)$ ……………………………………………………………. 3

The $5DE$ can increase by increasing number of empowered individuals or by increasing adequacy scores of disempowered individuals.

The Gender Parity Index is constructed using two components;

$H_{GPI} = \frac{h}{m}$ where h is the number of inadequate households in gender parity and m is the total number of dual adult (male headed households) in the sample.

The second componenet of the GPI is the average empowerment gap, and is the average percentage gap between the censored inadequacy scores of the women and men living in households that lack gender parity (I_{GPI});

$$\boldsymbol{I_{GPI}} = \frac{1}{h}\sum_{j=1}^{h} \frac{c'_j(k)^W - c'_j(k)^M}{1 - c'_j(k)^M} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ 4$$

Where $c'_j(k)^W$ and $c'_j(k)^M$ are the censored inadequacy scores of the primary woman and man respectively (in this case they are the spouse and the primary respondent) living in j household and h is the number of households that are inadequate in gender parity.

The GPI is thus constructed as,

$$GPI = 1 - H_{GPI}(I_{GPI}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ 5$$

The GPI score can improve by increasing the percentage of women who attain gender parityH_{GPI} or, for those less empowered than the men by reducing the empowerment gap between the male and female from the same household (equivalent to reducing I_{GPI})

From the above sub components, the Women empowerment in Agricultural Index is estimated as:

$$WEAI = 0.9(5DE) + 0.1(GPI) \quad \text{...} \quad 6$$

The weights of the 5DE and GPI sub-indices are 90 percent and 10 percent, respectively. The total WEAI score is the weighted sum of the overall sample size. Achievement in these scores is set at a threshold for achievement empowerment at 80 percent of weighted indices; Alkire, et al.(2013) suggest this threshold having explored sensitivity of the empowerment classification for different cut-offs and considered an individual as disempowered if his or her inadequacy score is greater than 20 percent.

The women empowerment in agriculture index can therefore be used to determine the level of empowerment of attained by each primary adult male within the household and, the empowerment gap that should be covered in order for them to attain empowerment in the weighted domains.

Having ascertained the level of empowerment, it is possible to compute disempowerment by each index and Alkire et al. (2013) suggest the following formulation for decomposition of each indicator to disempowerment;

$$\boldsymbol{M_{0population} = w_i CH_1 + w_2 CH_2 + \cdots + w_{10} CH_{10}} \text{..} \ 7$$

Where; $w_1$is the weight of indicator 1, CH_1 is the censored[2] head count ratio of indicator 1 and the similar definition for the rest of the weights and their indicators such that $\sum_{d=1}^{D} w_d = 1$.

[2] Called censored because the inadequacies of the women who are not disempowered are excluded so that focus is on the disempowered (Alkire et al., 2013)

The following is adapted in our study since we use six indicators for the five domains as thus

$\boldsymbol{M_{0population} = w_i CH_1 + w_2 CH_2 + \cdots + w_6 CH_6}$ and still $\boldsymbol{\sum_{d=1}^{D} w_d = 1}$..................... 8

The percentage contribution of each indicator d to disempowerment

$\boldsymbol{M_0} = \frac{w_d CH_d}{M_{0population}}$.. 9

With the above formulation, we are able to obtain the contribution of each indicator to disempowerment of men or women in the sample.

3.5.2 Determinants of women empowerment: The Ordinal Logistic Model

In assessing the factors that affect women empowerment, one is faced with a choice of looking at women empowerment as either a continuous, binary or ordinal variable. This study adopts the definition of empowerment as a process (Malhotra and Schuler, 2005) and thus progressive in nature. Ordinal scales use numbers to indicate rank ordering on a single attribute (Long, 2014). The ordinal logit is therefore suitable because it can use choice of numbers to represent progressively more severe categories conveniently and, preserves the "greater than" or "less than" quality of the underlying attribute defining the categories themselves as argued by O'Connell (2006). Ordinal outcomes are analyzed by logistic regression model. Ordering in the achievement of higher levels of empowerment is given consideration; if ordering is ignored, the multinomial logit would be suitable (Long, 2014) but since ordering is important, the ordinal logit is used. The model for the ordinal regression model is derived from a regression on an unobserved, continuous variable y^*

$$y_i^* = \beta_i x_i + \varepsilon_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 10$$

Where;

ε_i is logistic with a mean 0 and variance $\pi^2/3$

The continuous y^* is divided into observed, ordinal categories using the

Thresholds τ_0 through τ_J

$$y_i = j \text{ if } \tau_{j-1} \le y_i^* < \tau_j \text{ for } j = 1 \text{ to } J \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 11$$

Where $\tau_0 = -\infty$ and $\tau_J = \infty$

Structure of the model can be looked at using cumulative probabilities of being less than or equal to category j

$$\Pr(y \le j / x) = \Pr(y^* < \tau_j / x) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 12$$

$\Pr(y \le j / x) = \Pr(\varepsilon < \tau_j - [\beta_i x_i] / x) \text{ for } j = 1, J-1$ when a substitution is done for y^*

The Cumulative Density Function for the logistic is;

$$\Pr(y \le j / x) = \Lambda(\tau_j - x' \beta) \text{ for } j = 1, J-1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 13$$

The probability of an individual category j is the probability that $y \le j$ minus the probability that $y \le j-1$;

$$\Pr(y = j/x) = \Lambda(\tau_j - x'\beta) - \Lambda(\tau_{j-1} - x'\beta) \ \ for \ \ j = 1, J \quad \text{...} \quad 14$$

For identification, the value of either one threshold or intercept has been fixed and thus the model

$$\Pr(y \le j/x) = \Lambda(\tau_j - x'\beta) \ \ for \ j = 1, J-1 \quad \text{...} \quad 15$$

For each j, the above is a binary logit on an outcome dividing categories between lower and higher values. For the J-1 ways of dividing the ordinal categories, the resulting binary logits have different intercepts but identical slopes. This is the parallel regression assumption

Because of the identical slopes adjacent categories of the outcome can be combined to attain estimates of the $\beta's$.

The odds of being less than or equal to j is;

$$\Omega_j(x) = \frac{\Pr(y \le j/x)}{1-\Pr(y \le j/x)} = \frac{\Lambda(\tau_j - x'\beta)}{1-\Lambda(\tau_j - x'\beta)} for \ j = 1, J \quad \text{..} \quad 16$$

But $\Lambda(\tau_j - x'\beta) = \exp(\tau_j - x'\beta)$ thus we get;

$\Omega_j(x) = \exp(\tau_j - x'\beta) \ for \ j = 1, J$ which can be interpreted as;

For a unit increase in x_k, the odds of being in a category less than or equal to j, changes by exp $-\beta_k$, holding other variables constant.

Within the reviewed literature, women empowerment is a function of several characteristics some from within the households while others can generally be classified as coming from without the household. The women empowerment equation is thus specified as;

$\boldsymbol{WE =}$
$\boldsymbol{f(household\ characteristics, household\ location, group\ membership)}$……….. 17

With women empowerment found within three categories of <40, 40-60 and attaining > 60 percent in weighted domains, the following model specifies the predicted probabilities for each level of the outcome of women empowerment;

$$P(Y=2)=\left(\frac{1}{1+e^{-(\alpha_2+\beta_i x_i)}}\right)$$

$$P(Y=1)=\left(\frac{1}{1+e^{-(\alpha_1+\beta_i x_i)}}\right)-P(Y=2)$$

$$P(Y=0)=1-P(Y=1)-P(Y=2)$$

Where the β_i s are the coefficients to be estimated while x_i s are the explanatory variables which in this case are; distance to the nearest town, age difference between couples, age of the man, age squared of the man, age of the woman, age squared of the woman, education of the woman, group membership of the woman, group membership of household head, household size, male childen per household, primary occupation of the woman, number of peope under care, condition of dwelling house, distance from the nearest road and monthly income. The choice of the variable such as distance from the nearest town is to capture the possible effect of urbanization on women empowerment; some studies have argued that women in urban areas are exposed to more opportunities, associated with their financial and social empowerment such as independence, economic attainment through trading, and networking to find better economic opportunities (Bello-Bravo, 2015); distance to the nearest town is therefore expected to have appositive effect on women empowerment. Group membership captures collective action and is therefore expected to have a positive effect on women empowerment. Personal and household characteristics such as age of the women, the man, income, number of sons have been noted to affect women empowerment (Wiklander, 2010) and thus we include them amongst the possible determinants of women empowerment,

3.5.3 Survey Site and Data Collection

Kilombero is located in Morogoro region and has a population of 407,880 people with population density of 31 persons per square kilometre, an average household size of 4.3 and covers an area of 14,245km^2 with 19 wards and 46 villages (URT, 2013b). The indigenous people in Kilombero are mainly of Bantu origin with a mixture of people from the tribes of Ndamba, Mbunga and Ngindo. Other minority tribes include Pogoro, Hehe, and Bena (Liheluka, 2014).

Kilombero is a major rice producing area (Kato, 2007; Mligo, 2015) and bears very conducive conditions for paddy production; Kilombero generally experiences a mean daily temperature of

22°C to 34 °C and annual precipitation between 1200 and 1400 mm while the mountainous areas are considerably cooler and wetter with a mean daily temperature of 17 °C and average annual precipitation ranging from 1500 to 2100 mm (Koutsouris et al., 2015). During the rainy season from November to May, households in some villages are not accessible by motor vehicle (Geubbels et.al, 2015). Kilombero supplies 9 percent of all rice produced in the country (Kato, 2007) and overall majority of agricultural households cultivate paddy (Mligo, 2015). The district is located in Morogoro region which is the second largest producer of paddy but also the closest at 340 Km from Dar es Salaam, the commercial capital of Tanzania.

Kilombero was purposively sampled; Johnson and Christensen (2004) argue that purposive sampling relies on the decision of the researcher, based on some criteria. In this case, Kilombero was sampled because it is a district that extensively grows rice (Furahisha, 2013; Mligo, 2015) and, there are a number of ongoing activities in the district by National Agricultural Research Systems (NARS), other partners and the research sponsors Africa Rice. For example, there are programs by other development partners for example in Njage Kilombero Plantations Limited (KPL) is engaged in building capacity of rice farmers by encouraging the use of modern techniques such as sowing rice in nursery beds and later transplanting, use of improved seed and access to credit facilities. The selected villages in Kilombero were Njage, Mbingu, Msolwa Ujamaa, Mang'ula A and Mkula.

The villages were selected from those that had earlier been selected by Africa Rice under the action to implement the 2011-2020 strategic plan, "Boosting Africa's Rice Sector 2011- 2020".

Within this strategic plan, the center aimed at concentrating research efforts in working with other research partners and selection of areas that were representative of the key ecologies for rice production in each member country. Out of these ecologies, particular areas were selected and villages were earmarked for various task forces. Each rice taskforce is comprised of a team from Africa Rice and the National Agricultural Research Systems (NARS). Africa Rice works in collaboration with partners from the NARS in each country in the implementation of research and development activities. The taskforces were set up in line with the priority areas identified in the Research for Development under the capacity building initiative by the center and its partners. These include rice breeding, agronomy, mechanization, policy, processing and value addition and the gender task force. These taskforces further work hand-in-hand with the national rice center of excellence within the framework of the Africa Agriculture Productivity Program. This initiative underscores the importance of rice in the region given that Tanzania hosts the rice center of excellence. Research outputs from these activities are implemented within areas involving large groups of rice farmers (1000-5000) and other value chain actors such as rice millers, input dealers and traders in areas known as "Rice sector development hubs" (Wopereis et al., 2013). The hubs are comprised of villages within which implementation of a number of activities is yet to be undertaken or already underway and the villages are clustered according to the kind of activity that it serves as a host to. Villages are therefore classified as 'agronomy villages', 'mechanization villages','seed training villages', 'participatory variety selection villages' or 'control villages. Within the control villages, there are no specific activities under implementation however the control villages were initially selected to exhibit similar characteristics to the villages within which programs were being implemented. In this way, after a period of five years an assessment will be done comparing the control villages to the other villages to highlight the possible observable and measurable impact of the projects implemented. In light of these classifications, we sampled 3 seed training villages namely Mkula, Njage and Msolwa Ujamaa; one mechanization village- Mbingu and a control village- Mang'ula A. Mkula is a village located in Mkula Ward comprising two neighbourhoods- Mkula A and Mkula B according to unit administrative classifications. Mang'ula A is located in Mang'ula ward and comprises 9 small neighbourhoods (Vitongoji), Mbingu is located in Mbingu Ward and the smaller unit is also known by the same village name; Njage is located in Mchombe and the neighbourhood is also called Njage. Lastly Msolwa Ujamaa is located in Sanje.

According to the sampling strategy adopted by Africa Rice which we also followed for the survey, we targeted areas where rice is grown in target ecology in the hub. In Tanzania there are two hubs namely, Kahama for rainfed lowland and Kilombero for irrigated ecology (GRiSP, 2014). In Njage, rice is grown in the targeted ecology as a major crop and the village suffers poor accessibility all year round. In Mbingu just as in Njage, rice is grown in the target ecology as a major crop and the village suffers inaccessibility due to the state of the roads. In Mkula rice is grown in the target ecology as a major crop and the village is easily accessible all year round. Mang'ula A also has rice grown in the target ecology as a major crop and the village is easily accessible. In Msolwa Ujamaa rice is grown in the target ecology as a minor crop and the village is easily accessible all year round.

For the conduct of the survey, we had a team of 10 enumerators engaged in the data collection process. We made prior contact with the extension officers who informed the farmers about our impending visit for the survey. Farmers were informed that we would seek information on rice farming activities and needed their participation. In an effort to guard against getting biased responses given that gender/ women empowerment issues are a contentious issue in most of our indigenous societies. Respondents were interviewed to find out how they practice rice farming and marketing in terms of resource use and decisions making processes within the household.

Of the 10 enumerators, 3 were male and these male were each paired with a female so that they interviewed the respondents that were from dual adult households (husband and wife). The males interviewed the men while the females, interviewed the females. This was a recommendation from the architects of the index at IFPRI. Moreover, it is a way of minimizing interviewer induced bias in responses that could arise from having a male interview a female respondent or a female interviewing a male respondent; indeed Zaller and Feldman (1992) suggests that at a practical level, survey researchers should take into account potential gender-of-interviewer effects where they might reasonably be suspected.

Data collection was conducted for a period of five days from 8th/08/2016 to 12th/08/2016 with the team spending a day in each village. Initially targeted were 40 households per village summing up to 300 households in total but the survey only successfully covered 256 households. Of the five sampled villages namely Mang'ula A, Msolwa Ujamaa, Mkula, Mbingu and Njage, the first three villages are located before Ifakara town while the latter are located after Ifakara town making accessibility hard given the condition of the road. In each village there were two kinds of households- the dual adult households that had both the primary and secondary respondent essentially, the male and primary female in the household (specifically an individual and their spouse). There were also female headed households where the female responded to both the household and the individual questionnaires. The survey therefore used structured and semi structured interviews. In assessing women empowerment it was important to have the female headed households acknowledging the fact that such women too are exposed to disempowering factors as a result of either internal factors or those outside the households. Indeed some studies have shown that throughout the lifecycle, women find themselves under subordination either to a father, husband or son (Cain et al., 1979).

The household and individual questionnaires had semi-structured questions answering of which, could take upto 45 minutes per questionnaire per respondent. Additionally there was a village level questions for which we sought responses using the Focused Group Discussions. While the household and individual interviews were underway, there were a number of people that were waiting to be interviewed and with these the (Focus Group Discussion) FGD was conducted. Men and women had separate FGD to enable them express themselves freely without fear of the presence of a spouse; Kumar (1987) and Bawah et al. (1999) suggest holding separate discussions for men and women and ensuring homogeneity across the groups. This was specifically helpful given that a number of respondents present had come with a spouse as identified by dual adult households (sampling as suggested by Alkire et al., 2013). The household semi-structured interviews consisted of household interviews that sought responses from the household head and individual level interviews that were administered to both the household head and the secondary respondent in the case of dual adult households; the individual level questions were meant for the respondent to self assess on the aspects of empowerment using IFPRI developed questionnaires for the WEAI index but adapted for rice production activities only.

3.6 Results and interpretation of results

3.6.1 Descriptive Results for the sampled area

From the five villages selected, a complete sample for which the women empowerment index could be computed was 188 households with 291 individuals. Table 2 below is a summary describing the sample:

Table 2: Summary Statistics of Socio-economic characteristics of the sample

Variable	Mean (Std Dev) [n = 188]
Type of Household (1=Female Headed)	0.52 (0.50)
Age of Household Head	48.10 (13.19)
Age of the women	44.07 (13.57)
Age of the men	47.08 (13.24)
Education of the household head (1=Primary)	0.69 (0.46)
Education of the woman (1=At least completed Primary)	0.70 (0.46)
Primary occupation household head as a Farmer [Woman] (1=Non-farm)	0.23 (0.42)
Distance to major town(km)	63.67 (9.43)
Household size (Individuals)	4.29 (1.92)
Male-female ratio	1.04 (1.06)

* refers to whether it is a female headed household or dual household with a primary male and primary female.

Household head is chief of the household in terms of income generation or decision making or just by (customary) statute.

There were two types of households- male headed households with both the primary male and the primary female (in this case, the husband and the wife) and the *de jure* female headed households (where the husband is permanently absent due to divorce, separation or death)[3] . Indeed 52 percent of the sample was from the *de jure* female headed households. The average age of the household head is 48 years. For the women in the sample, their average age was 44 years. Sixty nine percent of the household heads had attained at least a primary education and for the women in the sample, at least 70 percent had attained primary education. Even then, only 23 percent of the women held primary occupation outside farming from the sample. Generally, the households had an average size of 4.29 individuals with a male-female ratio of 1.04. In terms of distance from the nearest town, the villages selected were located at an average of 63.67 km away from the nearest towns.

3.6.2 Women Empowerment in Agriculture Index: Computed Results

In the analysis of women empowerment adopted, the Women's Empowerment in Agriculture Index (WEAI) which has been constructed by Alkire et al. (2013) is used. The 5DE is constructed from the domains; decisions about agricultural production, access to and decision-making power about productive resources, control of use of income, leadership in the community, and time allocation. The table below indicates the sub-indices and the indicators

[3] Moser, 1993

used for our own estimation of the index with the weights for each indicator adapted from the indicators suggested by Alkire et al (2012);

Table 3: Five Domains, indicators and indicator- weights used for calculating the WEAI

Domain	Indicator	Weight
Production	Input in productive decisions	1/5
Resources	Ownership of assets	2/15
	Access to and decisions about credit	1/15
Income	Control over use of income	1/5
Leadership	Group member	1/5
Time	Work load	1/5

Source: Alkire et al. (2012)

For the study site, we adopt the above indicators for the five domains.

The table below indicates the sub-indices and the overall WEAI scores for the study site with a break down on achievement by the men and women:

Table 4: Women empowerment in Agriculture Index: Scores for the study site

Indicator	Women	Men	Difference

5DE (1-M0)	0.50	0.49	0.01
Disempowerment score (1-5DE)	0.50	0.51	-0.01
N (number of observations)	188	91	
Percent of women achieving empowerment (1-H)	6.5	4.5	-2.0
Percentage of women not achieving empowerment (H)	93.5	95.5	-2.0
Mean 5DE score for not yet empowered women (1-A)	0.50	0.49	0.01
Mean Disempowerment score (1-5DE) for not yet empowered women (A)	0.50	0.51	-0.01
GPI Score ($1-H_{GPI}*I_{GPI}$)	0.86		
N (number of dual adult households)	91		
Percentage of women achieving gender parity ($1-H_{GPI}$)	62.07		
Percentage of women NOT achieving gender	37.93		

parity (H_{GPI}) percentage	
Average Empowerment gap (I_{GPI})	0.38
WEAI Score (0.9*5DE +0.1*GPI)	0.54

Source: *Author's own calculations using adapted STATA do-files by Ana Vaz and Sabina Alkire*[4]

The overall WEAI for the study area is 0.54 and is a weighted average of the 5DE sub-index value of 0.50 and the GPI sub index of 0.86.

3.6.2.1 Overall 5 Domains Empowerment

The 5DE shows that at an 80 percent achievement threshold, only 6.5 percent of the women are empowered and, a staggering 93.5 percent of the women not yet empowered. The not yet empowered women have an average inadequate achievement in 50 percent of domains. The women's disempowerment index (M0) is 0.50 and 5DE is 0.50. For the men in the sample group, 95.5 percent of men are not yet empowered; the average inadequacy score among these men is 51 percent. So, the men's disempowerment index (M0) is 51 percent and their 5DE is 0.49**.**

If the index had been estimated for women alone, one would have assumed that the men are enjoying higher levels of empowerment while the women are disempowered which would have

[4] Available at https://www.ifpri.org/weai-training-materials accessed 1st April 2018

provided evidence on only half the subjects of within the household. Women empowerment looks at how women have been subordinated but with this result arises the question of who is disempowering both the men and the women? Sen, et al. (2006) raise the argument about existence of other centers of power within the household that could be the cause of the disempowerment observed when both the men and women within the same households report disempowerment; this is so due to the presence of the extended family within the same household in the developing world. Moreover, the study also highlights the importance of multi-generational structure of the household in affecting women empowerment thus apart from cross-gender disempowerment, there is a possibility of cross-generational empowerment. Additionally, given that these are smallholder farmers with low incomes and in an area with high prevalence of poverty (Lokina et al., 2011 observe that poverty levels are highest among the rural population and among those who are mainly dependent upon agriculture for their livelihoods), reporting disempowerment is likely to be interpreted by farmers in the way stated by Narayan et al. (2000) that poor people agree to spend time with researchers in the hope that their voices will be carried to those who have the power to affect decisions that affect poor people's lives. Therefore, rather than exclusively looking at empowerment as a cross-gender, cross-generational issue, they also look at it as a cross-class issue in their self-assessment of the five domains. Indeed Kabeer (2012) argues that gender inequalities intersected with other forms of socio-economic inequality, including class, caste, race, ethnicity and location and, frequently exacerbating the injustices associated with them. With such a perspective, a self-assessment based index as the one hereby used can indeed result in both men and women within the same household reporting a comparable state of empowerment.

3.6.2.2 Gender Parity Index

This shows inequality in 5DE profiles between the primary adult male and female in each household the female adult only households are excluded from this computation as suggested by Alkire et al. (2013).

For the study area, 62.07 percent of the women are achieving gender parity with the primary males in their households. Of the remaining 37.93 percent not achieving gender parity, the average empowerment gap is 38 percent. The GPI for the study site therefore is 0.86 indicating that within a larger percentage of households, men and women are enjoying relative gender parity. In a comparative study assessing women's Access to agricultural technologies in rice production and processing hubs Achandi et al., (2018) estimate a simple women empowerment index adapted for rice farming systems to understand decision making within the household between the husband and wife and found that in Tanzania, women enjoyed relative parity in decision making with their spouses within the households.

3.6.2.3 Decomposition of disempowering factors for women and men within the study area

The disempowerment measures (M_0) for women and men decomposed by domain and indicator are presented in Table 5 below:

Table 5: Five Domains Empowerment Decomposed by Dimension and Indicator for the Study Site

Statistics	Production	Resources		Income	Leadership	Time
	Input in productive decision	Ownership of assets	Access to and decision on credit	Control	Grp membership	Workload
Indicator weight	0.20	0.13	0.07	0.20	0.20	0.20
			Women			
Censored headcount (Percent)	58.5	52.5	74.5	4.0	24.0	83.5
Percent contribution	18.89	20.18	12.39	1.62	8.73	38.19
Contribution	0.12	0.07	0.05	0.01	0.05	0.17
Percent contribution by dimension	18.89	20.18	12.39	1.62	8.73	38.19
			Men			
Censored headcount (Percent)	71.4	49.5	93.4	1.1	15.4	90.1
Percent Contribution	28.00	12.87	14.23	0.29	4.70	39.96
Contribution	0.14	0.06	0.07	0.00	0.03	0.18

Percent Contribution by headcount	28.00	12.8	14.23	0.29	4.70	39.96

Source: Author's own calculations using STATA do-files by Ana Vaz and Sabina Alkire[5]

With reference to table 5 above, the domains contributing most to women's disempowerment are workload (38.2 percent), ownership of assets (20.2 percent) and input in agricultural productive decisions (18.9 percent). For the men the domains contributing to their disempowerment are workload (39.96 percent) and input in productive agricultural decisions (28.0 percent). Workload defined as the allocation of time between productive and domestic tasks; ownership of assets, defined as sole or joint ownership of major household assets and, input in productive decisions defined as sole or joint decision making over food and cash crop farming, livestock, (Alkire et al. 2012) have been cited as key in their contributing to the disempowerment of women. Both men and women report an almost comparable contribution of workload to their disempowerment although the contribution of workload for men is reported slightly higher than that of women (For the men it is 39.96 while for the women is 38.2 percent). Higher workload thus assessed contributes to women's disempowerment although it has also been argued that with development interventions, sometimes women's workload increases and this has been interpreted as a favorable factor for the women; Kabeer (1998) in a study in Bangladesh found that women were happy with the extra burden because of the respect, personal satisfaction, and improved standard

[5]Available at https://www.ifpri.org/weai-training-materials accessed 1st April 2018

of living they experienced as a result of their income-generating activities that resulted in increased workload.

Both men and women reporting workload as key in contributing to their disempowerment is nonetheless an expected result; since the study targets rice farmers and rice farming in Tanzania is labour-intensive (Mdemu and Francis, 2013) with low levels of labour saving technologies (Kangile and Mpenda, 2016).

The lack of decision making around agricultural production contributes much more to men's disempowerment than to women's (28 percent compared to 18.9 percent). This is possible due to the fact that the initial bargaining position of men under patriarchy was that they were sole decision making agents within the households (Nwokocha, 2008; Sultana, 2012) but with the continued efforts at women empowerment, some studies have reported an increase in consensus between spouses in intra household decision making. Erbaugh, et al. (2003) reports that in family units with both spouses present there was a higher likelihood of sharing labor and decision making and Doe (2014) reports similar results arguing that albeit traditional norms, married women and men emphasized that husbands and wives must show mutual respect and both must have a say in household decision making. Moreover a study in Tanzania on women's technology adoption shows that men and women were almost at par in rice production decisions (Achandi et al., 2018).

Ownership of assets still ranks high as a limiting factor to women empowerment. This result is in line with arguments raised by previous studies such as Ali et al. (2014) who observed that men are by default treated as the sole legal owners of household land; Doss et al. (2015) observe that in Tanzania women constitute 27 per cent of land owners, yet land is a key resource that supports agricultural production (Odhiambo, 2006).

3.6.3 Estimating the determinants of women empowerment: An Ordinal Logit Analysis

When the Ordinary Least Squares method was adopted, the results were unsatisfactory thus the decision to treat women empowerment as an ordinal variable. Women empowerment is modelled as a dependent variable on an ordinal scale with three distinct groups defining achievement in the weighted domains i.e those falling less than 40 percent, between 40 and 60 percent and lastly those above 60 percent. This categorization of empowerment is to ensure that there is a sufficient number of observations in each category in order to undertake statistical estimations and tests.In the ordinal logit the dependent variable has more than two categories and the values of each category have a meaningful sequential order where a value is indeed 'higher' than the previous one (Torres-Reyna, 2012).

The ordinal logit or multinomial logit would be suitable for fitting the model save for the fact that application of the multinomial logit assumes no order in the categories of the outcome variable and as such would result in a loss of information contained in the ordering (Benoit, 2012). In the ordered logit models of the ordinal dependent variable is fitted on the independent variables. The actual values taken on by the dependent variable are irrelevant, except for the fact that larger values of the dependent variable are assumed to correspond to "higher" outcomes (Williams, 2006); simply stated by Long (2012) as, “rank ordering on a single attribute”.

In the ordinal logit model, the observed ordinal variable Y is a function of an unobserved variable Y*. The unobserved values determine the observed values and the unobserved values have several thresholds that determine the different categories that are used in the analysis.

In an attempt to address possible endogeneity problem between the explanatory variables and women empowerment, an attempt to use proportion of sons out of number of children gave unsatisfactory results. The ordinal logit model in stata, using women empowerment itself and interpret results as correlations rather than causal relationships, a method used by Malapit et al. (2015) when they suspected endogeneity.

We hypothesize from the literature reviewed that the factors affecting empowerment of women are; household charactriestics such as type of household, age of the household head, gender of household head and age of the woman, number of male children, household size, location of the household from a town or nearest road, number of bedrooms in the dwelling house; human capital investment with variables such as education level of household head, education level of the woman; social capital acquired though group membership by household head being a proxy for this; factors that capture the woman’s opportunities for productive resources such as primary occupation, condition of the dwelling house (women usually run home based small business activities) and monthly income.

From our analysis, Table 6 below shows results for female headed households, male headed households and a combination of both household types:

Table 6: Results for Determinants of Women Empowerment

Variable	Female-headed Households(n=94)	Male-headed Households (n=94)	Both household types(n=116)
Prob > chi2	0.0005	0.09	0.045
LR chi2	LR chi2(13)=36.51	LR chi1(12)=18.69	LRchi2(13)=22.72
Pseudo R	0.1943	0.101	0.0936
Cut 1:	8.4764	4.3814 (3.1131)	1.5298
Cut 2:	10.8474	6.6239(3.1621)	3.5657
Log likelihood	-75.7174	-82.7804	-110.0547
Distance nearest town	0. 0649 (0.0304)**	0.0065(0.0216)	0.0210(0.0201)
Age difference between couples		0.0042(0.0594)	
Age of the man		0.3130(0.1357)**	
Age squared of the man		-0.0030(0.0015)**	
Age of the woman	0.2133(0.1157)*	-0.1117(0.1484)	0.1442(0.0762)*
Age squared of the	-0.0015 (0.0012)	0.00160(0.0021)	-0.0013 (0.0008)*

woman			
Education of the woman	1.1587(0.5264)**		0.1387(0.3027)*
Group membership of the woman	2.0623(0.6583)***		
Group membership household head			1.1510(0.4183)***
Household size	-0.0156(0.2265)	-0.0330(0.1854)	-0.3216(0.1573)**
Male children per hh	0.2197 (0.2416)	-0.3993(0.2259)*	
Primary occupation_woman	-0.8351(0.6584)		0.0368(0.1650)
No_of people under care	-0.2331(0.2822)	0.2149(0.1847)	0.3736(0.2223)*
Condition of the house (C3)	1.1821(0.5677)**	0.6688(0.5579)	0.6604(0.4372)
C6 (number of bedrooms)	-0.1191(0.1758)		0.0448(0.1177)
C15 (Distance from nearest road)	-0.03621(0.1675)	0.1396(0.1530)	0.1372(0.1189)
C14 (Monthly income)	-0.0184(0.0071)**	0.3787 (0.4467)	-0.0021(0.0021)
Brant, test result (p>chi2)^{NS}	0.938	0.123	0.985

Note: *,**,*** significant at 10 percent, 5 percent, 1percent and NS = A significant test statistic provides evidence that the parallel regression assumption has been violated.

Three models are estimated- a female headed household model, a male headed households and, the joint model that incorporates both household types; this is because there have been arguments indicating that effects on the level of empowerment filter through differently to women as household heads compared to those that are spouses (Meemken et al.,2017) moreover, women as household heads generally report different attainments in terms of empowerment when compared to women within male headed households. This is specifically important because the WEAI is a self-assessment based index.

3.6.3.1 Female headed Households

For the female headed households, age of the women is significant at 10 percent; distance from the nearest town, education of the woman, condition of dwelling house and monthly income are significant at 5 percent while group membership of the woman is significant at 1 percent. This implies that moving from non-membership to membership to a group is associated with a 2.06 increase in the log odds of being in a higher level of empowerment; moving from a poor to a good dwelling place, is associated with a 1.18 increase in the log odds of being in a higher level of empowerment; the log odds of being in a higher level of empowerment increases with both age and education although the negative effect of age squared shows a quadratic (but not significant) association with empowerment indicating that younger women are less empowered, they become empowered over time but older women are less empowered; in effect over time the association of of age and empowerment is diminished. Our results for effect of age are in line with the arguments raised by Arestoff and Djemai (2016) who examine empowerment through the lens of marital violence and found that younger women are more likely to accept wife beating due to the people they live with (they live with their mothers who being from an older generation may be more accepting of the practice); nevertheless, Oyediran (2016) cautions that older women may also be more likely than younger women to have a good understanding of the norms and values that protect women within marriage or prevent men from being aggressive.

Education of the women has a high association with the level of empowerment; Warner et al. (2012) argue that education is essential for preparing adolescent girls for healthy, safe and productive transitions to adulthood while Duflo (2012) argues that education can increase women’s bargaining power within their households since it endows them with knowledge, skills, and resources to make life choices that improve their welfare. Indeed our results concur with these arguments and similar findings have been made by Jeckoniah et al. (2013) who looked at the importance of education attainment on women empowerment and found that empowerment increased with education attainment. Our results however are contrary to those of Losindilo et al. (2010) in a review of factors affecting women's participation in social, political and economic activities in Mainland Tanzania who found that the effect was not significant. Moreover education alone may not be sufficient; Meena (1996) cautions that education can be a two-edged sword that on the negative side perpetuates the gender stereotypes within the greater society and may therefore play a very vital role in the social construction of women and men in the

Tanzanian society through allocating gender specific packages which reinforce the oppressive gender relations.

Group membership has been found to also improve the position of the respondents in the patriarchal family systems through increased knowledge of legal system and enabling the members to engage in family decision making and, members also develop leadership qualities (Chitagubbi et al., 2012); provides members with a forum to voice their opinions, challenge cultural prejudices and misconceptions, and participate in decision making (Ross et al., 2015). Nonetheless, group membership is not an automatic ticket to women empowerment for example in Tanzania, wealthier women were more likely than poor women to join SHGs and thus the groups served to reinforce the idea that wealthier women have more access to financial services, social capital, and community respect than poorer women (Mercer, 2002).

Distance to the nearest town has an unexpected sign since the results show that a unit increase in distance is associated with a log odds of attaining a higher level of women empowerment. This could be due to the fact that empowerment as used in this study entails a self-assessment and as such possibly the women that are closer to town are more aware of their disempowerment (due to availability of information through media, cross cultural interactions and general public awareness) while those further away are not aware of their disempowerment. It has been noted that in the rural areas traditional customs usually persist (Eldred, 2013) and women themselves sometimes perpetuate patriarchal ideologies to the younger generations. This finding is contrary to arguments by Nayak et al. (2009) who found that urban married women are more empowered than rural women.

Household income also has a negative association with the level of empowerment attained by the women; Gilabert et al. (2016) caution that increasing levels of wealth alone might not necessarily translate into higher levels of empowerment for women in agriculture, as household wealth poorly captures intra-household allocation of resources. Moreover, Kantor (2003) examining home-based garment production found that women producers are more likely to lose control over their income when their earnings are high, because of the easier monitoring and access to benefits by other household members [Agarwal (1997) raises arguments about the possibility of women generally being more altruistic within their households as compared to men]. Contrary findings about the effect of income on women empowerment has been reported by Carlsson et al. (2009) who indicated that men overall have larger influence on joint decisions than women, but that women have a larger influence in households in which women have higher incomes. However, given that these are female headed households, we would have expected a positive effect of the household income on the level of empowerment of the women.

State of housing has also been seen to have a positive association with the level of empowerment; Ndinda (2009) suggests that housing plays a key role in women empowerment. Jacobson et al. (2016) argue that housing plays a vital role in the informal economy, particularly for people working from home especially those who work in the informal economy and rely on their homes as a physical asset to do their work. Indeed, the importance of housing to women's work has been emphasized by all three studies (Aggarwal, 2008; Jacobson et al., 2016; Ndinda, 2009) given that most women that have alternative economic activities for example they may run a shop from their house in order to be able to mind the children at the same time, instead of taking on productive employment work from outside home (Duflo, 2012). Additionally, Aggarwal (2008) concludes that housing improvements increased the average number of working hours and consequently the incomes.

3.6.3.2 Male headed Households

For the male headed households, only age of the man and number of male children have significant associations with the level of women empowerment. A unit increase in the number of male children reduces the log odds of being in a higher level of empowerment by 0.40, given all of the other variables in the model are held constant; a unit increase in age of the man, is associated with the log odds of attaining a higher level of women empowerment by 0.31 given that all the other variables are held constant. In terms of association of age of the man and the level of women empowerment, the empowerment of the woman diminishes as age of the man increases thus there is a quadratic relationship. Initially as age of the man increases, the level of empowerment achieved by the woman increases then reaches a certain threshold and begins to fall. Our findings echo those of Wiklander (2010) who argues that a mother may be restrained by her own sons when trying to express her opinion. Additionally, women prefer to have female children because girls generally engage in more housework than boys and in spite of all current social perception about the changing gender roles, the primary ideology about marriage is that women should, ‘‘make a house a home”(Sanchez and Gager, 2000) and as such having more girls reduces the workload for the woman. A comparison of the effect of number of male and female children (in the appendix Table A.1) does show the number of daughters as being associated with a higher level of women empowerment within male headed households. In fact, Adebowale and Palamuleni (2015) in a study on influence on child gender preference amongst women in Malawi found that women prefer to have female children especially within the matrilineal communities where the man marries and moves into the woman’s family. Our result however contradicts findings by Noreen (2011) who suggests that increase in number of sons increases women’s say in domestic decision making. Notably though, a few studies such as Furuta and Salway (2006) that indicate a positive influence of number of sons on a mother’s decision making were conducted in the patriarchal cultural context where the male children are highly valued above the female children.

A possible explanation for the effect of age of the man on women empowerment is that younger men are more exposed to the discourse on women empowerment and therefore make concessions to accommodate their wives in the decision-making process. Indeed, Wyrod (2008) reviews gender in urban Uganda and argues that some aspects of women’s rights are accommodated while retaining previous notions of innate male authority. The older men are however more inclined towards the patriarchal cultural norms that subordinate women; Ali et al. (2011) observed that the younger generation was more positive to modernization of gender roles than the elder generation.

3.6.3.3 Combined Model of both female headed and male headed households

For the overall model from Table 6 above, age of the woman and education of the woman are significant at 10 percent, household size at 5 percent and, group membership of the household head and number of people under care are significant at 1 percent. A unit increase in the age of the woman is associated with a 0.14 increase in the log odds of attaining a higher level of empowerment for the woman in the household. For group membership of the household head, moving from non-membership to group membership, is associated with a 1.15 increase in the log odds of being in a higher level of empowerment; moving from no education to a basic primary education, is associated with a 0.14 increase in the log odds of being in a higher level of empowerment for the woman. An increase in the number of people under care within the household raises the log odds of empowerment of the woman by 0.37 while a unit increase in household size reduces the log likelihood of empowerment for the woman by 0.32.

The relationship between women empowerment and the household size can be understood from the discussion on mobility which is noted to be inversely associated with number of children (Balk, 1994). Moreover Armendáriz and Roome (2008) suggests that the opportunity cost of women's time increases with micro-finance access and women are urged to reduce family size in order to increase education and health expenditure and to better manage the ability to repay; smaller family sizes are therefore associated with higher levels of women empowerment.

Within this model, group membership of the household head (either female or male) has a positive association with the level of women empowerment. Penunia (2011) argues that farmer groups can be institutions of empowerment; provide training and a platform of knowledge exchange for farmers and help farmers access markets. However, the effect of group membership on the level of women empowerment attained can vary due to the varying nature of groups and as such some may not necessarily work towards empowering women. Indeed, Meinzen-Dick et al. (2005) caution that collective action through group membership may have a negative effect on women's empowerment if collective action programs are designed "gender-blind" or with false assumptions regarding women's motivations for joining a given group. Moreover, membership to the group may not necessarily guarantee participation; it has been observed that women lack time to participate due to multiple work demand (Prakash, 2003) and as such the traditional gender roles play out in the group arena resulting in continued disempowerment of women an observation also noted by Kabeer (2001).

3.7 Conclusions

Overall from this sub section, the overall WEAI computed was 0.54 and is a weighted average of the 5DE sub-index value of 0.50 and the GPI sub index of 0.86 indicating a low attainment in terms of the five domains but, for a larger percentage of households men and women are achieving relative gender parity. Another key result to note is that using the same indicators for assessing women, men reported disempowerment; a result that can be attributed to the fact that men too are exposed to disempowering factors since empowerment has been observed to bear cross-class, cross-generational and cross-gender dimensions as it intersects with patriarchy and other social issues. Moreover for women, key domains contributing to disempowerment are workload, resource ownership and restricted inputs to productive decision making while the men also reported both workload and restricted input to productive decision making. Workload for both men and women could be exercebated by the fact that rice farming is a labour intensive activity and smallholder farming is still under mechanized in Tanzania thus relying heavily on physical manpower. With reference to resource ownership, women still face challenges in terms of asset ownership especially those in male headed households. The control and decision making over these assets are still largely held by the husband in the home or the males that are closest to the family. As pertains to decisions into productive decisions, both men and women reported these as contributing to their disempowerment and this can be due to the fact that given the patriarchal nature of societies in rural smallholder communities; empowerment in these communities bears cross-class, cross-generational and cross-gender dimensions.

The ordinal logit analysis is used to assess the determinants of women empowerment with women empowerment as a categorical variable within which women could attain three different levels of empowerment. Suitability of the ordinal logit is because subsequently higher ranks in the categorical variable do imply a higher achievement in empowerment of the woman within the household. Moroever in an attempt to address the endogeneity problem the study attempted to use the proportion of sons out of number of children although this yielded unsatisfactory results thus uing the women empowerment index itself with the results subsequently interpreted as correlations rather than causal relationships. For the female headed households, age of the household head, education level, condition of dwelling, monthly income and group membership were all significant; distance from the nearest town showed a positive sign that was not expected and this was attributed to the fact this study entails a self-assessment and as such possibly the women that are closer to town are more aware of their disempowerment given their exposure to information on what women empowerment should look like, while those further away are not aware of their own disempowerment status and may not know what empowerment entails.

For the male headed households, age of the man has a quadratic association with the level of empowerment attained by the woman and therefore with older men in the household, the level of women empowerment diminishes. This was explained by observations indicating that some aspects of women empowerment are accommodated while men still retain previous notions of innate male authority. Older men are however more inclined towards patriarchy and female subordination.

CHAPTER FOUR

TECHNICAL EFFICIENCY IN RICE PRODUCTION: ESTIMATION AND DETERMINANTS

4.1 Introduction

Technical efficiency has been defined as organizing available resources in such a way that the maximum feasible output is produced. This chapter seeks to i) estimate technical efficiency of production of small holder farmers and, assess the determinants of their technical efficiency. The chapter gives a background on the production process, the concept of efficiency and key elements, the measurement of technical efficiency and, how it has evolved through the contribution of several scholars.

Suitability of modeling of smallholder farmer behavior using the stochastic frontier is explained as a way of assessing their technical efficiency using different model assumptions that have been applied by different scholars. These include the two stage modeling procedure, the one stage modeling procedure and the Henningsen and Henning (2009) three stage procedure which addresses theoretical concerns by incorporating monotonicity and quasiconcavity restrictions in the modeling process.

Novelty of the chapter lies in the application of this theoretical consideration which although highlighted as important has been scarcely applied for efficiency studies carried out in Tanzania.

This procedure is incorporated in analyzing the determinants of technical efficiency of smallholder rice farmers and the results are discussed. Moreover, the estimation of efficiency is done for male and female headed households to highlight variation in efficiency attainment by the different household types given that different household types are exposed to different constraints in employing input to attain an efficient output. This adds to gendered analysis in technical efficiency for rice subsector.

4.2 The Production Process

The production process entails the transformation of inputs into outputs (Koskela, 2000). In microeconomic theory a production function is defined in terms of the maximum output that can be produced from a specified set of inputs, given the existing technology available to the firms involved (Battese, 1992).

Agricultural production in developing countries entails the use of inputs such as land, labour, seed and fertilizer to produce crop as an output. The transformation of these inputs into outputs however depends on the farm characteristics (Iliyasu et al., 2016; Chepng'etich et al. 2015), and managerial ability of the farmers (Kahan, 2013). The inputs and managerial ability of farmers generally affects the quality as well as the quantity of the output produced.

The production process is conceptualized in economics as the use of capital (human and other forms) to transform raw materials and 'unfinished' commodities (intermediate inputs) into finished goods and services ready for final consumption (Ironmonger, 2000). Present day agricultural production relies on the market for seed, fertilizer and farm implements and thus is closely interrelated to the market. Van der Ploeg (1990) argues that inputs in this case are not the result of preceding cycles but are mobilized wholly, or to a large extent, through the relevant markets and gives an illustration of the market dependent production process as in *Fig. 1* below;

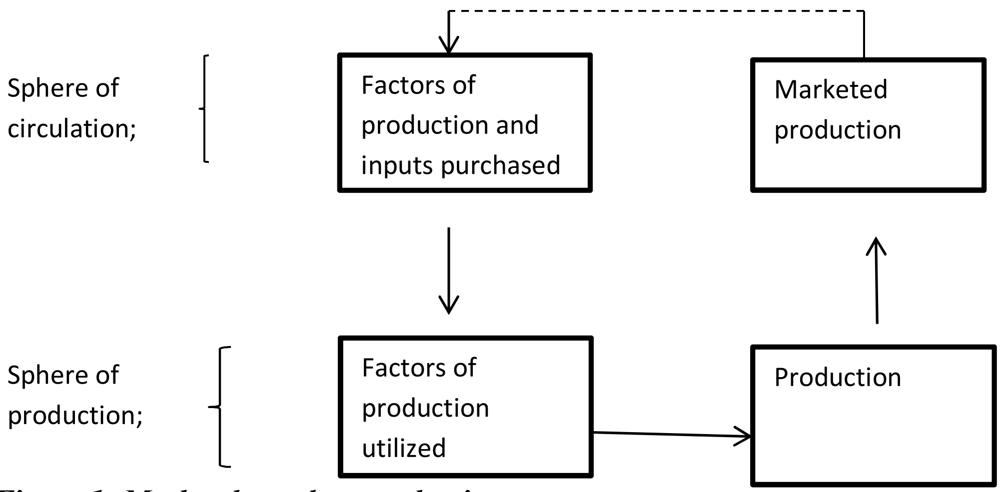

Figure 1: Market dependent production process

While the production process can be illustrated diagrammatically as in *figure 1* above, the production function can be used to describe production as well. The production function is a mathematical expression which describes a systematic relationship between inputs and output Miller (2008) or betterstill, describes the technical relationship that transforms inputs (resources) into outputs (Debertin, 2012).

4.2.1 Concept of Efficiency

Farrell (1957) defines efficiency as a firm's success in producing an output as large as possible from a given set of inputs. In crop production, Mango et al. (2015) argue that efficiency refers to the efficient use of farm inputs in crop production. Agricultural farms can therefore use more or less inputs and still arrive at the same level of output. The differences in employed inputs can be removed if the less efficient farms adopt the practices of the more efficient farms. The concept of technical efficiency is defined relative to the best performing farm (O'Neill et al.,1999; Minviel and Latruffe, 2017; Manevska-Tasevska et al, 2013). To obtain a farm's technical efficiency (TE), we calculate actual achievable output and divide it by maximum achievable output using a number of approaches that have been recommended by scholars in the field (Shih et al., 2004; Lambarraa et al., 2007,).

Farrell (1957) recommended two distinct methods in the estimation of technical efficiency; i) the non parametric approach with theoretical underpinnings of linear optimization and, ii) the parametric method which assumes a particular functional form and allows for hypothesis testing. According to Battese and Coelli (1988), the unit isoquant defines the input-per-unit-of-output ratios associated with the most efficient use of the inputs to produce the output involved. Battese and Coelli. (1988) further consider the deviation of observed input-per-unit-of-output ratios from the unit isoquant to be associated with technical inefficiency of the firms involved. It is important to distinguish technical efficiency from the other efficiency components; efficiency has a technical, an allocative (price) and a productive component (Palmer and Torgerson, 1999). Generally Koopmans (1951) defines a technically efficient producer as one for whom it is impossible to produce more of any output without producing less of some other output or using more of some input. Levin et al. (1976) defines technical efficiency as organizing available resources in such a way that the maximum feasible output is produced and defines allocative efficiency (price efficiency) as use of the budget in such a way that, given relative prices, the most productive combination of resources is obtained.

Battese (1992) illustrates technical efficiency with one output and multiple inputs as below;

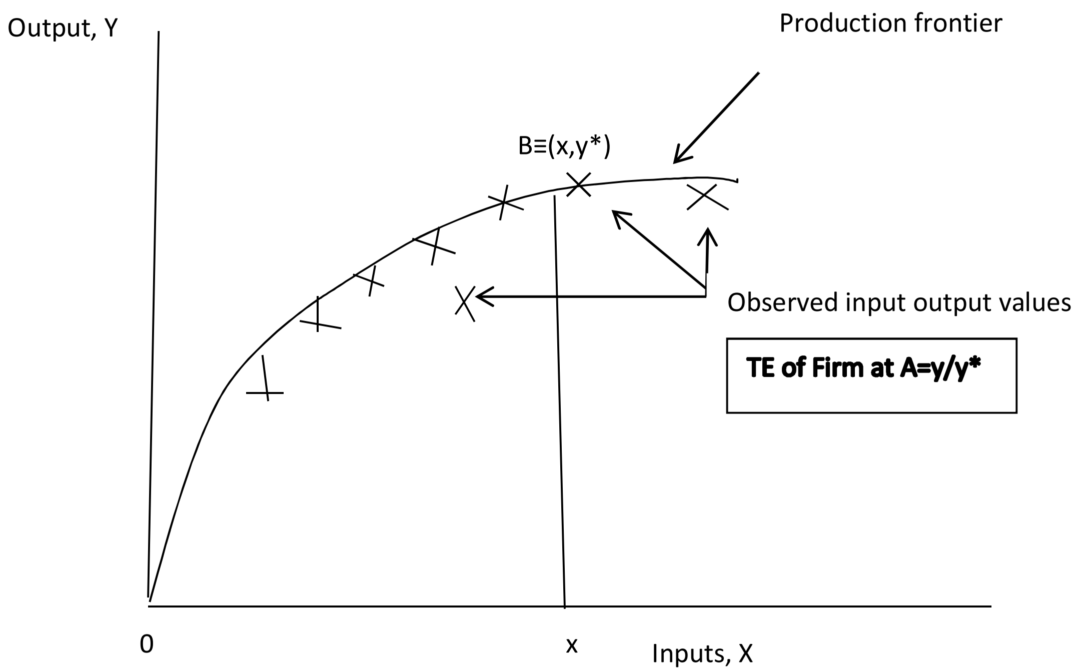

Figure 2: Technical efficiency with one output and multiple inputs

4.2.2 Advancements in Estimation of Technical Efficiency

There has been developments overtime to the estimation of the technical efficiency of the firm from an economic perspective by several scholars. Farell (1957) in his seminal work, "The measurement of productive efficiency", sought to ignite interest in the area of such measurement. He made an attempt at incorporating all inputs used while at the same time addressing the index number problem and under assumptions of constant returns to scale; which particularly enabled him to present relevant information in an isoquant diagram. Successive scholars such as Aigner and Chu (1968) followed through with more attempts at measuring technical efficiency specifically defining a function of maximum output obtainable from a given set of inputs

Aigner and Chu (1968) made more attempts at measuring technical efficiency specifically defining a function of maximum output obtainable from a given set of inputs therefore;

$$y_i = f(x_i;\beta) \quad \text{.......} \quad 18$$

To them x_i is a vector of non-stochastic inputs and y_i is maximum obtainable output while β are unknown parameters to be estimated using linear programming if $f(x_i;\beta)$ is linear in β . They further suggested that some output observations could be allowed above the estimated frontier. Timmer (1971) took up and developed the idea to obtain the probabilistic frontier production functions, for which a small proportion of the observations is permitted to exceed the frontier. Timmer's models though, yielded estimators with undefined statistical properties (Bravo-Ureta and Pinheiro, 1993). Timmer (1971) further criticized these models and suggested the probabilistic frontiers which were in a way developed to address the outlier problem of the linear programing method earlier suggested by Farell (1957). Although also estimated using linear programing techniques, some selection was made of observations that were allowed to lie above the frontier (Aigner et al., 1977). This method though was found wanting given that selection of a portion above the frontier was arbitrary (Coelli, 1995) and, this concept defied the frontier as being the maximum possible output (Aigner et al., 1977). Schmidt (1976) in Coelli, (1995) added the Maximum likelihood discussion to the modelling thereby adding a one-sided disturbance to Aigner and Chu (1968) production function to obtain;

$$y_i = f(x_i;\beta) + \varepsilon_i \quad i = 1,\ldots N \qquad \text{...} \quad 19$$

where $\varepsilon_i \leq 0$

Aigner et al. (1977) provided insight into the process of model building and indicated that although the model could be estimated by maximum- likelihood techniques, and that under appropriate assumptions linear and quadratic programming are maximum-likelihood techniques, a problem still existed since 'regularity conditions' for example, given $y_i \leq f(x_i;\beta)$, the range of y depends on parameters to be estimated thus theorems for determining the asymptotic distributions of parameter estimates cannot be invoked; in which case the conditions for application of maximum likelihood are violated. Battese (1992) further took up these suggestions and developed three possible models for econometric analysis of technical efficiency, one deterministic and stochastic for cross sectional data and the other panel data models if time series data are available (Battese, 1992). For the deterministic frontier the possible production Y_i is bounded above by the non-stochastic (i.e., deterministic) quantity i.e.

$$Y_i \leq f(x_i;\beta) \qquad for \quad i = 1,2,...N \quad \text{...} \quad 20$$

The inequality relationship in the deterministic frontier was first proposed by Aigner and Chu (1968).

4.3 The Stochastic Production Frontier

Smallholder farming production behavior can better be modeled by the stochastic frontier model due to its heavy dependence on natural conditions that are not under control of the farmers and the existence of measurement errors (Kidane and Ngeh, 2015), moreover, data from smallholder farmers remains largely inaccurate (Carletto et al., 2015); smallholder farmers often do not keep books of accounts and therefore may provide inaccurate varying information in which case the SPF proves quite useful (Nchare, 2007).

Within the stochastic production frontier first proposed by Aigner et al. (1977) and Meeusen and Van den Broeck (1977), the possible production is bounded above by the stochastic quantity;

$$Y_i \leq f(x_i;\beta) + (v_i) \qquad for \quad i = 1,2,...N \quad \text{..} \quad 21$$

The Stochastic production frontier above starts with the error term decomposed into its two components below;

$\varepsilon_i \quad \leq v_i + u_i \quad i - 1, ..., N$ 22

The error component v_i represents the symmetric disturbance: the $\{v_i\}$ are assumed to be independently and identically distributed as $N(0, \sigma^2)$. The error component u_i is assumed to be distributed independently of v_i, and u_i is intended to capture the effect of technical inefficiency· Producers thus produce on or below their stochastic production frontier thus $u \leq 0$. It is equal to zero if the farmer produces on the frontier and it is less than zero if the farmer produces below the frontier. Meeusen and van den Broeck (1977) in Battese (1992) assigned an exponential distribution to u, Battesse and Corra (1977) assigned a half normal distribution while Aigner et al. (1977) gave a critique of either assumptions about u and considered both distribution assumptions. Either distributional assumption implies that the composed error term $(v - u)$ is negatively skewed thus statistical efficiency requires the model to be estimated by Maximum Likelihood method (Kumbhakar and Lovell, 2003).

Technical inefficiency can be modeled as either input-oriented or output-oriented however in the estimation of parametric stochastic production frontier models using maximum likelihood, only the output oriented measure is used (Kumbhakar and Tsionas, 2008). Walden and Kirkley (2000) defined input-oriented technical efficiency measure as examining the vector of inputs used in the production of any output bundle, and it therefore measures whether a firm is using the minimum inputs necessary to produce a given bundle of outputs. Coelli (1995) on the other hand defined the output oriented measure (primal approach) of estimating technical efficiency in production as indicating the magnitude of output of a farm relative to the output that could be produced by the fully efficient farm using the same input vector.

Studies on efficiency measurement such as Nkamleu (2004); Bravo-Ureta and Pinheiro (1997); Kalirajan (1989), regressed the predicted efficiency indices against household and farm characteristics with an intention of explaining the observed differences inefficiency among farms using a two -stage procedure. In the two-stage process, efficiency is estimated in the first stage, then the estimated efficiencies (or, in a few cases, ratios of estimated efficiencies, Malmquist indices, etc.) are regressed on covariates (typically different from those used in the first stage) that are viewed as representing environmental variables (Simar and Wilson, 2007).

However, though recognized as a useful procedure, the two -stage estimation used has been faulted as inconsistent in its assumptions with regard to the independence of the inefficiency effects within the two-stage estimations. Kumbhakar et al. (1991) give a critique of the two stage procedure arguing that technical efficiency might be correlated with the inputs thus resulting in inconsistencies in the estimated parameters and the technical efficiency and, standard OLS results from the second stage estimation may not be appropriate since technical efficiency (the dependent variable) is one sided. Furthermore, Coelli (1995) noted that with the two stage procedure, the inefficiency effects in the first stage are assumed to be independent and identically distributed while in the second stage, they are assumed to be a function of firm specific factors implying that they are not identically distributed.

Wang and Schmidt (2002) argue that the two step procedure falls short since the model in the first step is misspecified and provide further theoretical insights into the severity of the bias problem with the two stage estimation technique thus further solidifying an argument for the one step procedure. Given the shortfalls of the two stage estimation procedure, Kumbhakar et al. (1991); Coelli (1995) and Wang and Schmidt (2002) suggest a one stage estimation procedure which results in more reliable estimates.

Aside from the two stage and one stage estimation issue in the estimation of technical efficiency, more recent interest has been shown in the microeconomic theoretical consistency of the estimation procedure. One basis for this interest is in grounded in the guiding principles raised by Lau (1978) for the theoretical properties required by the particular economic relationship for an appropriate choice of parameters. With regard to production theory and specifically, production possibility sets, this would mean that the relationships are single valued, monotone increasing as well as quasiconcave. Sauer et al. (2006) cautions that due to the free availability of easy-to-use efficiency estimation software, there has been an increase in the number of efficiency studies without a critical assessment on theoretical consistency, flexibility and the choice of the appropriate functional form. O'Donnell and Coelli (2005) and Griffiths et al.,2000) raise the importance of imposing regularity conditions and argue that only the estimates obtained from the regularity-constrained models are theoretically plausible.

Attempts have been made at incorporating this theoretical concern into efficiency estimates. Henningsen and Henning (2009) suggest a three step procedure for estimation with the incorporation of the monotonicity and quasiconcavity; moreover, they demonstrate how monotonicity of a translog function can be imposed not only locally at a single data point but regionally at a connected set (region) of data points. Other studies such as Karimov (2014); Watto and Mugera (2015) and Olsen and Henningsen (2011) have applied this methodology and results show differences between the theoretically constrained and the unconstrained models.

In light of the above developments in the modeling procedure, there is need to model technical efficiency using the three stage procedure, incorporating checks for monotonicity and quasi concavity in order to arrive at a theoretically sound conclusion about the estimated parameters.

4.4 Determinants of technical efficiency of production of small holder farmers

Several empirical studies have shown that technical efficiency is affected by individual (agent), household demographic factors, socio-economic, institutional and cultural factors within which a production system is located. Individual characteristics (so called agent factors by Van Passel, 2007) such as age, education level have extensively been fronted as accounting for technical efficiency for example age has been found to be significant in affecting technical efficiency (O'Neill et al., 1999). However, the jury is still out on the exact kind of effect that age has on efficiency; for example, Asefa (2011) in analyzing technical efficiency of crop producing smallholder farmers in Tigray, Ethiopia suggests that the relationship between age and technical efficiency could take an inverted U shape, that is, efficiency increases with age up to some point and then decreases with rise in age. Moreover, the study hypothesizes that age reflects experience of the farmer for example; Gebreegziabher et al., 2004) in a study on Ethiopia examining the,'poor but efficient" hypothesis found that age does not have a significant effect on inefficiency and in fact a completely different finding is made by Baruwa and Oke (2012) in a study on coco yam production in Nigeria and Ogada et al., (2014) in Kenya, who found that age has a negative effect on technical efficiency. The effect of age can therefore be ambiguous since studies have found mixed results.

Education status can also have an impact on the technical efficiency of the farm especially since it can influence the adoption of technologies (Weir and Knight, 2004) and enhances the ability of individuals to utilize technical information (Elias et al., 2013). Moreover, it has been assumed to be related to the farmer's managerial skills (Revilla-Molina et al, 2008); nonetheless, its effect on technical efficiency has been found not significant in a study of wheat farmers in Punjab, Pakistan (Battese et al., 2014) while a contradictory evidence is given by (Saldias and Von Cramon-Taubadel., 2012 and Rahman et al., 2012) who found that technical efficiency increases with formal education. Nonetheless, a question can still be asked about how much education would be called ‘sufficient’ to affect efficiency, a gap that Weir (1999) sought to address and indeed the findings indicate that at least four years of primary schooling are required to have a significant effect upon farm productivity.

Gender of farmer has also been argued to have an effect on technical efficiency; Dadzie and Dasmani (2010) in a study on the level of efficiency of food crop farms in Ghana found that although farms under male farm management had higher mean value of production figures relative to the female farmers’ farms, the farms under female farmers management were more efficient compared to the farms owned by males and, gender significantly influenced technical efficiency. Similar findings were made by Koirala et al. (2015) who sought to find out whether gender makes a difference in farm productivity and technical efficiency of rural Malawian households; the findings indicated that technical was 15 percent higher for female headed households compared to the male headed households. Contrary arguments are raised by Yiadom-Boakye, et al. (2013) in a study on gender, resource use and technical efficiency among rice farmers Ghana who found that female rice farmers were relatively technically inefficient than their male counterparts. In examining the effect of gender on technical efficiency, it is important to beware of its interrelatedness with other productive resources; women face limited access to land (Doss and Morris, 2000), information (Manfre and Nordehn, 2013), technologies (Pingali, 2012)

These individual (agent) factors variables are more suitable for explaining differences in efficiency between firms (Bremmer et al., 2008) rather than changes in efficiency (and productivity) over the years.

Farm characteristics affecting technical efficiency are farm size, type of land tenure, land fragmentation, access to agricultural extension services, agroecology among others. Farm size has been found to have an effect on technical efficiency; a study by Masterson (2007) examining productivity, technical efficiency, and farm size in Paraguayan agriculture, concludes that smaller farms have higher net farm income per hectare, and are more technically efficient, than larger farms. The reason for this, they argue could be arising from the social distance between household and hired labor as supervision becomes less effective. Similar perspective is held by Rahman et al. (2012) who applied a stochastic frontier approach to model technical efficiency of rice farmers in Bangladesh and concluded that farm size has negative relations with efficiency. A different view is held by Helfand and Levine (2004) in studying farm size and the determinants of productive efficiency in the Brazilian Center-West who found that rather than an inverse relationship, where productivity falls as farm size rises, there exists a U-shaped relationship. An even different view yet still is held by Croppenstedt (2005) who estimated technical efficiency of wheat farmers in Egypt and found that technical efficiency did not vary with farm size.

Land tenure affects the level of technical efficiency. Land ownership drives farmers' land use decisions (Tenaw et al., 2009); defines property rights that give access to a whole set of benefits such as security in land use and access to credit when used as collateral; moreover technologies with long time frames tend to require tenure security to provide sufficient incentives to adopt, while those that operate on a large spatial scale will require collective action to coordinate, either across individual private property or in common property regimes (Komarudin et al., 2008). Kariuki., 2008) in analyzing the effect of land tenure on technical efficiency of smallholder crop production in Kenya found that parcels with land titles had a higher efficiency level. Moreover, owned land and fixed rent also reduce inefficiency (Donkor and Owusu, 2014) and compared to owner operators, farmers who lease land are less productive (Koirala et al., 2014), Nonetheless, there have been findings showing evidence of higher technical efficiency on rented plots as compared to farmer owned land or freely endowed with (Feng, 2008) while Michler and Shively (2015) in a study on land tenure, tenure security and farm Efficiency in the Philippines find no evidence that technical efficiency differs between parcels that are always owned and parcels that are always rented. The effect of land tenure system on technical efficiency is therefore not conclusive.

Agro ecology has been cited in examining possible determinants of technical efficiency. For example, Mariano et al (2010) make an inquiry into whether irrigated farming ecosystems are more productive than rainfed farming systems in rice production in the Phillipines using a stochastic metafrontier, essentially a production function which envelops the production frontiers of each farming ecosystem between them over time. Results indicate no significant difference in productivity between farms in the rainfed and those in irrigated ecosystems. A different conclusion is reached by Deressa (2011) in studying the effects of climatic conditions and agro-ecological settings on the productive efficiencies of small-holder farmers in Ethiopia who found that agro-ecological settings affect technical efficiency in Ethiopian agriculture.

Revilla-Molina et al. (2008), in analyzing improvement of technical efficiency in rice farming in China found that access to extension is significant for improving technical efficiency. Similar findings are made by O'Neill et al., (1999); Nyagaka et al., (2010) and Gebregziabher et al., 2012). Extension agents serve as communication links between researchers and farmers and therefore transmit new innovations from researchers to farmers; likewise communicating farmers' problems to researchers (Sienso et al., 2014). In addition to transmission of innovations, extension agents also assist farmers in the development of their managerial skills thereby facilitating an upgrade to more efficient production thus narrowing the gap between current and the potential productivity, given the existing set of technology and management alternatives (Dinar et l., 2007) Nonetheless, other studies have found that extension services do not significantly affect technical efficiency (Alene and Hassan, 2003 and Hoang 2012). Indeed Addai and Owusu (2014) cautions that it is not extension services per se but, appropriateness of extension message or training that counts.

A number of socio-economic factors do affect technical efficiency such as credit. Credit constraint affects the purchasing power of farmers in terms of acquiring farm inputs and covering operating costs in the short run, limits their ability to make farm related investments and adopt technologies (Komicha and Öhlmer, 2007). Agricultural credit is however a complex issue that goes beyond mere access; Llanto (2007) reflects upon overcoming obstacles to agricultural microfinance and indicates that barriers to agricultural microfinance go way beyond the simple provision of credit which is not a "one size fits all" approach, therefore dealing with the complexity and risks in agriculture, rural lenders would have to rethink their product design, lending technologies, risk management strategies; improve their information base; and strive to have access to market-based risk management products. Access to credit positively affects technical efficiency of farmers by enabling them purchase necessary inputs (Nchare, 2007; Bravo-Ureta and Pinheiro, 1993; Bäckman et al., 2011).

Another factor related to credit access that affects technical efficiency is off farm income. Indeed Babatunde, (2015) in examining on-Farm and off-farm work in Nigeria argues that to overcome their credit constraints, farm households are increasingly seeking alternative sources of income by participating in off-farm activities. Nehring and Fernandez-Cornejo (2005) find that off-farm income boosts scale and technical efficiency of smaller operations. Additionally, they indicate that the number of hours worked off-farm by the spouse contributes to a higher technical efficiency. An argument is however raised with evidence showing that higher off farm income increases the technical inefficiency of rice farmers, in explaining this, Bäckman et al. (2011) argue that the more off farm hours a producer works, the less time is devoted to farming, thus resulting in higher technical inefficiency; a similar view is held by Kumbhakar et al. (2014) in using competing models to analyze technical efficiency of Norwegian grain farming who saw that off-farm income share tended to affect technical efficiency in a negative way, but with the effect being highly variable between farms. The argument on off farm income may seem inconclusive so far but some agreement is that off farm income positively affects technical efficiency only ii incomes got off farm are spent as investment in the farming sector in the form of purchase of modern inputs and adoption of new technology (Abebe 2014).

Land fragmentation defined as farmers operating two or more geographically separated tracts of land considering distances between those parcels (Bizimana et al., 2004) and measured by the number of plots and Simpson Index (SI) (Chen et al., 2009). It could lead to sub-optimal usage of factor inputs and thus to lower overall returns to land (Jha et al., 2005). Indeed a number of studies have argued that land fragmentation negatively affects technical efficiency; Chen et al. (2009) indicate that land fragmentation results in inefficiency; Monchuk et al. (2010) look at fragmentation in three dimensions namely; number of fragments, spatial disconnect and variability in area out of which they found that only the number of fragments has a significant negative impact on productivity while the other two do not; Brázdik (2006) applied a non-parametric analysis of technical efficiency to establish the factors affecting efficiency of West

Java rice farms and concludes that high land fragmentation was the main source of the technical inefficiency during the final period of the intensification era, known as the Green Revolution. Contary to the view that land fragmentation negatively impacts on technical efficiency, Wu et al., 2005) use the Simpson Index (SI) and average plot size to capture two dimensions of land fragmentation and found no effect of land fragmentation on the average production function.

Hired labour does have a positive effect on technical efficiency even as shown by finding from Abatania et al. (2012) while analyzing farm household technical efficiency in Ghana using bootstrap Data Envelop Analysis; Omonona et al. (2010) in examining farmer resource use and technical efficiency in cowpea production in Nigeria found that hired labour positively and significantly affects technical efficiency. A positive effect of hired labour on technical efficiency is also found by Amaza et al. (2006) in identifying factors that influence technical efficiency of food crop production in West Africa. Obwona (2006) in reviewing determinants of technical efficiency differentials amongst small and medium scale farmers in Uganda found a negative relationship between hiring labour and technical efficiency which he explains could be resulting from shirking since hired workforce dispersed over a large area is costlier to monitor and its output more difficult to measure (e.g., fertilizing or seeding).

Nonetheless in studying determinants of technical efficiency, factors are examined in interaction rather than in isolation and several studies have used this approach thus reporting a cocktail of factors and their possible effects on technical efficiency for example Mustapha and Salihu (2015) apply a stochastic frontier production function analysis to examine the determinants of technical efficiency of maize/cowpea intercropping among women farmers in Gombe State, Nigeria found that household size, educational level, farming experience, access to extensions services and off farm income generation were the major determinants of technical efficiency in the study area. They further found that the mean technical efficiency of the farmers was 0.84 which they interpreted to mean that the women farmers are relatively efficient in maize/cowpea intercropping. Their study focused on women farmers and did not seek to make a comparison between women and male farmers. Itam et al. (2015) on the other hand use a similar sampling technique and assess the technical efficiency of small scale cassava farmers in Cross River State; their study included both male and female farmers cassava farmers from Ikom and Ogoja Agricultural zones in the State. The result of the stochastic production function used in estimating the farmer's technical efficiency showed a mean technical efficiency of farmer's was 89 percent. With the post estimation generalized Likelihood Ratio (LR) tests they indeed confirmed that cassava farmers were technically inefficient, implying that there is room to improve technical efficiency with the farmers' current resource base and available technology. In their analysis, age and sex of the farmers were found to have a negative but significant effect on technical efficiency, while education, family size, farming experience and farm size had significant positive effect on farmer's technical efficiency.

Kibirige and Obi (2015) examined the allocative and technical efficiencies and determinants of technical efficiency of smallholder farmers at Qamata and Tyefu irrigation scheme using a Cobb-

Douglas production function and the stochastic frontier analysis. Their findings show that though farmers are allocatively inefficient, underutilizing resources such as seeds, pesticides and herbicides and incurred higher costs in fertilizer use; they are technical efficient at approximately 98.8 percent and the factors that determine technical efficiency are household size, farming experience, use of agro-chemicals, off-farm income, and gross margins earned from maize, and household commercialization level. In terms of determinants of technical efficiency, Ng'ombe and Kalinda (2015) find a relatively different set of variables except for off firm income which they also found to be significant. Their study applied the Stochastic Frontier Analysis to estimate technical efficiency of maize production under conditions of minimum tillage in Zambia. In terms of methodology, they adopt the stochastic frontier analysis based on both the half-normal and exponential model distributions and study cross sectional nationally representative data of smallholder maize farm households that adopted minimum tillage in Zambia. Their results indicate that technical efficiency of these farmers is affected by marital status, level of education of household head, square of household size, off farm income, agro-ecological region III, distance to vehicular road and access to loans. Still introducing more possible determinants of technical efficiency of small holder farmers, Alwarritzi et al. (2015) present a study investigating oil palm productivity of smallholder farmers with stochastic frontier approach to provide evidence on agricultural practices that were beneficial in the enhancement of productivity of oil palm. They found that farmers group, extension program, education level, and farm diversification increase farmers' technical efficiency.

Technical efficiency has also been said to be affected by environmental factors; Ogada et al. (2014) in a study in Kenya used a two-stage nonparametric approach on household panel data to estimate the efficiency levels of the smallholders and establish the sources of its variation across households. Their results showed that technical efficiency differentials are influenced by environmental factors, production risks and farmer characteristics. Moreover, Sherlund et al. (2002) in a study on traditional rice plots in Côte d'Ivoire show that controlling for heterogeneous environmental production conditions significantly changes inferences; they argue that there could be omitted variables bias because farmers' input choices typically respond in part to environmental conditions but they also generally observe that few data sets collect necessary, detailed information on environmental production conditions.

Women empowerment also has an effect on technical efficiency through certain pathways; women empowerment involves reducing or eliminating the gender gap in resource access, decision making, access to productive resources and complimentary resources amongst others. Empowering women would therefore result in increasing their access and control over productive resources such as land, increase their access to complimentary inputs such as credit, and improve their scope in decision making. These would enhance their efficiency in production since such are often cited as the reasons for their low productivity in agriculture.

In Tanzania, studies have been undertaken in highlighting factors that affect technical efficiency of farmers. Some are agent based, others are socio economic; yet still others are institutional. Agent based factors such as age have been found to affect technical efficiency of farmers in Tanzania (Msuya and Ashimogo, 2005) who found out that older outgrowers were less efficient when compared to younger ones; according to them this could be due to the fact that sugarcane cultivation is very strenuous giving the younger farmers an advantage. Ilembo and Kuzilwa (2014) confirm this result and found that only age of household head showed a positive relationship with inefficiency.

In a study conducted to establish determinants of technical efficiency, Mbehoma and Mutasa (2013) found that age, gender, education level, experience of the farmer and selling to processor are major factors having a significant and positive influence on the farmers' technical inefficiency while marital status and use of hired labor are the major factors having a significant and negative influence on the farmers' technical inefficiency. Similar findings are raised by Msuya and Ashimogo (2005) who estimate technical efficiency in Tanzanian sugarcane production using a Cobb-Douglas production frontier and found that there were significant positive relationships between age, education, and experience with technical efficiency. Kalimangasi and Kalimangasi (2014) also support the view that experience has a positive effect on technical efficiency with the argument that the more experienced farmers were able to adopt new technologies but attained results suggesting that age and education level cannot explain any anything in the production of cocoa.

Family size has a positive effect on technical efficiency even as suggested by findings from Kalimangasi and Kalimangasi (2014) in studying technical efficiency of Cocoa Production through contract farming in Tanzania. The positive effect of household size on technical efficiency has been confirmed by Sarris et al., 2006) in exploring the role of agriculture in reducing poverty in Tanzania who also agree that age indeed has a positive effect on technical efficiency. In addition to family size and hired labour also has been cited as affecting technical efficiency.

Socio economic variables like easy access to formal credit and household being involved in non-farm business have a positive effect on technical by as shown by Sarris et al. (2006) and, Kalimangasi and Kalimangasi (2014). Sarris et al. (2006) also suggest that age could be a proxy for experience and has a positive effect. Muange et al. (2015) examine the effects of social networks on technical efficiency in smallholder agriculture: and found that inter-village networks positively influence technical efficiency of improved sorghum varieties, but have no effect in case of maize and that links to public extension officers increase efficiency of improved maize varieties. Chi and Nordman (2017) suggest that social networks provide a wide range of benefits to workers by reducing transaction costs, facilitating access to information, helping overcome the dilemmas of collective action, generating learning spinoffs and providing informal insurance.

4.5 Conclusion from the literature

Studies reviewed have agreed that age, family size, land ownership status, gender, agro ecology, hiring of labour and environmental factors among several other variables affect technical efficiency. Studies however disagree on the direction of this effect with some having a negative while the others appearing to have a positive effect. Notably, most studies look at a host of factors in understanding the determinants of technical efficiency. These can affect technical efficiency through different pathways that are not explicitly explored in most of the studies, for example gender and extension can independently affect technical efficiency but a combination of gender-extension may have a different result in terms of effect on technical efficiency. In this case, exploring the effect of each variable and the possible interaction between these variables can give more elaborate pathways of the effects that they have on technical efficiency.

4.6 Data and Methodology

4.6.1. Production Frontier Analysis

The study uses the stochastic frontier analysis in estimation of technical efficiency and adopted the specification of the stochastic production in terms of the initial production values as proposed by Aigner et al. (1977) below;

$$y_k = f(x_{ki};\beta_i)\exp(v_k - u_k) \quad \text{..} \quad \text{Equation 23}$$

Where;

y_k is potential output level from farms x_k is a vector of inputs and other farm specific explanatory variables, β is a vector of unknown parameters and $v_k - u_k$ is a two sided error term with v_k assumed to be iid N(O, σ_v^2) random errors and independently distributed of the u_k. v_k is random and not under control of the farmer such as weather changes and measurement error (Battese, 1992). u_k is a asymmetric, non-negative and reflects technical inefficiency (Dinar, et al., 2007). If farmers attain maximum possible output then they are technically efficient thus u_k =0.

Given the x vector of inputs and the farms, the technical efficiency of the k^{th} farm is given as

$$TE_k = \frac{f(x;\beta)e^{(v_k - u_k)}}{f(x;\beta)e^{-u_k}} = \frac{e^{(v_k - u_k)}}{e^{-u_k}} = e^{v_k - u_k + u_k} = e^{v_k} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; 24$$

The score attained for technical efficiency lies between zero and one with a completely efficient firm attaining a score of one while the completely inefficient farm attains a score of zero.

Aside from the methodology, one emerging issue in the estimation of technical efficiency is the theoretical consistency of the stochastic production frontier method with regard to microeconomic assumptions of monotonicity and quasiconcavity (Sauer et al., 2006).

Many studies have not taken these key properties into consideration and Henningsen and Henning (2009) argue that non-monotonicity distorts the efficiency estimates and can therefore result into misleading conclusions. Henningsen and Henning (2009) however highlight the fact that a non-quasiconcave point of the production function cannot reflect profit-maximizing behavior under standard microeconomic assumptions. They further argue that measuring technical efficiency generally assumes that producers maximize output given their input quantities rather than maximizing their profits thus concluding that there is no technical rationale for production functions to be quasiconcave.

Henningsen and Henning (2009) therefore suggest a three step procedure based on a two-step procedure by Koebel et al. (2003). In the first step they suggest estimation of the unrestricted stochastic production frontier, the minimum distance function and a final stage restricted frontier.

$$\ln y = \ln f(x, \beta) - u + v \qquad \text{..} 25$$

$$E[u] = z'\delta$$

Where $u \geq 0$ is the level of technical inefficiency, v is statistical noise, z is a vector of variables explaining technical inefficiency and δ are the parameters to be estimated.

The unrestricted parameter of the production frontier $\hat{\beta}$ and their covariance matrix $\sum_{\beta}$ are obtained from the estimation results.

In the second step we obtain the restricted β parameters by a minimum distance estimation

$$\hat{\beta}^0 = \arg\min(\hat{\beta}^0 - \hat{\beta}) \sum\nolimits_{\beta}^{-1} (\hat{\beta}^0 - \hat{\beta}) \qquad \text{..} 26$$

$s.t. f_i(x, \widehat{\beta}^0) \geq 0 \ \forall i, x$

$\widehat{\beta}^0$ are the model's restricted parameters while the constraint $f_i(x, \widehat{\beta}^0) \geq 0 \ \forall i, x$ is the monotonicity condition imposed on the model.

The third stage involves determination of the efficiency estimates of the farms and the determinants of technical inefficiency using a theoretically consistent production function. We estimate the frontier model below;

$$\ln y = \alpha_0 + \alpha_1 \ln \widetilde{y} - u^0 + v^0 \quad \text{..........} \quad 27$$

$$E[u^0] = z'\delta^0 \quad \text{..........} \quad 28$$

The only input variable is the frontier output of each firm calculated with parameters of the restricted model $\widetilde{y} = f(x, \widehat{\beta}^0)$ 29

The parameters of the α_0 and α_1 permit the adjustment of the restricted production frontier to;

$$y = e^{\alpha_0} f(x, \widehat{\beta}^0)^{\alpha_1} \quad \text{..........} \quad 30$$

A key shortfall of the approach is that it does not involve the determination of the standard errors for the restricted parameters (Tiedemann and Latacz-Lohmann, 2013). Nonetheless, it is a straightforward procedure when compared to the Bayesian approaches (Henningsen and Henning, 2009; Karimov, 2014), which either involve complex algorithms that have some convergence problems or are complex and laborious.

4.6.1.1 The Translog Production Function

The translog functional form is popular in stochastic frontier analysis because it satisfies the second order flexibility condition (Diewert, 1974) and also its logarithmic form enables the capture of inefficiencies by an additive term thus simplifying economic estimation (Henningsen and Henning, 2009).

We adopt the translog form defined by Henningsen and Henning (2009) as,

$$\ln y = \ln f(x, \beta) = \beta_0 + \sum_{i=n}^{n} \beta_i \ln x_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \beta_{ij} \ln x_i \ln x_j + v_i - u_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 31$$

$$\beta_{ij} = \beta_{ji}$$

The marginal products which are drawn from the first derivatives are;

$$f_i = \frac{f(x, \beta)}{x_i} \left(\beta_i + \sum_{j=1}^{n} \beta_{ij} \ln x_j \right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 32$$

The second derivatives are;

$$f_{ij} = \frac{f(x,\beta)}{x_i x_j}\left(\left(\beta_i + \sum_{k=1}^{n}\beta_{ik}\ln x_k\right)*\left(\beta_j + \sum_{k=1}^{n}\beta_{jk}\ln x_k - \Delta_{ij}\right) - \beta_{ij}\right) \qquad \text{.....................................} \quad 33$$

Where

$\Delta_{ij} = 1$ if $i = j$ and $\Delta_{ij} = 0$ otherwise.

And below are the dependent and independent variables used in the translog function;

$y = \ln Output$

$x_1 = \ln Plotsize$

$x_2 = \ln Labour$

$x_3 = \ln Seed$

$x_4 = \ln Plot^2$

$x_5 = \ln Plotsize * \ln Labour$

$x_6 = \ln Plotsize * \ln Seed$

$x_7 = \ln Labour^2$

$x_8 = \ln Labour * \ln Seed$

$x_9 = \ln Seed^2$

The study uses calculations within the "R software environment for statistical computing and graphics" (R Developemnt Core Team, 2009) using the R package "frontier" developed by Coelli and Henningsen (2017), "micEcon" (Henningsen, 2017), "quadprog" (Turlach, 2013) and "car" (Fox, et al., 2017) to estimate the initial unrestricted stochastic frontier, the latter restricted stochastic frontier and the subsequent likelihood ratio test. In the second stage, monotonicity is imposed by solving a quadratic optimization model. Monotonicity is imposed on parameters via the asymptotically equivalent minimum distance estimator, together with the parameters of the production frontier, $\hat{\beta}$, and their covariance matrix, $\hat{\Omega}_{\beta}$, which are extracted from the first step. Monotonicity restriction is imposed in order to ensure theoretical consistency of the estimation and indeed there is a change in the model coefficients between the unrestricted and the restricted models.

4.7 Results and Discussion of Results

4.7.1 Descriptive Results

The data used in this study was collected using a household survey conducted in August 2016 from 5 villages in Kilombero district, Tanzania as in the the Chapter 3 on women empowerment chapter from five villages namely Njage, Mbingu, Msolwa Ujamaa, Mang'ula A and Mkula.

From the total responses, data from 256 households has been adopted for use in the analysis for this chapter.

With missing values and non-response, the remaining effective sample upon which the technical efficiency is based was 200. Table 1 below gives a description of the sample from which the data was drawn;

Table 7: Descriptive Results for Variables Used in Analysis

	Mean (Std. Dev)	Minimum	Maximum
Socio economic variables			
Age	49 (12)	21	80
Gender of hh head (1= Male)	0.49 (0.50)	0	1
Education (1=Attained atleast primary educ)	0.69 (0.46)	0	1
Primary Activity (1=Non Farm)	0.19 (0.39)	0	1
Empowerment of the women (1= Empowered in 60 percent))	0.40 (0.49)	0	1
Marketing of rice (1=Marketing)	0.79 (0.41)	0	1
Accessing extension	0.70 (0.46)	0	1

(1=Accessing)			
Growing Improved seed (1=Improved)	0.46 (0.50)	0	1
Growing rice in Irrigated plots (1=Irrigated)	0.35 (0.48)		1
Applying Fertilizer	0.47 (0.5)	0	1
Production Variables			
Production in Kg	1726 (1407)	2	5000
Plot size in acres	2.1 (1.4)	0.25	10
Seed in Kg	46 (42)	2	300
Labour (No of people)	26 (14)	2	50
Fertilizer used (Kg)	69.3 (55.71)	1	275

Of the total sample, average age was 49 years old with the oldest farmer being 80 years and the youngest 21 years of age. Forty nine percent of the sampled farmers were male, 69 percent had attained at least a primary education, 19 percent practiced alternative non-farm activities as primary activities for income generation. In examining the level of women empowerment in the sampled households, 40 percent of the households had women that reported empowerment in atleast 60 percent of the weighted domains. Seventy nine percent of the sample reported marketing rice produce.

In terms of the production variables, the mean level of production was 31,726 kilograms, average acreage of 2.1 acres, average seed used was 46 Kg and average labour of 26 persons. Forty six percent of the sampled farmers grew improved varieties, 35 percent grew paddy in irrigated ecologies while 47 percent applied fertilizer to their rice crops. In the estimation of technical efficiency scores and determining the inefficiency effects, the study adopts the method by Sherlund et al (2001) and Chirwa (2007) where for those not using fertilizer they use a tenth of the smallest value reported amongst fertilizer users because for non fertilizer users, the estimation would entail obtaining the natural log of zero. In the sample used, the smallest value of fertilizer reported in this study is 1kg.

Results for technical efficiency scores and determinants of technical efficiency are presented in Tables 8 to 14 for models that take into account fertilizer use; and similar estimations are reported in the Tables A2 to A6 in the appendix without considering fertilizer in the production function given that a section of the sample did not report using fertilizer on their crops. Moreover, there is a strong variation amongst those that use with some using very low quantities while others applied higher qunatities.

4.7.2 Technical Efficiency Scores and Model Estimation Results for inputs and inefficiency effects

An initial estimation of technical efficiency scores for the male headed and female headed households using a single frontier shows the distribution of the scores in Table 8 below for the two household types;

Table 8: Technical Efficiency Attainment: Male Headed versus Female Headed Households

		Male Headed Households		Female Headed Households	
No.	**TE Range**	**Frequency (n=97)**	**Mean (Std Dev)**	**Frequency (n=103)**	**Mean (Std Dev)**
1	0 to 0.1	3	0.0540 (0.0251)	8	0.032 (0.0222)
2	0.11 to 0.2	0	-	7	0.1382 (0.0178)
3	0.21 to 0.3	2	0.2613 (0.0351)	5	0.2700 (0.0409)
4	0.31 to 0.4	2	0.3666 (0.0204)	8	0.3616 (0.0325)
5	0.41 to 0.5	8	0.4534 (0.0230)	18	0.4569 (0.0295)
6	0.51 to 0.6	14	0.5668 (0.0315)	19	0.5567 (0.0373)
7	0.61 to 0.7	20	0.6572 (0.0271)	17	0.6612 (0.0302)
8	0.71 to 0.8	22	0.7600 (0.0331)	17	0.7506 (0.0295)
9	0.81 to 0.9	26	0.8308 (0.0158)	4	0.8384 (0.0124)
10	0.91-1.0	0	-	0	-
	Total	**97**	**0.6644**	**103**	**0.5012**

Note: Own computation of a single production frontier using R-Codes by Henningsen and Henning (2009). The overall means for male heaed and female headed households are statistically significantly different at 1 percent (p=0.000)

For technical efficiency scores overall mean for the male headed households is 0.6644 and is higher than that of the female headed households whose overall average is 0.5012.

These results are contrary to those of Koirala et al. (2015) who found female headed households to have attained higher technical efficiencies and Kinkingninhoun-Mêdagbé et al. (2010) in a study in Benin who found that although women had lower productivity, they were as technically efficient as men.

Furthermore, efficiency scores are generated and compared across grouping variables such as education, primary occupation, access to extension, group membership among others, the mean scores are shown in Table 9 below and an assessment is done to establish whether there is a significant difference between these mean scores.

Table 9: Group Comparison of Mean Technical Efficiency Scores

Group	Different Groups	Mean TE Scores	Mean comparison
Education	Non educated (n=62)	0.5319 (0.0288)	***
	Attained primary educ (138)	0.6216 (0.0169)	
Occupation	Non Farm (n=38)	0.5082 (0.0465)	***
	Farming (n=162)	0.6139 (0.0145)	
Extension Access	Accessing (n=140)	0.6157 (0.0175)	**
	Not Accessing (n=60)	0.5427 (0.0276)	
Group Membership	In a group (n=73)	0.6492 (0.0249)	***
	Not in a group (n=127)	0.5620 (0.0182)	
Fertilizer Use	Using (n=106)	0.6167 (0.0184)	NS

	Not Using (n=94)	0.5680 (0.0239)	
Empowerment of the female	Empowered (80)	0.5811 (0.0194)	NS
	Not empowered (120)	0.6130 (0.0235)	
Marketing produce	Not Marketing (n=43)	0.5554 (0.0303)	NS
	Marketing (n=157)	0.6043 (0.0171)	
Improved Variety	Growing improved (n=92)	0.6100 (0.0213)	NS
	Non Improved (n=108)	0.5800 (0.0209)	

Note: ***, **, NS= Statistically significant at 1 percent, 5 percent and Not statistically significantly different

An attempt to disaggregate analysis by technologies applied such as according to improved versus traditional seed or modern technologies such as (tractor vs hand hoes) gave unsatisfactory results and notably, farmers did not exclusively report inclination to use of one strict technology set given that at different stages of production they alternated between using hoes, some ploughs and tractors. For those that planted improved seed, there were also reports of mixing of seeds types where they reported planting both varieties as well as recycling of seed from previous seasons which practices probably compromised the possibility of reliable results from such disaggregated analysis. Additionally, being smallholder rural farmers, the use of improved technologies was by very few who were the exception and not the norm within the sampled area.

Due to the short coming in disaggregation of analysis, the combined data is used in the exploring technical efficiency in terms of the inputs contributing to output and the inefficiency effects; the results of efficiency scores are as indicated below in Table 10 for the unrestricted and the restricted models:

Table 10: Distribution of Technical Efficiency Estimates for the study site from Unrestricted and the Restricted Models

		Unrestricted model		Restricted Model	
No.	**TE Range**	**Frequency (n=200)**	**Mean (Std Dev)**	**Frequency (n=200)**	**Mean (Std Dev)**
1	0 to 0.1	11	0.0380 (0.0241)	12	0.0440 (0.0290)
2	0.11 to 0.2	7	0.1382 (0.0178)	6	0.1593 (0.0290)
3	0.21 to 0.3	7	0.2675 (0.0366)	4	0.2660 (0.0220)
4	0.31 to 0.4	10	0.3626 (0.0295)	11	0.3653 (0.0340)
5	0.41 to 0.5	26	0.4558 (0.0273)	24	0.4587 (0.0264)
6	0.51 to 0.6	33	0.5610 (0.0348)	30	0.5503 (0.0284)
7	0.61 to 0.7	37	0.6590 (0.0282)	45	0.6563 (0.0284)
8	0.71 to 0.8	39	0.7558 (0.0315)	37	0.7550 (0.0265)
9	0.81 to 0.9	30	0.8318 (0.0154)	31	0.8276 (0.0149)

Source: *Author's estimation using "frontier" package in R software using codes by Henningsen and Henning (2009). Mean for unrestricted model is 0.5803 and for the restricted is 0.5861*

From the combined data, initial parameter estimates of the unrestricted model in translog form of the production function are indicated in Table 11 below;

Table 11: Estimates from the Unrestricted Translog Production Function

Variable	Parameter	Coefficient	Std error	Z value
Constant	β_0	5. 5567**	1.9799	2.8066
Ln(plot size)	β_1	-0.4603	1.1770	-0.3911
Ln(labour)	β_2	1.2091*	0.5708	2.1183
Ln(Seed)	β_3	-0.1663	0.7950	-0.2092
Ln (Fertilizer)	β_4	-0.2008	0.1842	-1.0901
$(\text{Lnplot})^2$	β_5	0.3616	0.4453	0.8120
$(\text{Lnlabour})^2$	β_6	-0.1266	0.1017	-1.2444
$(\text{LnSeed})^2$	β_7	0.2944	0.3042	0.9678
$(\text{LnFertilizer})^2$	β_8	0.0414	0.0500	0.8287
LnPlot*LnLabour	β_9	0.0600	0.2449	0.2450
LnPlot*LnSeed	β_{10}	-0.1288	0.3153	-0.4087
LnPlot*LnFertilizer	β_{11}	-0.0448	0.0645	-0.6940
LnLabour*LnSeed	β_{12}	-0.1610	0.1604	-1.0039
LnLabour*LnFertilizer	β_{13}	0.0152	0.0392	0.3871

LnSeed*LnFertilizer	β_{14}	0.0629	0.0525	1.1966
SigmaSq($\sigma^2 = \sigma_u^2 + \sigma_v^2$)	σ^2	2. 3797***	0.7830	3.0390
Gamma(σ_u^2/σ^2)	γ	0.7312***	0.1140	6.4146

Source: Author using frontier package in R software using codes by Henningsen and Henning (2009)[6]

From table 11 above, σ^2 is the total variance $(\sigma_u^2 + \sigma_v^2)$ and γ is the proportion of the variance of technical inefficiency in the total error variance (σ_u^2 / σ^2) . The β_s are defined as those parameters affecting output. Gamma is equal to 0.73 and significant at 1 percent, which indicates that much of the variation in the composite error term is due to the inefficiency component.

The primary input labour has a significant effect on output thus an increase in the amount of labour results in an increase in the level of output given the current level of other inputs. This is an expected result given that smallholder rice farming is labour intensive activity (Mdemu & Francis, 2013). In testing the null hypothesis of no inefficiency effect, the null hypothesis is rejected thus implying that the joint effect of the explanatory factors significantly contribute to technical efficiency. This is because the value of gamma is relatively high (0.73) and highly significant thus indicating that much of the variation in output is not directly due to changes in the level of fixed inputs only but rather is due to changes in capacity utilization thus the analysis of socio-economics aspect of smallholder farmers is more suitable in explaining the existing variation in technical efficiency.

Therefore from the unrestricted model, Table 12 below indicates the results of the determinants of technical efficiency.

Table 12: Determinants of Technical Efficiency from the Unrestricted Translog Production Function

Variable	Parameter	Coefficient	Std. Error	z-value
Empowerment at 60 percent of domains	δ_1	-1.4235*	0.7611	-1.8704
Age	δ_2	0.0582	0.0445	1.3085
Age squared	δ_3	-0.0005	0.0006	-0.8238
Gender of household head(1=Male)	δ_4	-2.2713**	1.0941	-2.0758
Fertilizer use (1=Fertilizer use)	δ_5	-2.4855**	1.0240	-2.4272
Education of household head(1=attained primary)	δ_6	-1.3394**	0.6654	-2.0128
Primary occupation of hh head (1=Non Farm)	δ_7	3.5538***	1. 2661	2.8069
Marketing rice produce (1=Marketing)	δ_8	0.6834	0.7614	0.8976
Extension access (1=Accessing extension)	δ_9	-0.3181	0.5181	-0.6404
Growing improved varieties (1=Improved)	δ_{10}	-0.6437	0.5943	-1.0831
Irrigating (1=Irrigating)	δ_{11}	0.2219	0.7278	0.3049
Group membership (1=Hold membership)	δ_{12}	-2.0527**	1.9848	-2.0845

Source: *Author's estimation using "frontier" package in R software using codes by Henningsen and Henning (2009)*

From Table 12 above the δ_s are those parameters affecting technical inefficiency. In interpreting the results of the inefficiency model, positive parameter estimates for the *z*-variables are interpreted as a positive relationship between the *z*-variables and the inefficiency term, *u* (Olsen and Henningsen, 2011). Notably, empowerment of the woman within the household, gender, primary occupation, fertilizer use and group membership of the household head are significant in their effect on technical inefficiency of the household. Although fertilizer use has been argued by studies such as Abebe (2014) to indicate improvement in technology, or as an input in production such as by Geta et al. (2013), Chirwa (2007) analyzes fertilizer as an improvement in technology but also examines it as one of the inefficiency effects; it is found to have an insignificant effect on technical efficiency thus cautioning that although some farmers had adopted fertilizer technology, given the low level of education among most farmers and the small land holdings, such technologies may be applied inappropriately.

In the test of monotonicity condition, we find that the translog function is monotonically increasing in plot, labour, seed and fertilizer however for these exogenouse variables, for "plot size" monotonicity is fulfilled in 90 percent of observations; for labour it is fulfilled for 98.5 percent for seed it is fulfilled in 56 percent and for fertilizer it is fulfilled in 46 percent while the variable with monotonicity fulfilled in the least number of observations is "seed" at 48.5 percent.

For plot size and labour the level of monotonicity achieved is acceptable even as Henningsen and Henning (2009) suggest that if the monotonicity condition is violated only at a few data points, these are probably random deviations from the ‘‘true’’ monotonically increasing production frontier and they suggest imposing the monotonicity condition in the estimation. For seed, monotonicity is achieved in less than half the observations. Although our data does not provide evidence of this, one possible reason for the result on monotonicity of seed can be explained by the difference in crop establishment methods thus differences in seed rate that translates into different levels of output (farmers traditionally broadcast seed at 30Kg per Ha but under the recently introduced SRI (System of Rice Intensification) some plant 6-7 Kg per Ha). Some farmers plant in the nursery bed and the transplant seedlings later while others directly sow by planting in lines. A high seed rate through broadcasting may not necessarily result in high output due to the compromise in the vigour of viable crops while those planting in lines or transplanting may have a low seed rate but harvest higher levels of output thus for a section of the observations, monotonicity may not be observed. For fertilizer, while some farmers applied in the nursery, others applied fertilizer in the rice fields after crop establishment yet still others applied no fertilizer at all.

In the second stage of analysis, we obtained the coefficients by the minimum distance estimation which Kumbhakar (2006) describes as adopting an input-saving approach to the measurement of the distance from a producer to the boundary of production possibilities and the results are presented in Table 13 below;

Table 13: Minimum Distance Results

	Parameter	Coef (min Dist Result)	Diff	diff/std.err	Adj.coef**
Constant	β_0^0	5.4989	0.0578	0.0292	5.5721
lnPlot	β_1^0	-0.0810	-0.3793	-0.3223	0.0807
lnLabour	β_2^0	0.8100	-0.3991	-0.6992	0.7944
lnSeed	β_3^0	-0.0465	-0.1198	-0.1507	-0.0457
lnFertilizer	β_4^0	0.0000	-0.2008	-1.0901	0.000
($\ln Plot^2$)	β_{11}^0	0. 1614	0.2002	0.4496	0.1583
(lnPlot*lnLabour)	β_{12}^0	-0. 6667	1.2668	5.1727	-0.0654
(lnPlot*lnSeed)	β_{13}^0	0.0387	-0.1676	-0.5316	0.0379
(lnPlot*lnFertilizer)	β_{14}^0	0.000	-0.0448	-0.6946	0.000
($\ln Labour^2$)	β_{22}^0	-0.0548	-0.0718	-0.7060	-0.0537
(lnLabour*lnSeed)	β_{23}^0	-0.0158	0.1452	0.9052	-0.0155
(lnLabour*lnFertilizer)	β_{24}^0	0.0000	0.0152	0.3878	0.000
($\ln Seed^2$)	β_{33}^0	0.0177	0.2767	0.9096	0.0174
(lnSeed*lnFertilizer)	β_{34}^0	0.0000	0.0629	1.1981	-0.0000
($\ln Fertilizer^2$)	β_{44}^0	0.0000	0.0415	0.8300	0.0000

Source: *Author's estimation using "frontier" package in R software using codes by Henningsen and Henning (2009).* **Results from step 3 estimation

From Table 13 above, the change in coefficients (minimum difference result minus unrestricted production result) is captured by the column ‘‘diff’’, but all changes are all less than two times the standard error of the first-step estimation (column ‘‘diff/std.err’’ i.e diff of minimum distance/ std error of unrestricted translog function). The last column (‘‘adj.coef’’) in the table indicates the restricted coefficients after adjusting the production frontier with α_0 and α_1 estimated in the final step. Monotonicity condition is still not fulfilled at all observations with seed exhibiting monotonicity in only 45 percent of the observations; an assessment of monotonicity of inputs indicates that; i) 'plot' is fulfilled at 199 out of 200 observations (99.5 percent); ii) 'labour' is fulfilled at 195 out of 200 observations (97.5 percent) iii) ‘seed' is fulfilled at 97 out of 200 observations (48.5 percent). Additionally, just as with monotonicity, quasiconcavity is also not yet fulfilled in all observations and is reported as fulfilled in 26 percent of the observations.

From the last stage of estimation, the results of the final stochastic frontier showing detreminants of technical efficiency are obtained and presented in Table 14 below;

Table 14: Final Stochastic Frontier Estimation: Determinants of Technical Efficiency (Step 3 Estimation)

	Estimate	Std. Error	Z value
Intercept	0.1786	1.4221	0.1255
cFitted	0.9808***	0.1804	5.4384
Age	0. 0508	0.0448	1.1343
Age squared	-0.0004	0.0006	-0.7633
Empowered at 60 percent (1=empowered at 60	-1.5838**	0.7907	-2.0029

percent)			
Gender of household head (1=Male)	-2.5682**	1.1043	-2.3257
Education of household head (1=Attained primary)	-1.4046*	0.7379	-1.9035
Primary occupation of hh head (1=Non Farm)	4.0580***	1.5830	2.8956
Marketing of rice produce (1=Marketing)	0.6544	0.7989	0.8191
Extension access (1=Accessing)	-0.4728	0.6302	-0.7502
Growing improved variety (1=Growing Improved)	-0.6393	0.6242	-1.0241
Growing in irrigated ecology (1=Irrigated)	0.2095	0.8320	0.2518
Group membership (1=Has Membership)	-2.3606**	1.0409	-2.2680
Fertilizer use	-2.2577**	0.9807	-2.3023
SigmaSq	2.6805***	0.9073	2.9544
Gamma	0.7590***	0.0938	8.0956

Source: *Author's estimation using "frontier" package in R software using codes by Henningsen and Henning (2009)*

The intercept is not significant and the cFitted (the scaling coefficient) is one indicating the robustness of the model. Moreover, the results of the final SFA presented in table 13 above indicate the coefficient of the intercept as zero and the coefficient of the ''frontier output'' as virtually one. A closer look at the result indicates that the coefficients of the adjusted and non-adjusted restricted production frontier are almost identical (when we compare the columns ''coef'' and ''adj.coef'' of Table 13).

Noticeably while in the unrestricted model and the restricted models similar variables are significant, with the restricted (theoretically consistent) model monotonicity and quasiconcavity are reported as; i) the monotonicity condition for 'plot' is fulfilled at 199 out of 200 observations (99.5 percent); ii) for 'labour' is fulfilled at 200 out of 200 observations (100 percet) iii) for 'seed' is fulfilled at 197 out of 200 observations (98.5 percent) and, iv) for fertilizer is fulfilled in 75 out of 200 observations (37.5 percent). In the study however, fertilizer users comprised only 47 per cent of the sample while the rest did not use fertilizer and as such monotonicity was not expected to be fulfilled in all observations especially given that we adopted a method used by Sherlund et al. (2002) and Chirwa (2007) where for those not using fertilizer, a tenth of the smallest value of fertilizer used by the fertilizer users is used to estimate the model. The average efficiencies of the unrestricted and the restricted models are 0.5803 and 0.5861 respectively and therefore almost identical.

The variables affecting technical efficiency are discussed as women empowerment in atleast 60 percent of weighted domains, gender, primary occupation and group membership of household head and, fertilizer use. Women empowerment has a negative effect on technical innefficiency; these results echo the finding by Seymour (2017) in understanding the implications of women empowerment on technical efficiency in Bangladesh; the study found that reduced gender disparities within households (measured in terms of the empowerment gap between spouses) are associated with higher levels of technical efficiency, a result observed on plots women jointly manage with their spouses, as well as those that women do not actively manage. Furthermore, empowerment of women lifts the binding constraints that they face in accessing and making decisions on productive assets for example Doss and Morris (2000) observe that women face greater limitations in accessing inputs such as labour and yet from our sample labour contributes significantly to output gains. The lifting of these limitations as a result of empowerment reduces their inefficiency in production.

Male headed households are more technically efficient than female headed household. This result is consistent with findings Makate et al.(2016) in a study on maize production in Zimbabwe who argued that this can be the case because planting, weeding, harvesting, and other crop management operations are labour-intensive and female farmers have relatively less access to productive resources. Additionally in terms of the labour that male and female household heads provide, Doss (2015) cautions that male and female labour may not be perfect substitutes due to social norms, skills, physical capabilities and the overall care roles that are assigned skewed towards the women. These studies raise possible reasons fro the differentials in technical efficiency attained specifically with reference to male headed households being more efficient.

With regard to primary occupation of the household head, farmers are more technically efficient than those who participate in rice farming but have an alternative non-farm primary occupation. This can be attributed to the fact that those who are primarily farmers have greater experience in farming which enhances their technical efficiency. Indeed Kalimangasi and Kalimangasi (2014) also support the view that experience has a positive effect on technical efficiency with the argument that the more experienced farmers were able to adopt new technologies in the production of cocoa. Moreover, rice farming is a labour intensive activity and requires attention to detail which may be hard to achieve for those with alternative employment although they may earn sufficient income to hire labour; Chowdhury, (2016) used data for three crop seasons and cautions that family labour is more productive than hired labour with Lipton (2010) raising the argument that hired labour does require supervision by family labour. Our findings are however contrary to those of Seng (2015) in a study of effect of nonfarm activities on farm households' food consumption in rural Combodia and argues that farm households engaging in nonfarm employment tend to enjoy higher household incomes and produce agricultural products more efficiently, suggesting the vital role of nonfarm activities in raising farm households' incomes and improving farming practice.

Group membership of the household head has a negative effect on technical inefficiency thus indicating that it indeed does enhance the efficiency of smallholder rice farmers. Similar findings have been made by Bhatt & Bhat (2014) in a micro level study conducted at Jammu and Kashmir. Group membership works through the channel of easing access to productive inputs and facilitating extension linkages (Abate et al., 2013). Our findings though, contradict results from Addai et al. (2014) who found no significant impact of farmer based organization on technical efficiency of maize farmers across various agro ecological zones in Ghana.

Education has a negative effect on technical inefficiency thus indicating that it improves technical efficiency. Indeed Abatania et al. (2012) argue that education enables farmers to interprete extension and other information thus enhancing technical efficiency. Our findings concur with those of Yegon et al. (2015) in a study on soybean production in Kenya who found that education reduced technical inefficiency among farmers.

The last hypothesis that the study tests, is the suitability of the restricted model versus the unrestricted model. The study fails to reject the hypothesis that the restricted model is a preferred estimation given the likelihood ratio test that returns a p-value of 0.92. Given this result, monotonicity is a key property that should be given consideration in frontier modeling and our results have shown that empowerment of the woman within the household, gender, primary occupation and group membership of the household head and, use of fertilizer have significant effects on technical efficiency of production for rice producing households.

4.8 Concluding Remarks

In conclusion, the analysis of technical efficiency of production was undertaken using the stochastic production frontier. Following the recommendations by Henningsen and Henning (2009) that non-monotonicity distorts the efficiency estimates and can therefore result into misleading conclusions, a three step procedure suggested by Henningsen and Henning (2009) with the unrestricted frontier, minimum distance estimation and, a final stage restricted frontier was used and estimation done with R software. The restriction is done via imposing monotonicity which is meant to ensure estimation of a theoretically consistent model. Results show that the null hypothesis of no inefficiency effect is rejected thus implying that the joint effect of the explanatory factors significantly contribute to technical efficiency. With the unrestricted and restricted models empowerment of the woman in atleast 60 percent of weighted domains, gender of the household head, primary occupation of the household head, group membership and fertilizer use are significant in their effect on technical efficiency of the household

In the testing for monotonicity, results showed that it was violated in the input seed while nearly achieved in plot size and labour and this could be attributed to the different seed establishment methods such as nursery bed use, direct seeding and sowing in lines. Imposing monotonicity and estimating the restricted model improves theoretical consistency of our model with quasi concavity achieved in over 95 percent of the observations and monotonicity achieved in all the primary inputs. Nonetheless, average efficiencies of the unrestricted and the restricted models are almost identical and are 0.5938 and 0.5879 respectively.

Suitability of the restricted model over the unrestricted model was tested and with a likelihood ratio test p-value of 0.92, the study fails to reject the hypothesis that the restricted model is a preferred estimation. Monotonicity is thus a key property that should be given consideration in frontier modeling and the results of the restricted model are more appropriate in explaining the attained technical efficiency and its determinants.

CHAPTER FIVE

DETERMINANTS OF MARKET PARTICIPATION BY SMALL HOLDER RICE FARMERS

5.1 Introduction

This chapter seeks to analyze market participation and its determinant for smallholder farming households. It begins by reviewing pertinent features of smallholder farming systems in Africa followed by a highlight of Tanzanian smallholder farming sector with a focus on its characteristics and, hypotheses about its future. Within the chapter, smallholder farming household behavior is examined in light of economic theory with a chronology on progression in scholarship over this behavior. A simple smallholder model suggested by Barrett (2008) is used to illustrate the rational utility maximizing household faced with transaction costs and this is followed by a review of the importance of markets to smallholder farmers.

Given the importance of market participation for smallholder farmers, the chapter also adopts a model to assess market participation; within this model, some farmers participate in the market while others choose to self-select out of the market as possible forms of rational behavior in light of the transaction costs that they face. Households are classified as female headed and male headed in examining market participation given that transaction costs could possibly affect the households differently depending on gender of the household head. Cragg's double hurdle model is adopted for analysis of market participation. The chapter is concluded with a detailed description of market participation patterns and a discussion of results from the model on market participation by smallholder farmers.

5.2 Smallholder Farming Systems in Africa: Some perspectives

Food supply in developing countries is predominated by smallholder farmers; more so in Sub-Saharan Africa (Chauvin et al. 2012; Chamberlin, 2008). So by definition, who are smallholder farmers? There has been a plethora of characterisations; Salami et al. (2010) defines smallholder farmers as those cultivating less than 2 hectares of land and owning only a few heads of livestock while Berdegué and Fuentealba (2011) describes smallholder farms as being 2 hectares or less and representative of 80 percent of all farms in Sub Saharan Africa. However, the definition has not been cast on stone and, Morton (2007) uses smallholder or subsistence farmers to denote those farmers that are on a continuum between subsistence production and concentration on crop production for the market. Morton (2007) however cautions that definitions by scale are relative to national contexts, and 'smallholders' in transitional or developed countries may have farms (and incomes) many times larger than those in developing countries. The terms smallholder and family farm are often used interchangeably or in combination without clear differences and over time, average farm size has decreased in the developing world (Lowder et al. (2016). In examining agriculture in SSA, it has been noted to employ 59 percent of the population and generate 27 percent of the GDP of these countries as at 2005 (Staatz and Dembele 2007).

Looking at the developing world such as Africa in terms of land endowment, there is an abundance of land in Africa (Deininger and Byerlee, 2010; Fenske, 2013). So, why do we have food crop production predominated by smallholder farmers? Lowder et al. (2016) observes that the majority of the region's uncultivated arable land is concentrated in a few countries and, Bationo, et al. (2006) notes that African soils have an inherently poor fertility because they are very old and lack volcanic rejuvenation; moreover 55 percent of the land is unsuitable for cultivated agriculture while 16 percent of Africa's land is considered high quality, 13 percent medium quality and, 16 percent low potential. Furthermore, population in Africa has been rising and the level of urbanization in Sub-Saharan Africa has also increased dramatically to 40 percent (Hove et al., 2013) with UN (2014) projecting that the global urban population will grow by 2.5 billion urban dwellers between 2014 and 2050, with nearly 90 percent of the increase concentrated in Asia and Africa. Further still, the predominance of smallholder farms in Africa has been attributed to the fact that, they are small, family-operated and benefit from a number of advantages related to incentives, information and management effectiveness (Gollin, 2014). Nonetheless, smallholder farmers are marginally integrated into markets (Losch et al., 2010) and this implies that they cannot fully tap into benefits of market participation.

A review of Tanzanian smallholder agriculture sector reveals remarkable similarities with the observations about the African smallholder characteristics. According to Kawa & Kaitira (2007) Tanzanian agriculture is dominated by small scale subsistence farming and, Wolter (2008) observes that food production remains dominated by smallholder farmers whose productivity is low. Moreover smallholders' share in agricultural output for Tanzania was 75 percent (Salami et al., 2010) and it is a subsector characterized by limited commercialization. Furtherstill, smallholder farmers in Tanzania lack access to basic agricultural inputs and to credit, agricultural productivity is low, and landholdings are small and fragmented. Aside from dominating Tanzanian agricultural sector, Sarris et al. (2006) observe that average size of land cultivated varies amongst smallholders, from less than 1 ha to 3 ha of land and much of their land is cultivated by hand as opposed to machines such as ploughs and tractors. With increasing pressure on land, Kadigi et al. (2017) observes that landholdings of smallholder farmers might become increasingly more fragmented and this could result in a large number of landless farmers. Moreover, there are signs and speculations about possible changes in the horizon that might ruffle feathers within the smallholder subsector; Nolte & Sipangule (2017) suggest a largely speculation based "rush for land" theory with transnational and domestic investors acquiring land and highlights Tanzania among the few hotspots. Nonetheless, only time will tell how much of a change will be observed in the sub sector given the observations of Deininger & Byerlee (2010) about the conflicts that arise with the disturbance of the traditional land rights; moreover the study also notes that transfer of such land largely depends on the land tenure regime and for Tanzania land rights are firmly vested with the villages especially such smallholder rural agricultural land.

5.3 The Smallholder Farming Household Behaviour: A Review of Economic Theory

A number of theories have been developed in economics to explain behaviour of economic agents; one such is the neoclassical economic theory which assumes rationality and use of utility maximization as the criterion for rationality; emphasis on equilibria and, neglect of strong types of uncertainty particularly fundamental uncertainty (Dequech, 2007). An early example is Malthusian theory which observes that while food production increases at an arithmetic rate, population if unchecked, grows at a geometric rate (Malthus, 1888). The neoclassical agricultural household model has subsequently been developed that looks at the household as profit maximizing, utility maximizing but also cautious about the existence of risk (Mendola, 2005); Schultz's (1964) "efficient but poor" hypothesis in Nerlove (1999) describes the peasant production mode as profit-maximization behavior, where efficiency is defined in a context of perfect competition. Criticisms of the hypothesis highlight existence of trade-offs between profit maximization and other household goals, and the role of uncertainty and risk in farm household production decisions (Mendola, 2005) giving way to utility maximization theories which encompass the dual character of peasant households as both families and enterprises and thereby take account of the consumption side of peasant decision making. This model was applied by

Chayanovian and with extensions by (Becker, 1965) in Schreyer & Diewert (2014) showed that the household as a production unit converts purchased goods and services as well as its own resources into utilities when consumed. Mendola (2005) argues that these theories ignore the effect on farm household behavior of the uncertainty and risk involved in peasant production, and the social context in which peasant production takes place; moreover, most of these models are static and assume that households are risk-neutral. Lipton (1968) gives a critic of the profit approach showing how the existence of uncertainty and risk eroded the theoretical basis of the profit-maximizing model and argues that small farmers are, of necessity, risk-averse, because they have to secure their household needs from their current production or face starvation. There is no room for aiming at higher income levels by taking risky decisions (Lipton and Longhurst 1989). Ellis (1992) reasons that peasants produce under very high levels of uncertainty induced by natural hazards (weather, pests, diseases, natural disasters); market fluctuations; and social uncertainty (insecurity associated with control over resources, such as land tenure and state interventions, and war). These conditions pose risks to peasant production and make farmers very cautious in their decision making (see Walker and Jodha 1986 in Mendola, 2005). Farmers are consequently assumed to exhibit risk aversion in their decision making. In spite of the developments that neoclassical economics makes in explaining smallholder production, it falls short by assuming away institutions and economic agents are assumed to operate in almost a vacuum (Makhura, 2001). Moreover, the 'firm' seemed to have been treated as a 'blackbox' which Williamson (2007) while expanding on the work of Coase (1935) opened to investigate the firm as an institution (Hodgson, 2009). However, seeking a theory that is inclusive of institutions alone is not enough; for indeed the old institutional economics would have been sufficient since it does consider institutions (Yefimov, 2004). The old institutional economics however falls short since it has little analytical rigor (Makhura, 2001) and lies outside the framework of neo classical economics (Kherallah and Kirsten, 2002). The new institutional economics (NIE) builds on, modifies, and extends the neo-classical theory to enable it come to grips with an entire range of issues beyond its ken (North, 1995). NIE acknowledges the importance of institutions and suggest that that one can analyze institutions within the framework of neoclassical economics (Kherallah and Kirsten, 2002; Leite et al., 2014). North (1995) defines institutions as the rules of the game of a society or the humanly-devised constraints that structure human interaction and are composed of formal rules (statute law, common law, regulations), informal constraints (conventions, norms of behavior, and self-imposed codes of conduct), and the enforcement characteristics of both. NIE however has several branches such as New Economic History, Public Choice and Political Economy, New Social Economics, Transaction Cost Economics, Theory of Collective Action and Law and Economics as explained by Kherallah and Kirsten (2002). Of all the theories, transactions cost theory is more apt at investigating agricultural markets in developing economies (Cuevas, 2014; Kherallah and Kirsten (2002). Makhura (2001) submits that Transaction Cost Economics is principally relevant for agricultural market analysis in developing countries for the reason that many of the institutions, or formal rules of behaviour, that are taken for granted in developed countries which facilitate market exchange are absent in low-income countries. Moreover, with globalization and deregulation the transaction becomes the unit of analysis thus showing the usefulness of the theory (Kherallah and Kirsten, 2002). Transaction costs are the embodiment of barriers to access to market participation by resource poor smallholders (Holloway et al., 2000) yet these are the producers of food in developing countries (Zhou, 2010). Heltberg and Tarp, (2002) define transaction costs as all costs of entering into a contract, exchange or agreement: searching for trading partners, screening potential candidates, obtaining and verifying information, bargaining, bribing officials, transferring the product (including transport, storage and packaging cost), and monitoring, controlling and enforcing the transaction and, transaction costs are only partly observable.

Allen (1999) outlines two key positions in reference to transaction costs, transaction costs occurring when a market transaction takes place; and, occurring whenever any property right is established or requires protection. Additionally, there are two categories of transaction costs i) proportional transactions costs that change according to how much a household sells or buys and, ii) fixed transactions costs are independent of the quantities sold or bought (Vakis, et al, 2003). Moreover, these costs generally arise from information search, bargaining, making of (formal or informal) contracts, monitoring of contractual partners, the enforcement of the contract and the collection of damages when partners fail to observe their contractual obligations, screening costs and, transfer cost (Makhura, 2001). Transaction costs can thus considerably affect agents' decisions on whether or not to participate in the market (Cuevas, 2014). Infact Goetz (1992) attributes the failure to participate in specific commodity markets to high fixed transaction costs.

5.4 The Household Model: Smallholder farmers' participation in agricultural markets

In examining market participation by farmers, the simple household model suggested by Barrett (2008) provides an illustration of the decision making process. In adoption of NIE specifically the Transaction Cost theory, we can still look at the household utility maximizing behavior recalling that NIE relaxes some of the unrealistic assumptions of neo-classical economics (such as perfect information, zero transaction costs, full rationality) (Kherallah and Kirsten, 2002).

Barrett (2008) suggests a model for an agricultural household that participates in both a domestic market and export market. The household is assumed to maximize utility U , by consuming a vector of agricultural commodities, y^C for crops, and a Hicksian composite of other tradables, x . This is true for our definition of smallholder farmers whom Harvey et al. (2014) observes as typically depending on agriculture for food and income and, selling produce when they have a surplus or are in need of cash irrespective of market conditions (Tadesse & Bahiigwa, 2015).

In the model the household earns income from production, possibly from sale of any or all crops, and possibly off farm income, W (this can be income from paid work or transfer earnings). In Tanzania there has been evidence of off farm employment when farmers fail to realize earnings from on farm activities and, when low income households with limited access to land choose to diversify so as to bridge their consumption needs (Katera, 2016). Production of each crop is determined by a crop specific production technology, $f^{C}(A^{C}, G)$ which depends on inputs (e.g. fertilizer, pesticides, seed, labor) and services of a privately held quasi-fixed productive assets, represented by the vector A and the availability of public good and services, G , such as extension services that may affect output. The farmer is faced with a market participation decision; M represents the decision of whether to participate or not in the market as a seller, represented by the vector M^{CS} and this value is 1 if the farmer enters the market to sell or zero if he does not sell the crop; or buyer, M^{Cb}.

$$M^{CS} = \begin{matrix} 1 \ \textit{for sale of the crop} \\ 0 \ \textit{for not selling the crop} \end{matrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 34$$

Net sales of a crop c, $NS^{C} = f^{c}(A^{C}, G) - y^{c}$ and is positive if and only if $M^{CS}\ or\ M^{Cb} = 1$.

Given our interest in smallholder rice farmers, the focus of this study is on farmers' decision as to whether or not to participate in the rice market as a seller in the domestic market. Moreover, it is a one period model looking at the most recent cropping season production and marketing dynamics faced by the household. Boughton et al.(2007) and Barrett (2008*)* argue that households will not both buy and sell the same crop in the one-period model because of the price difference created by transaction cost, we thus focus on the household selling produce in this model, moreover this is a one period model. Therefore, there exists a complementary slackness condition, $M^{CV} * M^{CB} = 0$ at any optimum. The parametric market price each household faces, p^{cm} is affected by both crop and household specific transaction costs $\tau^{C}(A, G, W, Z, NS^{C})$. That is, the household faces wide price margins (referred to as a price band) between the low price at which it could sell a crop and the high price at which it could buy that crop (Sadoulet et al., 1998). Because of the transaction costs some households will be self-selecting out of the market for some crops (de Janvry et al. 1991; Barrett 2008). Following Boughton et al. (2007) and Barrett (2008), transaction costs are assumed to be a function of household's productive assets, A, access to public good and services, G (such as good infrastructure, roads or even markets), liquidity from off-farm income, W, household specific characteristics, Z and amount traded, NS. The household's choice can be represented by the following optimization problem:

$$\underset{s^{C}, x, A^{C}, M^{Ci}}{Max} \quad U(y^{C}, x) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 35$$

Subject to the liquidity constraint

$$W - p^{x}x + \sum_{C=1}^{C}\left[\left(p^{c^{*}}\left(M^{CS} + M^{Cb}\right)\left(f^{c}\left(A^{C}, G\right) - y^{C}\right)\right)\right] = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \quad 36$$

And equilibrium conditions for non-tradables

$$A = \sum_{C=1}^{C} A^{C} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 37$$

$$f^{c}\left(A^{C}, G\right) \geq y^{c}\left(1 - M^{Cb}\right) \qquad for\, c = 1,2,3,\ldots,C \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 38$$

With the assumption of the one period model where for rice the household will not both buy and sell the same crop within the same period. Considering rice as a specific crop, each household-specific price is determined by the household's net market position:

$$p^{c^*} = p^{cm} - \tau^c\left(A, G, W, Z, NS^c\right) \; if \;\; M^{CS} = 1(net\ seller) \qquad 39$$

$$p^{c^*} = p^a \qquad if \;\; M^{CS} = 0\ (autarkic) \qquad 40$$

Where p^a is the autarkic (i.e. non-tradable) shadow price that equates household supply and demand. The second equilibrium condition for non-tradables implies that, if the household does not purchase crop c ($M^{cb} = 0$), production must be greater than or equal to the quantity of crop c consumed (may be a net seller).

For either the net seller or the autarkic household, the system is solved for the optimal solution and then the market participation regime that yields the highest utility level is chosen (Key et al. 2000). The optimal choices of $\{y^c, A^C, x\}$ are substituted into the utility function to obtain the indirect utility function, V which is evaluated at M^{CS} to obtain the market participation vectors $\{M^{CS}\}$ that yields the highest level of V (Key et al. 2000; Barrett 2008).

Based on the structural model above, the reduced form of each choice variable can be represented as a function of observable (exogenous) variables $A, G, W, Z, P^{Cm}\ and\ p^x$.

Moreover with prohibitively high transaction costs, we assume the farmers sell only in the domestic market. Hidden prohibitive costs in Kilombero such as the district crop cess and the seasonality of the roads (West & Haug, 2017) pose a hinderance to farmers thus making export markets almost impossible for them to individually engage in directly.

5.5 The Importance of markets: An empirical review of literature

Marketing, in agriculture, includes all the various activities involved in the transformation of commodities sold by farmers into food and fiber products purchased by consumers (Ikerd, 1995). There are three basic market types namely i) informal markets with high levels of bargaining, few regulations and very little or no taxation; ii) the formal market with standard weights and measures and where transactions are agreed upon based on using clearly defined legal frameworks and iii) structured public markets that are organized by public sector buyers who offer standardized contractual buying arrangements with specific conditions (Ferris et al., 2014; Anbarci et al., 2012).

Informal markets are accessible to everyone whether sellers or consumers (Roesel & Grace, 2014) and for rural producers the most important markets are the domestic informal markets. The importance of informal domestic markets lays in the facets it exhibits which fit in with the reality of rural farmers; Csaky (2014) notes that most smallholder farmers operate in informal markets. Grace et al. (2014) observes that informal markets have many unlicensed, traditional processing and retailing predominate plus, they escape effective health and safety regulations while Fraser et al.(2014) argue that the informal sector is characterized by easy entry, reliance on indigenous resources, self-employment and low productivity.

In accessing formal markets, smallholder farmers face constraints such as strict requirements set in the formal markets (Mpandeli & Maponya, 2014); stringent sourcing criteria (Baloyi, 2010) amongst others. But even for the accessible informal markets, smallholder farmers still face a number of challenges such as inadequate value addition; weak institutional set for agricultural marketing, limited options for marketing risk management as highlighted by Kawa and Kaitira (2007). Nonetheless, informal markets provide farmers with an opportunity to earn income (Roesel & Grace,2014) and also ensures food supply and access to much of the urban Sub Saharan Africa by providing employment opportunities for women and other marginalized groups, and by making food products available at affordable prices to urban dwellers who buy more food than they produce (Fraser et al.,2014).

Boughton et al. (2007) suggests that market participation is both a cause and a consequence of economic development. Moreover, markets offer households the opportunity to specialize according to comparative advantage and thereby enjoy welfare gains from trade **(**Boughton et al., 2007). In addition, markets provide households the opportunity to benefit from trade; i.e. they can sell their surpluses and purchase goods and services they need (Reyes et al., 2012). Markets act as an engine of growth and, as households' disposable incomes increase, demand for variety in goods and services also increases thus inducing increased demand-side market participation, which further increases the demand for cash and thus supply-side market participation (Boughton et al. 2007). Likewise, marketing plays a key role in the process of development (Ifezue, 2005) by stimulating and extending development opportunities (Abbot, 1993). Markets guide the allocation of resources (Zhang, 2002); enhance specialization through division of labour (Smith, 1937), distribution of resources (Queralt, 2013) and also play an important role of information transmission through price signals (Williams et al., 2007). This specialization over tasks improves productivity, leading to greater production and supply (Wickramasinghe and Weinberger, 2013). Increased productivity is especially of importance in the face of increasing interest in food security with goal number two of the sustainable development goals being 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' (UN, 2015). Furthermore in terms of agricultural modernization through technology adoption, good access to distant markets enable absorption of excess local supply, a condition necessary for adoption of more productive technologies (Williams et al., 2007). Markets help in management of risks and uncertainties that impede the agricultural sector, in light of which Antonaci et al. (2014) recommend market -based approaches for risk management, a view also held by Williams et al. (2007) who contend that markets help in managing risk associated with demand and supply shocks through facilitating adjustment in net export flows across space and in storage over time thus reducing price variability faced by consumers and producers. Additionally, households derive benefits such as income and open opportunities for rural employment through participation in markets (Dorward et al., 2003). Undeniably, marketing activities such as processing, transportation and selling provide avenues of employment for smallholder farmers willing to exit the farming sector (Jari and Fraser, 2009).

Ferris et al. (2014) suggest agriculture as the best opportunity for the estimated 1.5 to 2 billion people living in smallholder households to escape poverty. Indeed the importance of agriculture has been highlighted by Cervantes-Godoy and Dewbre (2010) who in a study on 25 countries found that growth in agricultural GDP per worker was more important that non agricultural GDP per worker and remittances in poverty reduction in 12 out of the 25 countries. Moreover in the 25 countries studied, over one half the reductions in poverty in the selected countries was due to growth in agricultural incomes. Acknowledging and measuring the importance of agriculture is however largely tied to market participation by farmers; Andolfatto (2008) argues that GDP is generally calculated using tradable/ exchangeable goods and services that go through the market system.

5.6 Determinants of market participation: A review of empirical literature

In spite of the importance of markets highlighted in the section above, smallholder farmers are affected by a number of factors in their bid to participate in markets. Transaction cost Economics argues that farmers will not use the markets when the value of participating in the market is outweighed by the costs of undertaking the transaction (Makhura,2002). Moreover according to Barrett (2008)**,** transaction costs are assumed to be a function of household's productive assets, A, access to public good and services, G (such as good infrastructure, roads or even markets), liquidity from off-farm income, W, household specific characteristics, Z and amount traded, NS and because of the transaction costs, some households will be self-selecting out of the market for some crops (de Janvry et al. 1991).

A number of studies have found that individual factors such as age, level of education, marital status, gender of household head affect market participation. Randela, et al. (2008) in examining factors that enhance market participation by small-scale cotton farmers anticipated a negative relationship between age and market participation but found that it had a positive effect on market participation. Indeed Olwande and Mathenge (2012) suggest that age is indicative of experience and more experienced farmers are more market oriented; their finding does however indicate a negative correlation to the decision to participate. In explaining this positive/negative effect, Musah et al. (2014) suggest that older farmers may be more concerned about food security while the young farmers may want to enhance the quality of their lives through participating in the market.

The level of education also affects market participation as highlighted by Jaleta et al. (2009). Education enables farmers to gain a better understanding of the market in terms of interpretation of market information as well as market signals (Makhura, 2001; Namazzi et al., 2015) and therefore has a positive effect on market participation (Mukundi et al., 2013; Ehui, et al., 2009); it however bears a negative effect on decision to participate in the market as highlighted by Musah (2013) who explains that it is probable for higher level of education to be associated with a reduction in the probability of participating in the maize market as farmers seek off- farm employment and yet still, Osmani and Hossain (2015) found no significant effect of education although they had anticipated a positive one.

Gender represents differences in market orientation between male and female heads of households (Omiti et al., 2009). Males generally participate more in the market because they have more social contacts with buyers and their agents whom they often meet in trading centers while the women are more engaged in domestic tasks (Sebatta et al., 2014). In any case there are usually more male buyers and agents as argued by Farnworth and Munachonga (2010) which makes their interaction easier for the male farmers rather than the female farmers; culture sometimes makes the male-female interaction unacceptable (Gallina, 2010). Additionally women's social and cultural roles may assign productive and reproductive roles to men and women which limit their access to markets (OECD, 2004) and women's role of care for the household versus the men's role of providing cash requirements of the household, affects women' ability to participate in markets (Kaaria et al., 2009). Male headed and female headed households are therefore likely to exhibit different levels of market participation for example Reyes et al (2012) observes that male headed households participate more in the market. But the type of crop being marketed could alter this as shown by Zamasiya, et al. (2014) who indicate that male-headed households are less likely than female-headed households to participate in soybean markets because legumes are seen as women's crops in Zimbabwe and similarly

Mukundi et al. (2013) in a study conducted in Kenya on sweet potato marketing. It has been noted that social norms differentiate between cash and food crops and dictate that more males are involved in the decision making, production and sale of the cash crops and indeed there is lower market participation by females for the cash crops markets (Hill and Vigneri, 2014).

Institutional factors such as group membership enhance collective action by farmers improves their bargaining power (Gyau et al., 2014). Farmer organizations are a formal way of expressing collective action (Hellin et al.,2009) and therefore can also affect market participation positively or negatively. Collective action is defined as action taken by a group either directly or indirectly in pursuit of members' perceived shared interest (Gyau et al. 2014). Olwande and Mathenge (2012) argue that group membership positively affects market participation by increasing members' access to vital information for both production and marketing decisions. Group membership can however negatively affect market participation through incidences such as disagreements among group members which can distort marketing decision. Njuki et al. (2006) are hence cautious to add that forming farmer groups, though recognised as essential for efficient farmer learning, receiving external support and achieving economies of scale, must be accompanied by incentives to participate in markets.

Distance to the main urban center measures the degree of market integration and does affect market participation by farmers (Omiti et al., 2009). Makhura et al. (2001) and Gebremedhin and Jaleta (2010) find that distance to the market negatively influences both the decision to participate in the market and the proportion of output that is sold. Makhura (2001) suggests that distance to the market is part of the transaction costs that farmers face; infact Pingali, et al. (2005) further reason that transaction costs are exacerbated, the higher the distance to the markets. Mkenda and Van Campenhout (2011) in estimating transaction costs in Tanzanian supply chains argue that without an efficient transport system, rural people face higher costs of transportation and spend more time travelling between places. The argument is valuable in understanding smallholder rice farmers since most of the Tanzanian population lives in the rural areas and depend on agriculture for livelihood (Boniphace et al., 2015). Notably though, Fafchamps and Hill (2005) observe that wealthy farmers can sell their produce at far away markets given that they can afford high transport costs as compared to poorer farmers.

The household size has been argued to affect market participation by smallholder farmers (Gani and Adeoti, 2011**).** Household size captures the productive and consumption capacity of the household (Makhura, 2001) and specifically forms, the supply of labour needed for production (predominantly production) but also the consumption side (predominantly consumption) of the household that reduces the marketable surplus the household can have. Makhura (2001) suggests that members of the household represent labour available for agricultural activities and as such larger households are likely to produce more for the market and also keep more for own consumption. Domestic consumption is further noted to have an adverse effect on the marketable surplus as explained by Raquibuzzaman (1966) and in this case reduces the amount that the family takes to the market.

Resource endowment has an effect on household's market participation (Gebremedhin and Jaleta, 2010). Such resources include land, income and other productive assets. Farm size affects market participation; land holding of a household largely determines how much they can produce and thus the size of the marketable surplus available to them. Moreover, Osmani & Hossain (2015) argue that resource endowment are internal determinants of market participation; assets such as land, oxen, farm implements, and human capital are essential for production of a marketable surplus at a smallholder level, while larger farm holdings enable households to exercise economies of scale by adopting modern technologies.

5.7 Conclusion from the literature

Markets have been said to have several functions such as stimulating and extending development opportunities, increasing incomes, enabling absorption of excess local supply, managing risks among several functions. Nonetheless market participation is not a costless venture and as such market participation by smallholder farmers is affected by the presence of transaction costs involved in engaging in agricultural markets. Moreover transaction costs are said to be a function of household productive resources, public goods and services, household specific characteristics among many such factors. These either serve to promote or to hinder market participation and are to be understood within context sine they do vary but also interact with other factors within the farm environment. Use of appropriate methodologies can help understand the direction and magnitude of the effect of factors that are related to market participation by smallholder farmers.

5.8 Methodology

In reviewing marketing studies, we cannot help but notice that marketing studies are plagued with the possibility of recording zero sales, purchases or consumption of certain commodities which Humphreys (2013) refers to as hurdle models in a highlighting how to deal with zeros in economic data and argues that the observed zeros are when the consumer argues not to consume any of the product. Humphreys (2013) refers to such an outcome as a genuine corner solution for instance when some farmers decide not to participate in the market in an optimizing behaviour (Burke, 2009) or self-select out of the market (Reyes et al., 2012). The outcome variable is continuous for others in terms of the intensity of participation. Two distinct decisions are observed: a participation decision and a supply volume decision also described as the extent of participation (which is measured in quantities) (Jagwe et al., 2010). While some authors take these decisions as simultaneous, implying that the same vector of parameters determines both decisions, other studies in the literature assume sequential decisions (Bellemare and Barrett, 2006) who also argue that for the case of sequential decisions, certain factors may only have an effect on market participation choice and not on the quantity decision. Indeed, Burke (2009) acknowledges that marketing decisions may be due to constraints on production or a response to stochastic production shocks and allows factors affecting production decisions to differ from those affecting market participation. The Tobit (Tobin, 1958) is sufficient to accommodate the zeros observed alongside other positive values if simultaneity of decisions is assumed. The participation decision hence becomes irrelevant. The observed zeros imply that the producer does not participate in the market and this is therefore a 'corner solution'. A possible reason may be because of the low market prices or high transaction costs. The Tobit assumes that the same variables that affect the probability of participation decision also affect the extent of participation and moreover with the same sign (Yen and Jones, 1996; Norris and Batie, 1987) and that the zeros observed are a genuine corner solution (Aristei and Pieroni, 2008; Blundell and Meghir, 1987; Newman et al., 2003) yet Yen and Huang (1996) argue that the zeros could be a result of abstention, misreporting or infrequency and indeed Wodjao (2007) observes that the zeros could come from self-selection. Such limitations undermine sufficiency of the Tobit model for empirical analysis. Cragg proposed a more flexible alternative that allows these outcomes to be determined by separate processes through the incorporation of a probit model in the first tier and a truncated normal model in the second as suggested by Burke (2009). Moreover, Aristei and Pieroni (2008) and Burke (2009) suggest that the Tobit is nested in Cragg's model. The idea behind the double hurdle model assumes that the decision by the households to participate and the extent of this participation are determined by a different set of explanatory variables and to observe a positive extent of participation, two separate hurdles must be passed (Newman et al., 2003; Zhang et al., 2008).

Occurrence of the event is associated with a continuous positive random variable while if the event does not occur, the random variable takes a value of zero. Such is the decision about market participation. It is guided by a latent variable model linking unobserved utility derived from market participation to the behaviour observed. The individual's decision to take part in rice marketing can be represented by the indicator function;

$$d_i^* = Z_i^{'}\alpha + u_i \quad \text{Equation 41}$$

Where d_i^*, is a latent variable indicating whether or not the individual participates in the sale of rice; α is a vector of unobserved parameters to be estimated and Z_i is a vector of observed independent covariates that explain individual's decision to participate in marketing and, u_i is an unobserved error term capturing all other factors that affect the individual's decision to market rice.

$$y_i = X_i^{'}\beta + v_i \quad \text{Equation 42}$$

Where y_i how much the farmer sells when he goes to the market, X_i is a vector of covariates that explain the decision on amount marketed, β is a vector of unobserved parameters to be estimated and v_i is a random variable indicating all other factors apart from X that affect the decision on quantity marketed.

Equation (40) describes the participation decision while equation (41) describes the determinants of extent of participation. An individual will participate in marketing if $u_i > -(Z_i^{'}\alpha)$ with the probability of observing the individual participate in marketing given as $P(u_i > -(Z_i^{'}\alpha))$. In this model, there is an allowance for $P\left(u_i > -\left(Z_i^{'}\alpha\right)\right) <= 1$ and both factors affecting participation and extent of participation (measured by quantity) are established. The model gives room for the possible difference between factors that affect participation $\left(u_i, Z_i^{'}, \alpha\right)$ and factors that affect extent of participation $\left(v_i, X_i^{'}, \beta\right)$. In the choice between the use of the Tobit and the double hurdle, the latter considers what is already contained in the Tobit model but also incorporates relevance of the participation decision hence, the Tobit model is considered nested in the double hurdle model (Humphreys et al., 2009). It is an equivalent of the restricted model while the double hurdle is the unrestricted model.

We adopt Cragg's double hurdle model in analyzing farmer participation in marketing of rice. In our case, the farmer decides to sell on the market before he makes a decision on how much to sell. Moreover, we consider that the decision of the quantity of produce to sell may be uncorrelated with the original decision to sell if for example he plans to sell on the market at the time of planting and then decides how much to sell based on how well is the production from the season. The interaction between the two hurdles leads to the following estimation for the model;

$$\left.\begin{array}{l} y_i = X_i^{'}\beta + v_i \; if \; y_i^* > 0 \; and \; d_i^* > 0 \\ y_i = 0 \; otherwise \end{array}\right\} \cdots\cdots 43$$

The variables that explain participation in the market and extent of participation are explored through a review of earlier work. Following Cunningham et al. (2008), Omiti et al. (2009), Jagwe et al. (2010), several variable explaining participation and extent of participation in rice marketing are retained. These include household and farm characteristics such as sex, age, level of education of household head empowerment of the woman within the household, agro ecological zones, extension access, hiring labour, ownership of modern farm equipment, land tenure, rice variety diversification and transaction costs such as distance to the market. In addition, cropped area and amount of paddy sold are also included.

So for the empirical model

$$\left.\begin{array}{l} y_i = X_i^{'}\beta + v_i \; if \; y_i^* > 0 \; and \; d_i^* > 0 \\ y_i = 0 \; otherwise \end{array}\right\} \qquad 44$$

Where;

y_i is the quantity sold X_i s are the determinants of decision to participate in the market and these also determine the quantity marketed; we use one set of explanatory variables for both processes, as these variables represent all of the relevant demographic information available in the data which may be related to both processes (Zhang et al., 2008). These we hypothesize to be education of the household head, occupation of the household head, ecology, variety diversification, group membership of household head, access to extension, hiring labour, empowerment in atleast 60 percent of weighted domains, empowerment in atleast 40-60 percent of weighted domians, customary ownership of land, freehold ownership of land. By including the participation decision, the double hurdle model allows for observed non-marketers in a sample to include both those that abstain from marketing and corner solutions (Humphreys at al., 2009).

5.9 Results and Discussion of Results

5.9.1 Descriptive Statistics

5.9.1.1 Household characteristics

Age of the household head is a key variable in the analysis of market participation by households. Out of the 256 households interviewed, there were both female and male headed households and a closer look at age indicated that both household types had a mean age of 48 years with a maximum of 80 years for the oldest household heads. The minimum age for the female household heads was 20 while that for the male was 21 years old.

5.9.1.1.1 Age of Household Head by Gender

Table 15: Age of Household Head by Gender

	N	Mean (Std Dev)	Min	Max
Female Headed Households	131	48.1603 (12.9845)	20	80
Male Headed Households	116	48.0862 (12.5964)	21	80
Total*	247	48.1255	20	80

*sample drop with missing values for gender of household head

5.9.1.1.2 Level of women empowerment

In understanding the relationship between women empowerment and market participation, we explore the level of women empowerment achieved by households in the survey sample. Within the female headed households, 19 percent of households had women empowered in more than 60 percent of weighted domains, 42 percent were empowered in 40-60 percent of weighted domains and 39 percent were empowered in less than 40 percent of the weighted domains. For the male headed households, 18 percent had women empowered in over 60 percent of weighted domains, 38 percent were empowered in 40-60 percent of the weighted domains while 44 percent were empowered in less than 40 percent of weighted domains. In summary for the total sample, 19 percent were empowered in over 60 percent of weighted domains, 40 percent were empowered in 40-60 percent of weighted domains while 41 percent were empowered in less than 40 percent of weighted domains. The differences in these levels of empowerment attained by women are not significant across female and male headed households for the respective categories.

Table 16: Empowerment Attainment by Women across Female Headed and Male heaed Households

Empowerment category for the primary female	Female Headed households (n=131)	Male Headed households (n=116)	Chi square test of association	Total Sample (n=247)
Empowered in more than 6o percent of weighted domain	19.08	18.10	NS	18.62
Empowered in 40-60 percent	41.98	37.93	NS	40.08
Empowered in less than 40 percent of weighted domains	38.93	43.97	NS	41.30

Note: NS means Not significant

5.9.1.2 Household Endowment (Assets)

5.9.1.2.1 Land (Endowment by tenure)

Land is a key factor of production and we describe land tenure across the female and male headed households as in Table 16 below.

Land endowment varied across customary, leasehold and other (such as rented land); Male headed households were more endowed in terms of land under customary ownership than their female headed counterparts with percentages reported at 46 percent and 28 percent respectively.

Female headed households on the other hand had more land under leasehold and other tenure (such as renting) compared to the male headed households.

Table 17: Land Endowment by Household Type for the Study Site

Mode of Land Tenure	Female headed households (n=126)	Male headed households (n=115)	Chi square test	Total (n=241)
Government	11.11	13.91	NS	12.45
Customary	27.78	46.09	***	36.51
Freehold	34.92	31.30	NS	33.20
Leasehold	14.29	4.25	**	9.54
Others (such as rented)	11.90	4.25	*	8.30

Note: */**/***/NS means Significant at 10 percent, 5 percent, 1 percent and, Not Significant

5.9.1.2.2 Ploughing equipment (Handhoes, ploughs, Powertillers, tractors)

In terms of modern equipment for ploughing, a lower percentage of both female headed households and male headed households use better farm impements such as ploughs, powertillers and tractors although the percentage of use is even much smaller for the female headed households at 12.98 percent compared to 18.97 percent for the male headed households.

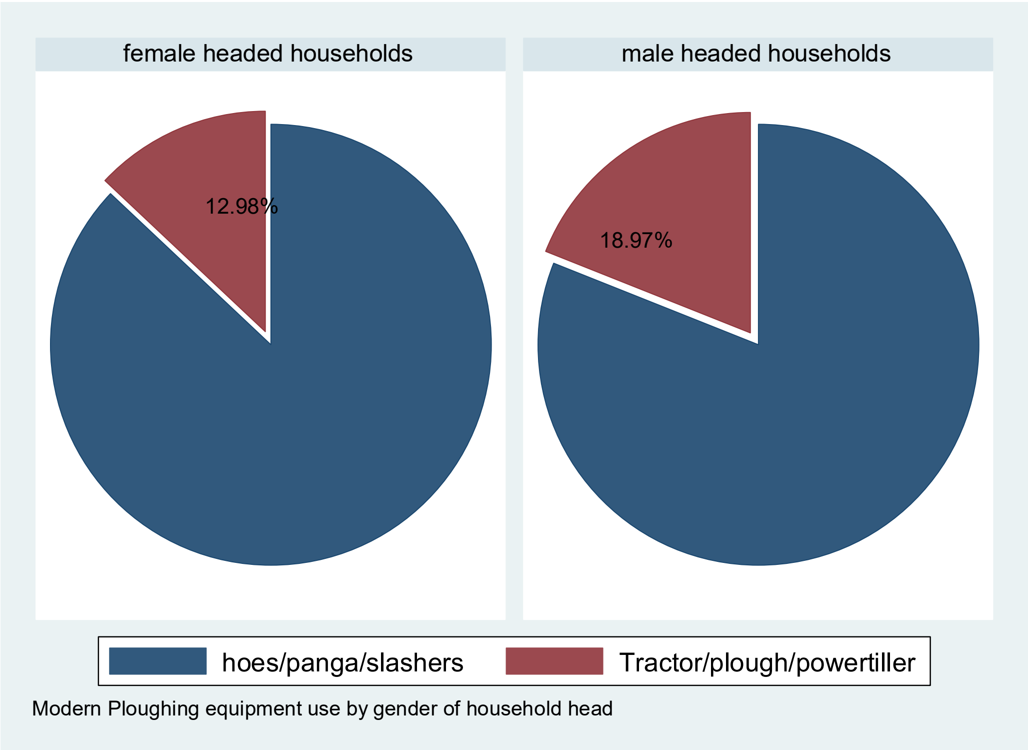

Figure 3: Ploughing Equipment by household type

5.9.1.3 Household size and hiring labour

Female headed households on average had four members while male headed households had 5 members although the female headed households also reported a higher maximum number of members as 12 compared to 10 reported by male headed households. Female headed households reported hiring on average less labour with an average of 80 compared to male headed households that reported 91 persons across the rice farming activities. Using Levene's test, we can not reject the hypothesis that the standard deviations are the same (2*Pr(F > f) = 0.8919) so we use the t test for equal variance and Pr(|T| > |t|) = 0.0001, therefore there is a significant difference in household size between female headed and male headed households. In terms of hiring labour, there is still a significant difference between female headed and male headed households with male headed households hiring more labour as shown in table 17 below;

Table 18: Hiring of Labour Across Household Types

Household Type	Household Size			Percent Hiring Labour
	Mean (std dev.)	Min	Max	
Female headed households (n=131)	4 (2)	1	12	80
Male headed households (n=116)	5 (2)	2	10	91
Test in difference of means	***			**
Total (n=247)	4 (2)	1	12	85

Note: **/***means Significant at 10 percent and at 5 percent

5.9.1.4 Nonfarm income (source of income, percentage receiving income, mean income, standard deviation)

Non-farm and off-farm income are both essential for purchase of inputs for rice production and we explore the distribution of this across the survey sample. Across the female and male headed households, a comparable 76 percent received non and off-farm income although male headed households received a mean income of 109,837 significantly higher than the income received by the female headed households reported at 52,613. Notably though, the income from rice sales did not vary across the two household types as reported in table 18 below;

Table 19: Incomes earned Across Household Types

Household Type	Percentage receiving non farm and off farm income	Mean of nonfarm and off-farm Income (Standard Deviation)	Mean revenues from rice sales
Female Headed Households (n=131)	76.33	52,613 (50,301)	1,515,613 (7,617,449)
Male Headed households (n=116)	75.86	109,837 (157,648)	1,002,365 (1,105,328)
Chi square/ ttest	NS	***	NS
Total (n=247)	76.11	82,016 (118,807)	1,034,358 (4,575,101)

Note: ***/NS means Significant at 10 percent and, Not Significant

5.9.1.5 Household location and information access

5.9.1.5.1 Distance from the nearest road in Kilometers

Distance from the nearest road is an important factor that affects market participation since it directly feeds into the cost of transport for produce. In terms of location of households away from the main road, there was a comparable distance with no statistically significant difference across female and male headed households. The mean distance from the main road for female headed households was 0.96 km while that for male headed households was 1.26 km as reported in table 19 below;

Table 20: Location of Households from The nearest road in kilometers

Household type	Mean (Std Dev) (km)	Min	Max
Female headed households(n=131)	0.9622 (1.120)	0	10
Male head households (n=116)	1.2585 (2.0493)	0	20
ttest of mean	NS		
Total	1.1014 (1.6274)	0	20

Note: NS means Not Significant

5.9.1.5.2 Access to extension and membership to rice farmer groups

Both access to extension and membership to rice farmer groups are important to farmers in terms of providing information both for production and for access to the markets. Sixty one percent of the female headed households had access to extension compared to 75 percent of the male headed households and this difference is statistically significantly different at 5 percent. Fewer (25 percent) female headed households had membership to rice farmer groups compared to the male headed households (53 percent) and this difference in group membership was statistically significantly different as shown in table 20 below;

Table 21: Access to Extension and Membership to Rice Farmer Groups

Household type	Percentage accessing extension	Percentage that are group members
Female headed households(n=131)	61.07	25.19
Male head households (n=116)	75	53.45
Chi square test	**	***
Total (n=247)	61.67	38.46

Note:*/ ** means Significant at 10 percent and 5 percent

5.9.1.5.3 Level of education

Education achievement enables farmers to understand extension advisory services and market signals. Education can be at the formal level with formally standardized achievements or at a level of the ability to read and write for the farmers which enables them acquire knowledge. From the female headed households, 66 percent were able to read and write while 90 percent from the male headed households were able to read and write. This difference is statistically significantly different at 1 percent. In looking at attainment in terms of formal education, 60 percent of the female headed households had completed at least primary education compared to 80 percent of the male headed households. This difference in achieving formal education is also reported in Table 21 to be statistically significantly different.

Table 22: Level of Education of Household Head

Household type	Percentage of those who can read and write	Percentage attaining atleast a primary education
Femaleheaded households(n=131)	66	60
Maleheadhouseholds (n=116)	90	80
Chi square test	***	***
Total (n=247)	77	69.23

Note: *** means Significant at 10 percent

5.9.1.6 Pattern of market participation

5.9.1.6.1 Market participation by village

Respondents were drawn from 5 villages namely Mang'ula A, Mkula, Msolwa Ujamaa, Mbingu and Njage. Villages were located 50-75 km away from the nearest major town with Msolwa Ujamaa being furthest at 75 km away and Mang'ula A being closest at 50 km. The percentage of participation of farmers in the market for the different villages varied. Between 44 percent for Msolwa Ujamaa as the lowest and 89 percent for Mkula, as the highest participation rate reported within a village as shown in Table 23 below;

Table 23: Market Participation by Village

Village Name	Sample size	Distance from the nearest Town (km)	Percentage of those Marketing by village
Mang'ula A	52	50	78.85
Mkula	38	55	89.47
Njage	55	75	83.64
Mbingu	47	65	87.23
Msolwa Ujamaa	55	70	43.64

5.9.1.6.2 Market Participation by Gender

Notably across female and male headed households, 66 percent of the female headed households reported market participation compared to 85 percent of the male headed households and these differences were statistically significantly different at 1 percent and, these results are shown in table 24 below;

Table 24: Market Participation of Households by Gender of Household Head

No.	Composition in the Sample	Percentage Participating in the market
Female	131	66.41
Male	116	85.34
Chi-square test		***
Total	247	75

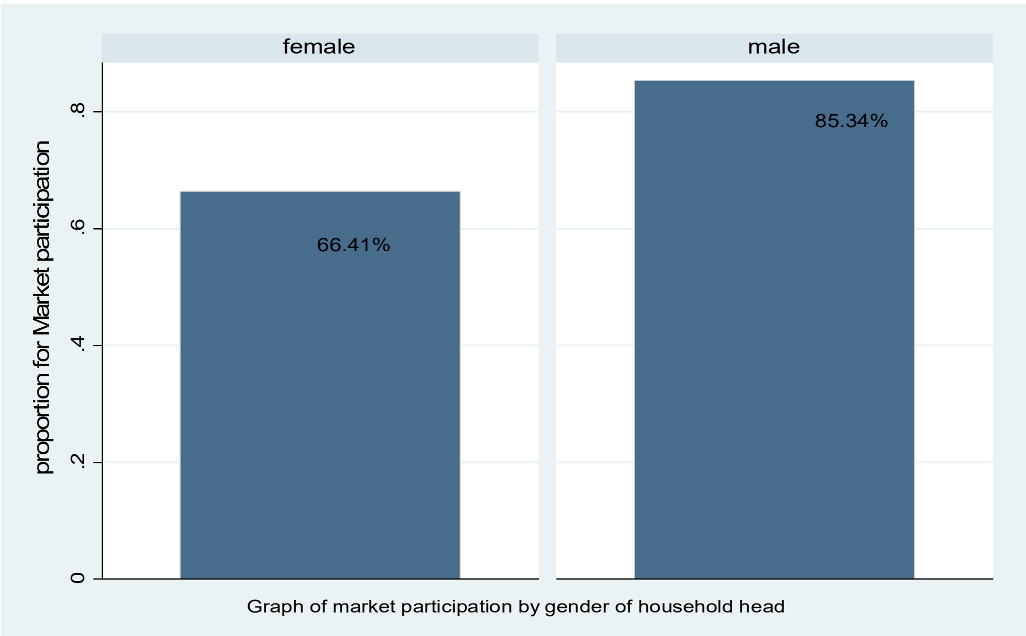

Figure 4: Market Participation by Gender

5.9.1.7 Value of subsistence and market exchange

5.9.1.7.1 Mean Production by household type

Paddy production is explicitly important for marketing since it is from it that farmers raise a marketable surplus. Female headed households reported producing on average 2,193 kg of paddy while the male headed households produced 3,025 kg of paddy and this difference was not statistically significant as shown in table 25 below;

Table 25: Paddy Production by Gender of Household Head

	Mean Production (Std Dev) (kg)	Min	Max
Female headed households	2193 (5251)	12	40000
Male headed households	3025 (5517)	17	56000
Test of Mean Difference	NS		
Total	2595 (5386)	12	56000

Note: NS means Not Significant

5.9.1.7.2 Household Participation in markets

From the production reported some farmers sold paddy, used a portion for own consumption or gave out. And across the sample, these activities were undertaken concurrently thus a household could market paddy and at the same time retain a portion for own consumption; other households could consume rice from own production and yet still give out a portion to relatives and friends. Below in table 26 is a summary of how the sampled households used portions of their overall production for different purposes.

Table 26: Proportion of Rice Sold, Consumed and Donated Out by HouseHolds

Category	Percentage of Households	Mean volume in Kg
Selling out rice produce for cash	76	765 (1267)
Consuming Rice	67	614 (730)
Donating Out Rice Produce	36	131 (188)

5.9.2 Estimation Results for Market Participation

Results from test of association, mean comparison between non marketers and marketers and, the estimation results for the Double hurdle Model are reported in Table 27 below;

Table 27: Mean Comparison Test, Test of Association and the Double Hurdle Model

Variable	Non Marketing	Marketing (n=186)	ANOVA/Chi Square (independe	First Hurdle (Participation)	Second Hurdle (Quantity)

	(n=61)		nce test)		
Continuous Variables					
Paddy sold (in Kilograms)	0	775.1943 (777.6693)	N/A	-	-
Percentage of rice sold over rice produced	0	47.77	N/A	-	-
Plot size	1.7828 (1.4233)	2.2578 (1.7221)	*	0.0183 (0.0754)	2.020* (1.052)
Age of Household Head	52.0000(12.55 61)	46.9563 (12.6603)	**	0.0151 (0.0558)	-2.400*(1.299)
Age squared	2797.803(1241 .055)	2374.016(1252. 655)	**	-0.0004 (0.0006)	0.0243* (0.0133)
Distance from the main road	1.0984 (2.5415)	1.1024 (1.1945)	NS	-0.0180 (0.0542)	-1.482 (1.323)
Distance from the nearest major town	65.4918 (8.7894)	62.7097	*	-0.0111 (0.0114)	0.1948 (0.1361)
HH_Size	4.2787(1.7714)	4.3226 (1.8954)	NS	-0.3503 (0.2356)	2.264 (2.573)
HH_Size squared	21.39344 (17.5796)	22.2581 (20.6043)	NS	0.0294(0.0230)	-0.1281 (0.2173)
Nominal Variables			Chi2 Test of Association		
Gender of hh head(1=Male)	0.2203 (0.4180)	0.5401 (0.499+7)	***	0.8287*** (0.2558)	1.3971 (2.3028)
Primary Occupation (1=Non Farm)	0.1311	0.2312	*	0.4562 (0.3103)	-2.978 (2.712)
Education of hhHead (1=Atleast Primary completed)	0.5254 (0.5036)	0.7486(0. .4350)	***	0.0697 (0.2457)	14.988 (9.0186)*
Ecology (1=Irrigation)	0.4098 (0.4959)	0.3495 (0.4782)	NS	-0.3686* (0.2227)	1.147 (1.9080)

Variety Diversification (1=more than 1 variety)	0.1803 (0.3877)	0.2366 (0.4261)	NS	0.0284 (0.2857)	5.1380 (3.2864)
Group membership of HHHead (1= Member)	0.2033 (0.4060)	0.4560(0.4994)	***	0.7448*** (0.2665)	3.1048 (2.6474)
Access to extension (1=Ac	0.6102 (0.4919)	0.6885 (0.4643)	NS	0.0618 (0.2257)	4.7194 (3.6531)
Hiring Labour (1=Hiring)	0.7288 (0.4484)	0.8852 (0.3196)	**	0.6257** (0.2772)	-2.9970 (3.1812)
Empowerment in 60 percent of weighted domains (1=Empowered)	0.1356 (0.3453)	0.2021 (0.4027)	NS	0.6518* (0.3337)	1.4168 (2.6667)
Empowered in 40-60 percent of weighted domains(1=Empowered)	0.4407 (0.5007)	0.3825 (0.4873)	NS	0.0937 (0.2370)	-3.5261 (2.6511)
Ownership of equipment(1=Modern)	0.0508 (0.2216)	0.1857 (0.3900)	*	1.1269** (0.4827)	5.2867* (3.1335)
Customary Land ownership (1=Customary)	0.3607 (0.4842)	0.3548 (0.4797)	NS	-0.5072* (0.2728)	-0.0516 (2.2248)
Freehold	0.3114 (0.4669)	0.3280 (0.4707)	NS	-0.3350 (0.2750)	-6.3079 (4.3652)

Note:ANOVA test performed for continuous variables and Chi-square test is perfomed for categorical variables

***/**/* significant at 1 percent, 5 percent and 10 percent; NS stands for Not Significant, and N/A for Not Applicable. Between brackets are standard errors.

Source: own calculations

Given that in the sample there were those that participated in the market and those that did not, some group comparison tests are undertaken before running the model. The test of mean differences is done using Analysis of Variance (ANOVA) which tests whether there is a significant difference between the means of two or more groups (Kao and Green, 2008). For the

ANOVA, a test for the variance being equal or unequal using Levene's test for equality of variances is conducted before comparing the two groups for each variable. Levene test is robust to non normality and also takes advanttage of the fact that classical ANOVA procedures for comparing means are robust to violations of the assumption that the data follow a normal distribution (Gastwirth et al., 2009).

For the variable age of household head across marketers and non marketers, Levene's test returns p-value of 0.5324) (greater than 0.05), the group variances are treated as equal while for plot size, the p-value for equality of variance test (0.0125) thus even less than 0.05 therefore treated as a test for a group with unequal variance. For distance from the main road, there is unequal variance (p=0.0000), distance from the nearest major town equal variance is assumed (p=0.1318), for household size (equal variance with p=0.5487) and likewise for household size squared.

The overall results in the difference for average age, distance from the nearest major town and average plot size across those marketing and those not marketing rice are statistically significantly different at 5 percent for age and, at 10 percent for plot size and average distance from the nearest major town. Moreover, the non-marketers are on average older at 52 years while the marketers have an average age of 47 years.

While age has no significant effect on the decision to market, it has a statistically significant effect on the quantity marketed; moreover, while age has a negative effect on quantity marketed, age squared has a positive relationship with the quantity marketed; this can be interpreted as a U shaped relationship between quantity marketed and age. As age increases, quantity marketed reduces possibly due to increase in household size (and number of dependants) and thus consumption since dependants contribute to consumption but not production. At higher values of age, the household is able to expand its labourforce and produce more for the market since the children are no longer just dependants but rather also contribute to the productive labour pool of the household; Ngongoni et al. (2006) does argue that household size is a source of labour (indeed within this study, household size does have an initial increase on quantity marketed although household size squared has a negative effect). Nonetheless, other studies have argued differently and suggest that older farmers can be part of the category that Kent & Poulton (2008) terms “marginal farmers” who are “farming but hungry” and unable to respond to existing commercial incentives within agriculture and addition, Musah et al. (2014) observes that older farmers may be more concerned about food security.

Average plot size between those marketing and those not marketing was also statistically significantly different with those marketing having a higher average plot size. Subsequently in the double hurdle estimation, plot size has a positive effect on both the decision to market and the quantity marketed and, although its effect on the participation decision was not significant, it had a statistically significant effect on the quantity marketed. Plot size having a positive effect on quantity marketed can be attributed to its effect on the volume of output; Achandi & Mujawamariya (2016) in a study in Tanzania found that cropped area affects both decision to market and quantities marketed; Alam & Afruz (2002) in a study of major crops in Bangladesh found that total area under cultivation was significant and positively influenced marketable surplus of all varieties of rice, wheat, potato, mustard and lentil. Indeed it has been argued that much of the increase in rice production in Tanzania over the past years can be attributed to area (land) increase; moreover Van Oort et al. (2015) in reviewing rice self-sufficiency in eight African countries concluded that for Tanzania to achieve rice self-sufficiency, physical land area in 2025 would need to more than double. The increase in output directly affects self-sufficiency and the availability of a marketable surplus. These results are in line with the finding of Rios et al. (2009) who concluded in their study in Tanzania that the only variable that was correlated with market orientation was farm size.

For the nominal and ordinal variables, the chi square test for association is used. Unlike the ANOVA, the chi-square test does not require equality of variances among the study groups or homoscedasticity in the data (McHugh, 2013); the relationship between the categories of nominal variables is examined. The chi-square test alone though is not sufficient and is usually supplemented with the cramer's v test as a statistical strength test (Michael, 2001). Moreover, either the Pearson's test or Fischer's exact test is applied depending on the size of the count. For the very small counts, Fischer's exact test is used while for the sufficiently large counts across the nominal variables, Pearsons' test is used.

For gender of the household head the p-value is 0.001 therefore there is a statistically significant association between gender of the household head and market participation and the cramer's v value of 0.2191 indicates that the strength of this association is moderate. Within the model, having a male household head positively affects the decision to market rice. These findings are coherent with perspectives of Sebatta et al. (2014) who argued that in most cases it is the males in a family who make the decisions on whether or not to sell and how much to sell and females were therefore less likely to participate in the whole process of selling and price and other transactional bargaining. Besides, women have been observed to face several constraints that limit their participation in the market as Hill & Vigneri (2014) observes that women are less likely than men to own means of transport and as a result the time they take to travel to the market will be higher than that of men; additionally Brenton et al. (2013) argue that women are more readily denied access to key trader networks than men and time-consuming trade procedures and documentary requirements impinge more heavily on women, given the time they need for their household duties.

For level of education (p-value is 0.003) there is a statistically significant association with market participation although according to cramer's V (0.1878) the association is weak. Having attained a primary education positively affects the quantity marketed although its effect on the decision to market is not significant. Weir (1999) argues that education may either increase prior access to external sources of information or enhance the ability to acquire information through experience with new technology. Indeed education has been argued to improve the quality of products, which can in turn attract better prices (Ehui et al., 2003). Mittal and Mehar (2012) complements the above argument and suggests that information for decision making leads to growth in the adoption of technology; the use of modern inputs like machines and fertilizers all of which improve yields. Our results are consistent with findings by Osmani and Hossain (2015) whose results showed no significant effect on the farmer's decision towards commercialization and, Fischer and Qaim (2014) who found that education had a positive effect on the quantity and share of collective marketing but contradicts findings by Kan et al. (2006) in a study in a study in the Republic of Georgia who argued that education has a negative effect on market participation, mainly through its positive effect on non-farm income in which case people have alternative sources of income other than relying on agricultural income arising from market participation.

For irrigation, extension access, variety diversification, empowerment (at 40-60 percent), there is no statistically significant relationship with market participation between those who market and those who do not market. Empowerment (at greater than 60 percent of weighted domains) of the woman in the household has a positive and statistically significant effect on the decision to market produce. The index of empowerment used is constructed from control over resources, time availability, leadership involvement and control over income. Empowerment embodied in all these creates an atmosphere for the households including female headed households to deliberately decide to participate in the market knowing that they will share in the gains from market participation. Studies reviewing direct effect of women empowerment on household market participation are scarce but given that this study focuses on both female headed and male headed households, empowerment in this study has a positive effect on market participation. Moreover, the relationship can run either way and indeed Lenjiso et al. (2016) argues that women in market participating households showed interest in controling resources in the game and men decided to transfer more resources to their wives.

For key primary activity, there is a statistically significant association (0.094) and this association is weak with a cramer's v of 0.1066 which indicates that the relationship is very weak and this variable neither affects the decision to participate in the market nor the quantity sold when farmers participate in the market.

Moreover, irrigation has a negative statistically significant relationship with decision to market at 10 percent; but no effect on the quantity marketed. The negative sign was not an expected result since it signifies that those growing paddy in rainfed ecology are more inclined to produce for the market. This result contradicts findings by Hagos et al. (2008) and Rosegrant et al. (1995) who argue that irrigation contributes significantly to increase market participation. A possible explanation for this is that farmers cultivating in the irrigated plots grow an improved variety

SARO 5 (TXD 306) according to irrigation organization constitution and all agronomic practices are done in respect to crop calendar. However, given local preference for the traditional varieties in the market, they usually have to wait until the supply of traditional varieties runs out before they can sell their harvest of improved variety SARO 5 given that the price for the improved variety is usually very low immediately after harvest. Moreover this is a one period model and as such reflects the decisions that had been taken within that single period. Data was collected in the period immediately after harvest. It is however important to note that once the decision to sell is crossed irrigation has a positive effect on quantity sold which can be attributed to the higher yields and thus a greater marketable surplus from irrigation.

For group membership, there is a statistically significant association (0.0000) and this association is moderate with a cramer's v of 0.2405, group membership positively affect both the decision to market and the quantity marketed although its effect was only statistically significant in the decision equation. In developing countries, farmer groups help farmers overcome the challenges they face concerning high external transaction costs and asymmetric market power (Fischer and Qaim, 2014). In this regard, group membership positively affects market participation. The effect of group membership has however been observed to be influenced by group characteristics; Francesconi and Heerink (2010) in investigating the impact of group membership focused on the organizational characteristics of co-operatives using two types of organizational forms of co-operatives: the market-oriented and livelihood-oriented. While the market oriented allowed members to sell their produce collectively and are linked farmers to output markets, the livelihood co-operatives focused on input provision while members sold their produce wherever they wanted. They thus found that membership in the livelihood co-operatives had a negative or no significant impact on commercialization. Fischer and Qaim (2014) also cautioned that factors such as delayed payment of group marketing has a negative effect on the decision to sell through the group since direct cash payments are more attractive.

Hiring labour has a statistically significant association (0.015) with marketing rice and this association is moderate in strength (Cramer's V= 0.1542). Hiring labour was statistically significant and positively affected the decision to market while its effect on quantity marketed was negative and not statistically significant. Hiring labour is a signal of deliberate increase in farm investments and therefore this positive effect on decision to participate in the market is an expected outcome. Moreover, it has been observed in a study of labour force composition on productivity in EU arable farming by Kloss & Petrick (2014) who concluded that hired labour is more productive than family members in countries traditionally characterized by family farms; the higher productivity can give the household an opportunity to retain a marketable surplus thus enhancing market participation. Rios et al. (2008) supports this view on productivity and argues after controlling for differences in market access and the underlying determinants of market participation, households with higher productivity tend to participate in agricultural markets. The negative effect on quantity marketed can be attributed to the practice of in-kind payment of hired labour using harvested produce when the household is short of sufficient funds to pay labour; this therefore reduces the marketable surplus of the household.

Ownership of modern equipment has statistically significant association (0.031) with market participation and cramer's v is 0.1371. Additionally, ownership of modern equipment has a positive and statistically significant effect on both the decision to market and the quantity marketed and this can be explained by the fact that modern farm equipments raise productivity and thus avail farms with a marketable surplus. Barrett (2008) lists access to productive technologies as one of the key factors if farmers are to achieve a marketable surplus and Barrett et al. (2012) argues that those using highly modern productive technologies are far more likely to produce more than they choose to consume than are those who use the same input bundle but, with more rudimentary production technologies. Moreover ownership of such equipment tends to enhance farmers' participation in the market through provision of transport for farmers' produce. A similar observation has been made by Bwalya et al. (2013) who argued that with farmers bearing the transport cost of produce to marketing centers household assets such as ox-carts enhanced quantities marketed by those owning these assets since ownership of such assets helped in reduction of variable transaction costs. The provision of transport for produce is especially important in the study area given that the transport problem is exacerbated as Bardosh et al. (2014) observes that in the district the road is tarmacked around the district capital and flooding disrupts road transport in the Kilombero Valley during the rainy seasons.

5.10 Conclusions

Markets offer households the opportunity to specialize according to comparative advantages and thereby enjoy welfare gains from trade, provide farmers with an opportunity to earn income, act as an engine of growth, guide the allocation of resources and, play an important role of information transmission through price signals among several other functions. Given such advantages of marketing, farmers would all be expected to participate in marketing of their produce. Nonetheless, farmers' participation in the market is hindered by the presence of transaction costs which are the embodiment of barriers to access to market participation by resource poor smallholders (Holloway et al., 2000). Given the assumption of rationality of economic agents, farmers too assess the cost and benefit of participation in markets and self-select out of the market for some crops a process that can be classified as a two-decision procedure; i) a participation decision and, ii) a supply volume decision also described as the extent of participation (which is measured in quantities). This study adopts the double hurdle model which assumes that two decisions- the decision by the households to participate and the extent of this participation. Findings indicate that age has a U shaped relationship with the quantity marketed since younger farmers probably have less to market due to the number of dependants but as age increases, the household is able to raise more output for the market through the increase in production that could be arising from the availability of low cost family labour; plot size has a positive effect on quantity marketed probably due to its effect on the volume of output, thus availing a marketable surplus to the producer. Additionally, the household head being male has a positive effect on market participation decision; level of education has a positive effect on the quantity marketed although it had no effect on the decision to market; group membership positively affects both the decision to market and the quantity marketed although its effect is only statistically significant in the decision equation; hiring labour has a positive effect on only the decision to market and not quantity marketed; ownership of modern equipment has a positive effect on both the decision to market and the quantity marketed and this can be attributed to the fact that modern equipment ownership is an indication of deliberate investment in agriculture and has the effect of increasing output produced thus resulting in a marketable surplus and facilitating market participation.

Overall, household characteristics that are not transaction costs in themselves but have a significant effect on them, access to public roads and services affect market participation through either the decision to market, the quantity marketed or both. The effects are however not uniform and can be explained in the context of the smallholder farmers themselves depending on the extent to which they pose a binding transaction constraint on the farmers.

CHAPTER SIX

SUMMARY, CONCLUSION AND POLICY IMPLICATIONS

6.1 Summary and Conclusions

The Tanzanian economy has been classified as largely agrarian and women contribute substantially to the sector. Moreover, rice has been identified as a strategic crop with potential to result in higher income earnings for smallholder farmers and contribute to food security. Tanzania has made several international and domestic commitments to empower farmers including female farmers although there still exists gaps in the empowerment of women. Moreover, little is known about women empowerment in specific subsectors such as the rice subsector thus requiring a need for a subsector specific study. This study therefore sought to explore the level of women empowerment among smallholder rice farming households. Women empowerment was estimated using the Women Empowerment in Agriculture Index (WEAI) which is a survey-based index designed to measure the empowerment, agency, and inclusion of women in the agricultural sector and developed by Alkire et al. (2012). The index looks at women empowerment in five domains (5DE) and also looks at gender parity in empowerment within the household (GPI). Women and men, as primary adults within the households self assess on achievements in 5 domains namely input in production decisions, resource ownership, control over income, leadership and time (workload). The total WEAI score is the weighted sum of the overall score with 5DE and GPI weighing 90 and 10 percent respectively; for the study site, the overall WEAI was 0.54 with a 5DE sub-index value of 0.50 and the GPI sub index of 0.86 indicating a low attainment in terms of the five domains but, a larger percentage of households men and women enjoying relative gender parity. Additionally, when men were also assessed using the same indicators as the women, they too reported disempowerment; this can be attributed to the fact that men too are exposed to disempowering factors since empowerment has been observed to bear cross-class, cross-generational and cross-gender dimensions as it intersects with patriarchy and other social issues. Furthermore, for women in the study site, key domains contributing to disempowerment are workload, resource ownership and restricted inputs to productive decision making while the men also reported both workload and restricted input to productive decision making. Women are generally known to face a heavy workload and for women and men within rice farming, the weight of the workload is further exacerbated given that rice farming is a labour intensive activity and smallholder farming is still under mechanized in Tanzania thus relies heavily on physical manpower. With reference to resource ownership, women still face challenges in terms of asset ownership especially those in dual-adult households. The control and decision making over these assets are still largely not in the hand of the women in the homes. As pertains to decisions into productive decisions, both men and women reported these as contributing to their disempowerment and this can be due to the fact that given the patriarchal nature of societies in rural smallholder communities; empowerment in these communities therefore bears cross-class, cross-generational and cross-gender dimensions.

In examining the determinants of women empowerment, an ordinal logit analysis was used with women empowerment as a categorical variable within which women could attain three different levels of empowerment namely empowerment scores below 40 percent of the weighted domains, from 40-60 percent of the weighted domains and, 60 percent and above attainment in the weighted domains. Although the multinomial logit could have used, the study did not, due to the fact that it does not consider the information contained in the ordering of the categorical variables (Williams, 2006) and as such was unsuitable since subsequently higher ranks do imply a higher achievement in empowerment of the woman within the household.

Given the study analyzed both female headed and male headed households, a combined model was considered as well, as a separate models for either of these household types. In an attempt to address the endogeneity problem that could have been a source of bias in the results, the study attempted to use the proportion of sons out of number of children although this yielded unsatisfactory results and therefore used the women empowerment index itself but, the results were then interpreted as correlations rather than causal relationships, a method earlier also reported by Malapit et al. (2015) when they suspected endogeneity.

For the female headed households, age of the household head, education level, condition of dwelling, monthly income and group membership were all significant. Age, group membership and education enhanced a women's social and human capital and enabled her gain an understanding of mechanisms through which to bargain with those around her through exposure to information. Nonetheless, these do not serve as magic shots towards empowering women and can work differently given the context. Distance from the nearest town showed a positive sign that was not expected and this was be attributed to the fact this study entails a self-assessment and as such possibly the women that are closer to town are more aware of their disempowerment given their exposure to information on what women empowerment should look like, while those further away are not aware of their own disempowerment status and may not know what empowerment entails. This is because within the rural areas usually traditional customs persist (Eldred, 2013) and women themselves sometimes perpetuate patriarchal ideologies to the younger generations. Household income was found to have a negative association with the level of women empowerment possibly because with an increase in wealth, female smallholder producers are more likely to lose control over their incomes once their earnings are high due to the ease of monitoring and access to benefits by other household members. The state of housing had a positive association with the level of women empowerment possibly because women usually have alternative income generating activities which they operate from home and the status of their dwellings therefore determines how much they are able to engage in and reap benefits from these activities. Although unexpected, income of the household has a negative association with women empowerment and this can be explained by the fact that income increment alone cannot be viewed as a pathway to empowerment; increase in income coupled with improvement in the woman's human and social capital provides a better opportunity for empowerment while, increase in income alone can further serve to expose her to disempowerment with her income being taken away since it is easier to monitor inflows as income size increases.

For the male headed households, age of the man has an inverted U shaped association with the level of empowerment attained by the woman. This was explained by arguments that some aspects of women empowerment are accommodated while men still retain previous notions of innate male authority. Older men are however more inclined towards patriarchy and female subordination. Additionally, number of male children also has a negative association with women empowerment since women can sometimes be constrained by their own male children when trying to take decisions. When the same model was run using the number of daughters, with results reported in the appendix, results indicated that the number of daughters has a positive association with level of women empowerment for the male headed households, possibly due to the sharing out of workload such as care responsibility across female household members thus relieveing the mother's workload burden.

In analyzing technical efficiency of production, the stochastic production frontier analysis was used. Additionally, the recommendations by Henningsen and Henning (2009) that non-monotonicity distorts the efficiency estimates and can therefore result into misleading conclusions was taken into consideration in our estimation. Initial estimation of technical efficiency shows that on average the male headed households were more technically efficient that the female headed rice farmers with efficiency scores averaging 0.68 and 0.52 respectively. The study therefore adopts the three step procedure used by Henningsen and Henning (2009) with the unrestricted frontier, minimum distance estimation and, a final stage restricted frontier. The restriction is via monotonicity restriction which is meant to ensure estimation of a theoretically consistent model. "R" software was used for estimation using the codes written by Henningsen and Henning (2009). In testing the null hypothesis of no inefficiency effect, the null hypothesis is rejected thus implying that the joint effect of the explanatory factors significantly contribute to technical efficiency. Results show that empowerment of the woman at 60 percent, gender, fertilizer use, group membership and primary occupation of the household head are significant in their effect on technical inefficiency of the household and, male headed households were more technically efficient than the female headed households. Seymour (2017) observes that reducing gender disparities within households is associated with higher levels of technical efficiency, the effect of gender of the household has been observed to have an effect on technical efficiency because crop management activities are labour intensive and female farmers usually have less access to productive resources as compared to men (Makate et al., 2016). With reference to primary occupation, farmers have experience which enhances their technical efficiency and more experienced farmers are able to adopt new technologies (Kalimangasi and Kalimangasi, 2014) while group membership eases access to productive inputs and facilitating extension linkages thus enhancing technical efficiency (Abate et al., 2013).

In the test for monotonicity, results showed that it was violated mainly in seed while nearly achieved in plot size and labour. Although the data does not provide evidence of this, some farmers plant in the nursery bed and the transplant seedlings later while others directly sow by planting in lines; a high seed rate through broadcasting may thus not necessarily result in high output due to the compromise in the vigour of viable crops while those planting in lines or transplanting may have a low seed rate but harvest higher levels of output thus for a section of the observations, monotonicity may not be observed.

Imposing monotonicity and estimating the restricted model shows that monotonicity is achieved in almost all observations for plot size, labour and seed. Quasi concavity is achieved in 95 percent of the observations. Nonetheless, average efficiencies of the unrestricted and the restricted models are 0.5938 and 0.5879 respectively and therefore almost identical.

The last hypothesis that the study tests, is the suitability of the restricted model over the unrestricted model. With a likelihood ratio test p-value of 0.92 the study fails to reject the hypothesis that the restricted model is a preferred estimation. Monotonicity is therefore a key property that should be given consideration in frontier modeling; the restricted model results are a preferred estimation given the theoretical consideration during the modeling process and we conclude from its results therefore.

It is important to understand that technical efficiency in production is not an end in itself but rather, of greater importance if the resultant output can be traded for a profit in the market. Markets offer households the opportunity to specialize according to comparative advantage and thereby enjoy welfare gains from trade (Boughton et al., 2007). Moreover, markets provide farmers with an opportunity to earn income, act as an engine of growth given that as households' disposable incomes increase, demand for variety in goods and services also increases thus inducing increased demand-side market participation, which further increases the demand for cash and thus supply-side market participation. Markets also guide the allocation of resources, enhance specialization through division of labour, distribution of resources, and also play an important role of information transmission through price signals. Given such advantages of marketing, farmers would all be expected to participate in markets. Nonetheless, their participation is hindered by the presence of transaction costs. Transaction costs are the embodiment of barriers to access to market participation by resource poor smallholders (Holloway et al., 2000). Transaction costs include all those costs of entering into a contract , exchange or agreement and include search costs, screening costs, obtaining and verifying information, bargaining, bribing officials, transferring the product (including transport, storage and packaging cost), and monitoring, controlling and enforcing the transaction and, transaction costs are only partly observable.

Given the assumption of rationality of economic agents, farmers too assess the cost and benefit of participation in markets and self-select out of the market for some crops (de Janvry et al. 1991; Barrett 2008). Two distinct decisions are thus observed: a participation decision and a supply volume decision also described as the extent of participation (which is measured in quantities) (Jagwe et al., 2010). In estimation of the participation model, the Tobit (Tobin, 1958) is sufficient to accommodate the zero observed alongside other positive values if simultaneity of decisions is assumed. While the Tobit assumes that the same variables that affect the probability of participation decision also affect the extent of participation and moreover with the same sign (Yen and Jones, 1996; Norris and Batie, 1987), the zeros could also result from self-selection out of the market as optimizing behavior (Burke, 2009), and the Tobit is thus not sufficient for this latter analysis. The study therefore adopts Cragg (1971) flexible alternative that allows these outcomes to be determined by separate processes through the incorporation of a probit model in the first tier and a truncated normal model in the second as suggested by Burke (2009). Moreover, Aristei and Pieroni (2008) and Burke (2009) suggest that the Tobit is nested in Cragg's model. The double hurdle model assumes that the decision by the households to participate and the extent of this participation are determined by a different set of explanatory variables and to observe a positive extent of participation, two separate hurdles must be passed (Newman et al., 2003; Zhang, et al., 2008). Using the double hurdle model, the study found that age had a negative effect on the quantity marketed but age squared had a positive effect on quantity marketed. As age increases, quantity marketed reduces possibly due to increase in household size (and number of dependants) and thus consumption since dependants contribute to consumption but not production. At higher values of age however, the household is able to expand its labourforce and produce more for the market since the children are no longer just dependants but rather also contribute to the productive labour pool of the household. Plot size had a positive effect on quantity marketed probably due to its effect on the volume of output; Alam and Afruz (2002) in a study of major crops in Bangladesh found that total area under cultivation was significant and positively influenced marketable surplus of all varieties of rice. Physical land area planted has an effect on market participation through its effect on output, thus availing a marketable surplus to the producer. Gender of the household head being male also had a positive effect on market participation coherent with perspecties from earier reseach such as by Sebatta et al. (2014) who argued that in most cases it is men who sell produce. Moreover with the transactional costs that typically impede market participation women especially female smallholder farmers, are less likely to participate in the market given that they have several reproductive activities such as home care, child care and care for the elderly that further make it difficult for them to navigate around the transaction costs and participate in the market. Their participation is further hindered by the fact that women are less likely to own means of transport, and have less access to trader networks compared to their male counterparts.

The level of education had a positive effect on the quantity marketed although it had no effect on the decision to market and this has been observed in other related studies such as Osmani and

Hossain (2015) and Fischer and Qaim (2014). Education increases access to information and leads to growth in the adoption of technology; the use of modern inputs like machines and fertilizers all of which improve yields and the available marketable surplus.

Group membership positively affected both the decision to market and the quantity marketed although its effect was only statistically significant in the decision equation. Farmer groups help farmers overcome the challenges they face specifically those related to high external transaction costs and asymmetric market power as argued by Fischer and Qaim (2014). Hiring labour also had a positive effect on only the decision to market and not quantity marketed. Hiring labour signals increase in investment on the farm and a previous study by Kloss & Petrick (2014) observed that hired labour is more productive than family members in countries traditionally characterized by family farms. Ownership of modern equipment had a positive effect on both the decision to market and the quantity marketed and this can be attributed to the fact that modern equipment ownership is an indication of deliberate investment in agriculture and has the effect of increasing output produced thus resulting in a marketable surplus thus facilitating market participation. Moreover, modern assets such as powertillers, tractors and ox-ploughs (usually converted to ox-carts) can be used by farmers to transport their produce to the market in areas where road infrastructure places is a constraint to transport availability.

6.2 Policy Implications

A number of policy implications arise from findings of the study;

With regard to women empowerment especially in the five domains, women are still disempowered with a 5 domains empowerment level of 0.50 and key disempowering domains are workload, limitations in resource ownership and restricted inputs to productive decisions. In spite of the overall macro level policies intended to improve women empowerment, at the micro level such as within smallholder rice farming systems women still face the burden of workload, are limited in the sphere of resource ownership and remain limited in making inputs to productive decisions. Moreover, men too report workload as a key domain where they feel disempowered. There is thus need for increased investment in labour-saving technologies especially for rice production which is labour intensive. Moreover these technologies can be introduced through targeting female only, or male only farmer groups in order to ensure that women too can access and use such technologies. Additionally, the farmers can be encouraged to form such groups in order to pool together capital for purchase of labour-saving technologies. This approach would help address both the workload issue and the limitations on resource ownership.

With regard to limitations in making inputs to productive decisions, both women and men need to be engaged in trainings that raise awareness about importance of joint input to decision making so that they can learn to negotiate with the factors and institutions that are disempowering to them. Moreover engaging men as change agents would go a long way in helping farmers work around the pecking order in the patriarchal systems that are disempowering to both men and women.

Furthermore, age of the woman, education level, condition of dwelling, and group membership had a positive association with women empowerment. Age of the woman, education level and group membership all increase the woman's human and social capital thus enabling her to negotiate with those around her or find coping strategies to deal with disempowering factors. There is need to encourage women to form collective action groups within which they can be educated on the importance of their own empowerment and these support groups can provide voice to the voiceless women within such groups so as to forge a way for empowerment. There is also need for continued effort in education of the girl child with a hope that this will form the basis of empowered women in future. Furthermore, younger female farmers need to be encouraged to join such groups because they seem even more vulnerable to disempowerment as compared to the older women. There is also need to rethink those interventions that focus only on raising women's or family income as a way of empowering women because a focus on monthly income alone does not seem to indicate a good result and may instead result in disempowerment of women.

With regard to technical efficiency of production, male headed households were more technically efficient than the female headed households. Moreover since women had indicated that the most disempowering factors for them are workload, limitations in making input into productive decisions limitations in the sphere of resource ownership and in making inputs to productive decisions. These definitely serve to depress their achievements in terms of technical efficiency especially given the fact that rice farming is labour intensive and there are few labor saving technologies which women are often unable to access in time for such activities as land clearing, weeding and harvesting. In this regard, it is important to invest in improved but also female friendly technologies that women too can acquire and use either individually or as a group in order to raise their efficiency in production. Caution should be taken in the design of these technologies so as to meet women's needs in terms of ability to use (manpower requirement) and to own such equipment; otherwise, simply introducing technologies has been observed to further crowd women out of employment for activities such as weeding where the technology is easily used by men and the women are unable to manage due to the complex design or weight of the new machines.

Since technical efficiency in production is not an end in itself but rather, of greater importance if the resultant output can be traded for a profit in the market; the study examined market participation by smallholder farmers too. In order to increase market participation by farmers, there is need to encourage more young people joining the rice sub sector since young people are more inclined towards market participation than the elderly that place food security as a priority. Moreover with the growing unemployment problem, rice farming at a commercial scale can serve to atleast partially address the unemployment problem. Plot size has a positive effect on the quantity marketed; Tanzania still has the potential to increase rice farming through expansion of land area. And indeed, use of irrigation can create opportunity for more land area under cultivation to meet both local and regional demand for rice thus raising incomes of farmers. Male headed households participated more in the market as compared to the female headed households. This shows that there is still need to improve physical infrastructure and information channels so as to reduce the transaction costs that impede market participation by women. Also improving transport infrastructure, creating agricultural marketing offices or improved market facilities within the villages will improve women's access to the market given the time constraint they face, and would encourage them to participate in the market.

Education had a positive effect on quantity marketed although it had no effect on decision to market. This shows that commercialized agriculture can indeed be possible with higher levels of education and as such the populace should be encouraged to pursue education even for those that feel they are in rural smallholder farming communities and will want to pursue agriculture. The effect of education has been suggested to be through its effect on access to information, use of technologies and modern inputs that improve yields. There is therefore continued need to provide training to farmers so as to enable them access and process such information to benefit from rice farming.

Group membership was found to have a positive effect on both decision and quantity marketed. Smallholder farmers should therefore be encouraged to form groups strategically meant to increase their voice and bargaining power in negotiating with other post production value chain actors so as to increase their access to profitable markets. Moreover formal contracts usually set requirements that are too high for individual farmers to meet but which as a group they can meet by pooling together produce, technologies and knowledge in order to navigate. Formalization of these groups will also enable farmers access resources such as through credit schemes targeting farmers and improve their agricultural investment, output thus resulting in further commercialization of rice farming. Additionally ownership of modern equipments such as powertillers, tractors and oxploughs were also seen to have a positive effect on market participation by smallholder rice farmers. There is continued need for mechanization of agriculture as a policy to support commercialization. Through mechanization, production will be increased but the farmers can also use the same equipments for transportation of produce to central collection centers or markets thus facilitating them to participate in the market.

6.3 Limitations and Areas for Further Research

Within the study, the women empowerment in agriculture index is applied across 5 villages in Kilombero district to across female headed and male headed households. The sample size was limited due to limited resources that were available for data collection although we would have desired a larger sample and village coverage in order to arrive at a more representative sample.

In examining the relationship between women empowerment and technical efficiency and, women empowerment and market participation, a good instrument could not be identified especially given that women empowerment was constructed from five different domains. A suitable instrument for women empowerment would have been able to give a better result in terms of effect of women empowerment on technical efficiency and, on market participation by the household.

With the availability of more resources, the estimation of women empowernment for rice based farming systems can be improved and a more suitable instrument would also better highlight the relationship that it has with technical efficiency and market participation.
Additionally with a bigger sample size with farmers at different scales of production, technical efficiency and its effects could have been disaggregated at different technology levels to cover areas such as use of modern seed, use of improved technologies like tractors and other improved agronomic practices that can constitute technological change.

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Local Legislation

The Land Act No.2 of 2002

The Constitution of the United Republic of Tanzania, 1977

The Law of Marriage Act No.5, 1971

Land Act No. 4 of 1999

The Village Land Act No. 5 1999

APPENDICES

Table A.1: Determinants of women empowerment using number of female children instead of male children for female headed and male headed households

Variable	Female-headed Households(n=92)	Male-headed Households (n=97)
Prob > chi2	0.0005	0.0166
LR chi2	LR chi2(13)=36.45	LR chi1(12)=24.65
Pseudo R	0.1904	0.1320
Cut 1:	10.8879	4.4022 (3.1671)
Cut 2:	13.2067	6.8922(3.2253)
Log likelihood	-77.4642	-81.0017
Distance nearest town	0. 0755 (0.0312)**	0.0085(0.0217)
Age difference between couples		0.0301(0.0613)
Age of the man		0.3073(0.1387)**
Age squared of the man		-0.0029(0.0016)*
Age of the woman	0.2682(0.1252)**	-0.0583 (0.1513)

Age squared of the woman	-0.0022 (0.0013)*	0.0011(0.0021)
Education of the woman	1.12316(0.5240)**	
Group membership of the woman	1.9083(0.6258)***	
Group membership household head		
Household size	0.1706(0.2249)	-0.5023 (0.1662)***
Female children per hh	**-0.2171 (0.2494)**	**0.5508(0.2515)****
Primary occupation_woman	-0.6820 (0.6402)	
No_of people under care	-0.0523(0.2774)	0.1222(0.1256)
Condition of the house (C3)	1.3723(0.5692)**	0.5007(0.5425)
C6 (number of bedrooms)	-0.0541(0.1853)	
C15 (Distance from nearest road)	-0.0394(0.1674)	0.1973(0.1891)
C14 (Monthly income)	-0.0165(0.0074)**	0.4610 (0.4455)