DRIVERS OF FARM HOUSEHOLD INCOMES IN RURAL TANZANIA

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Dedication

To my mother and the memory of my father and young brother Raphael.

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I owe this book to various institutions and many individuals who played an invaluable role in my endeavours. There are so many that any attempt to mention them all would be as good as writing another book. I would like to say to them all, “thank you very much, you have made it happen”. A few deserve special attention though.

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CHAPTER I

AGRICULTURE IN TANZANIA AND MOTIVATION FOR THIS BOOK

1.1 Background

Throughout the history of Tanzania, agriculture has been considered the back bone of its economy. Its contribution to the export earnings has been sizable. Its role in ensuring domestic food security has always been very important. Even more importantly, it employs more than 70% of the population, most of them living in rural areas where poverty is pervasive. Thus, it makes sense to say that any measures that address poverty are likely to succeed if they target bottlenecks existing in the agriculture sector.

Despite its importance, the sector is still dominated by traditional practices with about 70% of farming being dependent on the hand hoe; 20 per cent on draft animals; and 10 per cent on tractors and power tillers;[1] Production has thus been mainly for subsistence (URT, 2016).[2] Specifically, the main obstacles that hinder the development of the agricultural sector include: poor access and low use of improved seeds and fertilizers; under-investment in productivity enhancing technologies including agricultural mechanization; limited access to financing for uptake of technologies; unreliability of rainfall in some of the regions; and limited use of available water resources for irrigated agriculture (*Ibid*). Nonetheless, the sector has been identified as a growth driver (URT, 2018). The diverse climatic zones of the country provide potential for many crops, livestock and forestry products, as well as sufficient water for irrigation and livestock, and large size of arable land. Thus, given its role in supporting the rural poor and in reducing malnutrition, agriculture has the potential to lift many of the poor out of poverty. Moreover, increased food demand in neighbouring countries provides further opportunities for agriculture to expand and increase exports to these countries.

1.2 Overview of Agriculture in Tanzania

1.2.1 Composition and Nature

Tanzania is estimated to have 44 million hectares of land suitable for crops production. Out of this, only 10.8 million hectares are under cultivation. That is 25% of the potential land. In addition, the country has 50 million hectares of grazing land suitable for livestock keeping but only about 50% is under use.

[1] National Sample Census of Agriculture 2008-09

[2] The acronym URT means United Republic of Tanzania

Generally, there is ample land suitable for crops and animal production which is either unused or underutilised. Crop sub-sector is very important because food security in any year depends on the output of this sub-sector. Land holdings for crop production covers an average of 0.2 to 2 hectares per household. With this small land holding, farming households can grow if they apply high technology or if they have alternative economic activities to complement farm outputs. Tanzania grows both food and cash crops. The main food crops are maize, paddy, sorghum, millet, and wheat, which are in the category of cereals. On the other hand, pulses, banana, potatoes and cassava are non-cereals, which are also common food crops in Tanzania. Over the last decade, production of food crops has increased from 7.3 million tonnes in the agriculture year 1999/00 to 15.9 million tonnes in 2017/18 agriculture year (See Table 1.1). At the beginning of the decade of 1990s, there was no significant difference between production of cereal and non-cereals. However, recent trend shows dominancy of cereal over non-cereal.

Table 1.1 Production of Food Crops ('000 tonnes of grain equivalency)

	Cereal	*Non-cereal*	*Total*
1999/00	3,367 (46%)	3,955 (54%)	7,322 (100%)
2000/01	4,141 (54%)	3,553 (46%)	7,695 (100%)
2001/02	4,462 (52%)	4,111 (48%)	8,572 (100%)
2002/03	,696 (51%)	3,638 (49%)	7,375 (100%)
2003/04	4,870 (55%)	3,967 (45%)	8,838 (100%)
2004/05	5,015 (52%)	4,651 (48%)	9,669 (100%)
2005/06	5,282 (48%)	5,668 (52%)	10,945 (100%)
2006/07	5,422 (51%)	5,238 (49%)	10,660 (100%)
2007/08	5,589 (51%)	5,285 (49%)	10,872 (100%)
2008/09	5,218 (48%)	5,554 (52%)	10,773 (100%)
2009/10	7,398 (60%)	4,924 (40%)	12,322 (100%)
2010/11	6,935 (54%)	5,939 (46%)	12,972 (100%)
2011/12	7,436 (56%)	5,908 (44%)	13,344 (100%)
2012/13	7,807 (53%)	6,876 (47)	14,680 (100%)
2013/14	9,829 (61%)	6,187 (39%)	16,015 (100%)

	Cereal	***Non-cereal***	***Total***
2014/15	8,919 (57%)	6,610 (43%)	15,529 (100%)
2015/16	9,457 (58%)	6,716 (42%)	16,173 (100%)
2017/18	9,389 (59%)	6,512 (41%)	15,901(100%)[3]

Source: URT, 2013

In the category of cereals, maize is a dominant food crop, and in recent years it comprised more than 60% of total cereals and more than 30% of all food crops (see Figure 1.1). Indeed, maize production in Tanzania has for a long time remained the most important agricultural activity and is considered to be the main economic driver in rural areas (Thurlow & Wobst, 2003). On the other hand, main cash crops are coffee, tobacco, sisal, cotton, sugarcane, cashew-nuts, and tea. Recently, horticultural crops have become fast emerging as a major component in the sub-sector. There is great product range of fruit, vegetables and flowers in Tanzania. The most important fruit include pineapples, passion, citrus, mangoes, peaches, pears, and sweet bananas. Vegetables include tomatoes, spinach, cabbages, and okra. Flowers include many tropical varieties and some temperate types.

[3] Data for 2016/17 could not be found at the time of compiling these statistics

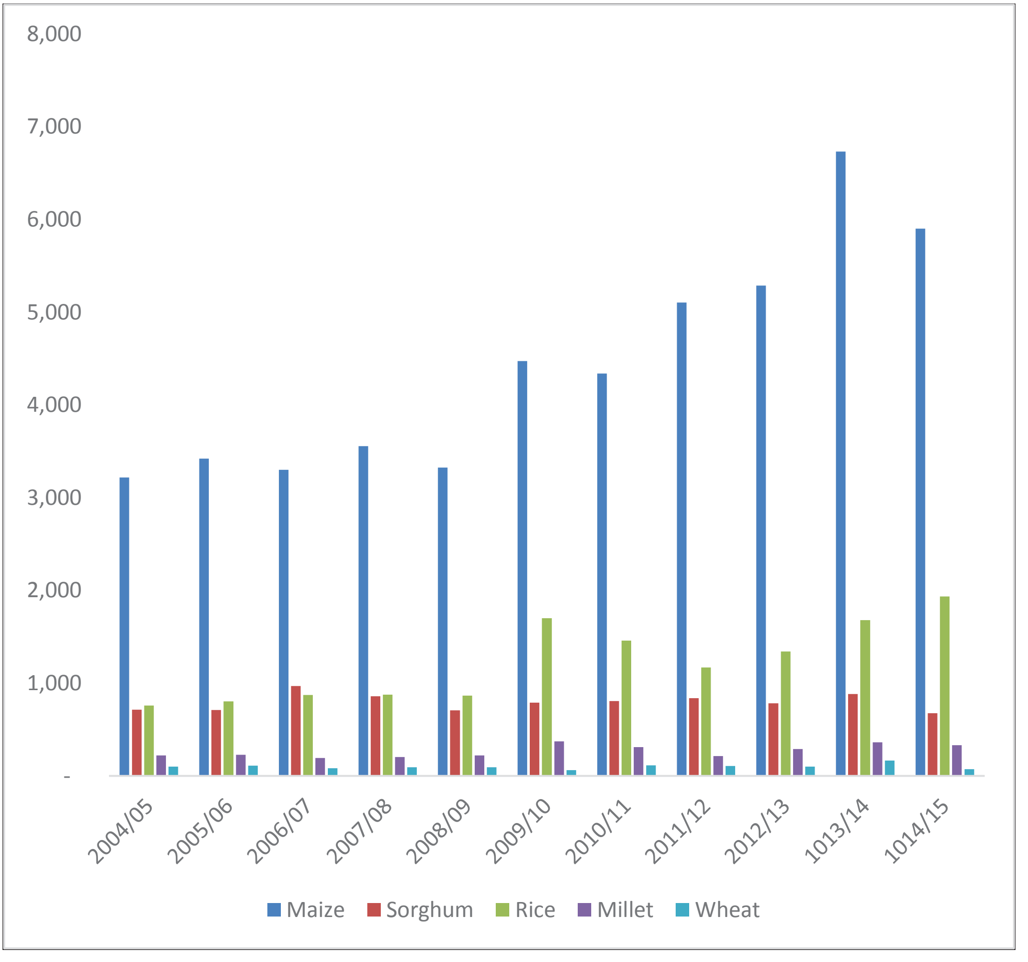

Figure 1.1 Production of Cereals Overtime

Source: URT, 2018

Limitation in the availability of and access to modern technology is a major obstacle to the expansion of land under cultivation. Consequently, Tanzania's agriculture has remained a largely traditional and highly subsistence-oriented and smallholder-production system although the modernization of agriculture has been on the national development agenda since independence in 1961. Small farms produce a major portion of the country's food. The country's agricultural potential is largely underdeveloped. The Agriculture Sector Development Strategy II shows that hand hoe is the main tool of cultivation to majority farmers (URT, 2015). The Agriculture Sector Development Strategy

II further shows that farmers in Tanzania are realizing low levels of their potential output due to impediments in adopting innovations.

Another area of limitation to development of agriculture in Tanzania is its dependence on nature. Some of the smallholder farmers live and earn their livelihoods in the ecologically and climatically vulnerable landscapes including hillsides, dry lands, floodplains and they rely on weather-dependent agriculture and natural resources which are quite uncertain in this era of climate change. Current projections by the Government of Tanzania and development partners indicate that climate change will dramatically affect the country's agricultural and water resources (URT, 2012). In particular, though Tanzania has abundant freshwater resources, the water storage capacity is limited and its hydrologic variability is high. That leaves the country vulnerable as rainfall patterns become increasingly unpredictable.

Meanwhile, it is predicted that mean annual temperature will increase by 1.0 to 2.7^{o}C by the 2060s, and 1.5 to 4.5^{o}C by the 2090s (Devisscher, 2010). These changes are hoped to have a profound impact on the patterns of rainfall in Tanzania leading to an increase in rainfall in the northern and eastern part of the country and a decrease in the southern, western and eastern part of the country. The extent to which such vulnerabilities will or will not compromise the on-going national efforts to eradicate poverty and move Tanzania to a middle-income country will, in fact, depend on the national, community and individual capacities to build resilience to climate change vulnerability in the agricultural sector.

1.2.2 Importance of the Sector

As it is one of the largest sectors in the Tanzanian economy, the importance of the agriculture sector cannot be overemphasized. It supports the majority of the rural population and has the potential of lifting them out of poverty. Approximately 75% of the population depends on primary agricultural production, most being rural dwellers where poverty is pervasive. Not only is the sector is key in ensuring food security, but its contribution to foreign exchange is also high. In 2015, for instance, the sector's contribution to export earnings amounted to 24% of total country's export earnings (UTR, 2018). Because of its role in food security and employment, the absolute growth of agriculture sector is an important input for Tanzania in the achievement of the Sustainable Development Goals (SDGs). The second National Development Framework, MKUKUTA[4] II, required agricultural growth rate to increase from

[4]MKUKUTA is a Kiswahili acronym, whose long form is *Mkakati wa Kukuza Uchumi na Kupunguza Umasikini Tanzania*, which was the National Strategy for Growth and Reduction

3.2 % in 2009 to 6.0 % by 2015, with corresponding sub-sectors growing correspondingly so that there is a tangible impact on poverty reduction. This was reinforced by the First Five Years Development Plan (FFYDP), which set the goal as *modernization, commercialization, and productivity enhancement* and targets of GDP growth at 5.6% for agriculture, 5.0 %for livestock, and 7.0% for fishery by 2015. The trend observed in the last two decades, however, has not been impressive. As a result, some of these targets were not achieved among smallholders who are key players in the sector. Over the last decade, the overall growth rate of the agriculture sector has fluctuated between 4.5% in 2000 and 3.6%in 2011 (URT, 2015). The growth rate of GDP during the same period also fluctuated between 4.9% in 2000 and 6.4 per cent in 2011 (*Ibid*). Thus, the average growth of the agriculture sector has been less than the national average during the last decade. The low growth of the sector is therefore a concern for rural development and poverty reduction efforts.

While agriculture growth for the last decade has been modest, its contribution to the GDP remains one of the biggest, accounting to nearly 25% to national gross domestic product (GDP) (See Figure 1.2). However, the last few years has witnessed consistent decline in that share from 28 % in 2005 to 23% in 2012. Gradual decrease of the share of agriculture sector in GDP is partly the result of low productivity in the sector which led to lower growth rate. But most of the decrease was attributed to investments and growth in other sectors of economy such as services and industry. During the period 2000 to 2012, Tanzania experienced structural change in the GDP in which the services and industry sectors gained bigger shares.

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of Poverty (NSGRP). This was a national framework guiding strategies for Growth and Poverty reduction in the country

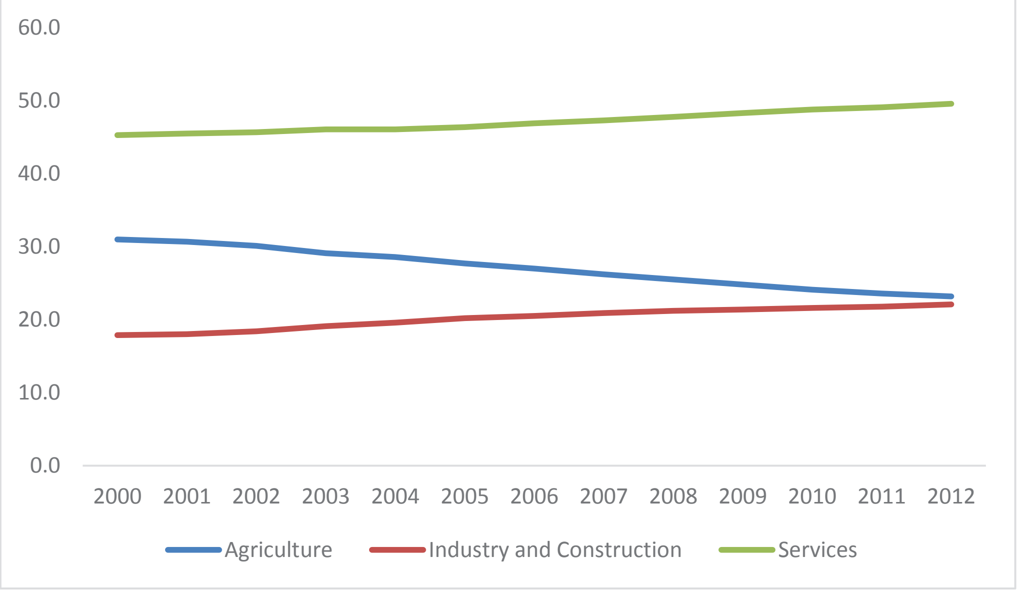

Figure 1.2 Sectoral Share of GDP

Source: URT, 2010

The Global Forum of Food and Nutrition of the UN shows that a declining trend of agriculture sector share of GDP due to fast growth of other sectors is found in other developing countries such as India, China and Turkey. In 1990, the shares of agriculture were 31% (India) and 27% (China). Recent data show that the shares of agriculture sector to GDP for the two countries dropped to 18% (India, 2014) and 9% (China, 2016). However, India, China and Turkey have increased agricultural production more than double in absolute values and have significantly increased exports of products from other sectors (FAO, 2011). The decreasing share of agriculture sector in these countries has been accompanied by increased productivity in the sector as well as releasing labour from the sector to other growing sectors such as service and manufacturing sectors. In other words, absolute increase in agriculture sector output should be the result of increase in the agriculture labour productivity. At the same time, decrease in the share of agriculture outputs should be accompanied by releasing labour to other fast-growing sectors. The faster growth rate of other sectors should imply that the agriculture sector efficiency is increasing to feed the manufacturing and service sectors and at the same time to release labour to those sectors. This does not seem to be the case with the Tanzanian agriculture. While the economy has shown diversification over the last decade, the agriculture sector has not been able to increase labour productivity and release part of its labour to other growing sectors. Consequently, the labour force employed in the sector remains at the level of 75%. One option of improving this linkage is to have an efficient labour in the agriculture sector, which increases production and is flexible enough to shift to other sectors. Within this context, necessity of formal education to farming cannot be over-emphasized.

1.3 Government Commitments and Efforts to Agriculture

1.3.1 Past Efforts

Tanzania has historically considered agriculture to be the backbone of its economy because the majority of Tanzanians (more than 70%) derive their livelihood from the sector. Thus, the modernization of agriculture has been on the national development agenda since independence in 1961. Throughout the country's history, leadership at all levels has directed much of its energies as well as public and private sector resources towards the transformation of agriculture. That was manifested in a range of initiatives and programs that were implemented to improve performance of the sector. These included: the Iringa Declaration of "Siasa ni Kilimo— Politics is Agriculture"; followed by "Kilimo cha Kufa na Kupona—Life and Death Effort to Improve Agriculture"; and the Arusha Declaration, which had anchored largely in agricultural transformation. Vision 2025, which has already been in operation for over ten years aiming at transforming Tanzania to semi industrialized country by 2025, has considerable focus on agriculture. All these were efforts by the government to give special emphasis to the agricultural sector development. The implementation of most of these efforts, especially those immediately after independence, faced a number of challenges. The major challenge was lacking popularity of the efforts, especially due to lack of ownership on the part of the stakeholders. The stakeholders lacked ownership because the programs were centrally planned with little or even without the involvement of citizens in their formulation.

1.3.2 Recent Efforts

The National Development Vision 2025 spells out the commitment of the government to transform the country from a low- to a middle-income economy. This commitment is implemented through the National Strategy for Growth and Reduction of Poverty, popularly known by its Kiswahili acronym MKUKUTA. Under MKUKUTA, development indicators were identified and targets to be met within specified period set. In addition, to serve achievement of National Vision 2025, MKUKUTA was also part of interim strategy for the achievement of United Nations Millennium Development Goals (MDGs) of 2015, whose successor is Sustainable Development Goals (SDGs) of 2030.

The government recognizes the fact that achieving this will not materialize unless the agriculture sector is modernised.

In its first cluster, MKUKUTA focuses on promoting growth for reduction of income poverty. One of its operational targets to achieve this goal was to ensure that agricultural growth in real terms increased from 2.7% in 2009 to 6.0% by 2015. The MKUKUTA document clearly shows that in the medium term, the emphasis is on small scale agriculture, with a gradual shift to the medium level and later to large scale farming. The shift away from small scale farming, thus releasing agricultural labour to off-farm sectors, is one of the outcomes of increases in agricultural productivity. And that can be achieved through the use of modern inputs–fertilizers and improved seeds and breeds; mechanization thereby reducing labour; and reliable water sources for irrigation. Strategies to ensure the economy absorbs labour released from farming, especially the rural non-farm activities become an integral part of rural development strategies. Implementation of recent strategies has taken into account challenges experienced in earlier efforts. Through MKUKUTA, these strategies provided guidance on the type of intervention needed, who should be key actors and how to finance the action.

The First Five Year Development Plan (FYDP I), which was running parallel to MKUKUTA and the current Second Five Year Development Plan (FYDP II) which has integrated both MKUKUTA and FYDP I, recognize the importance of agriculture. Both plans clearly prioritize development of the agriculture sector and recognize its importance in taking the country to the middle-income level in 2025. It is expected that industrialization will only be achieved through a sound agriculture sector development.

Agriculture Sector Development Strategy (ASDS)

In response to economic challenges including stagnant growth in the agriculture sector that resulted from failure of previous sectoral initiatives, the Government of Tanzania developed and approved the Agriculture Sector Development Strategy (ASDS) in 2001. The objective of ASDS is to achieve a sustainable agricultural growth rate of 5% per annum, primarily through the transformation from subsistence to commercial agriculture. The transformation is to be private sector led through an improved enabling policy environment and public expenditure. Among the core features of the ASDS is the use of district-level need identification, project management and implementation through preparation of the District Agriculture Development Plans (DADPs). The use of district level management is aimed at addressing challenges of previous perceived top down management.

The Government's operational tool of the ASDS and the main mechanism for its implementation is the Agriculture Sector Development Programme (ASDP), which is currently in its second phase. The first phase, known as ASDP I was launched in 2006. The key methodology underlying ASDP I was based on a participatory and iterative approach, in its design; beneficiary demand-driven approach, in its need assessment; and decentralised and result-based in its implementation. Through ASDP I basket fund, in collaboration with development partners, the Government was financing the implementation of the Programme. The Programme had two components: the local level support, which uses 75% of the total resources from the basket and the national level component which uses 25% from the basket. One of the key achievements of ASDP I was the creation of a mode of operation that streamlined planning, financial management, monitoring, and reporting systems. The programme also facilitated significant development of both human and physical capacity, especially that of the Local Government Authorities (MAFS, 2011). This capacity has provided an environment that supports implementation of the ASDP II activities.

Achievements have not, however, gone without challenges and as may be expected ASDP I faced several challenges. In the first place, this was a national wide programme, which started without strong financial base. That resulted in a situation where limited resources were thinly spread, and results were fragmented, hard to assess, attribute and report. Limited human capacity especially at the lower level was another challenge, resulting into carrying over of funds budgeted for the programme from year to year. Also, donor harmonization, which was a characteristic feature of its start, was weakened over time and proliferation of self-standing projects gradually emerged. Another challenge related to limited participation of private sector in the activities of ASDP I.

The second phase of the government 's operationalization of the ASDS, ASDP II, covers the period of ten years (2016/2017–2025/2026). ASDP II aims at addressing the challenges and gaps which were experienced in ASDP I. The focus of ASDP II is to address the key constraints and challenges facing the sector performance. To that effect, it aims at increasing the speed of agriculture GDP, improving growth of incomes of smallholder farmers and insuring food security by 2025 (URT, 2016). The point of departure for ASDP II is ASDP I. Under this arrangement, the second programme aims at strengthening successful investments which were made in the ASDP-1, but also integrating support to Big Results Now (BRN) plans on irrigation development and smallholder aggregation (discussion on BRN will follow in the next sections). Consistent with the long-term and medium-term policy frameworks are the sector development strategy developed in ASDS I (2001), the signed Tanzania Agriculture and Food Security Investment Plan of (URT, 2011), the revised ASDS II (2015) and key lessons learned from ASDP I implementation.

***Kilimo Kwanza*[5]**

The totality of the efforts Tanzania has directed in agriculture had aimed to achieve significant measure of agricultural productivity or more commonly known as a “green revolution”. A substantial amount of budget was required to achieve this. The government of Tanzania had, at both the AU and SADC level, committed that it would allocate 10% of the national budget to agricultural development. The most recent Agriculture Sector Review-Public Expenditure Review (ASR-PER) is not able to estimate the total agriculture sector expenditure as a percentage to GDP because of lack of adequate and reliable data on spending by development partners. Consequently, the review estimates the agriculture recurrent expenditure as a percentage of total government recurrent expenditure. This figure ranges between 3 to 3.7% between 2011/12 to 2013/14 (ASR-PER, 2015). This level of expenditure in the sector still seem be low to realize tangible agricultural transformation. The sector thus suffered lower investment in mechanized farming, characterised by low usage of improved seeds, fertilizers and limited use of machinery. Furthermore, the country is second in Africa, after DRC, for large volume of water resources and numerous water basins. It has 7.1 million ha of land classified as high and medium potential land (2.3 million ha and 4.8 million ha respectively), suitable for irrigation (MAFS, 2015). Of the 2.3 million ha of high irrigation potential, only 0.5 million ha had improved irrigation infrastructure by 2015, accounting for only 1.6% of the land which is potential for irrigation (*ibid*). Because of these problems, the sector has suffered lower investment and been unattractive to the private sector.

To address those challenges, in 2009, the government felt that the time had come to have a defined trajectory for the transformation of Tanzania’s agriculture, which would be commonly understood and shared by all the stakeholders, and capable of generating the impetus for high and sustained growth rate of the economy as a whole, for many years to come. The way forward for Tanzania was a national vision for a green revolution, popularly known by the name *Kilimo Kwanza***.** It was officially launched by the President on the 3rd August 2009. Under *Kilimo Kwanza*, emphasis started in transforming small scale agriculture from peasantry farming to a more commercialized farming. Agriculture sector-specific growth issues revolved around productivity, with particular concerns for the smallholder farmers who were the majority. The government and private sector investment efforts

[5]*Kilimo Kwanza* are Kiswahili words meaning Agriculture First.

focused on the identified drivers of growth in agriculture. The "drivers" were prioritized according to their impact in raising productivity and creation of decent employment (with variations per region/district depending on existed relative advantages). Education, whether formal or informal, could be one of the drivers of growth in farming and educated labour is flexible when it comes to releasing labour from farm to non-farm activities. Understanding the role of education in farm labour productivity could improve the recent debate within the context of *Kilimo Kwanza* green revolution initiative.

Big Results Now (BRN)

From the 2013/2014 fiscal year, with support from development Partners, Tanzania adopted a Big Results Now (BRN) initiative.

The initiative was based on a model of development that has proven successful in Malaysia. This comprehensive system of development implementation, described as a "fast-track people-centered growth 'marathon'" focused on six priority areas articulated in the Tanzania National Development Vision 2025, with agriculture being one of them (The Tanzania Big Results Now Initiative, 2013).

The Big Results Now initiative acknowledged participatory planning in which the public became actively engaged in learning about development plans and provided inputs that were taken into account. Transparency and efficiency were guiding concepts, and the reduction of corruption was of paramount importance. The aim of this initiative was not to substitute previous ones but rather to complement them in a way that big results could be seen within a short period of time. Narrowing down priorities and sequencing their implementation had been part of this initiative to speed up the results .

In the agriculture sector, the government had primarily identified a number of critical challenges hindering growth of the sector. The objective of BRN initiative was, therefore, to address these challenges in order to increase agriculture GDP growth, improve smallholder incomes and ensure food security by 2015. Growth in GDP was to be driven by commercial farming models, while increased smallholder incomes was to be achieved through smallholder engagement in modern agriculture. Both models contributed to addressing the question of food security. Social inclusion and sustainability were at the heart of these models.

As a whole, the initiative focused on an initial three priority crops: maize, rice and sugarcane as they were of high strategic importance to contribute to food security and import substitution for the country. The plan was to replicate the model to other crops depending on the challenges and lessons learnt in this initial focus (URT, 2013).

SAGCOT *(Southern Agricultural Growth Corridor of Tanzania)*

SAGCOT is one of the recent initiatives whose goal is to expand investment in agribusiness so as to increase income growth among smallholder farmers. It also sought to generate employment across agribusiness value chains in the Southern Corridor. SAGCOT initiative has the mandate of mobilizing private sector investments and partnerships within the context of Public-Private Partnership (PPP). This is done though catalysing large volumes of responsible private investment, targeted at rapid and sustainable agricultural growth, with major benefits for food security, poverty reduction and reduced vulnerability to climate change (URT, 2015). SAGCOT promotes clusters of profitable agricultural farming and services businesses, with major benefits for smallholder farmers and local communities. It focuses on value addition, infrastructure development, agricultural production and productivity, and public–private partnership. It is worth noting that the objectives of SAGCOT are consistent with the strategies and priorities of ASDS, complemented by *Kilimo Kwanza* as discussed earlier in this section.

1.4 Objective of the Book

The overall objective of this book is to contribute to the on-going debates on identifying sources of growth in rural Tanzania, in the context in which the country is striving to modernize agricultural practices, given the budgetary constraints. In doing this, we focus our analysis on the role of human and financial capital in promoting rural growth by motivating the adoption of innovation in a way that the rural growth is inclusive. For the role of human capital on rural growth, we focus on the role played by formal education in the adoption of farm innovations. Regarding the role of financial capital, our focus is on the role of off-farm employment in rural growth. In relation to that, we look at two issues: first, we explore the driving forces of off-farm employment and how such forces are accessible to lower income households. Secondly, we examine the role of off-farm employment on adoption of modern farm technologies and food security. These topics are addressed in separate chapters as explained below.

Chapter two is concerned with education and farm productivity. Achieving a high level of agriculture productivity through the adoption of modern practices requires that the farming communities are dynamic enough to cope with modern technologies. In the literature (e.g., Ajani & Ugwu, 2008; Alene & Manyong, 2007; Appleton & Balihuta; Asfaw & Admassie, 2004; Griliches, 1964; Hossain et al., 1990; Klasen & Raimers, 2013; Lockheed et al., 1980; Phillips, 1994;, 1996; Weir, 1999; Weir & Knight, 2004) ,farmer education is one of the variables which have been studied in relation to the adoption of modern farming practices, especially in the system that strives to move away from the traditional agriculture. Human capital in the form of formal education that is acquired during primary and secondary schooling has been associated with higher incomes and improved overall economic development and growth through increased labour efficiency (Becker, 1964). Yet, in the farm productivity, literature gives inconclusive evidence regarding the role played by formal education. As stated earlier, Tanzania is striving to modernize its agriculture in order to increase productivity, which by any standard is very low. Efforts are being made to identify factors for productivity and prioritize them in the order of the impact they may have on productivity. This book contributes to this on-going debate by quantifying the role played by formal schooling on farm productivity as well as quantifying the negative consequences of loss of opportunities of adopting innovation due to the low level of formal schooling.

Chapter three examines the driving forces of rural off-farm income generating activities and how such forces are accessible to low incomes rural households. Specifically, the chapter investigates determinants of household participation in off-farm employment. Then it analyses the factors with a focus on how easy (or difficult) it is for rural poor households to take part in such employment. There is a wealth of literature showing that in poor countries that have a dominant agrarian economy, off-farm employment can be an important source of alternative income (Bryceson & Jamal 1997; Chuta & Liedholm, 1990; Reardon 1997). Off-farm income has generally been positively correlated with farm income (Chikwama 2004; Haggblade & Hazell 1989; Hazell et al. 1991) and non-farm activities show a positive, broader role in poverty reduction, total household income, and household wealth (Barrett et al. 2001; Davis 2003; Lanjouw & Lanjouw, 2001; Reardon 1998). In Tanzania, the recent household budget survey shows that 62% of households living in rural areas reported running some forms of business outside farm activities (URT, 2014). However, due to limited understanding of the dynamics of this income, little attention is paid to it by policy makers when discussing promoting rural growth issue. This chapter quantifies the determinants of off-farm employment and their accessibility by low income households.

Chapter four looks at the role of off-farm employment in the adoption of modern farm practices as well as its role in food security and quality of nutrition. In this context, off-farm employment is expected to relax farm households from cash constraints. Literature has associated capital access and adoption of modern farm practices (Asafu-Adjaye, 2008; Chang & Boisvert. 2005; Cornejo et al.2005; Feder et al., 1985; Gedikoglu et al., 2011; Just & Zilberman, 1988; Mathenge & Tschirley, 2007). In Tanzania, farmers, especially smallholder ones, find it difficult to raise capital for farm inputs because they are not credit worth. This is because farm outputs are rain fed and so not predictable. Credit institutions consider small scale farmers to be risk customers (URT, 2010). The mushrooming of off-farm economic activities in rural areas suggests that, if well undertaken, they can be a close substitute to credit. The increased income will increase farm productivity through increased use of farm technology, which will then translate into food security. On the other hand, off-farm employment may also be used as a direct source of finance to food as urbanization increases in rural areas. However, as stated earlier, this sector is not well understood, and hence little or no attention has been given to it in the context of rural growth. This chapter quantifies the role played by this source of income in promoting the adoption of modern farming practices and food security.

While this book focuses on the central theme of drivers of farm household incomes in rural Tanzania, each of the three chapters can be read as standalone papers.

CHAPTER II

EDUCATION AND FARM PRODUCTIVITY IN RURAL TANZANIA

2.1 Introduction

In contemporary development, it is widely accepted that the growth of many developing countries, particularly those in Sub-Saharan Africa, will only be realized with a well-developed agriculture sector. This is because agricultural growth has powerful leverage effects on the rest of the economy, especially in the early stages of development and economic transformation, when agriculture accounts for large shares of national income, employment and foreign trade. Tanzania is not an exception in this aspect. Recent statistics show that 80% of its population depends on agriculture for livelihood, and agriculture contributes 95% of its food consumption. Furthermore, agriculture contributes more than 25% of the GDP, 30% of the total exports and 65% of the raw materials for its industries. The development of the Tanzanian economy cannot be isolated from the development of the agriculture sector. Within this context, researching agriculture remains an important aspect of development. That is best captured from the remark of Schultz (1979) made during his Nobel Prize lecture:[6]

> *Most of the people in the world are poor, so if we knew the economics of being poor, we would know much of the economics that really matters. Most of the world's poor people earn their living from agriculture, so if we knew the economics of agriculture, we would know much of the economics of being poor.*

Public investment in agriculture is an important driver of agricultural growth and has a significant bearing on poverty outcomes. However, because of budget constraints, countries find themselves in an increasingly difficult situation of having to meet the rising costs of social services to mitigate the immediate impact of poverty and, at the same time, raise investments to boost and broaden growth in the agriculture sector so as to reduce the prevalence of poverty especially in rural areas. Under such conditions of trade-off between social and growth sectors, it is important to understand, acknowledge and take advantage of synergies existing between them. Education is one of the social sectors that have a bearing on productivity. Specifically, education may enhance farm productivity directly by improving the quality of labour, by increasing the ability to adjust to disequilibria, and through its effect upon the

[6] The lecture is available through http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1979/schultz-lecture.html

propensity to successfully adopt innovations. Education is thought to be most important to farm production in a rapidly changing technological or economic environment (Alene & Manyong, 2007).

Since farming methods in Tanzania are largely traditional, there appears to be little economic justification for households to invest in education. However, with the recent initiatives like Kilimo Kwanza, Big Results now (BRN), Southern Agriculture Growth Corridor of Tanzania (SAGCOT) and those outline in the Agriculture Sector Development Programme II (ASDP II), the government is focusing attention on a modernized agriculture (URT, 2016)7. As technological innovations spread more widely within the country, the importance of formal schooling to farm production ought to become more apparent.

In Tanzania, however, formal education seems to have not been viewed as an input to agriculture productivity but rather as a channel though which formal employment in urban areas can be obtained. As the result, parents only attach importance to the primary education system if it will lead their children to higher education and eventually assures them with formal employment as they graduate. Agriculture is the main economic activity for many Tanzanians, particularly those living in rural areas. Unemployment is a serious problem among youths in the country (URT, 2015).[8] Thus, even when formal unemployment is high among youths, farmers should still consider primary education as an important input to agriculture, thus send their children to school. More important, the "Primary school (compulsory enrolment and attendance) Rule 2002" makes it a criminal offence for parents/guardians to fail to enrol seven- year olds in a primary school or allow a pupil to drop out before completion of the full primary cycle (URT, 2003). Despite imposed penalties, including cash payment and jail sentences, the efficiency of primary education measured in terms of cohort wastage raises a number of concerns. The average survival rate to Std. VII between 2005 and 2010 is 69% (URT, 2011). This suggests a low level of acknowledgement of the importance of

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[7] *Kilimo Kwanza* are Kiswahili words meaning *Agriculture First*, which is a new green revolution initiative. On the other hand, BRN is an initiative which was borrowed from Malaysia, which is a comprehensive system of development implementation, described as a "fast-track people-cantered growth 'marathon'" focused on six priority areas articulated in the Tanzania National Development Vision 2025, with agriculture being one of them. Finally, SAGCOT is an initiative, whose goal is to expand investment in agribusiness so as to increase income growth among smallholder farmers, but also to generate employment across agribusiness value chains in the Southern Corridor

[8] Integrated labour force survey, National Bureau of Statistics

primary education, especially if parents see limited chances for their children to excel to higher education levels for formal employment in urban areas.

In light of this, the purpose of this chapters two-fold: first, to challenge the hypothesis that demand for schooling in rural Tanzania is constrained by lack of visible benefits of schooling in terms of farmer productivity; and second, to understand better the possible consequences of low levels of demand for schooling in terms of missed opportunities to improve agricultural productivity in rural Tanzania by raising farmer efficiency through adoption of innovations. The first objective is to work out the importance of schooling to the rural economy. Parents may see the importance of primary education to their children if they view it as a channel to higher education and access to formal employment after graduation. Even when they don't see the chances of their children to excel to higher education and formal employment, parents may also see the importance of primary education to their children if they believe that it has contribution towards farming efficiency. If this is not the case in Tanzania, it may partly explain why there is such a high level of drop-out before completing Std. VII. The second objective is important for policy-makers concerned about high drop-out rates despite the free provision of education. Recent agriculture development initiatives focus on mechanizing agriculture with emphasis on inputs like machinery, chemical fertilizers, improved seeds, etc (URT, 2015). If education is found to have a significant impact on the adoption of agricultural mechanization, this will provide a rationale for agriculture policies to integrate issues of formal education.

There are several avenues by which schooling may create economic benefits in rural areas. Households receive income in cash and in kind from farming and off-farm activities, wage employment, and remittances from migrants. Education may increase the probability of success in each of these endeavors and, in so doing, diversify household income sources to reduce risk and improve economic security. Since farming is the primary activity of most households in rural Tanzania, this chapter will focus on the part played by schooling in agricultural production.

2.2 Experience of Education and Farm Productivity

2.2.1 Introduction

All governments around the world have been advocating investment in education because of its perceived importance in the labour market success of individuals (World Bank, 2018) . However, a majority of the population in developing countries depends on agriculture for their livelihoods. Knowledge of market returns to education is less useful as a guide to increase educational investment in such agrarian societies. Theoretically, education is expected to improve productivity in all spheres of activities, including agriculture.

Improvements in human capital should influence how an individual acquires, assimilates and applies information and technology. A positive return to education arises, for example, because educated farmers organize well their labour force, apply current improved seeds and other industrial fertilizers and can even engage in high risky (but with high-return) production technologies. Despite such common beliefs regarding the benefits of schooling in farm activities, there is a weak empirical evidence to advocate educational investment in agrarian societies (Gabre-Medhin, E., Barrett, C. & Dorosh, P. 2003). As will be seen in the subsequent literature, existing studies on the determinants of farm productivity and efficiency are largely inconclusive on the question of a positive return to education.

2.2.2 Importance of Education on Farm Productivity

From the human capital theory perspective, the role of education on returns to investment has been estimated for over 50 years now. Education, particularly formal education acquired during primary and secondary schooling, has been shown to result in higher incomes and improve overall economic development and growth (Becker, 1964). Many studies in the relationship between education and agriculture productivity used production function (See Alene & Manyong, 2007; Ajani & Ugwu, 2008; Appleton & Balihuta, 1996; Griliches, 1964; Lockheed et al., 1980; Phillips, 1994; Weir, 1999). Preference to use production function in estimating the relationship between agriculture productivity and investment in education is the absence of wage data in agriculture sector, especially in developing countries. Production function, thus, estimates additional outputs from a labour as a resulting of additional unit of human capital in the form on one more year of schooling. A major weakness of this approach, which is a point of departure of the current chapter, is that of treating education as a direct input to farm outputs. More likely, education contributes to increased farm output if educated farmers decide to make on-farm innovations that transform agriculture from traditional to modernized form. Thus, education may not likely affect agricultural outputs directly, but does so through its impact on the decision to make on-farm innovations (Spielman, D. J., J. Ekboir & K. Davis, 2009).

Griliche (1964) made one of the earliest attempts to study the relationship between farm productivity and farmer education. The study used a Cobb-Douglas production function, to study 39 states in America, with three cross sectional data sets that covered three years: 1949, 1954 and 1959. The study found that human capital in the form education contributed to 41% increase in average farm productivity, and it had substantial economies of scale in agriculture. Many other studies that followed (Ali & Flinn, 1989; Appleton & Balihuta 1996; Asadulla & Rahma, 2005; Hasnah et al. 2004; Llewelyn & Williams 1996; Seyoum et al. 1998; Wang et al. 1996 & Welch 1970) provided mixed results on the role of education of farm productivity. In certain cases, the relationships are negative whereas in others they are positive. However, there are great variation in the strength of association even in cases where studies show consistent relationships.

Having studied profit efficiency of small scale Basmati rice producers in Punjab, Ali and Flinn (1989), for example, found that lower level of farmer education contributed high level of inefficiency at farm resources and price levels amounting to 28%. This finding is consistent with a number of other studies that analyzed the association of education of the farmer and productivity including Wang et al. (1996), Appleton & Balihuta (1996), Seyoum et al. (1998) and Asadulla & Rahma (2005) in China, Uganda, Ethiopia and Bangladesh, respectively. Nevertheless, other studies (e.g., Welch,1970) support the importance of education but underline that its effects are combined with other factors. Studying education in production, Welch (1970) , for example, used a human capital approach combining education and other human capital factors and found that this combination has even a bearing on innovation, meaning education alone does not necessarily deliver enough capacity for innovation. On the other hand, there are also studies that do not show any significant contribution of farmers' education on farming efficiency. For example, Llewelyn and Williams (1996) did not establish any significant contribution of farmers' lower junior high school education on farming efficiency in Java, Indonesia. There are also studies that reported inconclusive results. Having reviewed previous studies in Africa which investigated the relationship between education and farm productivity, Appleton (2000) revealed insignificant association between education and farm level efficiency. On the other hand, Hasnah et al. (2004) report a significantly negative relationship between education level and technical efficiency in West Sumatra-Indonesia. Nevertheless, there is some consensus among scholars that education significantly influences the adoption of technological innovations in agriculture (see, e.g., Asfaw & Admassie, 2004; Hossain et al., 1990; Klasen & Raimers, 2013; Weir & Knight, 2004).

The lack of the significance association between education and farm efficiently in some studies in many African countries has been associated by statistical approach problems employed by those studies. Such problems are mainly the use of small sample that cannot allow generalization of results or measurement errors in agricultural production (Appleton, 2000; Appleton & Balihuta, 1996). Furthermore, differences in the agriculture technology used in different countries have also contributed to differences in the extent to which education contributes to farm productivity. For instance, education might have a bigger impact on farm productivity in areas where modern agriculture is practiced than in places where traditional agriculture is practiced (Lockheed et al., 1980). To put it differently, those studies that show a statistically non- significant relationship between education and farm productivity do so because they assume that technology used on the farm is homogeneous across countries. Consequently, they have failed to account for the fact that education plays a greater role in modern environments than in traditional environments. This is because farmers with higher education are more flexible to adjust to modern technological advancement than those who are less educated. Studying the effects of schooling and extension on cowpea production under both traditional and modern/improved technology in northern Nigeria, Alene and Manyong (2007), for example, found that farmer education had a positive and significant effect on adopters of improved cowpea varieties as opposed to non-adopters or traditional cowpea farmers. Definition of farmers' education level is another area in which those studies reporting unexpected negative or even non-significant relationships between farmer education and farm productivity have been challenged. Klasen and Raimers (2013) have applied advanced panel econometric techniques to study a sample of 95 developing and emerging countries from 1961 to 2002. Their findings show that, non-significant or even surprisingly negative effects of schooling on agricultural productivity are due to a problematic reliance on enrolment and literacy indicators rather than education attainment.

The same way Appleton (2000) did to review previous studies on the relationship between education and farm productivity in Africa, Lockheed et al. (1980) reviewed previous studies with the purpose of examining the information they contained concerning the correctness of three hypotheses: (i) higher levels of formal education increase farmers' efficiency; (ii) education has a higher payoff for farmers in a changing and modernizing environment than in a static and traditional one; and (iii) exposure to extension services improves farmers' productivity. Their review showed positive and significant relationship between education of the farmer and farm productivity in 31 datasets. Their review also showed a negative but a statistically non-significant effect in the other 6 datasets. Most important, this review supported the assertion that education effects are more pronounced in places where modern agriculture is practiced than areas where traditional agriculture is practiced.

Lockheed et al. (1980) work was extended by Phillips (1994) who performed a meta-analysis of 30 studies and 59 datasets to study association between farmer education and farm productivity. This approach used an individual study as a data point. To allow comparison, Philips (1994) followed Lockheed et al. (1980) to weigh the percentage gain of four years' schooling by the reciprocals of their standard error. The results of Philips' study confirmed and reinforced Lockheed et al.'s results as they both showed positive gain in farm productivity from increased years of schooling of a farmer. Furthermore, the role of education in modern agriculture was higher than in traditional agriculture (see also Arega et al., 2007). In supporting the findings that education has a stronger impact on modern than traditional agriculture, a cross-regional comparison found that the effect of education on farm productivity was stronger in Asia than in Latin America and Africa (Philips, 1994). This is because Asian agriculture is more technologically advanced than that of Latin America and Africa.

2.2.3 Desired Level of Formal Education

The level of education that matters for it to have an impact on farm productivity has been an important area in the literature of education and farm efficiency. The literature has shown a general consensus on the important role that education plays in farm efficiency. However, different studies have shown that different levels of education provides differing impacts on farm productivity. In their study which reviews literature on studies that investigated the relationship between education and farm productivity, Lockheed et al. (1980) concluded that farm productivity increases, on weighted average, by 7% (10% and 1% in the modern and non-modern environments, respectively). The increase is for farmers who have completed 4 years of elementary education rather than those with no formal education. However, results for other countries and states showed that the impact is higher for the education threshold of 4 to 6 years. An extension of Lockheed et al. 's study (1980), done by Philips (1994) showed that the weighted gain of 4 years of schooling is 6%. As shown in footnote 11, Philips (1994) believes that a weighted average of 7% obtained by Lockheed et al (1980) was a mistake, as his calculations based on Lockheed et al.'s figures and assumptions produces only 6%. The threshold of 4 years of schooling is also supported by Appleton and Balihuta (1996) study on education and agricultural productivity in rural Uganda.

One important topic that needs consideration in the literature of farmer's education threshold that may have an impact on farm productivity is the whole issue of different farming technologies. Most of the literature discussed earlier has shown almost a general consensus that formal schooling is most useful in an innovative environment where farmers face rapid technology changes, and hence can catch up faster with new technologies than their counterparts (Ajani & Ugwu, 2008; Alene & Manyong, 2007; Appleton & Balihuta, 1996; Arega et al., 2007;Asadulla & Rahma, 2005; Klasen & Raimers, 2013; Lockheed et al., 1980; Phillips, 1994; Weir, 1999). If this is true, formal education threshold may be associated with the nature of farming technology in place. That is, higher formal education threshold may be needed in a rapidly changing environment.

2.2.4 Appropriate Household Member to Access Formal Education

The farming household may have many members engaged in the farming activities. The question that arises in such household is: Whose education level among household members engaged in agriculture matters for farm productivity? Some studies (see, for example, Alene & Manyong, 2007; Nguyen & Cheng, 1997; Weir, 1999) have used the education level of the household head arguing that most of the farming decision are made by head. In this argument, it is the education level of the head of the household that matters for farm productivity than other members of the household. Other studies (e.g., Alene & Manyong, 2007; Weir, 1999) use the average years of schooling of adult members of the household. They do this arguing that in farming households all adult members have a contribution to farming practices. The challenge here might arise if all household members are not engaged in farming. A similar problem is likely to arise in those studies using average years of schooling attained by all household members. It is almost impossible for all members to have the same level of engagement in farming activities. While actual production may be mainly dominated by energetic youths, decision making may be dominated by elders, who spend less time in the actual farming. Also, children may be attending schools or stay at home, thus they have no role to play in farming, although their ages were used to calculate average household age. In trying to address these seeming shortcomings, some studies are considering that much of the farm work in agrarian societies is household- (instead of individual-) specific, and thus take that into account when determining levels of education of household members (Asadulla & Rahma, 2005)

Basu and Foster (1998) argue that only one-person education in the household is okay for whole household to benefit in the agriculture productivity using this person's skills. In this case, the education of the most educated person in the household can determine farm productivity than the average education levels of all members. (Foster & Rosenzweig, 1996). In applying new technology and modern inputs, the knowledge of this person can easily be adopted by other members of the household who engage in farming (Green et al., 1985). Thus, even if the household head has not attained any level of formal school, the household benefit if one of its members who practices agriculture has some levels of formal schooling which enables this person to practice modern agriculture. However, within the rural Tanzanian context, key farming decisions regarding practices as well as the final use of agriculture products are made by the household head (URT, 2012). It, therefore, makes sense to use the education level of the household head in our analysis of the relationship of farmer education and farm productivity.

Equally important in the literature regarding whose education matters is the role of external effect of education in improving productivity and efficiency. Educational externalities arise through learning from a neighbourhood who has education and applies modern agriculture methods in farming. This means that uneducated farmers simply access the basic literacy and numeracy skills of their educated neighbours. A similar case is when educated farmers are early innovators and are copied by those with less schooling (Knight et al., 2003). By way of contributing to this debate, Appleton and Balihuta (1996) examined the role of externalities for farmers in the same enumeration area where some are more educated than others. Their conclusion supports the important role of the neighbouring education to farm productivity. Their study found that education of a household increases neighbouring household farm productivity by 4.3%, compared to 2.8% of own household productivity. Gille (2011) confirms Appleton and Balihuta's (1996) findings when studying the role of education externality on farm productivity in India. The study concluded that one additional year in the mean level of education of neighbours increases farm productivity by 3%. Even more pronounced results were reported in Ethiopia by Weir (1999) where the external returns of education to farm productivity ranges from 17% to 56% across different sites.

Similar education externalities could prevail in farm production in Tanzania. In rural Tanzania, which is characterized by an extremely low level of literacy, educational externality could serve as an important non-market determinant of farm level productivity and efficiency. This is possible especially for maize producers whose farms border to each other, as they use the same inputs and cultivate in the same season. Such social proximity could improve knowledge-sharing and generate positive externalities.

While many studies seem to support the importance of farmer education in farm productivity, such results cannot be generalized (see Ahmed Diab, 2015; Larsen & Lilleor, 2014) . There are some cases where education is positively related to farm productivity; in others it is negative while still in others such relationship is non-significant. Some studies (Appleton and Balihuta, 1996; Gille, 2011 & Weir, 1999) have gone to the extent of showing that it is the neighbour's education that matters more in terms of farm productivity than own farm education. These results call for specific location analysis to determine such a relationship. The current study attempts to cover that knowledge gap within the Tanzanian context. If it is found that education plays an important role in improving farm productivity, the low demand for formal schooling in rural Tanzania may partly explain the current low level of farm productivity.

2.3. Analytical Framework

2.3.1 Model

This chapter seeks to understand the role of education in farm productivity. This relationship can be expressed by the following equation:

$$Y_i = X_i\beta + \varepsilon_i \qquad (1)$$

where

Y_i = farmer i^{th} output;

X_i = factors affecting output including farmer i^{th} education level.

The major problem in this relationship is that what is observed is only the contribution of education in productivity if educated farmers decide to make on-farm innovations that lead to increased farm outputs. The main assumption in this relationship is that educated farmers are smarter than their non-educated counterparts and may be more likely to make on-farm innovations in the form of investment or adoption of modern farming practices. The 'selection equation' for making on-farm innovations is:

$$U_i = w_i\gamma + u_i \qquad (2)$$

where,

U_i = utility to farmer i of making on-farm innovations;

w_i = vector of factors known to influence a farmer's decision to make on-farm innovations such as education level;

u_i = an error term assumed to be jointly normally distributed with ε_i and contains any unmeasured characteristics in the selection equation.

From the selection equation 2 above, we do not actually observe U_i. What we observe is a dichotomous variable D_i which takes a value of 1 if the farmer makes on-farm innovation ($U_i > 0$), and 0 otherwise. The relationships in equations 1 and 2 lead to a selection problem as a result of two effects: (i) farmers with higher levels of education will be more likely to make on-farm innovations and so we will have a sample of educated farmers; and (ii) some uneducated farmers will make on-farm innovations, and so also come into the sample. This is due to the fact that these farmers decide that on-farm innovation is worthwhile because they have a high value on some unmeasured variable that is captured in U_i in equation 2. To put it differently, these farmers enter our sample not because they have high education but because they have large error terms. In contrast, those farmers who get into our sample because they have high education will have a more normal range of errors.

The problem is that whether or not education (or independent variables of interest in the outcome equation) is correlated with the unmeasured intelligence (our unmeasured variable) in the overall population, these two variables will be correlated in the selected sample. If intelligence does lead to on-farm innovation, then we will underestimate the effect of education on innovation because in the selected sample farmers with little education are unusually smart. Estimating the above equations using Ordinary Least Square (OLS) method will result in biased estimates because the error term in the outcome equation is correlated with the error term in the selection equation. This means that the error term in the outcome equation will not have a mean zero and will be correlated with the explanatory variables. This, in turn, leads to inconsistent estimates. Taking expected value of the output given derived utility from investing in on-farm, adopting Heckman (1979), we get:

$$E\{Y_i \mid U_i > 0\} = X_i\beta + \theta\left[\frac{\phi(w_i\gamma)}{\Phi(w_i)}\right] \qquad (3)$$

Where $U_i > 0$ means that the observation was selected into the sample. In other words, this is the expected value of a farmer's output given that the farmer actually made on-farm investment. If we use OLS on the outcome equation in (1), we would be omitting $\theta[\phi(w_i\gamma)/\Phi(w_i)$. According to Heckman (1979), $\theta[\phi(w_i\gamma)/\Phi(w_i)$ is the inverse Mill's ratio. To get consistent results, Heckman (1979) comes out with more assumptions on the error terms of both basic outcome and selection equations. To see this, let us start with the basic selection equation:

$$Z_i^* = w_i\gamma u_i$$

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$$Z_i = \begin{cases} 1 \text{ if } Z_i^* > 0 \\ 0 \text{ if } Z_i^* \leq 0 \end{cases} \qquad (4)$$

and a basic outcome equation:

$$Y_i = \begin{cases} X_i\beta + \varepsilon_i & \text{if } Z_i^* > 0 \\ - & \text{if } Z_i^* \leq 0 \end{cases}$$

with

$$u_i \sim N(0,1)$$
$$\varepsilon_i \sim N(0,\sigma^2) \qquad (5)$$
$$corr(u_i, \varepsilon_i) = \rho$$

In equation 5, we typically assume a bivariate normal distribution with zero means and correlation ρ. Thus, we can compute conditional means in the Heckman's model as follows:

$$E[Y_i \mid Y_i \text{ is observed}] = E[Y_i \mid Z_i^* > 0]$$

$$= E[X_i\beta + \varepsilon_i \mid w_i\gamma + u_i > 0]$$

$$= X_i\beta + E[\varepsilon_i \mid w_i\gamma + u_i > 0]$$

$$= X_i\beta + E[\varepsilon_i \mid u_i > w_i\gamma] \qquad (6)$$

However, any correlation between the two errors means that the truncated mean is no longer $X_i\beta$ and we need to take account of selection. Thus, we need to obtain $E[\varepsilon_i \mid u_i > w_i\gamma]$ when ε_i and u_i are correlated. As Greene (2003) notes,

$$E[\varepsilon_i \mid u_i > -w_i\gamma] = \rho\sigma_\varepsilon\lambda_i(\alpha_u) \qquad (7)$$

where

$$\alpha_u = \frac{-w_i\gamma}{\sigma_u}, \lambda(\alpha_u) = \frac{\phi\frac{-w_i\gamma}{\alpha_u}}{1 - \Phi\left(\frac{-w_i\gamma}{\sigma_u}\right)} = \frac{\phi\frac{w_i\gamma}{\alpha_u}}{\Phi\left(\frac{w_i\gamma}{\sigma_u}\right)}$$

Thus, substituting equation 7 into equation 6, the conditional mean in the Heckman model (bivariate selection model) is:

$$E[Y_i \mid Y_i \text{ is observed}] = X_i\beta + \rho\sigma_\varepsilon\left[\frac{\phi\left(\frac{w_i\gamma}{\sigma_u}\right)}{\Phi\left(\frac{w_i\gamma}{\sigma_u}\right)}\right]$$

$$= X_i\beta + \rho\sigma_\varepsilon\lambda_I(\alpha_u)$$

$$= X_i\beta + \beta_\lambda\lambda_i(\alpha_u) \qquad (8)$$

Thus, we now have,

$$Y_i \mid Z_i^* > 0 = E\lfloor Y_i \mid Z_i^* > 0\rfloor + v_i$$
$$= X_i\beta + \beta_\lambda \lambda_i(\alpha_u) + v_i \qquad (9)$$

Note that using OLS on just the outcome equation would lead to biased and inconsistent estimates because $\beta_\lambda(\alpha_u)$ is omitted. Note also that even if $\lambda_i(\alpha_u)$ were included in the model, OLS would be inefficient since v_i is heteroskedastic. In estimating Heckman's model, the two-step procedure is the most common method, given the assumptions in equation 5. First, we estimate the profit equation (selection equation) by MLE to obtain estimates of γ. For each observation in the selected sample, we compute $\hat{\lambda}_i = \phi(w_i\hat{\gamma})/\Phi(w_i\hat{\gamma})$ (the inverse Mills ratio) and $\hat{\delta}_i = \hat{\lambda}_i(\hat{\lambda}_i - w_i\hat{\gamma})$. The $\hat{\delta}_i$ bit is useful for obtaining correct standard errors in the second stage. Secondly, we estimate β and $\beta_\lambda = \rho\sigma_\varepsilon$ by OLS of Y on X and $\hat{\lambda}_i$. The estimators from this two-step procedure are consistent and asymptotically normal. This procedure is often called a 'Heckit model'.

2.3.2 Variables Used in the Analysis

Our basic outcome equation is a production function whose dependent variable is natural logarithm of the total harvest of maize in kilogram harvested by the i^{th} famer in the long rain farming season of the agricultural year 2008/9. As pointed in the introductory chapter of this book, maize is a dominant food crop, comprised of more than 60% of total cereals and more than 30% of all food crops. Thurlow & Wobst, 2003, have also indicated the historical importance of maize as the main economic driver in rural Tanzania. The explanatory variables are a set of factors of production which are land, labour, capital, raw materials and other inputs. The variable for land is represented by actual planted area, whereas the variable for labour is total number of household members who are involved in farming (between the age of 15 and 66). Capital is represented by the use of machine (tractors, power tillers or draft animals, which are animals used to pull heavy loads, in our case plough disks) as well as the application of irrigation. Each of these variables takes the value of 1 if the household use them and 0 if otherwise. Raw materials are basically input in farming. They include the use of modern seeds, application of chemical or organic fertilizer, application of pesticides, application of herbicides and application of fungicides. Just like the variables for capital discussed earlier, each of these variables takes the value of 1 if a farmer used it and 0 if otherwise. All of these explanatory variables in the production function are hypothesized to have yield-increasing effects.

For the basic selection equation, our dependent variables are three farm innovations: erosion control or water harvest facility; planted trees in the field; and use of extension services at various stages of farming.[9] While erosion control and/or water harvest facility and planted trees in the field are purely farm innovations, extension service is not purely an innovation. However, it is included here to represent 'openness to innovation'. That is done with a belief that a household with access to extension services is likely to have a relatively higher exposure to innovations, even beyond those analyzed in this study. These variables take the value of 1 if the i^{th} farmer adopted them in the field in the agriculture year 2008/9, and the value of 0 otherwise.

Explanatory variables are those that are expected to have a bearing effect on the decision to make on-farm innovations. The first in this category are human capital variables, which include formal and informal educations. The formal education variables are number of years of schooling, as well as various education thresholds attained by the i^{th} farmer. The education thresholds have five categories: no formal schooling; up to 4 years of formal schooling; above 4 years up to six years of formal schooling; above 6 years up to 8 years of formal schooling; and above 8 years of formal schooling. While years of schooling represent actual number of years of schooling completed by a farmer, the five categories are dummies taking the value of 1 if the i^{th} farmer belongs to a given category and the value of 0 otherwise. The years of schooling aims to capture the impact of an additional year of schooling on decision to make on-farm innovation. The categorical variables aim to capture the education level threshold that has highest impact on decision to make on-farm innovation. The second set of the human capital variable, which is informal education, is a community tree planting programme. This variable takes a value of 1 if a farmer lives in a place with a community tree planting programme and 0 if otherwise. It is expected that this environmental conservation programme has positive relationship with the decision to make on-farm innovations.

Other explanatory variables in the selection equation include access to credit for farming, having off-farm income generating activities, livestock wealth and household wealth index. Farmers who accessed credit and have off-farm economic activities take the value of 1 in each of the two variables and 0 otherwise. Likewise, farmers with livestock wealth take the value of 1 for each category of a livestock type owned and 0 otherwise. The household

[9]Extension services are agricultural consultations offered by trained agricultural officers called extension officers. Extension officers operate as facilitators and communicators, helping farmer on best farming practices so as to improve productivity (Encyclopedia.com., October 22, 2018)

wealth index was created using household assets in which different assets owned by households were attached to some weights, which were then added.[10] Other things being equal, these four variables were expected to free households from cash constraints in order to make on-farm innovations, especially when such innovations require cash up-front. Another explanatory variable in the selection equation is the farmer's perception whether he/she has sufficient land. This variable takes the value of 1 if a farmer perceived that he/she has sufficient land and 0 if otherwise. Having bigger land among smallholders may be a disincentive to make on-farm innovation, especially if such farmers perceive that they can get enough harvest from their big farms even without any on-farm innovations. Thus, this variable is hypothesized to have a negative relationship with the decision to make on-farm innovations.

Included as explanatory variables in our selection equation are also presence of permanent crop/fruit tree in the field, distance of a farmer's residence from a nearby township (remoteness) and farmer's age. The permanent crop in the field variable takes the value of 1 if a farmer has such crops in the field and 0 otherwise. It is hoped that if the field has permanent crops a farmer is spending more time on those fields, hence more value is attached to the farm. Thus, this variable is expected to have a positive relationship with the decision to make on-farm innovations. On the other hand, distance of a farmer's residence from a nearby township measure distance in kilometer of a household residence from a nearby town where farmers get their daily needs. It is expected that the more remote farmers are from townships, the less exposure to and interactions with the local community, which reduces access to 'informal learning' and makes them less likely to make on-farm innovations. The final variable in our selection equation is age, which measures the age of a farmer. This variable is expected to have a negative relationship with on-farm innovations because older farmers have less energy and incentive to make innovations compared to young farmers. (Table 1 gives details of variables and their definitions).

2.3.3 Data

The Agriculture Sample Survey was conducted by the National Bureau of Statistics (NBS) in collaboration with the sector ministries of agriculture.[11] The

[10]Assets that were used to create wealth index are dwelling type include, roofing material, type of wall, source of drinking water, type of toilet; ownership of other assets including mobile phones, radio, television, wheelbarrow, vehicle, disc plough; main source of energy for lighting and cooking

[11] Ministry of Agriculture and Food Security, Ministry of Water and Livestock Development, Ministry of Cooperative and Marketing and the President Office-Regional Administration and Local Government

survey was conducted at the end of the 2008/09 agriculture year.[12] It collected data by administering a questionnaire to a sample of 48,315 small-scale farming households and 1,206 large-scale farming households. The survey covered agriculture in detail as well as many other aspects of rural development. It was conducted using three different questionnaires: small-scale farm questionnaire; community-level questionnaire; and large-scale farm questionnaire. The small-scale farm questionnaire was the main census instrument and included questions related to crop and livestock production and practices; population demographics; access to services, resources and infrastructures; and issues on poverty, gender and subsistence versus profit-making production units. Given the scope of the small-scale farm questionnaire, data were collected at household/holding level, allowing for sex disaggregation of most variables at the head of household level.

The sample consisted of 3,221 villages. These villages were drawn from the National Master Sample (NMS) developed by the NBS to serve as a national framework for the conduct of household-based surveys in the country. The NMS was developed from the 2002 population and housing census. Nationwide, all regions and districts were sampled with the exception of two urban districts. A stratified two-stage sample was used. The number of villages/EAs (Enumeration Areas) selected for the first stage was based on a probability proportional to the number of villages in each district. In the second stage, 15 households were selected from a list of farming households in each selected village/EA, using systematic random sampling, with the village chairpersons assisting to locate the selected households.

2.4. Results and Discussion

2.4.1 Summary Statistics

Table 2.1 below presents the data used in the production and selection functions to estimate the relationship between output and inputs, and the decision to make on-farm innovations and farmer's education attainment. As clearly shown in the Table, Tanzanian agriculture system is still a small-hold with limited use of modern technology. The land holding averages only 2 acres per household. The higher value of standard deviation than the mean implies that many farmers have land holding below this level. Furthermore, we see that nearly 30% of famers practice modern farming; while almost 70% of farmers do not use sophisticated machines like tractors, power tillers or even draft animals in farming and about the same parentage do not have access to the extension

[12] This is so far the most current Agriculture Sample Census Survey to date as no other survey has been conducted yet. Plans are in place to conduct a new survey in the near future.

services. Modern inputs like fertilizers, improved seeds, pesticides and herbicides are used by nearly 10% of farmers.

Table 2.1 Definitions and summary statistics of variables used in Heckman selection model

Variable	Definition	Mean	Std Dev
Harvest	Household total maize harvest in kilograms	644.14	949.23
Planted area	The actual land size (in acre) planted maize by a household in the 2007/8 agricultural season	2.17	2.63
Labour force size	Total number of household members between 15 and 66 in the farming household	2.57	1.47
Raised cattle	Household raising of cattle (=1 if the household raised cattle)	0.26	0.44
Raised goat	Household raising of goats (=1 if the household raised goats)	0.28	0.45
Raised sheep	Household raising of sheep (=1 if the household raised sheep)	0.11	0.32
Raised pig	Household raising of pigs (=1 if the household raised pigs)	0.08	0.27
Used improved seeds	Use of improved seeds (=1 if the household used)	0.16	0.37
Applied organic or chemical fertilizer	Application of either chemical or organic fertilizer (=1 if the household applied)	0.33	0.47
Applied pesticides	Application of pesticides (=1 if the household applied)	0.11	0.31
Applied herbicides	Application of herbicides (=1 if the household applied)	0.01	0.11

Variable	Definition	Mean	Std Dev
Applied fungicides	Application of fungicides (=1 if the household applied)	0.01	0.12
Applied irrigation	Application of irrigation (=1 if the household applied)	0.03	0.17
Use of machine	The use of draft animal, power tiller or tractor in farming (=1 if a household used either or all)	0.27	0.44
Literacy	If a famer can read and/or write at least one language	0.70	0.46
Years of schooling	Farmer's number of years of formal schooling	4.44	3.65
No formal education	The farmer has no formal education (=1 if the farmer has no formal education)	0.31	0.46
Four years of schooling	The farmer has up to up to four years of formal education (=1 if the farmer has up to four years of schooling)	0.15	0.36
Six years of schooling	The farmer has above four up to six years of formal schooling (=1 if the farmer has above four up to six years of schooling)	0.03	0.18
Eight years of schooling	The farmer has above six up to eight years of formal schooling (=1 if the farmer has above six up to eight years of formal schooling)	0.45	0.50
Above eight years of schooling	The farmer has above eight years of formal schooling (=1 if the farmer has above eight years of formal schooling)	0.04	0.21

Variable	Definition	Mean	Std Dev
Community tree scheme	Village having tree planting programme (=1 if the village has such a programme)	0.15	0.35
Credit	Access to credit for farming (=1 if the household accessed and used)	0.04	0.19
Sufficient land	Household perception that it has sufficient land size for cultivation (=1 if the household perceived to have enough land)	0.57	0.49
Permanent crops	Ownership of permanent/perennial crop or fruit tree (=1 if the household has)	0.41	0.49
Off-farm employment	Household with members in off-farm income activities (=1 if the household has at least one member in the off-farm activities)	0.73	0.44
Remoteness	Distance of the household residence to the nearest township	1.40	1.84
Household wealth index	Household wealth index created using household assets ownership	18.18	2.58
Age	Age of the farmer in years	45.01	15.46
Erosion control/water harvest facility	On-farm investment of erosion control/water harvest facility (=1 if the household has invested)	0.10	0.30
Planted trees	Household planting trees on its land (=1 if the household planted trees)	0.13	0.34

Variable	**Definition**	**Mean**	**Std Dev**
Use of extension service	Access to extension service at various stages of farming (=1 if the household accessed)	0.36	0.48
Northern Zone	Farmers in Northern Zone (=1 if the farmer is from Northern Zone)	0.21	0.41
Southern Zone	Farmers in Southern Zone (=1 if the farmer is from Southern Zone)	0.10	0.30
Eastern Zone	Farmers in Eastern Zone (=1 if the farmer is from Eastern Zone)	0.07	0.26
Western Zone	Farmers in Western Zone (=1 if the farmer is from Western Zone)	0.08	0.27
Central Zone	Farmers in Central Zone (=1 if the farmer is from Central Zone)	0.10	0.29
Lake Zone	Farmers in Lake Zone (=1 if the farmer is from Lake Zone)	0.14	0.35
Southern Highlands Zone	Farmers in Southern Highlands Zone (=1 if the farmer is from Southern Highlands Zone)	0.29	0.45

Note: Means are based on the 31,665 households producing maize out of 48,315 farming households surveyed by the National Bureau of Statistics.

Another important feature of rural Tanzanian agriculture is that very few farmers are practicing both crop production and livestock keeping. Less than 30% of crop producers are keeping cattle and goats whereas about 10% keep sheep and pigs. The percentage of farmers applying irrigation is also very low (3%), although this may partly be because the data were collected during a long rainy season.

What is also very obvious in Table 2. 1 is a relatively high level of illiteracy among farmers. On average, 30% of the farmers cannot read and/or write any language. The Table further shows similarity between the figure for illiterate and that of farmers with no formal schooling. This means that there are very little chances for farmers who have not attended formal schooling to access informal education that can enable them to read and/write at least one language. In terms of formal schooling, an average farmer has only 4 years of formal schooling. The majority of farmers (60%) who accessed formal schooling ended at the primary level. Those who have attained a level above primary school covers 4%, implying that agriculture in Tanzania is an activity that assimilates those who cannot climb the upper ladder in education. Within the same context, even when people have not gone higher in education levels, they do not join agriculture until they are old. In terms of age, the table shows that the average age of household heads in the sector is 45 years. This means that the sector is dominated by old households, making the sector facing difficulties to adopt new technologies but also denying the sector from young and energetic labour force.

Regarding actual field environment, the table shows that 41% of farmers have permanent crops or fruit trees in their farms and 15% are living in villages that have environmental conservation schemes like tree planting programmes. Another important issue in the context of on-field practices is that very few farmers (4%) are able to access credit for farming. It has been argued that credit institutions are not interested in small-scale farmers because they depend on nature in farming, thus it is very difficult to predict their incomes. Interestingly, we see majority of farming households in rural Tanzania (73%) engaging in off-farm income generating activities as an additional source of income, possible because of difficulties to access credit from formal financial institutions.. This means that diversification of income sources in rural areas is high. As more and more off-farm employments become integrated into the rural economy, it may be important to study its dynamics and actual contribution to rural economy to contribute to the debates on rural growth. This is because discussions on rural economy in developing countries have tended to centre on on-farm development while forgetting or giving little attention to off-farm activities.

In terms of on-farm innovation, very few farmers are making investments, a fact that may have a bearing on farm productivity. While there are many on-farm innovations that can potentially increase farm productivity, this study has focused on three innovations: building erosion control and/or water harvest facility, planting trees in the field, and the use of extension services at various stages of farming. And as can be seen in Table 2.1, only 10% of the farmers have built erosion control and/or have water harvest facility. Planting trees in the field is another innovation that also has few farmers. It covers 13% of the farmers. Though still at the lower level, but relatively better than the previous two innovations, is the exposure to innovations through the use of extension services, which has 36% of farmers. The choice of these three innovation variables, despite the fact that fewer farmers have adopted them, is because of the impact they have on farm output.

Table 2.2 distinguishes average outputs between farmers who adopted innovations and those who did not. As can be seen from the table, the average yield of maize for farmers who adopted erosion control and/or had water harvest facility was 886kg compared to 618kg for those who did not have such a facility on their farms. Similarly, the average yield was 880kg for those who had planted trees on their field compared with 608kg for those without trees on the field. Finally, the average yield was 747kg for farmers who had accessed extension services at various stages of cultivation compared to 586kg for those who did not use extension advices.

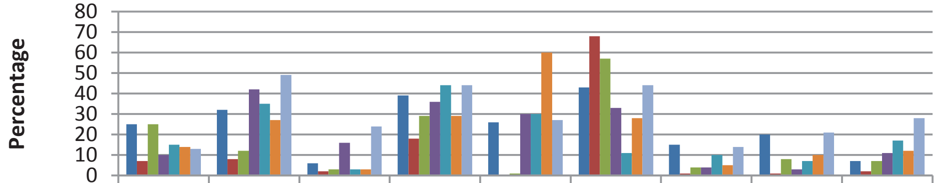
Table 2.2 Average Harvest for Each Innovation (Kg Of Maize Yield)

	Yes
Have erosion control/water harvest	886.4
Have planted trees on the field	880.3
Use of extension services	747.0

Source: Author's computation using NBS, 2008/09

Another important feature in the summary statistics is the sample distribution by zones, which ranges from 7% in the Eastern zone to 29% in the Southern Highlands zone. Generally, what we see is that those zones that are typically known for farming have relatively higher sample. The Southern Highlands zone comprises what is known as the 'Big Five', which is 5 regions that are agriculture intensive. On the other hand, the Eastern zone with a smallest sample includes Dar es Salaam, which is typically a commercial region.

While the use of inputs and innovations is recognized in increased farm productivity, disaggregating such use by zones gives interesting results worth informing policy makers. Fig 1 summarizes the use of selected inputs and on-farm innovations by 7 zones. What is very clear is that there exist disparities in the use of modern agriculture inputs as well as on-farm innovations between one zone and another.



	Improved seeds	Chemical fertilizer	Pesticides	Extension	Draft	Permanent tree	Errosion contro	Planted tree	Community tree
North	25	32	6	39	26	43	15	20	7
South	7	8	2	18	0	68	1	1	2
East	25	12	3	29	1	57	4	8	7
West	10	42	16	36	30	33	4	3	11
Central	15	35	3	44	30	11	10	7	17
Lake	14	27	3	29	60	28	5	10	12
S. High	13	49	24	44	27	44	14	21	28

Inputs and innovationsd

Figure 2.1 On-Farm Inputs and Innovation by Zones

Source: Author's computation using NBS, 2008/09

The Southern Highlands zone is leading in adopting inputs and innovations in almost every selected item. It leads over other zones in adoption of inputs like chemical fertilizers, pesticides. It is also leading in having tree community planting programmes. It is also on the lead in the adoption of on-farm innovation for the three selected farm innovations: .having erosion control/water harvest facility, use of extension services, and having trees planted in the field. Consequently, land productivity is highest in the Southern Highlands zone, which is about 475kg of maize per acre (see Table 2.3). On the other hand, Southern zone is lagging behind all other zones in the use of inputs as well as in making on-farm innovations. Consistently, its land productivity is 145kg of maize per acre, which is the lowest figure when compared to other zones.

Table 2.3 Land productivity by zones

	Average Planted area (acre)	Harvest (maize in kg)	Land productivity
Northern	2.4	711	296
Southern	1.3	188	145
Eastern	1.8	333	185
Western	2.4	611	255
Central	3.1	525	169
Lake	2.3	504	219
ıern Highlands	2.0	950	475

Source: Author's computation using NBS, 2008/09

Again, the importance of our selected three innovations in increasing land productivity is clearly seen here. The study has shown that, of the three selected innovations, extension services are adopted by relatively many farmers than the other two. This is also the case when we disaggregate the use of these innovations by zones. Although these innovations are not very commonly implemented by many farmers, their impact in land productivity is substantive. In all of the three innovations, the Southern Highlands zone appears to be at the top while the Northern zone appears at the second position. Looking at the land productivity figures in Table 2.3, one can observe the same trend. In land productivity, too, the Southern Highlands is leading followed by the Northern zone. The seeming strong correlation between these three innovations and land productivity is important to policy makers. Knowledge about their actual contribution to outputs, their relative importance, as well as which factors determine their adoption is limited, though. This chapter is an attempt to bridge that knowledge gap by providing empirical evidence of the role played by education in the adoption of such innovations.

2.4.2 Regression Results

2.4.2.1 General Results

Tables 2.4 through 2.6 present results from the Heckman model which show the relationship between output of maize and factors affecting production through production function, on the one hand and relationship between adoption of three farming innovations and factors affecting innovation including farmer's education, on the other.

As can be seen Table 2. 4, farmers' outputs are affected both directly by traditional inputs and indirectly through adoption of farm innovations. Specifically, we see from the production function that farmers' outputs are affected by traditional inputs variables (land, labour, capital, and raw materials). We also see from the selection equation that farmers' outputs are indirectly affected by other variables that influence the decision to make on-farm innovations. Results from the production function show that the coefficients of most of the conventional production factors that are significant in explaining output have expected signs. Thus, elasticity of planted area (*Ln* of planted area), use of either chemical or organic fertilizer (Applied chemical/organic fertilizer), use of pesticides (Applied pesticides), application of irrigation and use of modern machine-like tractor, power tiller or draft animal (Used machine) have positive and significant influence on production of maize.

Table 2.4 Regression results from the Heckman selection model

Explanatory variable	**Dependant variables**		
	Ln of Total maize production in Kilograms		
Production function			
Ln of planted area	0.769***	0.787***	0.669***
Ln of labour force size	-0.014	-0.095**	-0.032
Used improved seeds	-0.018	-0.129	0.005
Applied chemical/organic fertilizer	0.032**	0.148***	0.161***
Applied pesticides	0.117*	0.159***	0.201***
Applied herbicides	0.005	-0.179	0.153
Applied fungicides	0.194	-0.019	-0.007
Applied irrigation	0.016	0.176**	0.057*
Used machine (draft, power tiller or tractor)	0.104*	0.187***	0.089***
Constant	9.497***	8.454***	7.636***

Explanatory variable	**Dependant variables**		
	Erosion control/water harvest facility	***Planted trees in the field***	***Use of Extension services***
Selection equation			
Ln if years of schooling	0.033***	0.057***	0.036***
Have community tree planting programme	0.164***	0.268***	0.095***
Male	0.048*	0.001	0.023
Accessed credit for farming	0.036	0.048	0.127***
Perceives to have sufficient land	-0.022	-0.046***	-0.004
Has permanent crop/fruit tree in the field	0.152***	0.337***	0.030***
The household has off-farm employment	-0.004	-0.044**	0.001
Raised cattle	0.107***	0.079***	0.037***
Raised goat	-0.012	0.037*	0.003
Raised Sheep	0.059**	-0.005	0.003
Raised pig	0.091***	0.164***	0.030*
Ln of remoteness	-0.005*	-0.014***	-0.012*
Ln of household wealth index	0.580***	0.939***	0.692***
Ln of age of household head	-0.004	0.065**	0.049***
Northern Zone	0.042**	0.041**	0.032
Southern Zone	-0.004	-0.051	-0.066
Eastern Zone	0.007	0.038	0.019
Western Zone	0.005	-0.005	0.058
Central Zone	0.011*	0.011	0.036*

Explanatory variable	Dependant variables		
Lake Zone	0.009	0.040	0.039*
Southern Highlands Zone	0.036**	0.049***	0.056***
Constant	-2.974***	-4.139***	- 2.555***
/athrho	-2.163***	-1.791***	- 2.489***
Lnsigma	0.894***	0.740***	0.957***
ρ	-0.974	-0.949	-0.986
σ	2.445	2.096	2.604
λ	-2.381	-1.983	-2.568

Note: *** p<0.01, ** p<0.05, * p<0.1

Source: Author's computation using NBS, 2008/09

This implies that increasing the quantity of any of these inputs will increase the quantity of maize production. Actual planted area has the largest coefficient (elasticity ranging from 0.67 in the function in which use of extension service is a dependant variable in the selection equation to 0.79 in the equation in which dependant variable in the selection equation is planted tree in the field); meaning that maize production will increase appreciably if more land is cultivated. These results are not surprising; farm outputs have been associated with increased use of capital and inputs in previous studies as well (see Ajani & Ugwu, 2008; Alene & Manyong, 2007; Appleton & Balihuta, 1996; Asadulla & Rahma, 2005; Gille, 2011; Wear, 1999). However, this study has shown negative relationships between farm outputs and labour force. This means that production of maize decreases with increased labour force in farming. This is contrary to many similar studies (see, for example, Allene & Manyong, 2007; Gille, 2011). Our results are perhaps due to small land holding among smallholders, which is consistent with the law of diminishing marginal returns when more of the variable factor (in our case labour) is added to a fixed factor (in our case land).

Our selected equations give different results in terms of magnitudes, signs and significance of coefficients depending on the innovation under investigation. Education (defined as the number of years of formal schooling) is positively and significantly (p<0.001) related to all three innovations (namely, having erosion control/water harvest facility, planted tree on the field, and the use of extension services.) Consequently, our findings support the hypothesis that formal education increases adoption of farm innovations, thus increasing farm productivity. That is consistent with the findings Allene and Manyongo (2007) which revealed that the adoption of cowpea technology in Nigeria was positively related to education. Similarly, Klasen and Raimers (2013) support the hypothesis for a positive relationship between education and adoption of innovations in farming. Few studies (Battese & Coelli, 1995; Llewelyn & Williams, 1996) show non-significant or even negative relationship (Hasnah et al., 2004) between education and farm productivity.

While formal education seems to be significant in affecting the adoption of farm innovation, informal education seems to be even more significant for adopting innovations in rural Tanzania. The coefficient of a variable on having community tree planning programme (a very good proxy for informal education) is very significant ($p<0.001$) and has higher magnitudes in all the three innovations under investigation. This means that farmers living in communities where they have environmental conservation programmes have higher probability of adopting innovations than their counterparts living in areas with no such programmes. As would be expected, the coefficient of this variable is highest in the adoption of planting trees in the field than in building erosion/water harvesting facility, as well as in the use of extension services. A number of studies have shown positive relationship on adoption of best farming practices among farmers with conservation programmes (Allene & Manyong, 2007; Odendo et al., 2011). Asafu-Adjaye (2008) also shows higher probability of adopting soil conservation among farmers who had previous contact to extension services than their counterparts with no contact to extension services. Of interest in our findings is that informal education has higher magnitude in all three innovations than formal education, implying that the impact of informal education in the adoption of innovation is higher than that of formal education. This may imply that formal education gives general knowledge of literacy and numeracy, which is necessary to make a farmer able to appreciate the importance of innovations and to be able to adopt such innovations quickly especially if they are sophisticated. On the other hand, informal education provides location-specific needs, hence it can easily be assimilated by farmers. This seems to work well when it is done in a participatory way and farmers can benefit from demonstration effects (Asafu-Adjaye, 2008). These findings are consistent with the innovation-diffusion theory (Rogers, 1995), which postulates that innovation, if communicated through certain channels over time among members of a social system, speeds up technology adoption.

Being a male head is positively related to the adoption of all the three innovations. However, this variable is only significant in the adoption of erosion control/water harvest facility, but not significant in the other two innovations. This means that other household characteristics are more important in the adoption of most of the farm innovations than gender.

The variable for access to credit is not significant in explaining erosion control/water harvest facility and also in explaining planted trees in the field. However, it is positively significant in explaining the use of extension services, implying that access to credit for farming increases the probability of using extension services in various stages of farming. Access to credit is expected to relax a farming household from cash constraints, hence would be expected to have a positive relationship with the adoption of most of these innovations since they mostly require capital upfront. However, the Poverty and Human Development Report of 2011 shows that credit to small-scale farmers has remained low because banks and other financial institutions are reluctant to extend credit to them because of the unpredictable nature of farming (URT, 2011). The report further states that even when some microfinance institutions are ready to extend credit to farmers, they attach the credit with very high interest rates because of perceived high default rates (URT, 2011). Given this trend, it is possible that even when farmers access credit for farming, they end up using it on other off-farm activities with predictable incomes that can assure them timely repayment. Consequently, one should not be surprised to see access to credit for farming having no impact on the adoption of erosion control or planted trees in the field, especially because these innovations may take longer time to repay back. However, the positive and significant relationship between credit and use of extension services may mean that those who devote such credits to farming may be compelled to make regular contacts with extension services to increase productivity in the short term to enable them to repay their loans.

Though significant on only planted trees in the field out of the three farm innovations investigated by this study, household perceptions to have sufficient land tend to reduce adoption. Usually, small-scale farmers are mostly concerned with producing sufficient food with the lowest possible costs and at the shortest possible time. While planting of trees would increase income and maintain soil structure, small-scale farmers would be concerned with measures that increase income now, thereby opting for increasing land size. Findings that small-scale farmers tend to increase farm outputs through increased land sizes than through innovations are not typical to Tanzania alone. Similar findings are reported in other related studies. Asadulla and Rahma (2005), Allene and Manyong (2007) and Gille (2011) found that while traditional farming relies heavily on land and labour for increasing farm outputs, modern farming tends to depend on modern farm technologies.

Though with differences in magnitudes, the study also revealed that having permanent crop/fruit trees in the field increases the adoption of all three farming innovations. The magnitude of the coefficient is highest in farming innovation of planted tree in the field. This should not be surprising because farmers with permanent crops/fruit trees in the field are more likely to appreciate the importance of trees in the field. However, the fact that having permanent crop/fruit trees in the field increases the adoption of all three farming innovations may be due to the value attached to the land. If the land has permanent crops, farmers are likely to attend those fields throughout the year, hence, more values are attached to them, and this may explain this positive relationship.

As is the case with access to credit, having off-farm employment is expected to complement household farm incomes, hence enable them to adopt innovations (Ervin & Ervin, 1982; Odendo, et al., 2011; Shiferaw & Holden, 1998). This study, however, shows that having off-farm employment reduces the probability of adopting farm innovations. Specifically, having off-farm employment is negatively significant with planted trees in the field ($p < 0.05$), and negative but not significantly related to having erosion control/water harvest facility. Although off-farm employment is positively related to the use of extension services, the relationship is not significant. The negative relationship between off-farm employment and the adoption of innovation may imply that having off-farm employment leaves little time available to attend fully in the adoption of farm innovations. Typically, this is the case with farm innovations that are time intensive like erosion control/water harvest facility, but even more so with planting of trees, which require continuous maintenance until trees are old enough. Hua et al, (2004) found a negative and significant relationship between off-farm employment and participation in a formal conservation program but explained their results with high opportunity costs for the time that is required to participate in a conservation program. This may imply that off-farm employment would increase the adoption of farming innovations if such innovations require less time. This seems to be the same with our case because off-farm employment, though not significantly, is positively related to the use of extension services, an innovation that needs less time. Consistently, Cornejo et al. (2005) found positive and significant relationship between off-farm employment and the adoption of herbicide-tolerant soybeans and explained their results with the time-saving nature of this technology.

As would be expected, livestock wealth is positively and significantly related to the adoption of all the innovations. Unlike credit, livestock wealth is unconditional capital, hence farmers can even use it to try innovation, even when they are not certain about the actual returns of the innovation. To put it differently, with their own livestock wealth, farmers can even opt to be risk takers compared to credit which will need repayment with interests regardless of the outcome of farm production.

Similar to livestock ownership, household wealth is positively and significantly related to the adoption of all the three innovations ($p < 0.01$). The magnitude of elasticity of this coefficient is also very large in all the three innovations, but the highest is in planted trees in the field. This is because of the capital-intensive nature of this innovation from planting, pruning and maintaining until the trees are old enough to harvest. The use of extension services may not necessarily require that a household be very wealthy, especially if extension officers are provided by local government authorities. However, still this variable is positively correlated with household wealth because of the possible high on-farm investment that wealthier households may have made, which in turn necessitates the need of extension services. The positive relationship between household wealth and adoption of innovation is consistent with the results of the study by Abdulai and Huffman (2005) who found that households headed by elderly persons adopted dairy cattle faster than those headed by younger ones. This was because the adoption of dairy cattle required a significant capital investment, and because elderly household heads were more likely to have accumulated capital and also likely to be preferred by credit institutions, both of which made them more prepared to adopt technology faster than younger ones.

On the other hand, distance from a household residence to the nearest township (remoteness) is negatively and significantly related to the adoption of all the three innovations, indicating that farmers who are far from major clustered settlements, and hence have less exposure and interactions, are less likely to adopt farm innovations. Remoteness is probably denying these farmers from learning the importance of farming innovations, but also, they find it very expensive to access important inputs necessary to adopt innovations. Also, because of being away from markets, it is possible that they also face difficulties in marketing their farm outputs, which is a disincentive to increase outputs (See also Fischer and Qaim, 2012). Kristjanson et al. (2002) and Allene and Manyong (2007) also found negative relationship between access to markets and the adoption of intensifying cowpea production in Nigeria. Similarly, Odendo et al. (2011) found a negative relationship between distance to market and adoption decisions of mineral fertilizer (see also Obare et al., 2003; and Dadi et al., 2004).

Age of a farmer is negatively related to erosion control/water harvest facility, but positively related to planted trees in the field as well as the use of extension services., Though non-significant, the negative relationship between age and erosion control/water harvest facility may be due to the labour-intensive nature of erosion control. Thus, the ability for the older farmers to participate in such strenuous manual activities decline. Matuschke and Qaim (2008) and Adendo et al. (2010) also found that old age was associated with the adoption of less labour-intensive farming innovations. On the other hand, the positive relationship between old age and planting trees in the field may have to do with historical perspective in which most of the important resources, including building materials and energy source, came from trees. Hence, it is the old farmers that can put importance on plant trees than young ones. Also, having trees on the field is seen as an asset since they can be sold as timber. Chang and Boisvert (2009) found a positive relationship between age and participation in conservation reserve programme (CRP), and argued that as farmers get older, committing some land to CRP may be one way of reducing operator labour requirements on the farm. This may also be a way of holding onto farmland assets until they are needed for retirement years, or so that they can be passed on through an estate (Ibid.). Similarly, the positive relationship between old age and the use of extension services may also be because old farmers are more likely to appreciate the importance of extension services because of their long-time experiences in farming, which also remains their sole activity unlike young farmers who can migrate to urban areas for casual employment. The importance of experience in the adoption of better farming practices is acknowledged by other studies. Edmeades et al. (2008), for instance, concluded that relative farming experience increased the likelihood of the adoption of different banana varieties in Uganda.

Zonal dummies yield results that are consistent with the descriptive statistics explained earlier. Being a farmer in Southern Highlands zone increases the probability of adopting all of the three innovations. Also, being in the Northern and Central zones increases the probability of adopting two of the three innovations. On the other hand, being a farmer from the Southern zone reduces the adoption of all the three innovations. The Northern and Southern Highlands zones have large parts that are mountainous, making land scarcity a serious problem. Thus, it is possible that the adoption of innovation is the main way of increasing farm outputs in those zones. On the other hand, those zones with abundant land may increase outputs by increasing land size. For the Southern zone, the low level of adoption of innovation may be accounted for by the type of crop that is dominant, i.e., cashew-nuts. This is a tree crop that may not necessarily need a lot of investments apart from clearing and spraying pesticides.

While all the three selected innovations have yield-increasing effects, their relative importance differs. Table 2. 5 below summarises the impact of individual innovation on the production of maize.

Table 2.5 Relative importance of selected innovations

Dependent variable: Ln of harvest	*Coefficient*	*t-ratio*	*p-value*
Erosion control/water harvest facility	0.439 (0.034)	12.95	0.000
Planted trees on the field	0.470 (0.030)	15.50	0.000
Extension services	0.272 (0.023)	11.68	0.000
Constant	5.197 (0.015)	351.47	0.000

Note: Figures in parenthesis are standard errors
Source: Author's computation using NBS, 2008/09

Table 5 shows that all three innovations are positively significant ($p < 0.01$) in explaining maize yield. The variable on planted trees on the field has the highest coefficient, implying that it has the biggest impact in increasing yield. It is followed by having erosion control/water harvest facility, and then contact to extension services. This analysis says that conservation programmes are relatively more important to increase farm yield.

2.4.2.2 Cut-off point of the education level

Table 3.6 summarises results on the impact of different education level thresholds on adoption of farm innovations. Of the three innovations under investigation, the lack of formal education is found to be reducing their adoption, meaning that best farming practices are highly negatively affected by the lack of formal education. Results from summary statistics in our study show that 30% of farmers have no formal education, thus a large proportion of farmers has a high probability of reducing the adoption of best farming practices. Consequently, the lack of formal schooling may significantly contribute to the current level of low productivity in the agriculture sector in Tanzania. This means that improving access to formal education among farming communities will greatly improve farmer efficiency in the future.

On the other hand, having 1 to 8 years of formal schooling has a positive impact on the adoption of innovations.[13] However, the degree of the impact, as well as the significance, differs from one level of formal school to another; and between one innovation and another. Having completed 4 years of schooling is positive and significant in adopting all the three innovations. The impact is

[13] Eight years of formal schooling is a number of years for primary education in Tanzania

highest in the adoption of erosion control/water harvest facility (8%) and lowest in planted trees in the field (1%). Similarly, having completed 6 years of formal schooling is positive and significant in the adoption of all the three innovations.

More interesting is that the coefficients at this level of formal schooling are higher than those of the threshold of 4 years of schooling. What these findings say is that, while up to 6 years of schooling increases the adoption of best farming practices, the intensity of adoption increases with the number of years of formal schooling.. These findings are consistent with that of Alene and Manyong (2007) who found out that 4 years of schooling or more are more likely to adopt improved cowpea varieties. Likewise, Phillips (1994) found that while 4 years of schooling was enough to increase farm efficiency in some states, the threshold of 4 to 6 years of schooling becomes more pronounced in increasing farm productivity in other states. In spite of that, our results contradict those of Appleton and Balihuta (1996), which showed that in many African countries formal schooling has not shown any significant effect on agricultural output.

What is vivid in our findings is that while eight years of schooling has a positive impact on the adoption of innovations, the impact is only significant in the use of extension services. Adoption studies have associated prior contact to extension services with increased adoption of inputs and innovations, including those that farmers were uncertain on their potential productivity impact.

Table 2.6 Regression model with sample selection on different education level thresholds

Explanatory variable	**Dependant variables**		
	Ln of Total maize production in Kg		
Production function			
Ln of planted area	0.767***	0.787***	0.670***
Ln of labour force size	-0.015	-0.098***	0.031
Used improved seeds	-0.016	-0.099***	0.006
Applied chemical/organic fertilizer	0.029*	0.149***	0.162***
Applied pesticides	0.118**	0.155***	0.198***
Applied herbicides	-0.011	-0.175	0.160
Applied fungicides	0.199	-0.009	0.006

Explanatory variable	Dependant variables		
Applied irrigation	0.019	0.176**	0.057*
Used machine (draft, power tiller or tractor)	0.099*	0.182***	0.087***
Constant	9.487***	8.444***	7.736***
	Erosion control/water harvest facility	***Planted trees in the field***	***Use of Extension services***
Selection equation			
No formal education	-0.120*	-0.126**	-0.061
Up to four years of schooling	0.082*	0.016*	0.038*
Above 4 up to 6 years of schooling	0.095**	0.028**	0.042***
Above 6 up to 8 years of schooling	0.031	0.026	0.026**
Above 8 years of schooling	-0.011	-0.013	0.014
Have community tree planting programme	0.163***	0.268***	0.094***
Male	0.044*	-0.009	0.018
Accessed credit for farming	0.036	0.048	0.128***
Perceives to have sufficient land	-0.023	-0.047***	-0.004
Has permanent crop/fruit tree in the field	0.151***	0.338***	0.029
The household has off-farm employment	-0.004	-0.041**	0.001
Raised cattle	0.109***	0.082***	0.040***
Raised goat	-0.010	0.038*	0.002
Raised sheep	0.059**	-0.004	0.001
Raised pig	0.087***	0.162***	0.031*

Explanatory variable	**Dependant variables**		
Ln of remoteness	-0.017**	-0.014***	-0.014*
Ln of household wealth index	0.555***	0.937***	0.690***
Ln of age of household head	0.007	0.076***	0.053***
Northern Zone	0.051**	0.039**	0.048
Southern Zone	0.009	-0.060	-0.059
Eastern Zone	0.010	0.032	0.022
Western Zone	0.015	-0.014	0.071
Central Zone	0.009*	0.019	0.028*
Lake Zone	0.005	0.029	0.043*
Southern Highlands Zone	0.041**	0.051***	0.064***
Constant	-2.830***	-4.076***	-2.512***
/athrho	-2.156***	-1.781***	-2.491***
lnsigma	0.892***	0.738***	0.957***
ρ	-0.974	-0.945	-0.986
σ	2.439	2.091	2.603
λ	-2.375	-1.976	-2.567

Note: *** p<0.01, ** p<0.05, * p<0.1
Source: Author's computation using NBS, 2008/09

For instance, Chilot et al. (1996) found that prior contact with extension services increased the adoption of improved wheat in Central Ethiopia. Similarly, Kaliba et al. (1998) and Feleke and Zegeye (2006) found that such contacts increased the adoption of improved maize seeds in Central Tanzania and Southern Ethiopia, respectively. This means that with higher formal education, farmers adopt innovations that can even make them risk-takers. However, after 8 years of schooling, though not significant, education becomes negatively related to the adoption of farm innovations, except again for the use of extension services.

A clear interpretation of these results is that up to 6 years of formal schooling increases farmers' possibility of the adoption of farm innovations. Such innovations must, however, be those innovations traditionally known to contribute to farmers' incomes. Still, at higher levels of up to 8 years of schooling, farmers can engage in those innovations that may be risky but with higher expected returns. Beyond 8 years of schooling, which include secondary and tertiary education, farmers' adoption to innovation declines again. Perhaps such higher education levels drive households away from farm production, allowing them to engage in off-farm and non-agricultural activities, which presumably provide higher income compared to farm outputs. These findings are also shared by Asadullah and Rahman (2005).

2.5. Conclusions for Policy Implications

This chapter dwelt on an empirical investigation on the impact of formal education on agriculture productivity. The findings bring to light the importance of primary formal education as an essential production input in agriculture, and in rural economic development of the nation as a whole. Specifically, our analysis supports the relative importance of basic education in farm productivity. Household head's education, when decomposed by levels of education, shows that having bove zero and up to 6 years of formal schooling has a significant impact on the adoption of farm innovations. The top-end of this level of education can turn farmers into risk-takers and make them adopt risk innovations that have higher returns. This suggests that basic literacy skill, usually attained during primary schooling, is very relevant in farm productivity through its impact on the adoption of innovations.

Thus, the chapter shows that achieving self-sufficiency in food production and the much-desired growth in the agriculture sector of the economy will continue to elude Tanzania if problems of accessing formal education among farming communities are not properly addressed. Of more importance to formal education, the government has recently introduced initiatives like *Kilimo Kwanza,* Big Results now (BRN), Southern Agriculture Growth Corridor of Tanzania (SAGCOT) and those outline in the Agriculture Sector Development Programme II (ASDP II), which focus attention on a modernized agriculture (URT, 2016). Under these initiatives, the 'drivers' are then prioritized according to their impact on raising productivity and the creation of decent employment (with variations per region/district depending on existing relative advantages). From this study, it is evident that formal education is one of the key drivers of growth and has an impact on the adoption on farm innovations that have a bearing on productivity. For short-run farm productivity, the government should place emphasis on adult education for old farmers. This will equip such farmers with some levels of formal education that has shown beyond doubt to have productivity impact in the agriculture sector. For a long-run farm productivity, the current policy of compulsory enrolment for children aged 7 years should be strengthened. In this case, education capital expenditure is a justified basis of promoting development through large increase in farmer productivity.

Finally, while formal education seems to be an important input to farm productivity, informal education seems to have even a bigger impact. It may be that because of the high level of illiteracy in the country, primary education just gives a general knowledge, which makes a farmer understand more quickly and acknowledge the importance of best farming practices. Informal education, on the other hand, provides specific training depending on the type of climate and inputs necessary to a particular locality. Studies have shown that access to informal education is critical in promoting the adoption of modern agricultural production technologies because it can counter-balance the negative effect of the lack of years of formal education in the overall decision to adopt some technologies (Akudugu et al., 2012; Yaron et al., 1992). Access to informal education, therefore, creates the platform for the acquisition of relevant information that promotes technology adoption. Access to information through informal education reduces the uncertainty about a technology's performance, and hence may change individuals' assessment from purely subjective to objective over time, thereby facilitating adoption. This seems to be typically the case with rural Tanzania, especially because of the high level of illiteracy in rural areas.

CHAPTER III

DRIVING FORCES OF OFF-FARM INCOME GENERATING ACTIVITIES IN RURAL TANZANIA: HOW ACCESSIBLE ARE THEY TO POOR HOUSEHOLDS?

3.1 Introduction

More often than not, it is asserted that rural households in developing countries depend entirely on farming and/or animal husbandry as their only economic activities. This perception suggests little or complete absence of rural off-farm activities going on in rural areas. This remains the main scenario even today. Policy debates are also influenced by this perception in which discussions to promote rural incomes are geared towards increasing farm incomes and that relations between rural and urban is that of farm/non-farm perspective. In this context, ministries responsible for industries tend to focus more on urban-centred industries and those responsible for agriculture tend to focus on rural farming activities. Little or no attention is always paid to off-farm activities in rural settings, even among agriculturalists.

However, literature provides evidence that off-farm income (that is, income obtained by engaging in wage-paying activities and self-employment in trade, handicraft and provision of other services and even working on other people's farms) is an important resource for farming and other rural households, including the landless poor as well as residents in small towns close to rural areas.[14] In Africa, for instance, evidence is provided to show that the rural non-agricultural economy is sizable and actually growing. Reardon et al. (1998), did a survey-based study of about 100 farm-household from the 1970s–1990s and found an average of non-farm income share at 42% in Africa; 40% in Latin America; and 32% in Asia. While this study concluded increasing size of non—farm activities in rural areas, it is shown that the sector is very different between countries. Because of the said heterogeneity of the sector, addressing it needs country specific approach. In other words, there is no single approach to address the problem of non-farm sector that is applicable to all settings. Each country should address the sector following detailed analysis of the sector in that specific country.

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[14]Note that off-farm income includes income earnings from activities outside the farm as well as employment to someone else's farm. On the other hand, non-farm income includes only the income earnings from activities outside the farm activities. This means that non-farm income is a component of off-farm income.

In Tanzania, earlier attempt was made by Ellis (1999), who provided a review of the large-scale sample survey evidence on the significance of the non-farm sector in rural Tanzania. While the author admitted existence of measurement problems of non-farm income, the results his study show that non-monetised incomes was quite high, implying that households were mainly subsistence. The study further suggested that the transition out of subsistence agriculture was far from complete but also that non-farm income shares are fairly low and there was no clear evidence of a marked expansion of these shares over time. More recent studies have, however, given a different story. Having studied the non-agricultural earnings in peri-urban areas of Tanzania, Lanjouwet al. (2001) found that non-farm income shares rise sharply and monotonically with quintiles defined in per capita income terms. The Household Budget Survey (HBS) of 2011/12 also shows that rural income appears to be increasingly dependent on off-farm sources relative to on-farm sources. For instance, 62% of rural households reported that they run their own business compared to 25% in other urban areas and 13% in Dar es Salaam (URT, 2014). Furthermore, there has been a decline in the proportion of income from on-farm sources from 60 per cent in 2000/2001 to 50 per cent in 2007 (NBS, 2009). There are also other signs of increasing non-farm activities in rural areas: 56 per cent of food expenditure in rural areas comes from purchasing rather than own production.[15] Furthermore, some 45% of rural dwellers reported having a business in 2007 compared to 40% in 2000/2001 (NBS, 2009). Recent statistics show that 62% of households living in rural areas reported running some forms of business outside farm activities in 2012 (URT, 2014).

While these studies have concentrated on the presence (or absence) and magnitudes of non-farm incomes in rural Tanzania, they have not addressed the determination of their presence as well as their potentials in improving incomes of the poor. This chapter addresses part of that knowledge gap by attempting two main questions:

1) What are the driving forces of off-farm income generating activities in rural Tanzania?

2) How accessible are the driving forces to the poor households, particularly landless and other marginalized social groups?

In addressing the first question, the chapter seeks to quantify determinants of household decision to participation in off-farm employment. The argument put forward here is that, while farming is the dominant economic mainstay in rural

[15]This evidence challenges Ellis, F. (1999), whose findings suggested that the economy was predominantly subsistence with no evidence to change in the near future.

areas, diversification is an important aspect to reduce risk, especially in developing countries where agriculture is vulnerable to weather. While diversification is a risk reduction mechanism, different social groups diversify off-farm activities differently, implying that they have different incentive systems to diversify. In answering the second question, the chapter builds on the first question by analysing the extent to which the driving forces are accessible to relatively poor households. Since farming households with relatively lower incomes have relatively more incentive to opt for off-farm activities, if we find that the factors for entry are difficult, this may partly explain the current low speed of poverty reduction among rural households in Tanzania. If this is the case, then the chapter will justify government interventions in promoting off-farm economic activities in rural areas through targeted programmes that help the poor households and other marginalised groups to participate.

3.2 Dynamics of Farm/Off-farm Activities in Rural Tanzania

As is the case with other developing countries, farming in Tanzania continues to dominate the working time of the majority of its rural citizens. An integrated labour force survey conducted in 2014 indicates that two third of the adults (66%) of rural area citizens are employed in the agriculture sector (URT, 2015). While farming remains the biggest single employer in rural Tanzania, over time its relative importance has been declining. This trend is partly explained by the way it is practiced, whose characteristic is small holding cultivation, use of hand tools, and reliance on traditional rain-fed cropping methods and animal husbandry (URT, 2016). Also, poor financial status of small-scale farmers is one of the major constraints on agricultural production in Tanzania (Ibid). As a result, farm activities do not provide sustainable livelihood opportunities to a growing number of poor people in rural Tanzania. In addition to farming activities, rural farm households have, thus, tended to engage in off-farm income generating activities to supplement their incomes (Mung'ong'o, 2000; URT, 2004). In the last decade starting from 2000, for example, the percentage of households that reported to engage in non-farm income generating activities increased from 38%in 2000/1 to 43% in 2007. In rural Tanzania, these households increased from 26% to 28% during the same period (Table 3.1).

Table 3.1 Distribution of Main Activities of Adults by Geographical Area (Hbs 2000/01 and 2007)

Activity	Dar es Salaam		Other areas Urban		Rural areas		Mainland Tanzania	
	2000/1	2007	2000/1	2007	2000/1	2007	2000/1	2007
Farm	3.0	3.1	26.1	27.6	74.1	72.5	61.8	57.3
Non-farm	97.0	96.9	73.9	72.4	25.9	27.5	38.2	42.7
Total	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***

Note: for individuals age 15 to 60
Source: NBS, 2009

The Integrated labour force survey of 2014 shows some increase in percentage of engagement in farm activities to 66.3 percent (URT, 2015). This may have been contributed to by the government subsidies between 2008 to 2013. To a degree, this has increased agriculture productivity (WB, REPOA 2012). Despite these developments in agriculture sector, relative importance of the non-farm sector to farm sector in rural Tanzanian has remained high. In line with the decreased relative importance of farming activities in rural areas, is the increase in the households reported to depend on trade for their livelihood. It is reported that households depending on business in general increased from 42% in 2000/1 to 48% in 2007. In rural areas, statistics show that the households' dependence on trade increased in the same period from 40% to 45% (NBS, 2009).[16] Off-farm income generating activities in rural Tanzania have recently provided important source of capital and help finance social services that the households consume. When studying survival and accumulation strategies at the rural-urban interface in North-West Tanzania, Baker (1995) found that agriculture remained an important economic activity of rural dwellers, though a large majority of the households (83%) were also increasingly becoming dependent on a variety of other income-generating activities as survival and accumulation strategies. Other studies point out that such incomes in rural areas are very useful in accessing key social services like

[16]For rural areas, households still practice farming even when they engage in off-farm economic activities. In that case, these statistics represent the shift of importance of income from farm to off-farm incomes but does not mean people completely neglect farming activities.

education, health, societal customary practices such as paying bride price and buying food (Jambiya, 1998; Mwamfupe, 1998; Mung'ong'o, 2000). In developing countries, it has also been shown that income from rural off-farm activities enable poor households to overcome credit and risk constraints on agricultural innovation (Ellis, 1998).

Despite the apparent importance of off-farm economic activities to rural households in both social and economic terms, there is a lack of policy, financial and promotional support from the government. Because of the broad sectoral diversity, from farm input supply to agro-processing, manufacturing, transport, construction, wholesale, retail commerce and personal services, no line ministry holds clear responsibility for the rural off-farm sector activities (World Bank, 2007). It is also important to note that off-farm economic activities have no specific authority responsible for promoting them because of their diversity and lack of understanding of their dynamics. As a result, the rural off-farm sector in Tanzania has largely remained hanging independent of government, donor and NGO professional support for enhancement. Administratively, no single agency assumes responsibility for the welfare and growth of the rural off-farm sector. The resulting lack of understanding leads to little or no discussion at all among decision makers and development practitioners interested in rural development at a policy level on off-farm economic activities. This limited understanding may imply that currently rural off-farm economic activities do not yield their potential benefits to the participating rural households.

3.3 Motives to Diversify to Off-Farm Economic Activities

Rural farm households' motives to diversify to off-farm activities differ significantly across settings and income groups. Literature shows that, generally, the motivation to diversify can be grouped into two: push and pull factors (see Barrett et al., 2004; Bryceson & Jamal, 1997; Davies, 1993; Ellis, 2000; Ellis & Freeman, 2004; Evans & Ngau, 1991; Francis & Hoddinot, 1993; Reardon, 1994, 1997; Reardon et al., 1998; Senadza, 2011; Webb & Von Braun, 1994;).

Under pull factors, farming households are driven to diversify based on their desire to accumulate. The pull factors include relatively higher returns or lower risk to rural off-farm activities than those from farming activities (given risk preferences). Many studies at a national or regional level(e.g., Barrett et al., 2001; Reardon et al., 2006; Senadza, 2011) show returns to off-farm activities to be relatively higher than that of farming activities. The returns to off-farm activities become higher if the location is closer to towns. Returns are also higher in the favourable agricultural zones because effective demand is also higher. Being closer to town or being in favourable agriculture zones create consumption and production-linkages with the off-farm sector and drive up demand for off-farm goods and services. As economic activities increase, demand for labour and rising wage rates increase. These factors stimulate the emergence of high-return rural off-farm activities. The cotton zones of the southern Sahel, the green revolution in Punjab, the fruit-producing zone of Central Chile, and the coffee zones of southern Brazil have all witnessed eras of agriculture-led growth in their rural off-farm economies (Reardon, 2000; Reardon, Berdegue & Escobar, 2001).

Under push factors operate differently. In relation to push factors, households try to diversify so as to manage risk, cope with shock, or escape from agriculture in stagnation or in secular decline. Households are pushed into off-farm activities by factors which can be "idiosyncratic" (which are specific to a single house of group of households) or "common" to all households in a zone or region (Dercon, 2002). Moreover, as Alderman and Paxson (1994) note, there is a fundamental bifurcation of strategies to deal with risk and shocks in income. In the first place, households may decide to deal with the risk by choosing activities whose flow of income do not move together with returns to agriculture. In such cases, they will be getting relatively more income from those activities when outputs of agriculture sector go down and vice versa. They can also choose free risk activities even when their returns are small. On the other hand, households may decide to pursue "risk coping strategies" that involve precautionary savings and asset management, participate in the informal and formal insurance arrangements and diversifying income post facto (following a shock like drought and other similar shocks). Reardon et al. (2006) show that a drop of income from farming may be short term, thus pushing households into off-farm activities to smooth income and consumption, or may be inter-seasonally, or it may be transitory (in a given year), forcing farmers into the need of coping, ex post. Drop in farming income may also be permanent (inter-year); or chronic insufficiency of farming income, say from physical reasons such as environmental degradation, chronic rainfall deficit, and disease (Chase, 1997; Tacoli & Satterthwaite, 2003); or market/policy reasons (Bah *et al*., 2003 ;Bryceson & Jamal, 1997). Finally, a farming household may be pushed to off-farm in situations where there is strong variation (risk) in farm incomes (say due to rainfall instability) driving households to engage in off-farm activities with lower risk (even if they have low returns) or with the returns which do not vary with farming outcomes (see Habtu, 1997;Reardon *et al.*, 1992; 1998).

Although rural households tend to turn to off-farm activities to meet their needs and offset income shortfalls, participation tends to face barriers like limited capital assets: human, social, financial, and physical. In their study of off-farm employment participation in Honduras, Ruben and Van den Berg (2001) show that education and household wealth contribute significantly to household participation in the off-farm activities because of access to human and physical capital. In addition, in their study of off-farm employment in Columbia, Deininger and Olinto (2001) show households with limited education and other human capital ended up investing in a single income source. The limitations from access to credit and lack of education are also highlighted by Escobal's (2001) study of income diversification in Peru. Constraints to physical and human capital were also found to be important factors in the decision to diversify to off-farm activities in many developing countries. Haggabade et al. (2009) argue that poor men and women tend to dominate low-return activities, such as small-scale trading and unskilled wage labour in construction, pottering and many personal services. Wage labour, in both agriculture and non-farm businesses, also accrues primarily to the poor. On the other hand, white-collar jobs in areas such as medicine, teaching in higher levels, accounting and administration feature most prominently among higher income households. Furthermore, Lanjow et al. (2007) show that human and physical capital (education and wealth in our context), have influence in determining the access to non-farm occupations. Similarly, direct contribution of the non-farm sector to poverty reduction is possibly quite muted as the poor lack assets (Seebens, 2009).

What seems to be the conclusion of above studies is that, while reliance on off-farm income is quite common among rural households, it is wealthier households (with human and physical capital) that tend to have easy access to attractive and high-returns from off-farm activities. Poor households, on the other hand, face significant entry barriers into these high-return activities. They then end up in low earning off-farm activities, causing the off-farm sector to have little or no poverty reduction impact resulting from an inequality-increasing effect on rural income distribution (see also Barrett et al., 2001). However, other studies argue differently in terms of benefit incidence of off-farm incomes between the poor and wealthier rural households by emphasizing that very poor households may be pushed into non-farm activities, especially if they are landless and cannot access work in agriculture (Canagarajah et al., 2001). Thus off-farm income may not necessarily have a positive linear correlation with wealth status. As opposed to that, a U-like pattern may emerge in the distribution of non-farm income whereby the very poor (and landless) and the wealthy (land-rich) receive proportionately more of their total income from off-farm sources. For instance, the study of Barrett et al. (2000) revealed the existence of this relationship in Cote d'Ivoire. As shown in their study, the income received by the land-poor coming mainly from unskilled off-farm activities (agricultural wage, low skill non-agricultural wage and self-employment), while the land-rich derived off-farm income from trades and skilled employment.

As argued earlier, the inconclusive findings on the benefit incidence of off-farm gains on rural incomes among different social groups provide impetus for a need to examine the off-farm sector in different country contexts (Canagarajah et al., 2001). Adams (2001), for instance, investigated the impact of different sources of income on poverty and inequality in rural Egypt and Jordan. He found that while off-farm income reduces poverty and improves income distribution in Egypt, in Jordan, off-farm income goes mainly to the rich and thus tends to increase rural income inequality to the latter. Adams provides perspectives to these results by arguing that they are contributed by differences in land productivity and ownership. In Egypt, land is highly productive, but the poor have limited access to land and, therefore, they are "pushed" to work in the off-farm sector. However, in Jordan, land is not very productive and so the rich are "pulled" by more attractive rates of returns from the non-farm sector, whose entry requires capital that poor households' do not have access.

3.4 Regional Share and Nature of Off-Farm Incomes

Literature provides ample evidence that shows that rural households in developing countries receive quite a significant proportion of their income from off-farm activities. A review of surveys on rural households conducted between the mid-1970s and the late 1990s, Reardon et al. (1998) show that non-farm income (which is just part of off-farm incomes) significantly contributes to the total household income. The share of this source averages 42% in Africa, 40% in Latin America and 32% in Asia. [17] In terms of the general trend, most surveys administered in different countries reported moderate to fast growth rate in the share of off-farm in total income over the period 1980 to 2000. In China, for instance, in 1981 only 15 percent of rural income came from off-farm economic activities, whereas in 1995 this share had increased to 32% (de Brauw et al.). In Bangladesh, the share of off-farm incomes to total household income of the rural households was 42% in 1987, but this share rose to 54% by the year 2000 (Hossain, 2004). A similar trend is also observed in Africa where there was an increasing share of income from off-farm sources overtime. For example, Ghana is reported to have experienced an increase in the share of rural household income from non-farm source from 35% in 1998 to 41% in 2006 (Senadza, 2011). Valentine (1993) reported the share in Botswana to have increased from 54 percent in 1984/85 to 77 percent in 1985/86. Clearly, integrated farm-off-farm households are a common sight across the developing world, and the trend is steep especially as rural areas become more integrated with urban areas.

[17]Because these studies come from surveys across the developing world over various years, degrees of coverage, and differences in survey methods and definitions of variables, the results should be taken as broadly indicative

While the incidence is high, and the trend is steep, there exists a great variation in the nature of rural off-farm activities in developing world between regions and sub-regions (Lanjouw & Lanjouw, 2001; Lanjouw, Shariff & Rahut, 2007). The pattern in the level and composition shows that Africa and South Asia regions are in the initial stages of rural off-farm sector transformation. At this earlier stage, rural off-farm activities tend to have production or expenditure linkages with agriculture. Farming activities provide employment of most of the rural population directly. At this stage, there is little or sometimes even no urban-rural linkages with rural off-farm activities tending to be centred in the countryside itself as reported in a number of studies(Lanjouw & Lanjouw, 2001; Lanjouw, Shariff & Rahut, 2007; Mduma, 2003). Most of these activities at this stage are mainly home-based and include the small-scale production of goods that are mainly sold in the countryside (rather than emerging rural towns). In the farm/non-farm relations, agriculture tends to depend on local supplies of inputs and services and on local processes and distribution of farm products, which are usually carried out by small - to medium-scale firms (Mduma & Wobst, 2005). Examples of such activities include production or mixing of fertiliser, rental and repair of animal traction equipment; cart production; tractor services; crop processing; transport; construction or maintenance of market facilities and commerce.

Latin America is in the next stage (Reardon, 2001; Shariff and Rahut, 2007; World Bank, 2008). At this stage, there is a greater mix of activities than that of the earlier stage. Direct linkages of activities in this stage to the agriculture sector tend to reduce. Only few activities are directly linked with agriculture while others have not. Examples include tourism, mining and services. As a result, the share of Latin America's population that depends on agriculture is lower than in Africa and South Asia (Reardon, 2001; Shariff and Rahut, 2007; World Bank, 2008). This stage witnesses a stronger rural-urban links because urban-based or foreign companies start to sub-contract jobs to rural-based entities (particularly in light durables such as clothing). There is also a high degree of labour force commuting between the countryside and nearby towns as well as intermediate cities. Another important characteristic of this stage is "agro-industrialisation" which took place due to commercial agriculture, which is done at the small scale but particularly at the medium to large scales. Furthermore, there are differences in the levels of capital with small scale. Using labour intensive techniques is being practiced in countryside, whereas capital intensive producing similar product is taking place in emerging towns and local cities.

East Asia appears to be in the third stage (Reardon, 2001; Shariff and Rahut, 2007; World Bank, 2008). This stage is identified by intensification of characteristics that differentiate the previous two stages, which are more advanced rural-urban linkages. The movement of labour commuting between urban and rural is more pronounced, and the sub-contracting at this stage is beyond light durables to include medium durables (e.g. vehicle parts). Furthermore, there is substantial rural off-farm employment arising outside linkages with agriculture (for example, Taiwan).

3.5 Off-Farm Income Generating Activities and Demographic Characteristics

3.5.1 Gender and Off-Farm Employment

In the developing economies, both men and women play crucial roles which are either the same or different. Literature (see Christopher et al., 2001; Nancy & Sun, 2009; World Bank, 2003) shows that gender inequality has a direct and indirect negative bearing on economic development. The clear interpretation of this literature is that, since gender inequality has negative consequences on growth, measures to address such inequality will make a substantial contribution to turning the growth potential into a reality. Reducing gender-inequality in all aspects around access to and control of key productive resources which are key for growth is an important step towards accelerating and leveraging growth. In this way, growth becomes more sustainable, and everyone in the population is contributing to, and benefiting from it. Putting it differently, the growth of this nature is "pro-poor". However, in actual sense, gender inequality exists in developing countries, particularly in Sub-Saharan Africa. Access to important capital necessary for growth has remained a critical challenge to women, a phenomenon that has been a core dimension of poverty in the region (*Ibid*).

Access and ownership of land, particularly in rural areas is one of the areas where gender inequality is pervasive. This is a serious constraint to rural growth because land is a key ingredient in rural production. Usually, in many developing countries women remain to be key players in land related activities. However, they have limited command not only over land but also over the output from the land. Kenya is one of the typical examples of a country where women are key players in land related activities but with limited decision making on the outcomes of what is produced from the land. The Works Bank (1989) and Horenstein (1989)show that women in Kenya work 50% more hours than men in agriculture-related tasks. In terms of relative time, women provide approximately 75% of total agricultural labour. However, in terms of ownership, they own only 1% of the land. Taking further these findings, the 2003 World Bank Country Economic Memorandum for Kenya confirmed that inequality, particularly gender inequality, has played a big role in keeping Kenya's growth performance below the anticipated long-run trend. Other countries in sub-Saharan Africa also experience similar situations in which women have limited control over land as well as outputs from land, even though their engagement in farming is higher than their male counterparts (see Christopher et al., 2001; Nancy & Sun, 2009).

One of the critical challenges in this relationship is that, although women are denied access and control over land and related outputs, increased hardship and poverty exert pressure for women to contribute into household survival, especially in farm households (Aston, 2003; Jefferson & Mahundra, 2012). As a result of this increased pressure, participation of farm women in the paid workforce in recent times has dramatically increased (Alston 1994; Barret et al., 2001; Feder & Lanjouw 2000; Mahundra, 2012). In Australia, Alston's (1995) study found that 50 % of women who are commonly engaged in farming were also engaged in off-farm employment, particularly in part-time work. The missed opportunities report (1998) provided information on the importance of women's off-farm employment by estimating that over 80% of off-farm income was contributed to by the women (Aston, 2003). In Tanzania, Seebens (2009) shows that while women entrepreneurs often run low productivity enterprises, their contribution is an important supplement to household income. About 39 % of women whose informal sector is reported as their main economic activity shows that their participation is for generating additional income for the family purposes as opposed to only 25% of men with a similar response (Seebens, 2009).

Gender participation in the off-farm income generating activities has a bearing on the decision making at the household level. Women participation in off-farm activities has been found to empower them by increasing their bargaining power within the household, thereby increasing household welfare (Newman & Canagarajah 1999). This analysis suggests that off-farm incomes not only have financial returns but also social returns to women engaged in those activities. A lot of empirical literature (e.g., Abdulai & Delgado, 1999; Matshe & Young 2004) have indicated that relative to males, female household members are less likely to be involved in off-farm work in Africa in general. However, Canagarajah, Newman and Bhattamishra (2001) show that Ghana is slightly different in a sense that women have a long tradition of doing trade. Local community-based groups are also very common in Ghana; some of them are gender specific, and many of them have mixed membership. Women may also improve their intra-household bargaining position provided that they organize themselves in groups (Weinberger & Jutting, 2001). What this literature tells us is that, while returns to men's and women's labour in crop agriculture are the same, women benefit beyond mere income when they participate either in off-farm work or organize themselves in local community groups.

Gender participation in farming in Tanzania is more or less the same as in other African countries in which more women (69%) than men (63%) are employed in the agriculture sector (URT, 2015). However, the relative impetus to try and move out of agriculture into off-farm activities seems to be higher for women than men. For example, the percentage of rural women who reported depending on self-employment either with or without employees slightly more than doubled from 2.9% in 2000/1 to 6% in 2007. Within the same period, the percentage of men rose from 5.2% to 10.2%t (HBS, 2009). While we see an increasing proportion of women in the off-farm activities in rural Tanzania, average earning remains higher among men compared to women, though the gap is narrowing overtime. Table 3.2 below summarises the proportion of average earnings of men to women.

Table3.2 Ratio of Men to Women Average Monthly Earnings

	Dares Salaam	Other Urban areas	Rural areas	Mainland Tanzania
2000/1	2.4	2.3	1.7	1.9
2007	2.4	2.4	1.4	1.7
2012	N/A	N/A	N/A	1.1

Source: Author's computation using Household Budget Survey for 2000/1 and 207; and employment and earnings survey for 2012

Men's average earnings in 2007 were 1.7 times higher than women's, decreasing from 1.9 times in 2000/2001. The differences are largest in Dar es Salaam and other urban areas where men earn 2.4 times as much as women. Inequality is relatively lower in rural areas where men earn 1.4 times as much as women. There has been no changes in the last decade in the ratio of men to women average monthly earnings in Dar es Salaam, though there is a marginal increase in that ratio in other urban areas implying increased inequality. Improvement is seen in rural areas in a sense that ratio has decreased from 1.7 times in 2000/01 to 1.4 times in 2007. More importantly, while the trend data for all strata is not available, the recent employment and earning survey has shown significant improvement in gender equality where in 2012 there was almost no difference overall. Earlier on we saw that the last decade has witnessed increased percentage of rural households' income from off-farm sources. From Table 3.2 above, we see that overtime, income inequality between men and women decreased in rural areas but also overall, which may mean that increased off-farm activities in rural Tanzania tends to empower women relative to men.

3.5.2 Youth and Off-Farm Employment

Limited research on youth exists. The problem of absence of literature on youth is more serious for research that focuses on the relationship between rural growth and young people (Sumberget al., 2012). As a result, rural policies that aim at improving young people conditions have based on common knowledge, anecdotes and narratives which are not backed by solid evidences. The major risk of formulating policy this way is to come up with a policy that do not yield expected economic benefit even though it can be politically popular. The problem is even greater when one deals with a complex issue like that of addressing youth problems in the rural settings.

One of the most pressing topics of discussion in the contemporary debates is on youth employment, with clear focus of a need to address high unemployment rate for this group of the labour force (ILO, 2012a,b,c; OECD, 2012). Part of these debates have tried to relate agriculture to solutions of the youth unemployment. Those who connect agriculture with the solution of youth unemployment tend to feel that youth are better positioned to bridge the current world food need. Despite improved undernourishment estimates in recent years, one in eight people suffered chronic undernourishment in 2010–2012—, a problem being even worse in Sub Saharan Africa where one in four suffered undernourishment(FAO, 2012). With this high shortage of food, the average age of the farming population is now in the range of late-50s to early 60s. A clear conclusion of this debate is that the problem of food shortage will be solved if youth are encouraged to engage in farming; they are considered energetic enough to produce more than the current average farming age. Within this context, it can be argued that agriculture will solve both problems of under-and unemployment of young people by providing them with employment and income. This will not only provide enough food through increased production but also will ensure that farming practices are sustained because they are passed from one generation to the next. This assertion is trying to put young people as a solution of the hunger problem, which has been so serious in recent years due to some factors, including climate change. This assertion can be true subject to young people perception of the whether agriculture practices provide them with the lifestyle of the current world.

As a matter of reality, most of the young people do not have interest in agriculture and agriculture does not account to any of their future vision. The young peoples' view on agriculture is also supported very much by their parents/elders (Leavy, 2012). Agriculture is always viewed as a back-breaking work; has little or no mechanization; and uses traditional inputs. As s a result, it is further believed, it ends up with little or low return. Hence, agriculture is not envisioned as an activity that provides a lifestyle and status that young men and women of the current era would like to be associated with. In other words, agriculture is perceived to be unable to deliver, thorough incomes and working conditions—the kinds of lifestyles that young men and women expect people aspire for current world. With the exception of revolutionary advances attained in communications technology that is accessible to the majority, even people living in the remote areas, living condition in many rural areas are not attractive to youths. Because of that, agriculture, especially in developing countries, is regarded as a poor peoples' activity, mainly to make them survive but not able to provide higher living standards or even people's sense of pride and self-respect. These are important dimensions of wellbeing and take us beyond narrow, one-dimensional conceptions of what it means to be poor, marginalised and disadvantaged. If agriculture is perceived not to be able to deliver either the desired living standards or the prospects for upward mobility, then it will be very difficult for it to attract young people into or retain them in the sector (Leavy, 2012). Those who believe that agriculture can lead them to better life, they want to see it smarter, more productive, more reliable and also more predictable. This suggests a need to bring about a revolution in agricultural practice, so that it is modern enough to be attractive by this group.

Within the context of agriculture and youth, education is actually another challenge for youth in two ways. To start with, ideally, it is expected that higher education should be able to transform farming practices from traditional practice to modern. However, attainment of higher education seems to be a challenge to engage in agriculture especially in developing countries. The common practice has been that once young men and women attain higher education, they seek jobs that require higher skill levels, and, as such, smallholder and traditional farming practices do not seem to fit in that category. To put it differently, the more education one gets, the more one is detached from the rural setting. In their study on young people and farming in Ethiopia, Tadele and Gella (2012) found a negative perception of farming among the youth. They attribute their results to the fact that life as a farmer is associated with life in a village which is considered hard, demanding and backward. According to their study, no one realizes that life in the village can still be enjoyable similar to town life. Young men who go to agriculture and do well after failing in formal schools are not viewed as vivid examples to attract other young men in agriculture. Instead, those young men who do well in their examination and end up in agriculture are accused of misusing the education they received (Tadele & Gella, 2012). From this perception, education is seen as something that should remove someone from the agriculture settings. Therefore, agriculture is still seen as a degrading occupation especially when someone is educated.

Secondly, education does not yet seem to yield the desired results; neither in agriculture nor in other fields. Higher unemployment levels, which is a youth phenomenon, suggest that there are no linkages between work and education. Lack of linkage between education and work has thus resulted in the failure of two key routes by which people move out of poverty and as crucial mechanisms linking economic growth to poverty reduction. At the moment, we have more children going to school than it has ever been in the past. However, the learning outcomes appear to be different from the skills needed in the labour market of the current world (UNESCO, 2012; World Bank, 2012). In other words, there appears to be a very big mismatch between the education system and the labour market demands. This is also likely true for agriculture sector skills, in which absence of young men into the sector might also be linked by lack of the required skills in the agriculture sector.

Literature reveals another important aspect that young people are forced out of agriculture even when they are willing to be farmers. Here, the emphasis is on aspects of agrarian structures, economies and transitions which limit young people's access to productive resources (Tadele & Gella, 2012). To start with, population is increasing very fast, leading to increased land pressure. Consequently, small scale farmers in Africa end up increasingly cultivating smaller plots overtime (Jaine et al. 2012). A similar problem is that of making land a commodity, which in countries like Ghana has denied youth from accessing land which initially belongs to the family (Amanor, 2010). In Sierra Leone, the 1991-2002 war was partly the results of grievances around deeply rooted agrarian structures and relations that restricted young people's access to land labour and thus limited their ability to build a livelihood in rural areas (Peters & Richards, 2011). In connection to the aforementioned discussion, it is highlighted that in Malawi, young people have expressed their feelings of marginalisation leading to powerlessness, alienation and hopelessness due to land grabs (Sumberg et al., 2012).

These emerging findings suggest the inexistence of conditions in the agriculture setting that encourage the youth to participate in the sector. Subsequently, any policy option that addresses rural economy and employment, especially in developing countries, by focusing attention on farming *per se* is unlikely to yield tangible results for the youth. Policymakers need to think beyond the conception of (young) people as units of labour to be placed in jobs. To engage and empower young people in agriculture, the sector needs to be able to address their aspirations and expectations and offer potential for social mobility. Using the language of the International Labour Organisation (ILO) and FAO, rural employment needs to provide 'decent work' but also as the importance to people of self-respect and status highlights, it needs also to address broader conceptions of human wellbeing. Farming needs a change of image to get over entrenched, though not unfounded, beliefs that it involves dirty, laborious work at low skill levels for minimal returns. Otherwise, the current urban unemployment which has a substantive contribution from migration from rural areas will still be a problem because young people are pushed to seek the so-called "descent jobs" in urban areas. Thus, modernising farming by creating an environment considered as being "conducive" for the youth or creating employment outside farming within rural areas that the youth may consider similar to what they seek in urban areas may partly help to address the unemployment and rural poverty problems. In light of that, this chapter attempts to find out whether off-farm employment in rural Tanzania may partly address this challenge facing youths, and if so, whether such activities are easily accessible.

3.6 Framework of Analysis

3.6.1 Conceptual Framework

The analytical framework, which is adopted from Abdulai and CrossRees (2001) is based on the following assumptions :

1. A farming household is endowed with labour and land as means of production;
2. Division of labour between on-farm and off-farm depends on opportunity cost of the forgone activity due to fixed household labour;
3. Entry into off farm activities require that a household has capital and some forms of skills; and
4. Vulnerability of farm outputs push households to diversify to off-farm activities

Given the above assumptions, a rural household i is said to maximise utility from outputs which is a function of allocating a fixed household labour among on-farm and off-farm activities,

$$U_i = Q_i(L_p, L_q) - - - - - - - - (1);$$

where U_i is utility derived by household i; Q is an output of household i; and L_p and L_q are labour allocation between on-farm and off-farm activities respectively.

The utility maximisation function above is subjected to financial or other physical capital constraints. Solving the first order condition of equation 1 will provide a solution of how the household allocates labour between on-farm and off-farm. The decision of how much labour is located to either on-farm or off-farm is informed by the marginal utility. That is, the higher the marginal utility of allocating labour to off-farm than on-farm, the more the labour will be allocated to off-farm.

Assuming return to labour allocated to off-farm income generating activities is denoted by the following equation two:

$Q_q f(L_q|B_i) - - - - - - - - - - - (2).$

From equation 2 above, Q_q represents the quantity of output and B_i represents requirements into off-farm activities like capital and skills. Combining equation 1 and 2 , relationship between the expected marginal utilities can be expressed by the following function:

$$E\left[U'(C_i)Q_p \frac{\partial l}{\partial L_p}\right] \; and \; E\left[U'(C_i)Q_q \frac{\partial f}{\partial L_q}\right], \text{------------------(3);}$$

where E denoted operator for expectation, $U'(C_i)$ is the marginal utility derived from outputs as a result of allocation of labour between on-farm and off-farm; L_p represents decision to allocate labour to on-farm activities; L_q represents decision to allocate labour to off-farm activities; and Q_P denotes quantity of output of goods produced in on-farm activities. If the left hand side of the equation 3 above is greater than the right hand side, then a farming household will allocate all its labour to the on-farm activities because the marginal utility derived from outputs resulting from labour allocation to on-farm activities is higher than that derived from off-farm activities.. This is shown in the equation below:

$$E\left[U'(C_i)Q_p \frac{\partial l}{\partial L_p}\right] > E\left[U'(C_i)Q_q \frac{\partial f}{\partial L_q}\right], \text{ and } L_p > 0; L_q = 0\text{--------------(4)}$$

However, as it is the case with many developing countries in which farmers are facing unexpected shocks like crop failure and price fluctuations of agriculture outputs, households tend to diversify with the purpose of spreading risks as long as they are assured with stable consumption, even if that would mean relatively less expected income. Poor households have relatively higher incentive to diversify so as to smoothen consumption even at the risk of less future expected incomes. Within this context, off-farm income generating activities are less risky than crop production, making poor farmers to opt for that as a complement to crop production.

A rural household may also opt to off-farm income generating activities due to limited land enough to meet household food requirements (Reardon et al., 1992). But also, capital may be another constraint for a rural household to engage in off-farm activities. In addition, certain levels of skills may be needed to some activities before the household can engage into them. In cases where a rural household decides to allocate labour to other activities in addition to on-farm, it would mean that such household derives the same utility for allocating labour to both on-farm and off-farm. In such cases, the first-order optimal conditions for labour allocation is expressed as:

$$E\left[U'(C_i)Q_p\frac{\partial l}{\partial L_p}\right] = E\left[U'(C_i)Q_q\frac{\partial f}{\partial L_q}\right], \text{ and } L_p > 0; L_q > 0\text{-------------}(5)$$

Definitions for variables in equation 5 are the same as in equation 3 above. We note in equation 4 that household equates utility for allocating labour to on-farm with that of allocating labour to off-farm activities. Thus, the household labour force is allocated in both activities as denoted in the last part of the equation ($L_p > 0$ and $L_q > 0$). As noted earlier, it is the poor households who mostly need to diversify to assure them with stable and predictable income, even though it might be less than expected incomes. The critical challenge, though, is that entry to off-farm income generating activities may need initial capital to stat business. Also, some of the higher returning activities may require that participants have certain levels of entrepreneurial skills to run them, which the poor may be lacking; that makes it a challenge for them to engage in such activities (Reardon et al., 2000; Woldenhanna & Oskam, 2001). This would mean that, while poor households have higher incentive to diversify, they are faced with entry barriers, making them to end up not engaged in such activities or engage in those with lower returns which are easy to enter. The actual participation of farmers in off-farm activities (income diversification of household) is informed by the incentive and the capacity to participate (Reardon, 1997; Woldenhanna & Oskam, 2001).

In other words, a farming household's decision of whether or not to work off-farm depends on the reservation wage rate and prevailing market wage rate. If the reservation wage rate is less than the prevailing market wage rate net of commuting cost, a farm household will choose among the available off-farm activities depending on the relative wage rates. If the farmer faces a liquidity (or credit) constraint, he or she prefers the one that requires less initial capital.

Most probably, the credit constrained farm household chooses wage employment above off-farm self-employment. A farm household with a better asset position may face relatively less credit constraints and hence may prefer to work in off-farm self-employment.

Lass et al. (1991) has shown that the reservation wage rate that determines the households' participation in off-farm activities is an endogenous variable. It depends on farm characteristics, family characteristics, locations, and endogenous and exogenous household sources of income. Farm characteristics include: the farm size (area of land cultivated), livestock size, and the number of animals used for transportation (donkey and horse). Family characteristics include age and educational level of family members and family composition. Endogenous household income consists of farm income, which depends on farm and location characteristics. An exogenous household income source consists of a non-labour income such as transfer income (remittance, gift, and food aid) and rent income from property. Off-farm wage is also an endogenous variable, which depends on individual and location characteristics.

3.6.2 Empirical Model

Off-farm labour supply of farm households is analysed using the Tobit model, also called a censored regression model. This model is usually designed to estimate linear relationships between variables when there is either left or right censoring in the dependent variable (Tobin, J (1958). Depending on whether there is left or right censoring in the dependent variable, the model is also known as censoring from below or above respectively). Censoring from above occurs when cases with a value that is at or above some threshold, all take on the value of that threshold so that the true value might be equal to the threshold, but it might also be higher. In the case of censoring from below, values those that fall at or below threshold are censored. In our case, the Tobit model is based on the latent variable expressed as follows: Let latent variable off-farm labour hours be denoted by L_m^* and observed off-farm labour hours by L_m . In a farming household model, an individual is willing to participate in off-farm work when his/her reservation wage (w_{ri}) is less than the off-farm wage net of commuting cost (w_{mi}) offered:

$$D_i = 1 \text{ if } w_{ri} \leq w_{mi},\ D_i = 0 \text{ if } w_{ri} > w_{mi} ------(6)$$

where D_i is the participation decision of a farm household to work off-farm. Consequently, the latent variable off-farm labour hours (L_m^*) and observed off-farm labour hours (L_m) can be expressed by a Tobit model:

$$L_{mi}^* = \beta' Xi + e_i,\ e_i \sim N(0, \sigma_e^2)$$ [18]

$$L_{mi} = \begin{cases} L_{mi}^* & if\ D_i = 1 \\ 0 & if\ D_i = 0 \end{cases} ----------(7)$$

where β' is a row vector of parameters; X is a column vector of variables that affect the reservation and market wage; e_i is the error term.

Explanatory variables in this model are farm characteristics, family characteristics and endogenous household's sources of income. Farm characteristics variables include cattle wealth (raised cattle), goat wealth (raised goat), sheep wealth (raised sheep), pig wealth (raised pigs) and the size of land cultivated. Included also as part of farm characteristics are the types of crops a farmer cultivated, both cash and food crops. Family characteristics comprises gender of the household head (male); whether the household head can read and write at least one language (literacy); education level of the household's head presented in the form of number of years of schooling (education level); age of the household head (age); total number of dependants in the household (dependants); household size (household size); and distance from the household to the nearest township (remoteness). Endogenous household's source of income is the household wealth (household wealth) generated using household asset ownership.[19] Crop types include both food and

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[18] In particular, the actual dependent variable is $L^* = \max(0, L^*)$. Since L is the off-farm labour hours, given household characteristics X, then $L > 0$ if household has a member in off-farm sector and 0 if not. The Tobit model is a convenient way of modelling this type of data

[19]Assets that were used to create wealth index are dwelling type include, roofing material, type of wall, source of drinking water, type of toilet; ownership of other assets including mobile

cash crops; food crops are maize, and paddy and cash crops are coffee, cashew-nuts, tobacco and cotton.

3.6.3 Data

The chapter uses the agriculture sample survey conducted by the National Bureau of Statistics (NBS) in collaboration with the sector ministries of agriculture.[20] The survey was conducted at the end of the 2008/09 Agriculture Year. Data were collected by administering a questionnaire to sample of 48,315 small-scale farming households and 1,206 large-scale farming households. The survey covered agriculture in detail as well as many other aspects of rural development and was conducted using three different questionnaires: the small-scale farm questionnaire; the community level questionnaire; and the large-scale farm questionnaire. The small-scale farm questionnaire was the main census instrument and included questions related to crop and livestock production and practices; population demographics; access to services, resources and infrastructure; and issues on poverty, gender and subsistence versus profit making production units. Given the scope of the small - scale farm questionnaire, data were collected at household/holding level, allowing for sex disaggregation of most variables at the head of household level.

The sample consisted of 3,221 villages. These villages were drawn from the National Master Sample (NMS) developed by the National Bureau of Statistics (NBS) to serve as a national framework for the conduct of household-based surveys in the country. The National Master Sample was developed from the 2002 Population and Housing Census. Nation-wide, all regions and districts were sampled with the exception of two urban districts. A stratified two stage sample was used. The number of villages/EAs selected for the first stage was based on a probability proportional to the number of villages in each district. In the second stage, 15 households were selected from a list of farming households in each selected village/EA, using systematic random sampling, with the village chairpersons assisting to locate the selected households.

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phones, radio, television, wheelbarrow, vehicle, disc plough; main source of energy for lighting and cooking

[20] Ministry of Agriculture, Food Security and Cooperatives, Ministry of Water and Livestock Development and the Prime Minister's Office-Regional Administration and Local Government

3.7 Results and Discussions

3.7.1 Summary Statistics

We first present the summary statistics of the variables used in the regression analysis of the decision to offer labour force to off-farm income generating activities in rural Tanzania. Table 3.3 below shows clearly that Tanzanian agriculture is still largely of small holder type with limited use of modern technology. The figures in this table are comparable to others in similar National Surveys, like Household Budget Survey and the National Panel Survey. The average size of land holding is 2.6 hectares, which is the same as the 2011 figure produced by the National Panel Survey, which suggests that there is no expansion. Similarly, rural households are characterised by high level of illiteracy rates among heads of households (21%), and generally few years of schooling (4.5). Household size among rural Tanzania is large with the average level of 5.1 persons per household, which is above national average of 4.8 in 2012 (NBS, 2013).

Over the years, the number of households headed by women has increased, with the level being 20% at the time of the survey. The HBS (2009) shows the level of female-headed households to have increased in recent years overall, mainly accounted for by the increased widowhood, separation and divorce. In rural areas, female-headed households stood at 16.4% in 1991/92. Furthermore, we see that very few farmers practice mixed-crop farming and animal husbandry: nearly 30% of farm famers raise cattle and goats while less than 15% raise sheep and pigs. The average number of dependants, which includes old people aged above 65 and children below the age of 16 years, is about 2.6 persons. What is also seen in the table is that, on average, households live 1.4 kilometres away from small townships where they can get their daily needs. But the value of standard deviation, which is far above the mean for this variable, suggests skewed distribution of this variable in that there are households that live very far away from these small townships.

Table 3.3 Definitions and Summary Statistics of the Variables Used in the Analysis

Variable	Definition	Mean	Std Dev
Household Characteristics			
Male	Gender of household head (=1 if the household head is male)	0.80	0.40
Literacy	Literacy rate of the household head (=1 if the household head can read and write at least one language)	0.71	0.45
Education level	Years of schooling of the household head	4.51	3.62
Age	Age of the household head	45.18	15.54
Household size	Household size	5.14	2.73
Dependants	Total number of dependants in the household	2.58	1.98
Farm Characteristics			
Raised cattle	Household raising of cattle (=1 if the household raised	0.26	0.44

Variable	Definition	Mean	Std Dev
	cattle)		
Raised goat	Household raising of goats (=1 if the household raised goats)	0.28	0.45
Raised sheep	Household raising of sheep (=1 if the household raised sheep)	0.11	0.31
Raised pig	Household raising of pigs (=1 if the household raised pigs)	0.07	0.26
Cultivated land size	The actual land size (in acre) cultivated by a household in the 2007/8 agricultural season	2.65	3.74
Household Income			
Household wealth	Household wealth index created using type of household asset	18.14	2.57
Proximity to Services			
Remoteness	Distance of the household	1.38	1.80

Variable	Definition	Mean	Std Dev
	residence to the nearest township measured in kilometres		
Crop Type			
Maize	Household growing of maize (=1 if the household grew maize)	0.79	0.41
Paddy	Household growing of paddy (=1 if the household grew paddy)	0.20	0.40
Cotton	Household growing of cotton (=1 if the household grew cotton)	0.08	0.09
Tobacco	Household growing of tobacco (=1 if the household grew tobacco)	0.02	0.13
Cashew nuts	Household growing of cashew nuts (=1 if the household grew cashew nuts)	0.11	0.31
Coffee	Household growing of coffee (=1 if the household grew coffee)	0.10	0.28

Variable	Definition	Mean	Std Dev
Zonal Dummies			
Northern Zone	Farmers in Northern Zone (=1 if the farmer is from Northern Zone)	0.21	0.41
Southern Zone	Farmers in Southern Zone (=1 if the farmer is from Southern Zone)	0.10	0.30
Eastern Zone	Farmers in Eastern Zone (=1 if the farmer is from Eastern Zone)	0.07	0.26
Western Zone	Farmers in Western Zone (=1 if the farmer is from Western Zone)	0.08	0.27
Central Zone	Farmers in Central Zone (=1 if the farmer is from Central Zone)	0.10	0.29
Lake Zone	Farmers in Lake Zone (=1 if the farmer is from Lake Zone)	0.14	0.35
Southern Highlands	Farmers in Southern Highlands Zone (=1 if the farmer is from Southern Highlands Zone)	0.29	0.45

Variable	Definition	Mean	Std Dev
Dependent Variable			
Off-farm incomes	Household with members in off-farm economic activities (=1 if the household has at least one member in the off-farm activities)	0.73	0.45

Source: Author's computation using NBS, 2008/09

It is worth noting that means are based on the 40,015 households (out of 48,315 households surveyed by the National Bureau of Statistics) which indicated to have practiced farming in the 2007/8 farming year. The difference between those who were surveyed and those who were included in our analysis is those who are practicing livestock only.

Another interesting result of the rural households is the high level of diversification to off-farm activities. The results indicate that 73% of farm households have at least one member on the off-farm employment. As discussed earlier, this may be the result of push or pull factors. In any case, it is very clear that moving out of the farm is on the higher side in rural Tanzania. However, what is also clear in the attempt to move out of farming is that different social groups are moving out of farming differently. Table 3.4 shows relatively higher move out of farming to off-farm employment for young households than older ones and also to women-headed households than male-headed households. This may imply that agricultural outputs have differential gender and age returns. In other words, agriculture outputs may be in favour of old households than young ones and in favour of male headed of households than that of female.

Table 3.4 Off-Farm Employment Participation by Gender and Age of Head of Household

	Have off-farm employment	
	Yes	No
Age is greater than sample average	65	35
Age is less than sample average	79	21
Male	72	28
Female	74	26

Source: Author's computation using NBS, 2008/09

To see the relationship between off-farm employment and household and farm characteristics, we run a correlation matrix, which is presented in Table 3.5 below. It was found that off-farm employment has positive correlation with household size, implying that engagement in off-farm employment is driven by excess labour in the household. Consistently, land size has a negative correlation with off-farm employment, meaning that more land pre-occupies all the household working time at the expense of off-farm employment. As shown in Table 3.4 and the correlation matrix in Table 3.5, off-farm employment is negatively correlated with the age of the household head, implying that it is young families that diversify more than older families. Looking at the pairwise correlation between age and land size, we see that the two have a positive and significant correlation. Thus, the seeming higher rate of diversification of young families may be the result of land shortage. That is also the case with female-headed households. As can be seen in Table 3.4 and the correlation matrix in Table 3.5, male-headed households are negatively, though not significantly, correlated with off-farm employment, implying that it is female headed households who diversify than their male counterparts. Again, being a male-headed household has a positive and significant correlation with land size, implying that female-headed households have limited land access.

Another important issue worth mentioning in the correlation matrix is the positive correlation between off-farm employment and household wealth. This means that to engage in the off-farm employment requires a capital up-front, which wealthier households have access to. Within this discussion of household wealth, we see that male-headed households have a positive correlation with wealth. The household budget survey whose results were earlier reported by the current study shows that men in Tanzania earn 1.7 times the earnings of women. The difference is even worse in urban areas where such earning is more than twice. Other studies elsewhere (e.g., Doss & Morris, 2001; Kaliba et al. ,2000; Odendo et al.; 2011) have also shown a similar trend. In their study on the effect of gender on adoption of agricultural innovations in Ghana, Doss and Morris (2001) ,for example, concluded that women had limited access to financial resources compared to men that has resulted in their limited capacity to adopt innovations. Similarly, Kaliba et al. (2000) and Odendo et al. (2011) concluded that male-headed households are relatively wealthier and have greater control over financial resources. As a result, they were able to adopt mineral fertilizers faster than their female-headed counterparts.

Table 3.5 Pair wise Correlation Coefficients of Selected Variables

	Off-farm employment	Household size	Age of household head	Land size	Male headed household	Household wealth
Off-farm employment	1.000					
Household size	0.0014	1.000				
	(0.7808)					
Age of household head	-0.0629*	0.01118*	1.000			
	(0.000)	(0.000)				
Land size	-0.0369*	0.2981*	0.0916*	1.000		
	(0.000)	(0.000)	(0.000)			
Male headed household	-0.0086	0.1970*	-0.1099*	0.1280*	1.000	
	(0.0858)	(0.000)	(0.000)	(0.000)		
Household wealth	0.0847*	0.1751*	-0.0681*	0.1409*	0.1670*	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	

(*) p-value is 0.05 or lower. Figures in parenthesis are p-values

Source: Author’s computation using NBS, 2008/09

Disaggregating the summary statistics of selected variables by zones gives very interesting findings (see Table 3.6). The variable for average age of household heads in farming households shows a very high similarity across the country. However, there are strong variations in other variables between one zone and another. Farm households’ involvement in off-farm employment for instance, shows highest incidence in Central Zone where 95% of its households have at least one member who is in off-farm employment. That is followed closely by Eastern Zone (93%) and Western Zone (81%). The lowest incidence is observed in the Lake Zone where only 53 per cent of its households have at least one member in the off-farm employment. In the earlier chapter on education and farm productivity, we saw that land productivity was highest in Southern Highlands and Northern Zones. However, these zones are not in the top position in household engagements in off-farm employment. This may mean that farmers in rural Tanzanian are mostly concerned with survival. It could thus be argued that off-farm employment is mainly dominant in those areas with low level of farm outputs. Some studies have shown highest returns and hence high incidence of off-farm activities in favourable agricultural zones where effective demand is high, thereby creating consumption and production-linkages with the off-farm sector and driving up demand for off-farm goods and services (Reardon, 2000; Reardon, Berdegue & Escobar, 2001). This doesn't seem to be the case in rural Tanzania because of the peasantry nature of agriculture.

Table 3.6 Summary Statistics of Selected Variables by Zones

Zone	Off-farm employment (%)	Average age of household head	Average years of schooling	Household wealth index
Northern	65	46	4.7	18.5
Southern	68	45	4.0	17.5
Eastern	93	46	4.9	18.4
Western	81	46	4.0	17.9
Central	95	45	4.2	17.6
Lake	53	45	4.3	18.1
Southern Highlands	75	43	4.8	18.4

Source: Author's computation using NBS, 2008/09

The varying formal years of schooling between zones as well as the variable for household wealth index are other interesting findings worth reporting. The zones with the highest average years of schooling among household heads are Dar es Salaam (4.9), followed by Southern Highlands (4.8) and Northern highlands (4.7). These are the zones whose households are wealthier than the rest. On the other hand, Southern and Central Zones have lower level of average years of schooling among their household heads and also are ranked the lowest in the household wealth index. This indicates that there is a strong relationship between household head education and farm productivity and also household head education and wealth.

3.7.2 Regression Results

The results from the Tobit model presented in Table 3.7 show that the main factors determining the supply of labour to off-farm activities are livestock wealth, years of schooling of the household head, location of the household in relation to the nearby township, size of household land cultivated, household wealth, age of the household head, family size, the number of dependants, crop type and geographical location of a farmer. For most of the variables, the results obtained meet our expectations. The impact of gender (=1 if male headed household and 0 if female headed household) on the supply of labour to off-farm employment is negative but statistically not significantly different from zero. These findings may probably be accounted for by the fact that our data do not allow us to identify the gender of the individuals participating in off-farm activities because we only have information of gender of household head. While this variable is negative and non- significant, other studies(e.g., Kaliba et al., 2000; Quisumbing et al., 1995) have shown negative and statistically significant relationship, implying that female headed households have relatively higher probability than male-headed households to offer labour to off-farm economic activities. Such studies have accounted that relationship with the fact that female- headed households in developing countries have lesser access to and control of critical resources, especially land, cash, labour and information. Similar findings are also reported by other studies (e.g., Alston, 1994; Barret et al., 2001; Feder & Lanjouw, 2000; Mahundra, 2012). These studies showed an increased participation of farm women in the paid workforce in recent times, implying that this is due to the increasing pressure of women to contribute to household income for household survival. Studying non-farm, income and gender in rural Ghana and Uganda, Canagarajah et al. (2001) also found that while women earned less than men did in both countries, being a female-headed household had a positive effect on non-farm income.

Table 3.7 Results of the Tobit Model of Decision to Supply Labour in Off-Farm Activities

Variable	Coefficient	T-ratio	P-value
Household Characteristics			
Male	-0.004	-0.47	0.640
Literacy	-0.020	-1.47	0.140
Ln of education level	0.038***	5.12	0.000
Ln of age	-0.032***	-3.43	0.001
Ln of household size	0.118***	13.13	0.000
Ln dependants	-0.037***	-5.01	0.000
Farm Characteristics			
Raised cattle	-0.080***	-9.96	0.000
Raised goat	-0.035***	-4.52	0.000
Raised sheep	-0.086***	-7.79	0.000
Raised pig	0.001	0.09	0.140
Ln of cultivated land size	-0.044***	-11.30	0.000
Household Income			
Ln of household wealth	0.383***	16.19	0.000
Proximity to Services			
Ln of remoteness	-0.005**	-2.76	0.006
Crop type			
Maize	0.038***	5.01	0.000
Paddy	0.023***	3.01	0.003
Cotton	-0.092***	-5.36	0.000
Tobacco	-0.116***	-5.10	0.000

Cashew nuts	-0.116***	-9.28	0.000
Coffee	-0.100***	-8.11	0.000
Zonal Dummies			
Northern Zone	-0.107***	-11.30	0.000
Southern Zone	0.028*	2.21	0.027
Eastern Zone	0.215***	18.94	0.000
Western Zone	-0.273***	-26.01	0.000
Central Zone	0.279***	24.97	0.000
Lake Zone	0.102***	8.53	0.000
Southern Highlands Zone	-0.324***	28.12	0.000
Constant	-0.457***	-6.14	0.000
Sigma	0.579		

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Source: Author's computation using NBS, 2008/09

It therefore follows that female-headed households in those studies have higher motivation to participate in off-farm employments than male-headed households, even though they only occupy lower returning off-farm employments. Other studies, however, report contrary findings. Block and Webb (2001), for instance, found that female-headed households have lower levels of income diversification because of less resources needed in the off-farm employment.

The education variable, which in this context is the number of years of schooling, is positive and significant with supply of labour to off-farm employment ($p<0.01$). This is so, especially in the case of self-employment, participation of which requires some levels of formal schooling. In agreement with that , Zhu and Luo (2006) and Babatunde and Qaim (2009) found that, while schooling does not seem to be important for agricultural wage labourers, it significantly increases the probability of finding work in non-agricultural sectors. Furthermore, Canagarajah et al. (2001) found that primary education leads to a 32% income than no-education and higher education gives a premium of almost 77% in non-farm employment. The literacy variable, which represents whether a household head can read and/or write at least one language, is negative but not significantly different from zero. The unexpected negative sign as well as non-significance may perhaps be the results of potential multicollinearity between the variable and year of schooling of the household head.[21]

The age of the household head affects the off-farm labour supply negatively implying that the supply of labour for off-farm activities is higher for younger household heads than for older household heads ($p<0.01$). The negative impact of age on labour supply to off-farm activities may be explained by the fact that due to traditional ownership of land, young farm household heads cannot access sufficient land to support their livelihood as compared to their older counterparts. Hence, these younger heads have to rely on off-farm activities in order to support their households. Besides, the older heads may not have the courage needed to venture into off-farm undertakings because they have historically been working on on-farms and have relatively higher experience in that direction. This means they are more productive on-farm and less productive off-farm. A similar trend is reported in Bezabih et al. (2011). The study showed that older household heads tended to be good matches for agricultural labour jobs. On the other hand, young families may not have agrarian ethics, as happens in many agrarian societies in the process of modernisation. Hence, when agrarian economies are open for off-farm work, the younger are the first to go. Similar findings are shared by Canagarajah et al. (2001), which show that the effect of age on earnings in non-farm employment has a concave shape, implying that earnings increase early in life as experience increases but then later decreases as the individual gets older. However, our results are different from those of Block and Webb (2001) who provide evidence that income diversification is positively associated with age of household head, arguing that older people have accumulated capital for a long time and can afford the capital needs of off-farm employment.

Participation in off-farm activities increases with family size ($p<0.01$) and decreases with number of dependents ($p<0.01$). Most of past studies (for example, Babatunde & Qaim, 2009; Bezabih et al., 2011;Woldenhanna & Oskam, 2001) have shown a positive relationship between household size and participation in off farm employment, arguing that participation in off-farm activities is critically dependent on labour availability. In other words, participating in off-farm employment by farm households is possible because larger households can maintain their farm and household activities while still sending one or more members to work in other activities outside on-farm. This seems to be also the case with rural Tanzania. These results imply that farming

[21] The variable “literacy rate” of the household head can be correlated with the variable “education level” of the household head.

households are involved in off-farm activities due to mainly push factors: insufficient farm incomes and surplus labour. In other words, off-farm activities are considered to be a residual employment that absorbs the surplus family labour, which cannot be fully employed on the farm. These results may imply that the association between labour supply and off-farm employment may be suggestive of "coping" responses to stress aimed at consumption smoothing, rather than "adaptive" strategies allowing households to accumulate productive assets. Our findings of negative relationship between number of dependants in the household and participation in off-farm employment are different from those of Barrett and Reardon (2000) and Block and Webb (2001) who provide evidence that income diversification is positively associated with a higher dependency ratio; that is, households with a relatively lower proportion of working adults (compared with children and non-working elderly) typically derive a larger share of income outside of cropping. They hypothesize this with the fact that households with more children have more hands available for income earning off the farm, including the gathering and sale of firewood, management of valuable livestock, daily wage labour or petty commerce. Such off-farm employments which have been accompanied by high incidence of child labour are mainly a survival mechanism rather than accumulation (Davies, 1993; Dercon & Krishnan, 1996).

Livestock wealth is negatively correlated to household supply of off-farm activities, implying that as the household engages itself more in livestock keeping, it finds it difficult to offer its labour to off-farm employment. It can be argued that this relationship is the result of substitution effect between the labour available for raising animals and that for off-farm income generating activities. In Tanzanian context, this relationship may further be strengthened by the fact that among some pastoral communities, especially the Maasai, there is a prestige derived from keeping large sizes of animals, and this reduces the labour available to other activities, including off-farm employment. Studying income divarication and entry barrier in Northern Ethiopia, Woldenhanna & Oskam (2001) found consistent results in that hours worked for off-farm employment decrease with an increase in the amount of livestock wealth and horses. However, other studies (e.g., Bezabihet al., 2011;Block & Webb, 2001) have provided evidence that the level of livestock ownership is positively and significantly associated with income diversification. The authors argue that a rise in the level of livestock wealth is used as a capital to invest in off-farm income generation activities. The off-farm activities arising this way are due to pull factors which does not seem to be the case with rural Tanzania.

A household's farm size has a negative relationship with the supply of labour to off-farm activities ($p<0.01$). This relationship is explained by both income and substitution effects; big farm sizes tend to exhaust all the time available for the household's labour supply at the expense of off-farm activities. But also, importance attached to expected incomes resulting from big farm sizes may be outweighing the expected importance of income from off-farm income generating activities. Corroborating that, Zhao (2001) and Chen et al., (2004), found that farmers in villages that have higher than average agricultural productivity tend to remain on their farms rather than engaging in off-farm work. In other words, farm households who have smaller farms are the ones likely to opt for off-farm activities to escape from poverty by way of supplementing farm incomes. These findings are also shared by Woldenhanna and Oskam (2001) who found out that farm households who have smaller farms tend to turn to off-farm employment to stabilize their incomes. However, Bezabih et al. (2011) provide results which are inconsistent to ours in that farm sizes are significantly and positively correlated to household labour supply to off-farm employment. The authors support this relationship by arguing that land size could measure household net-worth, enabling households to dispose of a portion of their incomes as start-up costs of off-farm employment. Such findings are possible where agriculture outputs and farmers' incomes are very high. This increases aggregate demand of outputs from the off-farm sector. Thus, off-farm employment in this context is the result of pull factors. However, this is contrary to what is being predicted by the current study for rural Tanzania, where off-farm employments are the results of push factors.

Household wealth positively affects the supply of off-farm labour in rural Tanzania. The coefficient of the variable is significant ($p<0.01$) and has a high magnitude in size, suggesting the importance of household initial capital in entry to off-farm activities. Past studies (Babatunde & Qaim, 2009; Bezabih et al., 2011) that have examined the role of access to finance and off-farm employment have shown consistent results indicating that, overall, financial constraints have a negative impact on the decision to participate in off-farm employment. Other researchers (e.g., Woldenhanna and Oskam, 2001) have even associated income with the type of off-farm economic activities and provided evidence that better-off farm households prefer working in off-farm self-employment to off-farm wage employment because the former has better return although it requires capital up-front. These results suggest that having higher incomes makes it easier to get into off-farm activities and even to go for risk higher returning activities than otherwise.

Distance of the household from the nearest township (remote) affects negatively the supply of labour to off farm activities ($p<0.05$), implying that households living in the proximity of towns have a higher probability to participate in off-farm employment than their counterparts living far away from towns. Babatunde and Qaim (2009) had similar findings and accounted them to the higher agricultural labour demand in areas close to the market, where farm production is often more commercialized than in settings further remote. Other studies (Canagarajah et al. 2001; Reardon ,1997; Reardon & Taylor,1996) have emphasized the importance of general infrastructure, agro-climatic conditions, access to markets, and the state of local economy as important variables in rural diversification. Consistently, Block and Webb (2001) provide suggestive evidence that households located in the highlands tend to be more diversified than in the lowlands thanks to higher density of population, roads and markets, all of which allow for higher-productivity agriculture and a greater variety in employment options.

In relation to types of crops, we have selected both food and cash crops that are very important in the Tanzanian agriculture. The food crops chosen are maize and wheat whereas cash crops selected include cotton, tobacco, cashew nuts, and coffee. Our study revealed that crop affects participation in off-farm employment depending on whether it is a food or cash crop. Food crops (maize and paddy) have positive and significant relationship with off-farm employment ($p<0.01$), whereas cash crops (cotton, cashew-nuts, tobacco and coffee) have significantly negative relationship with off-farm employment ($p<0.01$). This suggests that food crops growers have higher incentive to diversify to off-farm employment than their counterparts of cash crop growers. This means that cash crop growers may have a relatively more stable and predictable income than food crop growers. Thus the latter opt to diversify to smooth consumption. This may have resulted from selling restrictions to better markets which are imposed to food crops producers when some parts of the country are expected to experience food shortages. Moreover, cash crop producers are also producing some food crops. They are thus assured with some levels of food crops and cash from selling of cash crops to carter for other household needs compared to their food producers counterparts who have to sell part of their food crops and/or engage in off-farm employment so as to get cash to cater for needs other than food. It is, therefore, not surprising to see that food crop growers have a relatively higher incentive to participate in off-farm employment than cash crop producers. Thus, off-farm employment helps to cover the consumption gap.

Zonal dummies are also found to be indicating interesting results. From the previous chapter, we saw that Northern and Southern Highlands Zones have the highest use of inputs and were associated with higher farm productivity. Both zones have negative and significant relationships with participation to off-farm employment. This may further imply that rural farmers are mostly concerned with subsistence incomes. Once they are assured with enough food, they put less attention to other income generating activities. On the other hand, Southern, Eastern, Central and Lake Zones have positive and significant relationship with decision to participate to off-farm employment. The Eastern Zone has larger urban areas than other zones, noting that Dar es Salaam is located in this Zone. Farmers close to urban areas are most likely participate to off-farm employment because of high demand of off-farm products. Similarly, Central and Lake Zone have incentives for their farmers to participate in off-farm activities. Lake Zone has a lot of fishing as well as mining activities, which attract demand of off-farm outputs. Similarly, Central Zone hosts many visitors especially because many National meetings are held in Dodoma, which is located in this Zone.

Results from marginal effects presented in Table 3.8 are similar to those of the Tobit model in terms of trend, signs of coefficients and significance. The difference occurs in the magnitudes of the coefficients depending on the strength of the variable in influencing off-farm employment as well as the condition we impose on the expected value of off-farm. When expected value of off-farm supply of labour is above 0, that is, E(y/x,y>0), coefficients of the marginal effects are roughly one half of those in the Tobit model. On the other hand, when we condition the value of the off-farm supply of labour to be on the average, that is, E(y/x)* the magnitude of coefficients are roughly 70 per cent of the original Tobit model. Finally, when we condition expected value of supply of off-farm labour to be between 0 and mean, that is E (y/x, $0<y<\bar{y}$), the magnitudes of coefficients are very small due to the small range existing in the dependent variable.

Table 3.8 Marginal Effects (Dy/Dx) At Various Levels of Y

Variable	**E(y/x,y>0)**[22]	**E(y/x)***[23]	**E(y/x, $0<y<\bar{y}$)**[24]
Household			
Characteristics			
Male	-0.002	-0.003	-0.001
Literacy	-0.014	-0.018	-0.003
Ln of education level	0.026***	0.033***	0.005***
Ln of age	-0.022***	-0.028**	-0.004**
Ln of household size	0.080***	0.104***	0.016***
Ln dependants	-0.025***	-0.033***	-0.005***
Farm Characteristics			
Raised cattle	-0.054***	-0.070***	-0.011***
Raised goat	-0.023***	-0.030***	-0.005***
Raised sheep	-0.058***	-0.075***	-0.011***

[22] Expected value of off-farm supply of labour is above 0
[23] Expected value of off-farm supply of labour is at the mean value
[24] Expected value of off-farm supply of labour is between 0 and the mean

Raised pig	0.001	0.001	0.001
Ln of cultivated land size	-0.030***	-0.038***	-0.006***
Household Income			
Ln of household wealth	0.260***	0.336***	0.051***
Proximity to Services			
Ln of remoteness	-0.003**	-0.004**	0.001***
Crop type			
Maize	0.026***	0.033***	0.005***
Paddy	0.016***	0.020***	0.003***
Cotton	-0.062***	-0.081***	-0.012***
Tobacco	-0.079***	-0.102***	-0.015***
Cashew nuts	-0.079***	-0.102***	-0.015***
Coffee	-0.068***	-0.088***	-0.014***
Zonal Dummies			
Northern Zone	-0.072***	-0.094***	-0.014***
Southern Zone	0.019*	0.025*	0.004*
Eastern Zone	0.196***	0.256***	0.041***
Western Zone	-0.105***	-0.137***	-0.022***
Central Zone	0.189***	0.245***	0.040***
Lake Zone	0.069***	0.090***	0.014***
Southern Highlands Zone	-0.122***	-0.159***	-0.024***

*** p<0.01, ** p<0.05, * p<0.1

Source: Author’s computation using NBS, 2008/09

The most important thing in this analysis of the marginal effects is the importance of the variable in influencing off-farm employment. We see that household wealth is very important in household decision to offer labour to off-farm economic activities. In other words, a household must have a capital up-front to get into the off-farm employment. Another variable which provides strong positive relationship with off-farm employment is household size. As pointed out earlier, off-farm employment is taken as a residual activity to absorb excess labour that cannot be fully utilized in the on-farm activities. The variables that provide a strong negative relationship with off-farm employment are livestock wealth and growing of cash crops. With respect to livestock wealth, it may be because the time necessary to keep livestock exhausts all the necessary time needed to do off-farm employment, thereby strongly affecting it negatively. In other words, expected returns to livestock are higher than expected returns to off-farm employment. As regards to growing of cash crops, the relationship may have to do with the potential stability and predictable income from such crops compared to food crops.

3.8 Conclusions and Policy Recommendations

As indicated earlier, this chapter seeks to provide empirical evidence of driving forces of off-farm income generating activities and the extent to which such forces are accessible to farming households, especially to those with relatively lower incomes in rural Tanzania. From our findings, three main conclusions can be derived: (1) Participation in off-farm activities in rural Tanzania is a result of push factors; that is, potential participants do not realise earnings from on-farm activities and are thus pushed into off-farm activities; (2) households with relatively low incomes and those with limited access to land have higher incentive to diversify so as to bridge the consumption gaps; and (3) while off-farm activities remain the best options for the landless and other rural poor households, there are constraints caused by low financing and low educational levels.

These entry barriers cause the following: First, without the system that can facilitate credit access to the poor, it is wealthy households that have better chances to participate than relatively less wealthy households. Therefore, participation of poor households will be limited to low paying off-farm activities that have easy entry like providing farm labour to other farmers, leaving higher earning paying off-farm activities to better off farmers. In this case, off-farm income generating activities to poor farmers are limited to helping them secure earning for consumption but not to accumulate for growth and better life. On the other hand, the better-off farm households are able to dominate the most lucrative forms of off-farm activities such as masonry, carpentry and trading. Income inequality is likely to prevail in the absence of supporting participation of poor farmers to be involved in the high return off-farm activities. This is an important point for policy makers to reflect upon deeply. Secondly, lack of formal training hinders rural household participation in the off-farm activities. Absence of special entrepreneurial skills would make it difficult for less or no educated rural farmers to participate in rural off-farm income generating activities.

The current Tanzania's initiatives to transform agriculture, as specified in Agriculture Sector Development Programme II and the Second Five Years Development Plan, seek to bring about huge transformations of the rural economy. However, the attention has so far been towards increasing farming production and, as such, all efforts are geared towards addressing challenges facing farm activities. Our findings show that while farming is an important aspect of the rural economy, off-farm activities are equally important in addressing rural transformation, especially through empowering landless households and young families. In that case, rural transformation policy options should not be limited to farming, but rather must go beyond it. Specifically, there should be promotion of the rural economy by focussing on farming as well as off-farm activities. Refusing to do so is likely to lead to rural income inequality through increased income to those already with land access, leaving behind landless families like female-headed households and young families. Similarly, it will worsen the problem of urban migration among the youth, since the current nature of subsistence farming does not provide the lifestyle necessary for youth. It is, therefore, imperative that policies targeting rural communities should take on board off-farm income generating activities as one way of bridging the gap between land owners and landless rural dwellers.

Credit schemes may facilitate off-farm engagement through empowering citizens in rural self-employment activities. Equally important is the need to implement targeted entrepreneurial skills development centres focusing on small business and other rural activities. In other words, the establishment of training centres to tackle skill barriers is necessary. These skills may be delivered on the basis of resources available in a particular place. In other words, identification of skills should be on the basis of comparative advantage. Areas, for instance, rich in natural resources like timber, should focus on training necessary to make furniture. Similarly, areas close to tourist centres should focus on tourist-related business.

Also, as discussed earlier, being away from small towns also hinders rural household participation in off-farm activities. The development of infrastructure to open up rural areas to markets may be a good option. Rural roads connecting to small towns as well as other infrastructure like hospitals and schools would encourage clustering, thereby opening up the economy for marginalised groups to participate in off-farm economic activities. That, not only will the country will be able to address the twin-objectives of addressing rural poverty and inequality but also current urban youth migration. At the same time, high earning off farm activities can be used to support on farm activities, particularly the earnings that farmers get from their own farm activities but also create employment for wider groups, especially those that do not have access to land, in our case youth and female-headed households.

CHAPTER IV

OFF-FARM INCOME EFFECTS ON ADOPTION OF FARM TECHNOLOGY AND FOOD SECURITY IN RURAL TANZANIA

4.1 Introduction

In the developing world, agricultural modernization and growth will play a key role in addressing the current world food crisis. This will also contribute to overall economic growth and help the countries achieve the Sustainable Development Goals (SDGs), which emphasize the importance of meeting current needs without affecting the future generations' needs. The challenge of meeting SDGs under the current circumstances is huge, especially in sub-Saharan Africa (SSA). Under a New Partnership for Africa's Development through the Comprehensive Africa Agriculture Development Programme, countries in SSA pledged to increase their government support to agriculture, aiming at achieving an annual agricultural growth rate of 6%. In reinforcing this support to the agriculture sector, in the Maputo Declaration of 2003, which was reaffirmed by the Malabo Declaration of 2014, many African Heads of State agreed to allocate at least 10% of their government budgets to agriculture. Nevertheless, many countries have not mobilised resources to meet this level of expenditure. In Tanzania, for example, the budget allocation to the agriculture sector as a proportion of government expenditure ranges between 3% and 3.7% for the period between 2010/11 and 2013/14 (URT, 2016)..[25] The biggest share of the budget has been going to social sectors where in 2012/13 education took 23 per cent followed by health which was allocated 10 per cent (URT, 2013). The obvious interpretation of this trend is that, when a growth sector competes with a social sector, it is the former that is likely to suffer. The greater focus on the social sectors than on the growth sectors is mainly because poverty manifests itself immediately with lack of social services (Hicks, 2008). The challenge of complying with the Maputo Declaration remains to be low resource mobilisation capacity; consequently, we see that even after ten years since the Declaration was signed, Tanzania has not managed to meet the expenditure threshold. This suggests that, for sustainable rural transformation, it is necessary to devise other sources of finance to complement government efforts.

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[25] These figures represent the proportion of recurrent expenditure in the agriculture sector to total government recurrent expenditure. The data for development could not be obtained due to lack of adequate and reliable data on spending by donors in the sector.

Several studies on alternative sources towards complementing government efforts to promote mechanisation of agriculture and hence food security have cited development partners who have been supporting the development of the sector by contributing to the Basket Fund and stand-alone projects (URT, 2012). In addition, (Beck et al., 2011; URT, 2015; 2016) cite non-governmental organisations (NGOs), both local and foreign as important funding sources that complement government funding. As discussed in the previous chapters, private financial institutions have not been very common to small scale farmers in developing countries because they are considered not creditworthy (Beck et al., 2011; URT, 2016). While off-farm incomes form an important source of finance in rural economies of developing countries, far less attention has been given to them as potential source of financing farm production methods. There are few exception cases in which this source has been considering important to finance agriculture mechanization (see, for example, Ellis et al., 1999; Goodwin & Mishra, 2004; McNally, 2002; Nehring &Fernandez–Cornejo, 2005; Smith, 2002).

In Tanzania ,too, limited attention has been given to off-farm economic activities. Therefore, their role in transforming rural economy may be due to an earlier perception that they never existed, or they were in very small scale and that there was no clear evidence of a marked expansion over time (See Ellis, 1999). More recent studies, however, have proved the existence of such activities and the signs are that they will continue increasing overtime (Lanjouw et al., 2001; NBS, 2014). The relative importance of off-farm income in rural areas is also increasing. The Household Budget Survey (HBS) of the 2007 and that of 2011/12 show that apparently, there has been a decline in the proportion of income from on-farm sources from 60% in 2000/2001 to 50% in 2007 (NBS, 2009). In addition, increasingly more farming households report to be owning business enterprises outside farming (URT, 2014). While recent studies have concentrated on off-farm employment existence (or absence) and magnitude (Elli, 1999; Lanjouw et al., 2001; NBS, 2009; NBS, 2011/12) as well as on their roles in financing access to social services and customary practices like bride price (Jambiya, 1998; Mung'ong'o, 2000 Mwamfupe, 1998), limited attention has been given in this literature to their impact on farm performance and food security. More knowledge about the determinants of off-farm employment and their effects on farm performance could help policymakers to introduce better targeted rural development policies.

This chapter aims at filling part of the above-mentioned gaps by answering three questions:

1) To what extent does off-farm employment contribute to the adoption of best farming practices?

2) What are other factors that influence adoption of best farming technologies in rural Tanzania?
3) To what extent does off-farm employment affect food security and quality of nutrition?

In relation to the first question, the chapter attempts to examine what would be the probability of farm household to utilise best agricultural practices if it has off-farm employment compared to households without off-farm employment. Best agriculture practices considered here are the adoption of chemical fertilisers, adoption of improved seeds, use of extension services and adoption of draft animals. In connection with the second question, the chapter quantifies other determinants of farm household adoption of farm technologies and determines the extent to which they are barriers to low income household to adopt. Regarding the third question, the chapter investigates food security and quality of nutrition of households with off-farm employment. This is done by taking the following three variables into account: number of meals a household usually has in a day; number of times a household consumed meat within one week before the survey; and the frequency with which a household has had problems of satisfying food needs in the past one year prior to the survey. If it is found that off-farm employment improves food security either indirectly through increased productivity resulting from increased adoption of agricultural best practices, or through purchasing resulting from increased household incomes, then the chapter will justify government intervention in promoting off-farm employment to improve income and food security among rural poor households.

4.2 Adoption of New Farming Technologies: Incentives and Challenges to Food Security among the Poor

The importance of farming technologies in achieving growth in agricultural productivity cannot be over-emphasized. The literature on the role of technology in agricultural productivity in developing countries has been well documented (Arndt et al., 1977). The literature in this area has given credit to the speed of adoption of innovation. Batz et al. (2003); other things remaining constant, the literature shows innovations that are adopted in higher speed are more profitable than those adopted with low speed because the benefits occur faster and the ceiling of adoption is achieved earlier. While the benefits of adoption in general are obvious, the question of who benefits from the adoption of new technologies remains of interest among academics and policy makers.

Technological development as a way to promote equality between poor and rich farmers has been criticized in early studies of accumulation (Lenin, 1964; Marx, 1967, 1968). These studies show that the institutions of pre-capitalist village society in which people lived and owned land together with mutual-help associations and patron-client ties, assured the subsistence needs of the poorest members of the rural community. At the dominancy of capitalism, those traditional institutions were replaced by modern market institutions and new developments like private property rights emerged. At that stage, village elites began to accumulate land for commercial production by encroaching on the commons, by evicting tenants, and by purchasing or appropriating the holdings of small peasants. The introduction of modern machine technology at this time was considered to be further enhancing the efficiency of large-scale relative to small-scale operations, thereby enabling large capitalist farmers to displace the latter from their land converting them into landless labourers.

Quite recently, the critique of modern farm technology against small farmers has been linked with the Asian Green revolution. It has been shown that the Asian Green Revolution did not benefit the poor and better-off farmers equally despite the fact that it is praised for its general achievement of increasing productivity and food production (Mariano et al. 2012). The argument in favour of the critique of modern technology against small scale farmers is the sophistication of the technology necessary in the adoption of Green Revolution in which small farmers could not access. Consequently, while Green revolution had a positive outcome in terms of increasing agriculture efficiency and outputs, such benefits were offset by lack of equity due to its technology requirements acting as a barrier for poor farmers to take part. Similar arguments have been shared by other scholars of adoption of modern farming technologies. Increased farm size, for instance, has been viewed as an important factor for adoption of new technology, making small-scale farmers moving out of that development (Feder et al., 1985; Asafu-Adjaye, 2008). The main argument to support this view is the perceived association between large farm with greater wealth, easier access to capital and a higher ability to tame risk. Thus, all of these make investment in conservation more feasible to better-off farmers than the poor ones (Norris & Batie, 1987). In addition, it is easier for large scale farmers to take part of their field to try new technologies while continuing with the current technology on the rest of the field (Rahm & Huffman, 1984). Generally, earlier studies have concluded that development of mechanical technology increased the relative efficiency of large farms (Lenin, 1964; Marx, 1967, 1968). Thus, scholars under this assertion view adoption of new technology in agriculture as a mechanism to improve income and food security disproportionately between the rich and the poor. In the extreme case of eviction, adoption may deteriorate food security among the poor households.

However, there are other studies which support technological progress in the agriculture sector as a vehicle to improve the lives of both rich and poor farmers. This is so, especially if the technology is accessible to all. Ruttan

(2002) studied controversy of agriculture technology, taking into account lessons from the Green Revolution and concluded that, modern technologies are not homogeneous in their effects on agrarian structure. Usually, advances in mechanical technology are accompanied by scale economies, resulting to simplification of management together with the use of labour in production. For instance, it is easier to supervise one tractor driver than several heads of bullock. On the other hand, agriculture technologies like those which are biological in nature, are generally embodied in divisible inputs such as improved seed and fertiliser and require intensive on-the-spot supervisory management decisions. Their effects are to increase relative efficiency of small family farms and promote a unimodal farm-size distribution (Ruttan, 2002). Furthermore, other studies (e.g., Chang & Boisvert, 2005; Cornejo et al.; Gedikoglu et al., 2011) have distinguished between farm households who adopt capital intensive technology from those who adopt labour intensive technology in farming. Both poor and better-off farmers can access labour intensive farm technology. The decision of mechanism to use the labour depends on the household labour endowment. In most cases, the non-poor end up using hired labour, whereas the poor use household labour because they normally tend to have relatively bigger household sizes. This suggests that, depending on the type of farm technology in place, both poor and non-poor can benefit, hence increased incomes and food security are enjoyed by both.

Another area of debate in relation to benefit incidence of adoption of technology is on the reduced price of the agriculture outputs as a result of increased supply. In actual sense, the distribution of gains in economic welfare between consumers and producers depends on the price elasticity of demand and supply for the commodity. If, for example, the demand for a given agricultural product is price inelastic, which usually is the case for many agricultural products in developing countries, consumers tend to be better off while producers tend to be worse off (Foster, 1992). In a situation when technology increases outputs of a product which is facing inelastic demand, there will be significant drop in the output price which will in turn threaten sustainability of the technology itself (Gabre-Medhin et al. 2003). Welfare economics theory, however, looks into the overall change before and after technological change. In other words, if the total gains from technological change are higher than the total losses, income from consumers can be redistributed to producers such that everyone has at minimal what they had before the technological change occurred. The conclusion from welfare economists is that, while there might be some individuals who do not benefit as others, the global outputs and welfare have increased after technological change. Moreover, some studies (e.g., Hayami & Herdt, 1977) have shown that farmers in developing countries are mainly semi-subsistence producers. Hence they are the main consumers of what they produce. This discussion implies that both producers and non-producers in developing countries can benefit from technological change.

From the welfare economics perspectives, adoption of new technology to improve people's living standards is a very important ingredient for development. Universal access of the new technology is an important component of welfare economics. If technologies are mostly adopted by relatively small number or small group of producers when they start, one needs to look into the dynamics of adoption to understand the distributional effects of technological change. A new technology that is adopted by a few farmers is likely to affect those who do not adopt it negatively. This situation will end up providing disincentive for non-adopter to adopt it even in the future. If at the introduction of a technology only a few farmers adopt, these initiators of the technology benefit in two ways: first, the unit cost of production is reduced due to the use of modern technology; and secondly, the price of outputs remain the same because adopters are still few to increase market supply significantly. But, overtime and as many farmers adopt new technology, market supply will increase, and the price will go down. This stage will witness significant decrease in the profit of adopters. The situation will be worse to non-adopters because they will be producing at a relatively higher cost but end up facing the same market price as adopters, who produce at lower costs. As argued by Mitchell (2001), any innovation has long-run costs to non-adopters because output increase due to the effect of technology leading to a reduced price but also to a reduced incentive to invest for those who have not yet adopted the technology.

4.3 Determinants of Adoption of Modern Farm Technology and Food Security

Determinants of adoption of farming technologies in several countries have been documented through literature since the late 1950s. Factors behind adopting a particular technology have evolved a lot depending on the importance of that factor at a particular time and the type of farm technology being studied. Due to lower outputs as a result of traditional farming practices, farming technologies that were earlier studied are those that would lead to more outputs (Griliches, 1957). However, due to increased demand for food as the global population increases, agriculture production has been accompanied by land degradation. Hence, conservation practices have been farm technologies featured in recent studies (Asafu-Adjaye, 2008; Gedikoglu & McCann, 2010; Odendo et al., 2011; Pannell et al., 2006; Prokopy et al., 2008;).

Among the reasons identified for adopting farm technology, profitability is one of the earliest reasons that was studied well and which showed positive relationship with adoption of new farm technology (Feleke & Zegeye, 2006; Griliches, 1957). However, the profitability motivation is likely to be short-lived as long as the adoption of new technology is expected to result in a significant increase in supply and a fall in price. As discussed earlier, this situation provides disincentive, particularly to non-adopters to adopt the technology, threatening its sustainability. It has, therefore, been argued that to sustain this technology, a short run government intervention is necessary to protect farmers' welfare (Feleke & Zegeye, 2006; Gabre-Medhin et al., 2003; Timmer, 1986).

Family characteristics like human capital/education, labour force size and composition and age on the one hand tend to increase adoption but on the other they reduce adoption. It is, for example, argued that education among household members increases the probability of a farm household to participate in new technology because educated farmers can quickly adapt themselves to a new technology no matter how complicated it is (Abdulai & Huffman 2005; Chang & Boisvert 2005; Walton et al., 2008). Similarly, educated farmers are better positioned to appreciate benefits of technology especially if the technology in place has to do with land management programmes (Chang & Boisvert, 2005). On the other hand, education is likely to lead to escape from farming reducing propensity for the adoption of new farming technology. In the developing world, agriculture is still seen as a low status occupation particularly if a person has relatively higher education. To the youngsters of the world today, this is even a serious concern as agriculture is not viewed as an activity that delivers the life style that young people would want, leave alone the perception that one cannot live a better life in rural areas. In their study on young people and farming in Ethiopia, Tadele & Gella (2012) found negative perception on farming. In More specifically, the study reports that young men and women view farming life to be tied to village life which is considered hard, demanding and backward. According to this perception, higher levels of education tend to pull young people to seek jobs they consider of a higher status. Studies on the role played by household labour force size in adoption of new farm technology found the positive relationship (Baker & Cordova, 1978; Feleke & Zegeye, 2006). The authors attribute these findings with the demand for more labour in the improved varieties than it is for the traditional varieties (Baker & Cordova, 1978).

Like education, literature on the role played by age on the adoption of farm technology is in inconclusive: positive as well as negative associations have been reported. Studies that have reported positive relationship between age of a farmer and adoption (Bultena and Hoiberg, 1983; Gould et al., 1989; Polson, 1991; Asafu-Adjaye, 2008) indicated that older farmers have more experience than their young counterparts on long-term productivity impacts of a new technology, especially those related to soil management. Within the same context, Chang and Boisvert (2005) argue that as farmers get older their farm labour time reduces and are likely to commit some land to conservation programmes as a way of reducing operator labour requirements. This is also an alternative way of holding onto farmland assets until they are needed for the retirement years, or so that they can be passed on to the next generation in the form of an estate. On the other hand, studies that show negative relationship between age and adoption (Featherstone and Goodwin, 1993; Bekele and Drake, 2003; Sidibe, 2005) attribute the findings with the view that older farmers exhibit a high-risk aversion and being at a later stage of a life cycle, cannot afford to adopt a technology which may take longer time before its benefits are realized. Furthermore, older farmers especially those in developing countries are less educated and are used to traditional practices. Consequently, they are less involved with innovative farming practices.

Other factors that tend to increase adoption of new farming technologies include increased farm size, access to finance and perception of soil erosion as a problem. With respect to farm size, it is argued that a large farm size is associated with wealth and high-risk bearing ability, making investment in farming technology preferable (Chang & Boisvert, 2009; Norris & Batie, 1987). Within the same context, Chang and Boisvert (2009) argue that the probability that a farmer can engage in conservation programmes decreases with engagement in vegetable or nursery production, compared with engagement in cash grain production—an argument that land for vegetable or nursery farms has relatively higher opportunity cost. Access to finance, on the other hand, plays the same role as increased wealth, enabling a household to have cash upfront for necessary inputs for moderm technology. Additional funds also mean that the household allow a household to take a risk that is associated with using improved technologies (Just & Zilberman 1988; Mathenge & Tschirley, 2007). Finally, perception of soil erosion to be a problem has a positive bearing on the probability of adoption through factors affecting perception of soil erosion (Asafu-Adjaye, 2008). Education, age, access to extension services, ethnicity, net farm income, distance to a research station and farm size are some of the factors which significantly affect perception of the soil erosion problem.

Uncertainty about the technology and market inaccessibility are some of the factors that have been singled to reduce adoption of technology. If farmers are certain on the outcome of a certain technology, they are more likely use it (Feder, 1980; Feder & O'Mara 1982; Just & Zilberman, 1988; Rahelizatovo & Gillespie, 2004). In their study on determinants of adoption of conservation, Tosakana et al. (2010) found that respondents who perceived that effectiveness of buffer strips are low decreased their use in all landscapes. Similarly, those who perceived that buffer strips had at least medium effectiveness has higher usage.

Another factor that affects probability of adoption is the distance a farmer is located from the market. Studies have shown a negative and significant relationship between market inaccessibility and adoption. Limited market accessibility implies higher transaction costs, which keep farmers from participating in the market. When transaction costs are high, farmers' resource allocation decisions are influenced by the peasantry nature of self-sufficiency rather than profit maximisation, thus hindering the technological change process. This is because transaction costs increase the effective purchase price and decreases the effective sale price faced by agriculture producing households (Feleke & Zegeye, 2006; Kuiper, 2002).

4.4 Off-Farm Incomes and Adoption of Modern Technologies

Most studies suggest that rural off-farm income has a substantial contribution to total household income (Bryceson, 2000; Ellis, 1999; Reardon, Berdegue & Escobar, 2001; Start, 2001). Because its share in the farm household income and its importance in household wellbeing is increasing overtime, recent studies have started examining the role of the off-farm income in the adoption of new technologies (Chang & Boisvert, 2009; Cornejo, Hendricks & Mishra, 2005; Gedikoglu et al., 2011; Hua, Zulauf & Sohngen, 2004; Odendo et al., 2011; Phimister & Roberts, 2006). The contribution from the rural non-farm income alone is 40–45% in sub-Saharan Africa, Latin America and South East Asia, and 30–40% in South Asia. Majority of these incomes are contributed by the local rural sources rather than from urban migrants (Bryceson, 2000; Reardon, Berdegue & Escobar, 2001; Start, 2001). This implies that, if remittances from urban areas are included, total rural non-farm income contributions may be close to 70% in some cases. In most areas, these shares have been rising as international terms of trade are against outputs from smallholder farmers. Such patterns of diversification promise to transform the structure of rural economies and societies.

In Tanzania, studies on off-farm activities started in the late 1990s by the work of Ellis (1999). Elliss work showed that rural economy was dominantly subsistence and non-monetised incomes remained important with no sign that monetized economy will take off in the near future. The analysis suggests that off-farm incomes, if they existed, were quite small. Recent studies (URT, 2014;World Bank, 2007), however, indicate that although farming remains the most important livelihood activity among rural households, non-farm sector remains crucial in income generation. The proportion of rural households who derive incomes from a combination of agriculture and other sources is more than 60 per cent and the trend is already towards increasing employment in non-farm activities (URT, 2014;World Bank, 2007). According to the 2002/03 Agricultural Sample Census, 41% of households had one member engaged in off-farm income generating activities; 21.2% had two members; and 9.1% had more than two members (NBS, 2005). The share of households with at least one member in the off-farm income generating activity rose to 71 per cent (URT, 2014). Also, the Household Budget Survey of 2011/12 shows that 66% of rural households have reported to own business enterprise outside farming. Contrary to earlier findings of Ellis (1999), monetised economy in rural Tanzania is sizable: increasingly, food expenditure in rural areas is from purchasing rather than own production suggesting increasing rural people doing off-farm business.

Due to their increase, literature on the role of off-farm incomes on rural economy has dominated most of the recent works of researchers interested in rural economy. Huffman (1980); Barlett (1996); and Mishra et al., (2002), have argued that off-farm incomes, in addition to increasing household income, have reduced variability of farm income. Also, agriculture in developing countries is rain-fed, meaning more cork is during rainy season. In such situations, for many farm families, off-farm employment tends to be year-round rather than a temporary source of income (Ahearn & El-Osta, 1993). Although importance of off-farm incomes in rural economy, especially on their contribution to farm household incomes is obvious, literature on the surface provides inconclusive evidence of their role in farm productivity. Specifically, off-farm incomes would be expected to reduce financial constraints at household level, thereby enabling such households to adopt modern farm technologies. However, literature shows that off-farm incomes increase the adoption of some practices and decrease the adoption of others.

Prokopy et al. (2008) found that adoption of best management practices tends to increase with labour availability, both family and hired. What this study implies is that any attempt to releasing part of household labour force to off-farm activities would mean fewer and fewer household members are available for farming. Off-farm employment would then be expected to decrease adoption of best management practices. In line with that, McNally (2002) argues that off-farm work reduces time available for farm activities. This may lead to a neglect of the countryside stewardship role played by farmers and an increase in the use of the inputs most likely to cause environmental damage. Taking these results forward, Smith (2002) provides a mechanism through which this might occur. His study has shown that the reduction in the time available for farm management inhibits the adoption of farming techniques that are intensive like integrated pest management, soil testing to avoid over-fertilisation and precision farming. Goodwin and Mishra (2004) confirm Smith's hypotheses by showing that a greater involvement in off-farm activities decreases on-farm efficiency. Other scholars also found a negative and significant relationship between off-farm activities and participation in conservation programme (see Hua, Zulauf & Sohngen, 2004). They attribute their findings to the fact that an off-farm job may increase the opportunity cost of the transaction time needed to learn about and enrol in conservation programmes. Thus, additional funds are needed to compensate people in the off-farm job so that they can be willing to participate in these programmes, especially because they only cover part of the participation cost. This tendency is a disincentive for those in off-farm job to participate in such programmes.

Studies that have shown a positive and significant relationship between off-farm incomes and adoption have accounted their findings for labour saving technology and availability of finance from off-farm activities to pay for necessary technologies as contributing factors. Cornejo, Hendricks and Mishra (2005) found that adoption of herbicide-tolerant soybeans, a high time saving technology, is positively and significantly related to farmers' off-farm income. Similarly, participation in the Conservation Reserve Programme (CRP), which is a programme that reduces farmed acres and thus operator labour requirements had a higher probability to be adopted by farmers who have off-farm employment (Chang & Boisvet, 2005). Other adoption programmes are focused on working lands and provide technical assistance and cost sharing and are believed to increase labour and/or capital requirements.

Having studied the speed of adoption of soil fertility management technologies in Kenya, Odendo et al. (2011) found that, in general, households which had off-farm income as a major source of income at the year of household formation had a higher probability of adopting manure and mineral fertilizer faster than those who did not, other things remaining constant. This is because off-farm income relaxes the household with cash constraints on purchase of mineral fertiliser and hiring labour. Similarly, the findings of Gasson (1988) show that income from off-farm work provides flexibility in which farmers can farm in a manner more attune to their environmental aspirations than otherwise. These results are consistent that of Ervin and Ervin (1982) and Shiferaw and Holden (1998). Both studies show that adoption of soil management technology among farmers was high to those households with prior access to off-farm incomes than those without.

What we see from the empirical literature is that while there is a general consensus of an existence in the relationship between an off-farm income level of farmers on their decisions to adopt new technologies, the direction of the relationship is complex. On the one hand, off-farm income sources releases financial constraints of the household and thus increase the likelihood of adoption, particularly for practices that require significant upfront investments. However, on the other hand, holding an off-farm job, whether seasonal or year-round, reduces the amount of time available to work on the household's farm. That may increase adoption of time-saving technologies and reduce adoption of time-intensive technologies. In some cases, it has been shown that the intensity of the adoption of a technology varied with the time in which the farmer works off-farm. Phimister and Roberts (2006) demonstrate this by showing both positive and negative intensity. The intensity increases when a farmer works off-farm between 200 and 430 hours a year but decreases when farmers work more than 430 hours a year. In addition, off-farm employment may imply that less importance is attached to the farming enterprise, which reduces adoption of new technologies or practices.

4.5 Off-Farm Incomes and Food Security

In the available literature, much less is known about the effects of off-farm income generating activities on food security and nutrition (Chang & Mishra, 2008). The impacts of off-farm incomes on food security and nutrition may be positive because off-farm income increases cash available to the household to access enough and high-quality food through purchasing. Controlling for total household income, however, the impacts might also be negative. This is typically the case if more time spent in the off-farm economic activities implies less time for the on-farm activities, hence, less food production at the household level (see Huang et al., 2009; Pfeiffer et al., 2009). Nonetheless, most studies that have looked into food security and nutritional effects of the household off-farm incomes have shown positive relationships. Reardon et al. (1992), for instance, concluded that diversification into the non-farm sector for the farm household improves calorie consumption in Burkina Faso. Similar findings are reported by Ruben and van den Berg (2001) for Honduras, and Ersado (2003) for Zimbabwe, the latter showing that non-farm income diversification is associated with a higher level of consumption expenditure. In addition, Babatunde and Matin (2010) found that not only off-farm income has a positive net effect on food security and nutrition but its magnitude is also the same as that of farm income.

Another area of debate in relation to off-farm income and food security has been on the redistribution nature of off-farm incomes. Many studies have shown that as countries reform their economies, they realize growth with increased aggregate household incomes but with widened inequality. Knight and Song (1993), for instance, found that the distribution of non-farm income is more unequal than that of farm income. Comparing the distributional effects of on-farm and off-farm income, Hussain et al. (1994) concluded that household inequality increases when the distribution of off-farm income is more unequal. The implication of these findings is that as household's diversification to off-farm income generating activities increases, income inequality in rural areas will continue to worsen. A number of other studies have confirmed these results (see, for example, Bhalla, 1990; Yao, 1999; Zhu, 1991). What these studies suggest is that differences in household endowments in terms of education, skills, capital to start business causes these inequalities (see also Asafu-Adjaye, 2008; Feleke & Zegeye, 2006; Feder et al., 1985;

Norris & Batie, 1987). Following the economic reforms, which have resulted in differences in capital accumulation and in knowledge and skills, further inequalities are expected. In addition, there are differences in the growth of rural off-farm sectors across regions, differences in the development of township and village enterprises, all contributing to greater inequality. The argument in favour of the conclusions that off-farm employment has a unequal effect is that such activities have entry barriers to poor households. Specifically, starting of such activities requires capital, some level of entrepreneurial skills, and other inputs, which may be difficult for poor households to secure. While these studies stress differential gains of the off-farm employment between the rich and the poor, they say nothing in absolute terms. It is possible that although better off households benefit relatively more than poor households, the latter may be better off than if they do not completely engage in off-farm employment.

While there seem to exist differential in gains discussed above, there is a general consensus in the literature that off-farm employment helps to solve the problem of low income that appears as a result of small farm units by raising income directly as well as through raising the productivity of the farm unit, thus improving overall household income and food security. A number of studies (e.g., de Bruaw & Rozelle, 2002; de Bruaw et al., 2002; Liu & Xie, 2004) found out that rural households with off-farm employment have better income opportunities compared to those that concentrate on farm activities only. Similar findings are also echoed in the work of Zhang et al. (2004) who concluded that large part of the increase in rural income during 1990s was contributed to by incomes from off-farm employment. The increase in household income was in line with the increase in food security and access to better quality food.

4.6 Conceptual Framework

4.6.1 Adoption of Modern Farm Technologies

Theoretical Approach

The adoption of a new technology by farmers can be represented in a random utility framework developed by Greene (2003). Under this framework, the adoption of a new technology is usually modelled as a choice between two alternatives: the traditional technology and the modern technology. In other words, the utility gained from adoption of a practice is compared to the utility from non-adoption. Using the random utility theory (Greene, 2003), we can define the utility of farmer i associated with adopting a technology or not as:

$$U_{ij} = \mu_{ij} + \varepsilon_{ij} ------------------------------(1);$$

where μ_{ij} is a systematic utility, which is a non-stochastic function of explanatory variables and unknown parameters; and ε_{ij} is an unobservable random utility component which accounts for taste variation along with measurement errors. A utility maximising farmer i adopts a technology only if the random utility $U_{i1} > U_{i0}$, where $j = 1$ for the adoption of technology; and $j = 0$ for not adopting the technology. That is:

$Y_i = 1$ (farmer adopts the technology) $------------------$ (2)

If $U_{i1} > U_{i0}$

$Y_i = 0$ (farmer does not adopt the technology)$---------------$(3)

If $U_{i1} \leq U_{i0}$

Since these utilities are unobservable, the observed choice between the two varieties reveals which one provides the greater utility. Hence, a farmer's choice of either variety is modelled based on a binary random variable. The utility function $U(.)$ is assumed to be a function of farmer socioeconomic characteristics (SC); off-farm employment (OFE); farm characteristics (FC); endogenous household income (EHI); and amenities around the farmer (AM). That is:

$$U_i = U(SC, OFE, FC, EHI, AM, \varepsilon) ----------------- (4)$$

The specification of a logistic or standard normal distribution for $U(.)$ enables the estimation of equally asymptotically efficient parameter estimates using an iterative maximum likelihood (ML) approach. Amemiya (1981) notes that both logit and probit models yield similar parameter estimates and is thus difficult to distinguish them statistically. Nevertheless, Demaris (1992) argues that when one or more of the predictors in the model are continuous, which is the case in this study, logit modelling with disaggregated or individual level data (logistic regression) is used. Hence, assuming a logistic distribution for the ε, the logistic regression is chosen for this study.

Empirical Model Specification

For the econometric model, a univariate logit model is used for each practice (Greene, 2003). This model can be represented as:

$$Y_i = X_i \beta_i + \varepsilon_i \,,\ \varepsilon_i \sim N(0, \sigma_e^2)$$

$$Y_i = \begin{cases} 1 \ \textit{if} \quad \textit{practice} \quad \textit{is adopted} \\ 0 \quad \textit{otherwise} \end{cases} \text{------------------} (5)$$

where X_i is the vector that includes the values for the variables that form the deterministic part of the utility function (SC, OFE, FC, EHI, AM) for the observation i, and β_i is the vector that includes the coefficients to be estimated. The socioeconomic characteristics (SC) variables in this model are: gender of the household head (Male); whether the household head can read and write at least one language (Literacy); education level of the household head presented in the form of number of years of schooling (Education level); age of the household head (Age); total number of dependants in the household (Dependants); and household size (Household size). Off-farm employment (OFE) variables include whether the household has at least one member in off-farm employment (off-farm income) and number of household members in the off-farm employment (number of off-farm incomes). Farm characteristics (FC) variables include: cattle wealth (Raised cattle), goat wealth (Raised goat), sheep wealth (Raised sheep), pig wealth (Raised pigs), and the size of land cultivated (Cultivated land size). Endogenous household income (EHI) is the household wealth (Household wealth), which was generated using household asset ownership.[26] The variable for amenities around the farmer (AM) is represented by distance from the household to the nearest township (Remoteness).[27] The dependent variable, Y_i, is represented by four technologies adopted which are: use of chemical fertilizers; use of improved seeds; use of extension services; and use of draft animals, which are animals used to pull heavy loads like plough discs and trolleys. The choice of these variables have been informed by recent development which have happened I the agriculture sector in Tanzania. Chemical fertilizer and improved seeds are the two inputs that are part of the National Agriculture Input Voucher Scheme

[26]Assets that were used to create wealth index are dwelling type include, roofing material, type of wall, source of drinking water, type of toilet; ownership of other assets including mobile phones, radio, television, wheelbarrow, vehicle, disc plough; main source of energy for lighting and cooking

[27] Just as in the previous chapters, the variable for remoteness captures the distance in kilometre of the household in relation to the nearby town where a household gets daily necessities. The further the household is, the less the exposure it has to learn and recognize the importance of farm technologies. Also, it is expensive to access most of these technologies like chemical fertilizers and seeds.

(NAIVS) starting from the 2007/08 Agriculture year, aiming at increasing access of modern inputs to small-holder farmers to improve their productivity and food security. The best use of these inputs depends on the extent to which small-holder farmers interact with extension officers at various stages of crop season. But also, most of the small holder farmers' incomes do not enable them to access modern farming equipment like tractors, power tillers and others of similar nature. The most possible sophisticated accessible tool for small-holder farmers is the plough operated by draft animals.

The probability of adopting the practice, conditional on the explanatory variables, can be represented as:

$$P(Y_i = 1|X_i) = G(X_i\beta_i) ----------------------(6)$$

Where $G(.)$ is the cumulative distribution function in the case of the logit model, the standard normal distribution function is used for $G(.)$ (Greene, 2003). The marginal or partial effect of a continuous variable x_j can be calculated as:

$$\frac{\partial P(Y_i = 1|X_i)}{\partial x_j} = \frac{\partial G(X_i\beta_i)}{\partial x_j}\beta_j --------------------(7)$$

The coefficient in the right-hand side, that is,

$$\frac{\partial G(X_i\beta_i)}{\partial x_j} ----------------------------------(8)$$

is the probability density function, which is valued at the mean of the independent variables to measure the partial impact of an independent variable, x_j , on the probability of adopting a practice. For a discrete variable, x_j such as a dummy variable, the partial effect can be calculated following Greene (2003) as:

$$G(\beta_0 + \beta_i X_i + ... + \beta_j + ... + \beta_k X_k) - G(\beta_0 + \beta_i X_i + ... + \beta_k X_k) ---------(9)$$

In the first parenthesis, $x_j = 1$ and in the second parenthesis $x_j = 0$.

4.6.2 Off-Farm Income Effect on Food Security and Quality of Nutrition

In investigating the impact of off-farm income on food security and quality of nutrition, we use a single equation model as follows:

$$y_j = \beta_0 + \beta_i \sum_i \beta_i X_{ij} + \varepsilon_j ----------------------(10)$$

where y_j is log of dependent variables which represent food security and quality of nutrition. Three variables are used here: number of meals a household usually has in a day, number of times a household consumed meat in the past one week and frequency in which the household had problems of satisfying food needs in the past one year. While the number of meals a day and number of times the household consumed meat in the past one week represent quality of nutrition, the frequency in which the household had problems of satisfying food needs in the past one year represent food security. β_0 is a constant, β_i's are coefficients, X_{ij}'s are explanatory variables, ε_j's are stochastic terms. The explanatory variables in equation 10 are those factors that affect food security and quality of nutrition. These are Off-Farm Employment (OFE), household characteristics (HC), farm characteristics (FC), Endogenous Household Income (EHI) and amenities around the household (AM).

4.6.3 Data

The chapter uses the agriculture sample survey conducted by the National Bureau of Statistics (NBS) in collaboration with the sector ministries of agriculture.[28] The survey was conducted at the end of the 2008/09 agricultural year. It collected data by administering questionnaire to a sample of 48,315 small scale and 1,206 large scale farming households. The survey covered agriculture in detail as well as many other aspects of rural development and was conducted using three different questionnaires: the small-scale farm questionnaire; the community level questionnaire; and the large-scale farm questionnaire. The small-scale farm questionnaire was the main census instrument and included questions related to crop and livestock production and practices; population demographics; access to services, resources and infrastructure; and issues on poverty, gender and subsistence versus profit making production units. Given the scope of the small-scale farm questionnaire, data were collected at household/holding level, allowing sex disaggregation of most variables at the head of household level.

The sample consisted of 3,221 villages. These villages were drawn from the National Master Sample (NMS) developed by the National Bureau of Statistics (NBS) to serve as a national framework for conducting household-based surveys in the country. The National Master Sample was developed from the 2002 Population and Housing Census. Nation-wide, all regions and districts were sampled with exception of two urban districts. A stratified two stage sample was used. The number of villages/EAs selected for the first stage was

[28] Ministry of Agriculture, Food Security and Cooperatives, Ministry of Water and Livestock Development, and the Prime Minister's Office-Regional Administration and Local Government

based on a probability proportional to the number of villages in each district. In the second stage, 15 households were selected from a list of farming households in each selected village/EA, using systematic random sampling, with the village chairpersons assisting to locate the selected households.

4.7 Results and Discussions

4.7.1 Summary Statistics and Correlations

We first present the summary statistics of the variables used in the regression analysis of the decision to adopt farm technology in rural Tanzania. As can be seen in Table 4.1 below , in addition to farming, the vast majority of farm households (73% have off-farm economic activities and that on average each household has 1.2 members in off-farm employment. This finding is consistent with many studies which have shown that recently off-farm economic activities have significantly increased among farm households (e.g., Bryceson, 2000; Start, 2001; Ellis, 1999; Reardon, Berdegue & Escobar, 2001).

On household characteristics, the table reveals very interesting findings; it shows that the number of female-headed households stands at 20%. In rural areas, percentage of female-headed household stood at 16.4% in 1991/92, implying that the trend is increasing. The HBS (2009) shows the overall level increase of female-headed households in recent years, mainly due to increased widowhood, separation and divorce. It is also shown that while the literacy rate of adults is fairly good, more effort is still needed in terms of adult education as 31% household heads cannot read and write any language. In addition, the average year of schooling is 4.5 years. The table further shows that the average age of the household head practicing agriculture is 45.2 years. That implies that agriculture is not an activity that attracts the youth. Consistent with this finding, Leavy (2012) found that most young people in developing countries have no interest in agriculture since it is not within their own visions for the future. Household size among rural Tanzania is large with the average level of 5.1 persons per household, which is above national average of 4.8 in 2012 (NBS, 2013). Furthermore, the average number of dependants, which include old people aged 65 and above and children below the age of 16 years, is about 2.6 persons. This means that, on average, 50%of household members in rural Tanzania are dependants.

As pointed out earlier, farm characteristics used in this chapter are cattle wealth and the farm size cultivated by a particular household. As can be seen in Table 4.1, very few farmers practice mixed crop farming and animal husbandry. About 30% of crop famers raise cattle and goats while less than 15% raise sheep and pigs. Another interesting finding in Table 4.1 is that agriculture in rural Tanzania is predominantly small hold of average holding of 2.6 acres per household. The figures in Table 4.1 are comparable to others in similar national surveys like Household Budget Survey (HBS) and the National Panel Survey (NPS). The national panel survey conducted in 2011 has the same figure of land holding, implying that any efforts aiming at expanding land holding have not yielded any results.

On top of that, Table 4.1 indicates that on average, households live 1.4 kilometres away from small townships where they can access their daily necessities. But the value of standard deviation is far above the mean for this variable, suggesting skewed distribution of this variable. This signals that there are households which are living very far away from these small townships.

Something of great importance to policy makers and those interested in agriculture is that rural Tanzania is characterised by limited use of modern farm technology and services. The most accessed one is extension service. That is the case albeit only 36% of farm households have access to it. The other technology that is used by relatively many farm households is draft animals, which are accessed by 24%of farm households. Chemical fertilizer and improved seeds are used by less than 20% of the farming households. It is to be recalled that data presented an earlier chapter show great variation of using necessary inputs between different zones. Chemical fertilizer, improved seeds and use of extension services are mostly used by Northern (Kilimanjaro, Arusha and Tanga) and Southern highlands (Iringa,Njombe,Ruvima, Mbeya and Rukwa). On the other hand, Southern Zone (Lindi and Mtwara) is lagging behind using such inputs. Adoption of these modern technologies is associated with higher farm productivity. As we saw, Northern and Southern Highlands Zones had highest level of maize productivity and Southern Zone had the lowest.

Table 4.1 Summary Statistics and Definition of Variables Used in the Regression

Variable	**Definition**	**Mean**	**Std Dev**
Off-farm employment (OFE)			
Off farm income	Household with members in off-farm income activities (=1 if the household has at least one member in the off-farm activities)	0.73	0.45
Number of off farm incomes	Number of household members with off-farm incomes in the household	1.21	1.14

Household characteristics (HC)			
Male	Gender of household head (=1 if the household head is male)	0.80	0.40
Literacy	Literacy rate of the household head (=1 if the household head can read and write at least one language)	0.69	0.46
Education level	Years of schooling of the household head	4.51	3.62
Age	Age of the household head	45.18	15.54
Household size	Number of household members	5.14	2.73
Dependants	Total number of dependants in the household	2.57	1.98
Farm characteristics (FC)			
Raised cattle	Household raising of cattle (=1 if the household raised cattle)	0.26	0.44
Raised goat	Household raising of goats (=1 if the household raised goats)	0.28	0.45
Raised sheep	Household raising of sheep (=1 if the household raised sheep)	0.11	0.31
Raised pig	Household raising of pigs (=1 if the household raised pigs)	0.07	0.26
Cultivated land size	The actual land size (in acre) cultivated by a household in in 2008/9 season	2.65	3.74
Endogenous household income (EHI)			

household wealth	Household wealth index created using type of household assets	18.14	2.57
Harvest	Total harvested maize in Kilogram	644.43	950.42
Amenities around the farmer (AM)			
Remoteness	Distance of the household residence to the nearest township	1.38	1.80
Dependent variables			
Used of Chemical Fertilizer	Household use of chemical fertilizer (=1 if the household used)	0.14	0.38
Used of improved seeds	Household use of improved seeds (=1 if the household used)	0.19	0.39
Used of extension advise	Household use of extension advise (=1 if the household used)	0.36	0.48
Used of draft animals	Household use of draft animals (=1 if the household used)	0.24	0.43
Number of meals	Number of meals the household normally has per day	2.42	0.57
Number of meat	Number of days the household consumed meat last week	1.12	1.11
Frequency of food problem	Frequency the household had problems in satisfying the food needs of the household last year (responses ranging from never=1 to always=5)[29]	2.03	1.23

Source: Author's computation using NBS, 2008/09

[29] The whole range of response options are (1) never (2) seldom (3) sometimes (4) often (5) always

We also see that households in rural Tanzania take on average two meals a day and that meat consumption per week is on average once. However, households have seldom suffered with the problem of satisfying food needs in the past one year. This means that while households feel that they have access to food throughout the year, the quality of nutrition may be questionable given the number of meals and frequency of meat consumption per week.

While the above summary statistics highlight the average percentage of various variables, it does not give us the relationship between those variables. Correlation coefficients give the association of two variables as well as the strength of association. It also tells us the direction of association. It does not, however, tell us the direction of causality, which will shortly be presented through regression analysis. Table 4.2 shows the correlation of selected variables.

Correlation coefficients of adoption of farm technologies are very interesting. First, and perhaps most important, they are all positive and significantly correlated with harvest, implying that adopting them has a yield increasing effect. The second important thing is that they are positively correlated to each other, implying that the use of one technology induces the use of another. This means that once a farmer starts using certain technology, it is easier to adopt others. Given their yield increasing effect, this may mean that once farmers adopt one technology, they start enjoying high yields and they develop the adoption of others. To put it differently, once a farmer starts adopting one technology, it becomes easier to appreciate the importance of technology in farming and they can easily adopt others.

On the other hand, with the exception of use of extension services, all other adoptions are negatively correlated with off-farm employment. This may be because the time required to undertake off-farm employment substitute for the potential time to engage in on-farm activities and so adoption. In addition, this may mean that off-farm employment does not provide additional income to pay for such technologies, noting that even those households with bigger sizes do not seem to have positive correlation to capital intensive technologies like the adoption of fertilizers and improved seeds. Similarly, with the exception of use of extension services, old age is negatively correlated with use of chemical fertilizer and use of draft animals. Old age has a non-significant correlation with adoption of improved seeds. Decreased incomes and energy at old age may explain the limited adoption of these technologies. But extension may still be adopted at old age because it is neither energy intensive nor costly. While household size would be expected to have positive correlation with adoption of technology, it has a negative coefficient with adoption of chemical fertilizer as well as adoption of improved seeds. This may have to do with household's high poverty incidence caused by bigger family sizes, noting that the two adoptions need capital up-front. For the same reason, the need for capital up-front, household size is positively correlated with the use of extension services and draft animals—technologies which are cheaper.

The correlation coefficients between off-farm employment and other variables confirm the results of the previous chapter in this book. Off-farm employment has also negative and significant correlation with land size, implying existence of substitutability between the two. Again, it has a negative correlation with harvest, implying that off-farm employment in rural Tanzania are just means of supplementing low farm outputs, such that once the household is assured of enough to eat from farm output, they rarely engage in off-farm activities. In other words, farming may not be taken as a business activity for growth but rather for subsistence life. Also, off-farm employment has a negative correlation with age, meaning that old age households are inclined to on-farm than young ones. Issues of land ownership, which give power to old people, may have contributed to this trend. On the other hand, family size is positively correlated with off-farm employment. As discussed in the earlier chapter, this may imply that off-farm is just an activity to absorb excess labour that cannot be fully utilized on-farm.

Table 4.2 Pair Wise Correlation of Selected Variables

	Off-farm employment	*Chemical fertiliser*	*Improved seeds*	*Extension*	*Draft animal*	*Land size*	*Harvest*	*Age*	*Hh size*
Off-farm employment	1.0000								
Chemical fertilizer	-0.0216* (0.0000)	1.0000							
Improved seeds	-0.0086 (0.0871)	0.2415* (0.0000)	1.0000						
Extension	0.0465* (0.0000)	0.1867* (0.0000)	0.1791* (0.0000)	1.0000					
Draft animal	-0.0669* (0.0000)	-0.0788* (0.0000)	-0.0447* (0.0000)	-0.0036 (0.4769)	1.0000				
Land size	-0.0369* (0.0000)	0.0387* (0.0000)	0.0850* (0.0000)	0.0264* (0.0000)	0.1536* (0.0000)	1.0000			
Harvest	-0.0301* (0.0000)	0.2013* (0.0000)	0.0917* (0.0000)	0.0821* (0.0000)	0.1346* (0.0000)	0.2537* (0.0000)	1.0000		
Age	-0.0629* (0.0000)	-0.0465* (0.0000)	0.0001 (0.9940)	0.0115* (0.0215)	-0.0107 (0.0330)	0.0916* (0.0000)	-0.0178* (0.0016)	1.0000	
Household size	0.0014* (0.0016)	-0.0026 (0.5981)	-0.1024* (0.0000)	0.0457 (0.7808)	0.2037* (0.0000)	0.2981* (0.0000)	-0.1889 (0.0000)	0.1118* (0.000)	1.0000

(*) p-value is 0.05 or lower

Figures in parenthesis are p-values

Source: Author's computation using NBS, 2008/09

Other interesting results in the correlation matrix are association between land size, harvest and household size. We see a positive correlation between land size and harvest, signalling the importance of this factor of production in agriculture. We also see a positive correlation between land size and household size, signalling the importance of labour force in agriculture. However, we see a negative correlation between household size and harvest, meaning that while labour force is important, more and more labour in a fixed plot of land results in low production. This means that the importance of labour force makes sense in agriculture production only if land size is increased.

While the above correlation matrix shows that off-farm income is negatively correlated to most of farm technologies, implying that households having off-farm employment have less adoption of modern farm practices, off-farm employment seems to affect food security and nutrition status positively. Table 4.3 is a cross-tabulation of off-farm employment and food security and nutrition status variables. The first column covers food security and nutrition status variables; column two is the response option for each of the variables in the first column; and the third and fourth columns consists of information about farmers with and without off-farm employment respectively.

Table 4.3 Off-Farm Income and Food Security and Quality of Nutrition

		Household has off-farm employment	
		Yes (%)	**No (%)**
Number of meals a day	1	0.2	3.5
	2	52.5	51.3
	3 and above	47.3	45.2
Number of times of meat consumption in a week	0	20.8	39.4
	1	35.1	32.4
	2	26.5	19.2
	3 and above	17.7	9.0
Incidence of food problem past one year	Never	48.2	43.2
	Seldom	29.7	32.3
	Sometimes and above	22.0	24.5

Source: Author's computation using NBS, 2008/09

As we can see, the number of meals a household usually has in a day increases faster with off-farm employment than it does with those without off-farm employment. Similarly, the number of times a household consumed meat in the past week increases relatively in a faster rate in households with off-farm employment than in those without. Finally, we see that incidence of food problem in the past one year decreases relatively faster in households with off-farm employment than it does in households without. This means that while off-farm employment do not contribute to increased adoption of modern farm technology, they help in improving food security and nutrition status of households practicing it. What is also very obvious in Table 4.3 is that there is no very big difference between those households with and without off-farm employment in the number of meals in a day and incidence of food problems in the past one year. However, there is a big difference between those with and those without off-farm employment in the number of times in which the household consumed meat in the past one week. Note that meat is very expensive and nutritious meal, implying that income from off-farm employment enables households not only to access food but also to afford the best food at higher prices.

4.7.2 Results from Logit Model

We discuss results of logit model of adoption of four farm technologies: use of chemical fertilizers, use of improved seeds, contact with extension officers and use of draft animals. The results are presented in Table 4.4. Various factors have been identified to affect adoption of these technologies, although the degree and direction of effect for one factor may differ with adoption of others. We find that having off-farm income source in the household affects positively adoption of some technologies and negatively to others. Specifically, having off-farm income is negatively related to the use of chemical fertilizer ($p < 0.1$), use of draft animals ($p < 0.05$) and use of improved seeds (although the relationship is not significantly differently from zero). The negative and significant relationship between having off-farm income and adoption of these technologies indicates that, in general and holding other factors constant, households with off-farm activity as part of their income source have a lower probability of adopting them than those without. This is contrary to many studies which show that off-farm income relaxes the cash constraints on paying for inputs necessary for adoption of modern farming technologies. This is particularly the case with those farming technologies that require capital upfront. Ervin and Ervin (1982); Shiferaw and Holden (1998); de Janvry, Sadoulet and Zhu (2005) and Odendo et al. (2011), show that households with prior access to off-farm income were more likely to adopt soil management technologies. Studies that found negative relationship between off-farm employment and adoption of modern farm practices have associated such findings with the substitution hypothesis. This means that household engagement in off-farm employment reduces the time needed to work on-farm and also for adoption of farming practices. Hua, Zulauf and Sohngen (2004), for instance, found a negative and significant relationship between off-farm employment and participation in a formal conservation program. They argued that farmers with off-farm employment have a high opportunity cost for the time that is required to participate in a conservation program and that additional funds are required by farmers to participate in these programs. Such farmers can thus only participate in farming technologies that are labour-saving. Phimister and Roberts (2006), for instance, found out that the use of crop protection per hectare increases at relatively high levels of off-farm work, in particular when a farmer works between 430 and 900 hours annually off-farm, contrary to fertilizer intensity, which declines as off-farm labour increases.

While the above argument is applicable to Tanzania as well, it does not explain the whole story. As indicated earlier , in the current study, off-farm employment is correlated with household size, suggesting that labour availability affects positively off-farm employment. But also, as shown in the third chapter, off-farm employment in rural Tanzania is a result of push factors, farmers do not get enough from farming and thus are pushed to off-farm as a means to complement farm income to smoothen consumption. In other words, off-farm employment is just a means to survive but may not also be able to meet other expenditures like paying for the adoption of farm technologies. Obviously, off-farm employment reduces the time necessary to have full engagement in farm activities. Thus households with off-farm employment are more likely to engage in those farm technologies that are labour saving. But also, the income earned through off-farm employment is likely to be consumed only to meeting subsistence level and cannot be made available for adoption of those farm technologies. This is particularly true of those technologies that need capital up-front like chemical fertilizers and improved seeds. On the other hand, off-farm employment is positively significant related to adoption of extension services ($p<0.01$). Following the preceding discussion, it can be said extension service is not labour intensive. Furthermore, extension service among small-holders in rural Tanzania is a public service, which does not necessarily require that the beneficiary has cash up-front.

Table 4.4 Logit Model for Adoption of Modern Farm Technologies

Variable	*Chemical fertilizers*	*Improved seeds*	*Extension services*	*Draft animals*[30]
<u>*Household characteristics*</u>				
Off-farm income	-0.090*	-0.066	0.164***	-0.083**
Ln of number of years of	0.267***	0.248***	0.155***	-0.122***

[30] Draft animals are animals used to pull heavy loads like plough discs and trolleys

schooling				
Ln of age	0.091	0.233***	0.302***	-0.584***
Ln of household size	-0.130**	-0.362***	0.075	0.140***
Ln of number of dependants	-0.054	-0.193***	-0.080***	0.130***
Farm characteristics				
Raised cattle	-0.116***	0.226***	0.106***	1.827***
Raised goat	-0.096*	-0.018	-0.025	-0.136
Raised sheep	-0.380***	0.291***	0.140***	0.317***
Raised pig	0.878***	-0.089	0.250***	-0.211
Ln of cultivated land size	0.162***	0.044**	0.035**	0.388***
Household income				
Ln of household wealth	4.077***	4.035***	2.282***	-0.619***
Proximity to services				
Ln of remoteness	-0.180***	-0.013	-0.049***	0.086***
Constant	-13.778***	-14.895***	-8.793***	1.919***

*** p<0.01, ** p<0.05, * p<0.1

Source: Author's computation using NBS, 2008/09

The coefficient for education attainment (defined by number of years of formal schooling) of the house-hold head is positively related to adoption of the three farm technologies (chemical fertilizer, modern seeds and extension services) (p < 0.01). However, education attainment is negatively related to adoption of draft animals (p<0.01). This implies that additional years of formal schooling increases adoption of chemical fertilizer, improved seeds and use of extension service but it decreases adoption of draft animals. The positive effect of education on the three farm technologies could be transmitted through the knowledge-intensive requirements for the use of such modern farming technologies, which may be complex. Also, educated farmers are more likely to be commercial oriented than traditional farmers who are likely to be peasantry. Thus, it is the educated farmers who are likely to think on productivity and hence opt for modern farming practices. As argued by Chang and Boisvert (2005), farmer education hastens the adoption of modern farming technologies because better educated farmers are able to understand the benefits of the technology than their counterparts with no education. It is also important to note that optimal use of, say, chemical fertilizers requires much knowledge in understanding types of fertilizers for different crops including rates, time and method of application. All this requires high educational attainment. Similarly, adoption of improved seeds requires understanding of type in relation to season and expected length of rain season. This is also witnessed in the study of Weir and Knight (2000) which reported that household heads' level of education hastened the timing of technology adoption..

An interesting analysis of the relationship between formal education and adoption of best farming practices is the negative and significant relationship between formal schooling and adoption of draft animals. As will be discussed later in this section, the use of draft animals has been associated with remoteness and lower incomes characteristics which are likely not to be of those households whose heads have some levels of formal schooling. Thus, it is not surprising to see this farm technology being negatively related to attainment of formal schooling.

The study also found that age of the household head is positively (though not significantly) related with the adoption of chemical fertilizer; positively related with the use of improved seeds ($p < 0.01$); and positively related to the use of extension services ($p < 0.05$). However, the age of the household head is negatively significantly related to the adoption of draft animals ($p < 0.01$). The first three technologies which are positively related to age may be because their adoption requires a considerable finance (especially for chemical fertilizer and improved seeds) of which the elderly household heads may have accumulated capital, enabling them to access those inputs. Additionally, in the absence of enough capital, elderly household heads are better positioned to be preferred by credit institutions, making it easier for them to access such inputs than their younger counterparts. In a related study, Abdulai and Huffman (2005) found that households headed by elderly persons adopted dairy cattle, which were considered an expensive undertaking, more quickly than those headed by younger ones. Although the adoption of extension services in rural Tanzania may not necessarily require having cash up-front, elders have a positive relation with this adoption, perhaps because they have been farming for long time and can appreciate the importance of using extension services than young ones. As rightly argued by related studies (see Asafu-Adjaye, 2008 ;Bultena & Hoiberg 1983; Gould et al., 1989; Polson, 1991), older farmers are more experienced and so are likely to be aware of the long-term productivity impacts of technology, especially those related to soil management than their younger counterparts. Extension services have positive impacts with management of soils, so it is likely to be adopted by older farmers. On the other hand, the negative and significant relationship between age of the household head and adoption of draft animals may partly be explained by long-time wealth accumulation by elders, making them opt for more efficient and sophisticated power tillers and tractors than relatively less efficient draft animals. Also, the use of draft animals is energy intensive, which may be a problem for old farmers.

The household size is found to have a negative and significant relationship with adoption of chemical fertilizer ($p<0.05$) and also with adoption of modern seeds ($p<0.01$). On the other hand, the coefficient of this variable has a positive but non-significant relationship with the use of extension services and a positive and significant relationship with adoption of draft animals ($p < 0.01$). The negative relationship between household size, the adoption of chemical fertilizer and improved seeds imply that households with relatively bigger family sizes have lower probability of adopting these technologies. Demographic studies in Africa have associated household size and labour force availability (see Kamuzora, 2001). Since the adoption of chemical fertilizers and improved seeds have been categorized as labour-intensive technologies (Odendo et al., 2011), their adoption was expected to be positively affected by family size. A related study by Franzel (1999), for example, found that farmers' decision to adopt improved tree, which was relatively labour-intensive technology was constrained by household labour force size (eee also Feleke & Zegeye, 2006). The current unexpected trend in Tanzania could be explained indirectly through characteristics of the households with large family sizes in Tanzania. When studying rural poverty in Tanzania, Rutasitara (2002) found a strong positive relationship between family size and poverty. The recent household budget survey has also shown that poverty is widespread in rural areas where average family sizes are higher than those in urban areas (URT, 2009). Given that access to chemical fertilizers and use of improved seeds require capital up-front, more households with large family sizes are likely to experience difficulties accessing such technologies. Family size has also been found to have positive and significant relationship with adoption of draft animals. This is so because draft animal technology is relatively cheap technology for lower income households to afford. Similarly, household size has positive relationship—though insignificant—with the use of extension services, perhaps because this technology may not necessarily require capital upfront as it is mainly provided by the government.

Total number of household dependants is negatively related to the adoption of chemical fertilizer, improved seeds and use of extension services. On the other hand, number of household dependants is positively significant in explaining adoption of draft animal technology. The negative signs of coefficient of number of dependants imply that a high dependency ratio retards the adoption of those farm technologies. Studies which found negative relationship between high dependence ratio and adoption of farm technology explained such relationship as resulting from limited labour supply, noting that such households are dominated by younger people, elderly and the sick who cannot contribute labour to most of the works necessary for such farming technologies (Shiferaw & Holden, 1998). It is also possible that households with a higher dependence ratio also face financial constraints to afford inputs for adopting farming technologies, given that much of their resources are used to take care of dependants. Within the same context, we see a positive relationship between high dependence ratio and adoption of draft animal, the technology which is relatively cheaper.

Variables for livestock ownership have different signs on different farming practices. With the exception of pigs, household ownership of livestock has been found to have negative and significant relationship with the adoption of chemical fertilizer, implying that having livestock reduces the use of chemical fertilizers. Usually, small holder farmers would want to increase output using the simple and cheap technology available. Thus, negative relationship between livestock ownership (cattle, goats and sheep) may suggest the existence of substitution effects between chemical fertilizers and manure. That is, owners of livestock are able to obtain manure as the main source of nutrients to their land, which by the way remains relatively cheaper than chemical fertilizers, which must be purchased. This finding is consistent with that of Odendo et al. (2011) who found that cattle ownership increased the pace of the adoption of manure and such areas had limited usage of chemical fertilizers because they were mostly away from the market.

On the other hand, livestock ownership is positively related to the remaining farming technologies that are significant and negatively related to those that are not significant. The positive and significant relationship between livestock ownership and adoption of modern seeds and use of extension services may be due to income effects, that is, livestock keeping reduces household cash constraints necessary to pay for that technology especially the use of improved seeds which requires cash up-front. The results for the coefficient of relationship between livestock ownership, especially cattle, and adoption of draft animals give expected findings. Not only is the coefficient significant

($p<0.01$) but also the magnitude is high (1.8), suggesting that this technology is mostly used by a household that owns cattle. Just as was the case with the adoption of manure, this technology seems relatively cheaper for owners of cattle.

Cultivated land size is positively associated with the adoption of modern chemical fertilizer ($p < 0.01$), improved seeds ($p < 0.05$) and extension services ($p < 0.01$). Although the variable is also positively related to adoption of draft animal, the relationship is not statistically significant. These results imply that households with larger farm size are more likely to adopt modern farming technologies than their counterparts. It can be argued that a larger household's land holding is associated with greater wealth and increased availability of capital, which makes investment in modern technology management more feasible. Moreover, as reported by Rahm and Huffman (1994) farmers operating larger farms can afford to devote part of their fields to try out the improved technology. Our results are also consistent with that of Norris and Batie (1987), which showed that a larger farm size is associated with greater wealth, increased availability of capital and a higher risk bearing ability which makes investment in conservation more feasible. However, our findings differ from those of Shiferaw and Holden (1998), which show that a large farm per capital is negatively associated with adoption of soil conservation technology.

Household wealth is positively related to the use of chemical fertilizer ($p < 0.01$), adoption of improved seeds ($p < 0.01$) and use of extension services ($p < 0.01$). However, household wealth is negatively related to adoption of draft animals ($p < 0.01$). This implies that farm households which are wealthier have a relatively higher probability to adopt chemical fertilizers, improved seeds and extension services than their counterparts which are less wealthy. Wealthier households can apply chemical fertilizers and use improved seeds because they either have cash income to access these technologies or possess necessary collateral that would enable them to access the financial facilities for these technologies. These findings are consistent with Feleke and Zegeye (2006) who found out that farmers who had access to credit were more likely to adopt improved maize varieties than those without. Similarly, Asafu-Adjaye (2008) found that affordability was crucial in any adoption strategy by showing that a high level of soil conservation was associated with increase in farm incomes. Use of extension service is also positively related to household wealth. The coefficient of this variable has also high magnitude suggesting intensive use. The high and significant coefficient tells us that even in a situation where the government cannot provide enough extension service, which is typically the case in Tanzania and other developing countries, wealthier households can even afford to use private provided extension officers. While household wealth is significantly positive in explaining the adoption of all the three technologies discussed, it is negatively significant in explaining adoption of draft animals, implying that the higher the household wealth, the less the adoption of draft animals. It is very possible that wealthier farmers opt for more sophisticated technology, mainly power tillers and tractors rather than less efficient draft animals. Furthermore, it is wealthier farmers, who are likely own bigger land sizes that can efficiently be tilled by relatively sophisticated technology like tractors or power tillers. In a word, it could be said that draft animal technology seems to be most popular among less wealthy farming households.

Table 4.5 Marginal Effects after Logit

Variable	*Chemical fertilizers*	*Improved seeds*	*Extension services*	*Draft animals*
Household characteristics				
Off-farm income	-0.009*	-0.009	0.037***	-0.014**
Ln of number of years of schooling	0.026***	0.035***	0.035***	-0.020***
Ln of age	0.009	0.003***	0.069***	-0.096***
Ln of household size	-0.013**	-0.051***	0.017	0.023***
Ln of number of dependants	-0.005	-0.027***	-0.018***	0.021***
Farm characteristics				
Raised cattle	-0.011***	0.033***	0.024***	0.363***
Raised goat	-0.010*	-0.003	-0.006	-0.022
Raised sheep	-0.033***	0.044***	0.033***	0.056***
Raised pig	0.115***	-0.012	0.059***	-0.033
Ln of cultivated land size	0.016***	0.006**	0.008**	0.064***
Household income				
Ln of household wealth	0.401***	0.562***	0.522***	-0.101***
Proximity to services				
Ln of remoteness	-0.018***	-0.002	-0.011***	0.014***

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Source: Author’s computation using NBS, 2008/09

The coefficient for a variable on remoteness, which represents distance in kilometre of the household from the township has a negative sign with the use of chemical fertilizer ($p < 0.01$) and use of extension services ($p < 0.01$). The coefficient for this variable also has a negative but non- significant relationship with the use of modern seeds. On the other hand, distance to the nearest township has a significant positive relations to the adoption of draft animals ($p < 0.01$). These findings indicate that the further the household is from a township, the less the probability that it will adopt farming technologies, except adoption of draft animals. The negative relationship between distance to the township, on the one hand, and adoption of chemical fertilizer, improved seeds and extension service, on the other, is possibly because of relatively higher logistic costs of accessing those facilities compared to farmers living closer to small rural towns. Usually, stores where chemical fertilizers and improved seeds are most likely located in small towns where many households are clustered together. Likewise, extension officers are most likely living in these towns rather than in remote areas. These findings corroborate with results reported by Feleke and Zegeye (2006). Their study revealed that farmers far away from market centres are less likely to adopt improved maize varieties than those who are located close to the market centres. Their argument for this relationship is that farmers far away from market centres tend to be less market-oriented, that is, the technology use decisions of these farmers would rely more on subsistence production than profitability considerations. Consequently, the authors further note, these farmers may not be interested in investing their meagre resources on improved varieties as long as the traditional varieties provide a subsistence level of output for their families. Similarly, Dadi et al. (2004) and Odendo et al. (2011) reported that the speed of adoption of mineral fertilizer and herbicides was faster in a high agriculturally potential area with good infrastructure in rural Ethiopia and Kenya respectively as compared to a low agricultural potential area with poor infrastructure. On the other hand, the positive and significant relationship of remoteness with the use of draft animals ($p < 0.01$) implies that the use of draft animals increases with remoteness. Probably, due to logistical costs of accessing and negotiating on power tillers and tractors owners, who are most likely living in rural towns, remote farm households end up depending on draft animals for tiling their farms.

Results from the marginal effects (see Table 4.5) demonstrate the strength of association between the dependant and explanatory variables. What is quite clear in the table is that household wealth is very strong with adoption of farm technologies, especially those that require capital up-front. Thus, the coefficients of adoption of chemical fertilizer, adoption of improved seeds and use of extension services are very high. This means that lower income among farming households is a hindrance factor for adoption of farm technologies.

Thus, measures to increase rural incomes would, to a large extent, improve the adoption of modern farm technologies and hence more farm outputs. In other words, the current usage of modern farming practices in Tanzania is constrained by lower levels of farmers' incomes.

Table 4.6 Relative Importance of Selection Adoptions

Dependent variable: Ln of harvest	***Coefficient***	***t-ratio***	***p-value***
Used chemical fertilizer	1.297 (0.031)	41.43	0.000
Used improved seeds	0.109 (0.029)	3.76	0.000
Used extension services	0.185 (0.023)	7.97	
Used draft animal	0.612 (0.025)	24.92	0.000
Constant	4.984 (0.016)	314.11	0.000

(*) p-value is 0.05 or lower

Figures in parenthesis are p-values

Source: Author's computation using NBS, 2008/09

Relative importance of individual farm technology was determined by running a separate regression of output on the four adoptions (Table 4.6). As was the case with the earlier part of this section when analysing correlation between selected variables, all selected adoptions have positive bearing effects on yield. Also, they are all significant with yield ($p<0.01$), meaning that increased using of any of these inputs would result into increased yield. Analysis of relative importance-as presented in Table 4.6 shows that adoption of chemical fertilizer has the highest yield increasing effect, followed by using adoption of draft animals, then use of extension services. The last in the importance in yield increasing effect for the selected farm technologies is adoption of improved seeds..

4.7.3 Off-Farm Income and Food Security

In this section, we analyse the relationship between food security and off-farm employment. This helps us to understand more the dynamics of off-farm incomes, which seems to have limited impacts to adoption of modern farm technology, yet its practices grow substantially in rural areas. In modelling food security variables, we use the same household characteristics, farm characteristics, household wealth and proximity to services because they all determine rural household consumption. Our food security variables are number of meals a household usually has in a day; number of times a household consumed meat in a week preceding the survey; and how often did the household had food problems in the past one year.

Results of the relationship between off-farm income and food security are summarised in Table 4.7. We find that household off-farm income is positively related to number of meals a household usually has in a day ($P<0.01$); positive related to number of times a household ate meat in the past one week ($p<0.1$); and negatively related to frequency in which the household has experienced food problems in the past one year ($p<0.01$).

Table 4.7 Ols of Household Food Security and Nutrition Status

Variable	Ln of number of meals	Ln of number of meat	Frequency of food problem
Household characteristics			
Off-farm income	0.098***	0.079*	-0.060***
Male	0.027***	0.140***	-0.003
Ln of number of years of schooling	0.015***	0.235***	-0.029***
Ln of age	-0.015***	-0.752***	0.054***
Ln of household size	-0.006	-0.345***	0.071***
Ln of number of dependants	-0.002	0.067	0.013
Farm characteristics			
Raised cattle	0.014***	0.063**	-0.051***
Raised goat	0.022	-0.025	-0.058***
Raised sheep	0.048***	0.240	0.045
Raised pig	0.026***	0.101***	-0.121***
Ln of cultivated land size	0.015***	0.024**	-0.067***
Household income			
Ln of household wealth	0.418***	0.986***	-1.045***
Proximity to services			

Ln of remoteness	-0.001	0.018	0.020***
Constant	-0.333***	0.465***	3.328***

*** p<0.01, ** p<0.05, * p<0.1

Source: Author's computation using NBS, 2008/09

These results show that off-farm employment enables a household not only to be able to meet food needs on a normal daily frequency, but it is also helpful in accessing better food type like meat. Furthermore, the fact that household with off-farm income have less frequency of experiences of food problems means that, such income helps households to smooth consumption throughout the year. These results, thus, suggest that participation in off-farm activities is associated with better food access and nutrition. As shown in the previous section, off-farm income does not contribute to the adoption of most farm technologies, except those that are labour saving like adoption of extension services. Given the dominancy of farming activities in rural areas, one would associate household with off-farm income with food insecurity. However, these results are saying that while off-farm employments substitute labour necessary to participate in farming and hence to adopt modern farm technology, they complement well farm incomes and enable participating households to be able to purchase food. These results are consistent with the findings by Ruben and van den Berg (2001) for Honduras and by Reardon et al. (1992) for Burkina Faso. A related study by Babatunde and Qaim (2010) also showed an increase in annual off-farm income by 1000 naira per AE results in an average consumption improvement by 22 kcal per day in Nigeria. Similarly, the study also revealed that off-farm income has a positive net effect on food security and nutrition, which is in the same magnitude as the effect of farm income.

The results of this study further show that male-headed households have higher frequency of food consumption per day than female-headed ones (p<0.01). Similarly, male-headed households consume more meat than female-headed households (p<0.01). Furthermore, male-headed households have lower frequency of incidence of having faced problems of satisfying food needs in the past one year than their female counterparts. The relationship was, however, found to be non-significant. While it is known that women usually take greater care of family nutrition, female-headed households are often disadvantaged in terms of social status and economic opportunities (Kaliba et al., 2000; Odendo et al., 2011). Studying the impact of off-farm income on food security and nutrition in Nigeria, Babatunde and Qaim (2010) found also that male-headed households have better access to food security and nutrition status than female-headed households.

Education level, defined by number of years of formal schooling of the household head, is positively related to number of meals a day, number of times a household consumed meat last week but had negative significant relations with frequency of having faced food problem in the past one year. This means that households where a head has more years of schooling are likely to be more food secure. More importantly, the magnitude of coefficient of number of times a household ate meat in the past one week is greater. Noting that the price of meat is relatively higher, education enables households not only to be food secure but also to be able to purchase expensive foods. This may be because educated heads are relatively more entrepreneurial and can perform higher return from off-farm economic activities than those without or with lower level of formal schooling.

Age is negatively related to number of meals a household usually has a day ($p<0.01$); negatively related to number a household ate in the last one week ($p<0.01$); but had a positive relationship with frequency in which a household has faced problems of having food in the past one year ($p<0.01$). This implies that as the head of the household becomes older, ability to produce as well as to purchase food decreases. The magnitude of coefficient of number of times a household ate meat in the past one week is very high. Noting that meat is mostly bought, this may mean that old households have relatively high problem of cash incomes. In the context of rural Tanzanian, these results are not surprising because farming is mainly the activity of old families as shown in the third chapter. Given the labour-intensive nature of agriculture in Tanzania, productivity is likely to decrease with old age, hence food security as well as income. Similar results were reported by Babatunde and Qaim (2010) but the authors attributed their findings to the fact that older people are often less aware of nutritional aspects and that calorie and nutritional requirements for elders are usually somewhat lower than those of younger adults.

Household size is negatively related to number of days a household ate meat in the past one week ($p<0.01$) but positively related to frequency in which a household faced food problems in the past one week. Though non- significant, household size is negatively related to number of meals a household usually has in a day. A number of studies have associated household size with available labour force (Kamuzora 2001) and hence more farm outputs (Allene and Manyong, 2007; Gille, 2011). As shown in the second chapter, farm outputs decrease with the labour force size. This is perhaps due to the low mechanization of Tanzanian agriculture which limits expansion of farm size. Thus, as more and more labour are made available to a small and fixed land size, output decreases, hence food security and income out of farming decrease. The number of dependants is, however, found to be non-significant in explaining food security as well as the nutrition status of the household.

Livestock wealth appears to affect food security and nutrition positively, implying that households with livestock wealth are relatively food secure and have better nutrition status than those without. Considering that livestock is the source of meat, one would expect frequent meat consumption to be the highest among households with more livestock. That is, however, not the case with the current study. While coefficients of livestock wealth have expected signs (except few which are not significant), the magnitude of coefficient for the frequent of meat consumption in the past one week are not the highest. This means that consumption of meat among these households is not from directly slaughtering them but rather indirectly through income derived through the selling of livestock or livestock products like milk.

Farm size has been found to be positively affecting food security and nutrition status of the household. Farm size increases number of meals a household takes in a day ($p<0.01$); it increases frequent of meat consumption ($p<0.01$); and it decreases the frequency in which the household has suffered food problem in the past one year ($P<0.01$). These results are not surprising because farm size has been associated with more harvest in related studies as well (Ajani & Ugwu, 2008; Alene & Manyong, 2007; Appleton & Balihuta, 1996; Asadulla & Rahma, 2005; Gille, 2011; Wear, 1999) implying more food security. Indirectly, more harvests can be associated with higher incomes through selling of excess and hence enabling the household to purchase nutritious food like meat. Consistently, Babatunde and Qaim (2010) also found that farm size contributes positively to calorie supply with a marginal effect of 193 kcal per additional ha. This means that both off-farm and on-farm incomes are equally important when it comes to food security and quality of nutrition.

Household wealth has been found to have positive impact on food security and quality of nutrition. Apart from having positive and significant effects on number of meals a household takes a day and number of times a household consumed meat in the past one week, the magnitude of coefficients of this variable are very high (0.42 for number of meals and 099 for number of times a household consumed meats in the past one week). Also, it has a negative relationship with frequency in which the household had problems of satisfying food needs in the past one year. Similarly, apart from this coefficient being significant ($p<0.01$) its magnitude is very high. These results are expected because wealthier households have higher access to important resources enabling them to produce food on their own farms efficiently or to purchase food from other producers.

In contrast, remoteness was found to be reducing food security and quality of nutrition. We have shown that both off-farm and on-farm incomes are important for food security and quality of nutrition. We have also shown in the current study that remoteness does not provide a conducive environment to increase farm productivity. Farmers in remote areas face limited exposure to modern technology and they lack entrepreneurial skills. Thus, they are less productive when it comes to farm production. Similarly, as shown in the previous chapter, remoteness does not provide avenues for off-farm activities, as these activities are most favourable in the areas where communities are clustering together. In that case, remoteness has a negative impact on both on-farm productivity and off-farm employment.

4.8 Conclusions for Policy

Previous studies on the role of off-farm incomes on farmers' adoption decision and food security have provided conflicting evidence. In some cases, off-farm incomes are reported to increase food security through increased adoption of modern farm practices (see Chang & Boisvet, 2005; Cornejo, Hendricks and Mishra, 2005; Ervin and Ervin, 1982; Gasson 1988; Odendo et al. 2011; Shiferaw and Holden, 1998). Such studies have argued that off-farm employment increases farm household incomes necessary to adopt modern farm technologies. On the other hand, off-farm employment may imply less time available to adopt technologies hence less farm output, which may threaten food security among rural poor households (see Goodwin & Mishra, 2004; Hua, Zulauf & Sohngen, 2004; McNally, 2002; Prokopy et al. 2008; Smith, 2002). This inconclusive evidence of the actual impact of off-farm income on adoption of modern farm technology and food security calls for location specific study. As a response to specific context studies, this chapter sought to clarify the role of off-farm income on farmers' decision to adopt modern farm technology and food security in rural Tanzania. Four farm technologies (adoption of chemical fertilizer, adoption of improved seeds, use of extension services and adoption of draft animals) have been examined. Also, three food security and nutrition variables, namely number of meals a household usually has a day, number of times a household consumed meat in the past one week, and the frequency in which the household had a problem of satisfying food needs in the past one year were also investigated.

The current study has provided evidence that off-farm employment of at least one household member increases adoption of some technologies and decreases adoption of others. Specifically, off-farm income decreases adoption of those technologies that are labour-intensive. These results are contrary to many adoption studies, which have shown that off-farm income releases the household from cash constraints, thereby enabling them to adopt best farming practices especially those that are capital intensive (see Ervin & Ervin, 1982; Odendo et al., 2011,Shiferaw & Holden, 1998). The current study has shown that off-farm employment takes most of the time that would be used for adoption of best farming practices but also that the income generated from them does not translate into increased farm inputs through adoption of modern technologies.

However, food security and quality of nutrition appear to be positively affected by off-farm employment. This means that while the income derived from off-farm activities do not contribute to farm productivity, they help households practicing them to access food but also of better quality. Since As shown in the third chapter, since off-farm employment is a result of low outputs in the farm sector, these results may demonstrate that while off-farm employments contribute to households enough incomes to meet food needs, they are not substantial enough to meet other expenditures like farm technologies. Thus, enhancing off-farm economic activities in rural Tanzania should go hand in hand with increasing their scales so that they generate incomes beyond survival. Having off-farm incomes that do not go back to increasing farm technology utilization may also mean that urbanization in rural Tanzania is high. That makes the majority of rural people move from food production to buying food. In such cases, a deliberate measure to increase labour productivity in the agriculture sector is important. The reason for doing that is when off-farm increases in scales and attracts more labour out of farming, the remaining labour in on-farm activities is productive enough to meet the potential increasing needs of farm outputs. In other words, promotion of off-farm employment is justified as an instrument to attract excess labour that cannot be fully utilized in agriculture. In this way, both unemployment (and underemployment) and food security problems will be addressed.

What also emerges from this study and perhaps very important in transforming agriculture is the adoption of draft animals. First, it was found that this technology has one of the highest yield increasing effects among other farm technologies. The results, however, show that adoption of draft animals is negatively related to household wealth and positively related to remoteness. This means that the adoption of modern draft animals is mostly accessible to lower income farmers as well as those in remote areas. To put it differently, while draft animal technology is one of the most important tool in increasing productivity, it seems to be the cheapest and so mostly accessible by poor and remote farmers. The recent agriculture promotion initiatives, which are well documented in the Second Five Years Development Plan and the Agriculture Sector Development Programme II, place emphasis on the transformation of rural farming by applying modern farming technologies with a focus on chemical fertilizers and improved seeds, which are subsidized to small-scale farmers. This is very important, as we see that both inputs have a positively significant yield increasing effect. However, the scale seems to be small because the use of these inputs is very low. In terms of mechanization, great emphasis has been on power tillers and tractors, which has resulted in importation of over 5,000 power tillers. This is an important undertaking of promoting rural transformation. However, given the current statistics (that 70% of farmers use hoes; 20% use draft animals; and only 10% use tractors and power tillers) the adoption of draft animals appears to be a quick solution to transforming rural agriculture than concentrating on power tillers and tractors. Considering the current trend, it is likely to take long to be adopted by the majority of farmers. It is thus important that in the short run the government promotes the use of draft animals, a technology which is cheaper and readily accessible to the majority of farmers, while working on longer term plans of using power tillers and tractors.

CHAPTER V

CONCLUSIONS

Agriculture in Tanzania has been considered a backbone of its economy. This is because of the role it plays in providing employment to the majority of the rural citizens and due to its role as amajor determinant of food security in the country. Despite the importance attached to it, its share to GDP declined from around 50% towards the late 1980s to around 25% in the current decade. It is well known that poverty is still high in the country and more so in rural areas. Part of the reasons for high poverty in rural areas is lower farm productivity resulting from traditional nature of farming, where the hand hoe remains a main tool coupled with the limited adoption of innovations and modern inputs. The Government recognizes the importance of agriculture in addressing rural poverty, hence, devotes its efforts in addressing the bottlenecks facing it. This is reflected in the National Development Vision 2025, whose implementation is carried out through the short-term programmes. Initially, the country had the National Strategy for Growth and Reduction of Poverty, popularly known by its Kiswahili acronym MKUKUTA and now we have Five Years development Plan, which is now in the second phase. In all these programmes, agriculture is to be transformed from small to medium and large scale through increasing innovations and modern inputs use. Apparently, various efforts are put in place to identify drivers of growth in rural Tanzania in order of the impact they may have, so as to sequence their implementation. That was done taking into account the expertize and financial constraints that the country face. This book has sought to contribute to this debate by identifying potential drivers of farm households' incomes in a situation in which the government is striving to transform the agriculture sector from traditional to modern.

To that effect, chapter two focused on the role played by formal education on farm productivity. The analysis of this relationship centres on the hypothesis that formal education acquired during primary and secondary school can provide numeracy and literacy knowledge which is an important input in the agriculture sector in helping the farmer to adopt innovations. Our research findings bring to light the importance of primary formal education as an indispensable production input in agriculture and rural economic development of the nation as a whole. Specifically, our analysis supports the relative importance of basic education over higher education in agriculture. Household head's education, when decomposed by levels of education, shows that having over and above zero up to six years of formal schooling has a significant impact on adoption of farm innovations. The top end of primary education level can influence farmers to be risk takers and adopt risk innovation that have higher returns. This suggests that basic literacy skill, usually attained during primary schooling, is very relevant to farm productivity through its impact on the adoption of innovations.

Following the identification of education as one of the drivers of growth through accelerating adoption of innovation, the book has suggested solutions for promoting formal education, both short and long term. In the short term, it has been suggested that the government should place emphasis on adult education for older farmers. This is hoped to equip older farmers with some levels of formal education which have shown beyond doubt to have productivity impact in the agriculture sector. For the long run farm productivity, the current policy of compulsory enrolment for children aged 7 years should be strengthened. In this case, education capital expenditure is a justified basis for promoting development through large increase in farmer productivity.

The book has also identified informal education as an important input to accelerate the adoption of innovations. Informal education provides specific training depending on the type of climate and inputs necessary to a particular locality. In this context, it is suggested to identify location specific programmes that have a bearing on adoption of farm innovations and other best farm practices. Evidence has shown that access to information through informal education reduces the uncertainty about a technology's performance hence may change individuals' assessment from purely subjective to objective over time thereby facilitating adoption.

Chapter three has dwelt on the driving force of off-farm income generating activities and the extent to which they are easy (or difficult) for relatively lower income households to take part. The central hypothesis is that off-farm employment is a better destination for lower income rural poor households because they have low farm outputs. That necessitates another source of income to bridge consumption gap. Three conclusions are arrived at from our analysis: (1) participation in off-farm activities in rural Tanzania is a result of push factors; potential participants do not realise earnings from on-farm activities and so are pushed to off-farm activities; (2) poor households have higher incentive to off-farm employment to compliment low farm income so that they can smoothen consumption; and (3) while off-farm activities remain the best options for the poor and other landless rural families, there are entry barriers resulting from low financing and low educational levels. From these conclusions, it is obvious that since poor families have limited capital access, they end up in lower paying easy-entry farm wage labour market as well as labour intensive low paying rural off-farm activities and less in high paying rural off-farm self-employment. This makes off-farm employment just an activity for survival and not necessarily for accumulation of wealth and growth.

Due to limited knowledge on the off-farm employment dynamics in rural Tanzania, the government has not given adequate attention to it in terms of rural policies on growth. Instead, more attention has been given to farming practices, an action which is likely to exacerbate inequality between women and men and between youths and elders. The book puts forward two suggestions for the government and other rural development stakeholders. The first is to have a well-functioning credit market, which will enable access of capital for the poor people to start up the small rural enterprises. Secondly, it suggests the implementation of targeted entrepreneurial skills development centres focusing on small business and other rural activities. In other words, the establishment of training centres can help to tackle necessary skill barriers. These skills may be delivered based on locally compatible available resources.

The identification of skills should be on the basis of comparative advantage. For example, areas rich in natural resources like timber, should focus on training necessary to make furniture. Similarly, areas close to tourist centres should focus on tourist-related business.

It is of equal importance to promote off-farm employment through development of general infrastructure. This creates a conducive environment for business by clustering people together, thereby opening up the economy for marginalised groups to participate in off-farm economic activities. This way, the country is likely to address the twin-objectives of addressing rural poverty and inequality but also current urban youth migration. At the same time, high earning off-farm activities can be used to support on-farm ones, particularly by encouraging investment in activities that add value to agro-produce. This is hoped to improve the earnings farmers receive from their own farm activities and also create employment for wider groups, especially for those who do not have access to land, for instance, youth- and female-headed households.

Chapter four has built on the third chapter by looking at the role of off-farm employment on the adoption of modern farm practices as well as its role on food security and quality of nutrition. In this context, off-farm employment is expected to relax farm household from cash constraints, which can then increase use of modern farm practices and hence improve food security and quality of nutrition. In establishing the relationship between off-farm employment and use of modern farm technologies, four farm technologies (adoption of chemical fertilizer, adoption of improved seeds, use of extension services, and adoption of draft animals) have been examined. On the other hand, in establishing the relationship between off-farm employment and food security, three food security and nutrition variables (number of meals a household usually has a day, number of times a household consumed meat in the past one week and the frequency in which the household had a problem of satisfying food needs in the past one year) were used.

Our findings have provided evidence that off-farm employment of at least one household member increases adoption of some technologies and decreases adoption of others. Specifically, off-farm income decreases adoption of those technologies that are labour-intensive. In other words, our findings show that off-farm employment takes most of the time that would be used for adoption of best farming practices. Nevertheless the income generated from them, the study further indicated, does not translate into increased farm inputs through the adoption of modern technologies.

However, even though off-farm employment does not increase the adoption of modern farm practices, it improves food security and quality of nutrition of the households. This raises two very important issues for policy makers and others with interest in rural development: first, off-farm employment is in small scale to complement agriculture farm productivity; and, secondly, there is high rate of urbanization within rural areas in which people are moving from producing food to buying food. This further justifies the importance of promoting off-farm employment in rural areas as an instrument to attract excess labour that cannot be fully utilized in agriculture. This way, both unemployment (and underemployment) and food security problems will be addressed.

To increase farm productivity through the adoption of modern farm practices, the book has underlined, in the short run, the need to focus on cheap practices which are accessible to the majority of small-scale farmers. Draft animal technology is specific in this case. The book has shown empirically that this technology has one of the highest yields increasing effects among other farm technologies and most accessible to lower income farmers as well as those in remote areas. In the long run, the focus can be on power tillers and tractors, which are apparently accessed by very few farmers, despite the government's push.

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Drivers of Farm Household Incomes in Rural Tanzania

The broad objective of this book is to contribute to the on-going debates on identifying drivers of farm household incomes in rural Tanzania. In doing this, we focus our analysis on growth consequences of the human capital, in the form of formal schooling attained, and financial capital, in the form of off-farm employment, in promoting rural economy. We find that both human and financial capital are key ingredients in improvements of farm productivity and food security. Specifically, human capital through formal education is assumed to affect farm outputs through its impacts on adoption of innovations. On the other hand, financial capital through engagement in off-farm income generating activities increases household food security and quality of nutrition by reducing cash constraints to access high quality food. However, barriers to entry into off-farm income generating activities remain an obstacle to poor households because such activities require capital up-front, which the poor lack.

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