# RURAL CREDIT AND AGRICULTURAL PRODUCTIVITY; DOES ACCESS TO CREDIT MATTER? EVIDENCE FROM SMALLHOLDER MAIZE FARMERS IN ZAMBIA

**By**

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## DECLARATION

I, **Chileshe Kelvin**, declare that this dissertation:

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## APPROVAL

This dissertation of **Kelvin Chileshe** has been approved as a partial fulfilment of the requirements for the award of the degree of Master of Arts in Economics by the University of Zambia.

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**ABSTRACT**

Although there is widespread evidence that access to credit is critical for agricultural production, it is still unclear whether access to credit improves agricultural productivity. Productivity improvement are key to reducing wastages and sustainably increasing household incomes, and ultimately, their economic welfare. This paper assesses the impact of access to credit on agricultural productivity among smallholder maize farmers in Zambia using the Endogenous Switching Regression Model (ESRM) to account for endogeneity in the farmer's decision to access agricultural credit and consistently predicts productivity of farmers with access to agricultural credit had they not accessed and those without access and had they accessed credit. Using data on 7,888 agricultural households across the 10 provinces of Zambia from the nationally representative 2015 Rural Agricultural Livelihood Survey, the study finds that access to credit has a significant positive impact on maize productivity. The estimated average treatment effect on the treated and untreated were 4.5 and 6.5 bags of 50 Kilograms respectively. Improving access to credit in order to address farmers liquidity constraints may boost productivity.

Key Words**: *Access to Credit, Agricultural Productivity, Smallholder farmer***

# DEDICATION

I dedicate this work to my late parents, and my siblings.

## ACKNOWLEDGEMENTS

First and foremost, I'm grateful to the Almighty God who provided me with good health and breath throughout my study. I'm highly indebted to my supervisor, DR. Peter Hangoma for his persistent guidance and encouragement, critical comments and advice which together enabled me to complete this study. I also extend my appreciation to the University of Zambia and in particular Department of Economics for the conducive study environment and guidance from the staff during the course of this project.

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## ACRONYMS

| | |
|---|---|
| 7NDP | Seventh National Development Plan |
| ATE | Average Treatment Effect |
| ATT | Average Treatment Effects on the Treated |
| ATU | Average Treatment Effects on the Untreated |
| CAADP | Comprehensive Africa Agriculture Development Programme |
| CFS | Crop Forecast Survey |
| CSO | Central Statistical Office |
| CVM | Covariate Matching |
| ESRM | Endogenous Switching Regression Model |
| FIML | Full Information Maximum Likelihood |
| FISP | Farmer Input Support Program |
| FRA | Food Reserve Agency |
| GDP | Gross Domestic Product |
| ISIC | International Standard Industrial Classification |
| LCMS | Living Conditions Monitoring Survey |
| MoA | Ministry of Agriculture |
| PATE | Population Average Treatment Effect |
| PSM | Propensity Score Matching |
| RALS | Rural Agricultural Livelihood Survey |
| SATE | Sample Average Treatment Effect |
| SATT | Sample Average Treatment Effect for the Treated |
| SCD | Systematic Country Diagnostic |
| SEA | Standard Enumeration Areas |
| ZNFU | Zambia National Farmers Union |

# CHAPTER ONE
# INTRODUCTION

## 1.1 Introduction

Although the role of rural agricultural productivity in global food distribution is undisputable, rural communities have continued lacking access to key productive assets in their quest to maximize productivity and escape poverty (Ligon & Sadoulet, 2007). Globally, the agricultural sector engages more than 2.6 billion of the 3.1 billion rural populations in the world (World Bank, 2017) while in Zambia about 89.4% of households in rural areas engage in agriculture activities and 17.9% of households in urban areas (World Bank, 2015).

Despite the agricultural technological advancement, poverty incidence remains high in rural areas of Zambia. In 2015, the poverty incidence was about 54.4% at the national poverty line of ZMW 214 per adult equivalent per month. Though the incidence of poverty fell from 25.7% to 23.4% between 2010 and 2015 in urban areas, it rose significantly from 73.6% to 76.7% in rural areas. Thus, this has widened the urban-rural poverty divide in the country. The main concern is that 58% of the population are rural dwellers, but they represent 82% of the poor and 87% of the extremely poor in the country (CSO,2015 ; World Bank, 2017).

Mostly , higher incidence of poverty is attributed to the fact that a vast group of people who live in peri-urban and rural areas are characterized by a lack of access to key productive assets and market opportunities, leading to hunger and malnutrition rates, which are among the highest in the world (World Bank, 2017). Additionally, high poverty incidence despite an increase in per capita economic growth in the past one decade has been mainly linked to ever rising income inequality (World Bank, 2017). Could there be a way out for rural dwellers locked in poverty?

Timmer (2005) argues that no country has sustained a rapid transition out of poverty without first raising agricultural labour productivity while Verdin J, et al., (2005) argue that strong agricultural growth, especially increased productivity, has been a feature of countries that have reduced poverty successfully. Kuznet (1964) asserts that an increase in agricultural productivity can support and sustain industrial development in various dimensions. Firstly, it allows the agricultural sector to free its labour force to the nonagricultural sector while producing sufficient agricultural output to meet demand for the economy. Besides, it raises income of farmers and creates rural purchasing power required to meet the demand from the manufacturing sector. Secondly, it enables the agricultural sector to supply food at affordable prices to the economy and profitability of the manufacturing Sector. This scenario leads to structural transformation and creates jobs outside of agriculture sector. Therefore, a broad focus on understanding the factors that affect the performance of the agricultural sector is critical for poverty alleviation in developing countries like Zambia.

### 1.1.1 Background of the agricultural sector

Maize has been the most cultivated crop in Zambia. The Rural Agricultural Livelihood Survey shows that about 89.4% of farmers reported having cultivated maize in the 2014/2015 farming season. Figure 1.1 shows that maize is the dominant crop in Zambia even by land cultivated.

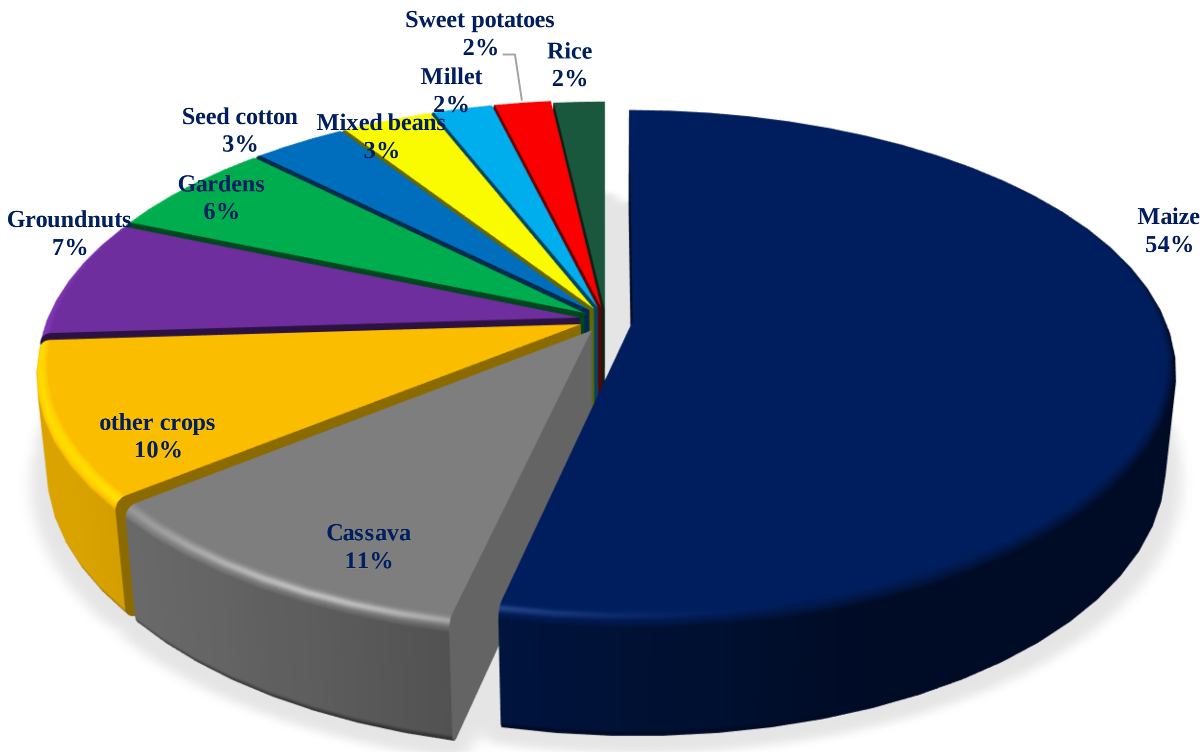



*Figure 1.1 Crop Proportion of Cultivated Area*

Maize was reported to take up about 54% of the total land under cultivation in the 2014/2015 farming season. The second most cultivated crop in Zambia is cassava which is followed by groundnuts accounting for about 11% and 7.5% of the total cropped land respectively (RALS, 2016). Over the past 10 years, maize production has increased citing an expansion in the area planted which has increased from about 1.5 million to 3.5 million hectares (CSO, 2016). Thus, this paper focused on agricultural productivity of smallholder maize farmers in Zambia.

Even though there has been growth in the banking and microfinance sector in sub-Saharan and Zambia, advancing loans and credit in an attempt to increase agricultural production remains one of the biggest challenges (Tenaw & Islam, 2009). In the 2014/15 farming season, only about 15% of farmers had access to credit/loan out of about 1.6 million households (RALS, 2016). Even those farmers who reported to have had access to credit in 2014/2015 farming season, about 87% of them accessed it through Out-grower scheme and friends/relatives. Furthermore, the findings show that only about 1.2% of farmers who had access to credit had accessed it through commercial banks while 3.5% via Zambia National Farmers Union (ZNFU) Lima Credit Scheme. Therefore, access to credit by smallholder farmers remains a challenge in Zambia.

Though the structure of the Zambian economy has undergone so much transformation over the past 40 years, the drivers of economic growth seems to have not changed. A breakdown of the

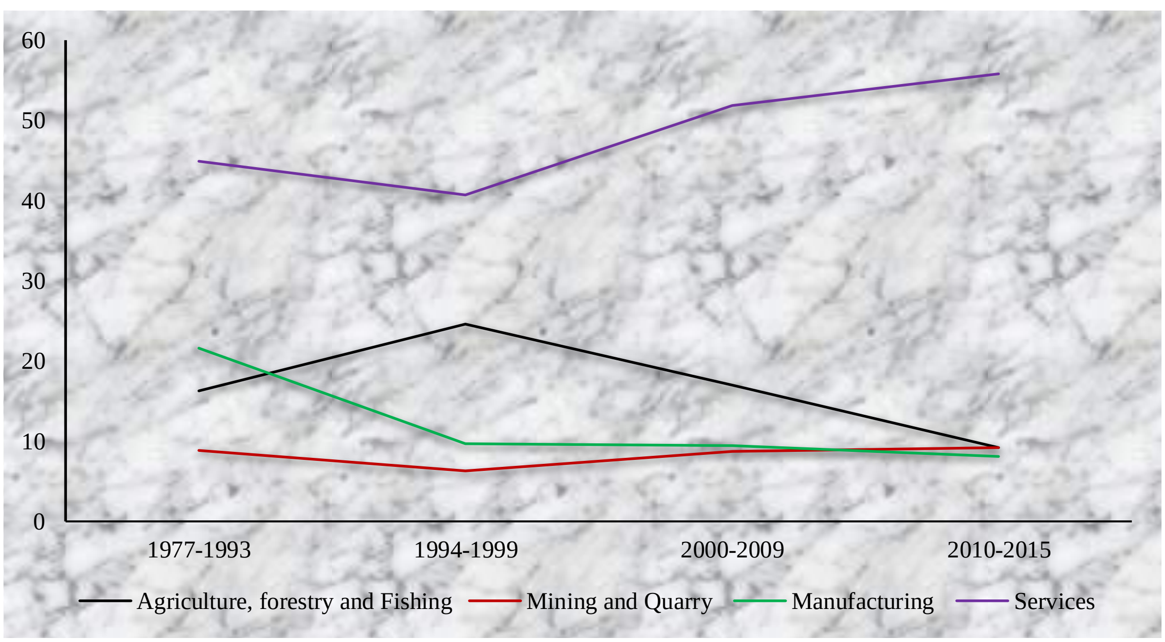



*Figure 1.2 Sectoral contribution to real GDP growth (average In %)*

drivers to GDP growth show the increasing importance of services and the fall of manufacturing and the agriculture sectors. The contribution to GDP growth from agriculture has been on the downward trend since 1994 (Figure 1.2).

Between 2006 and 2015, the contribution of agriculture, fish, and Forestry to GDP averaged 10%, which is only lower than mining and quarrying, and wholesale and retail trade industry. The average contribution to GDP of wholesale and retail trade was 20% while mining and Quarrying averaged around 13% as (Figure 1.3). Though the agriculture sector ranks among three notable contributors to GDP in Zambia, its contribution is quite low compared to an average GDP share of agriculture sector of 12% at world level and 22% for Africa between 2006 and 2015. Therefore, the relative low contribution of agriculture sector to GDP calls for radical strategies that would improve production and productivity as well as value addition along sub-sector value chains and other industries.

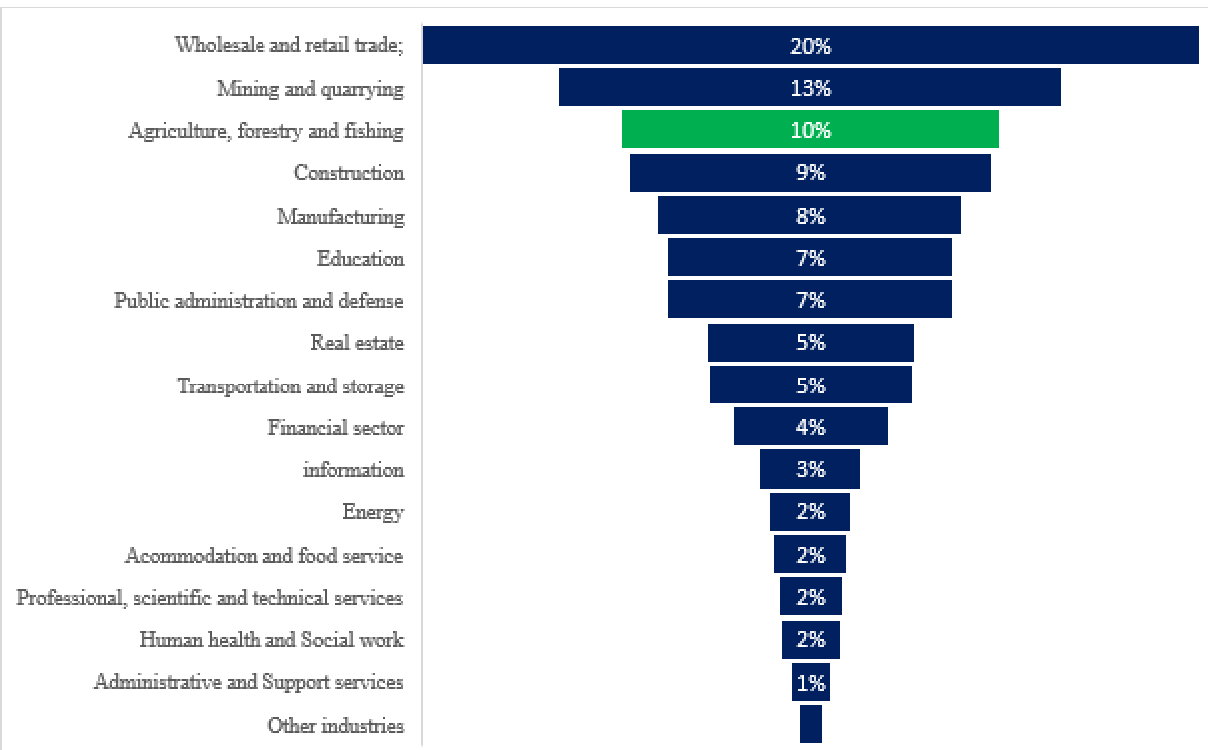



*Figure 1.3 Industry contribution to GDP (average), 2006-2015*

Agricultural productivity is critical for poverty alleviation and sustainable development of rural areas. This is because increased productivity results in the production of more goods and services for the same amount of work which in turn helps in transforming living standards of people. Theoretically, it is argued that there is a positive correlation between increase in physical capital, technology and human capital with an increase in productivity. Therefore, a rise in productivity is directly linked to improved standards of living in the form of higher consumption arising from higher growth rates. The World Bank (2017) define agricultural productivity as the value added per worker in the agriculture sector and higher value implies that the average farmer produces more output[1]. Basically, it measures the output of the agricultural sector (ISIC divisions 1-5) less the value of the intermediate inputs. Figure 1.4 below shows the agricultural productivity for the past 10 years in Zambia on aggregate basis.

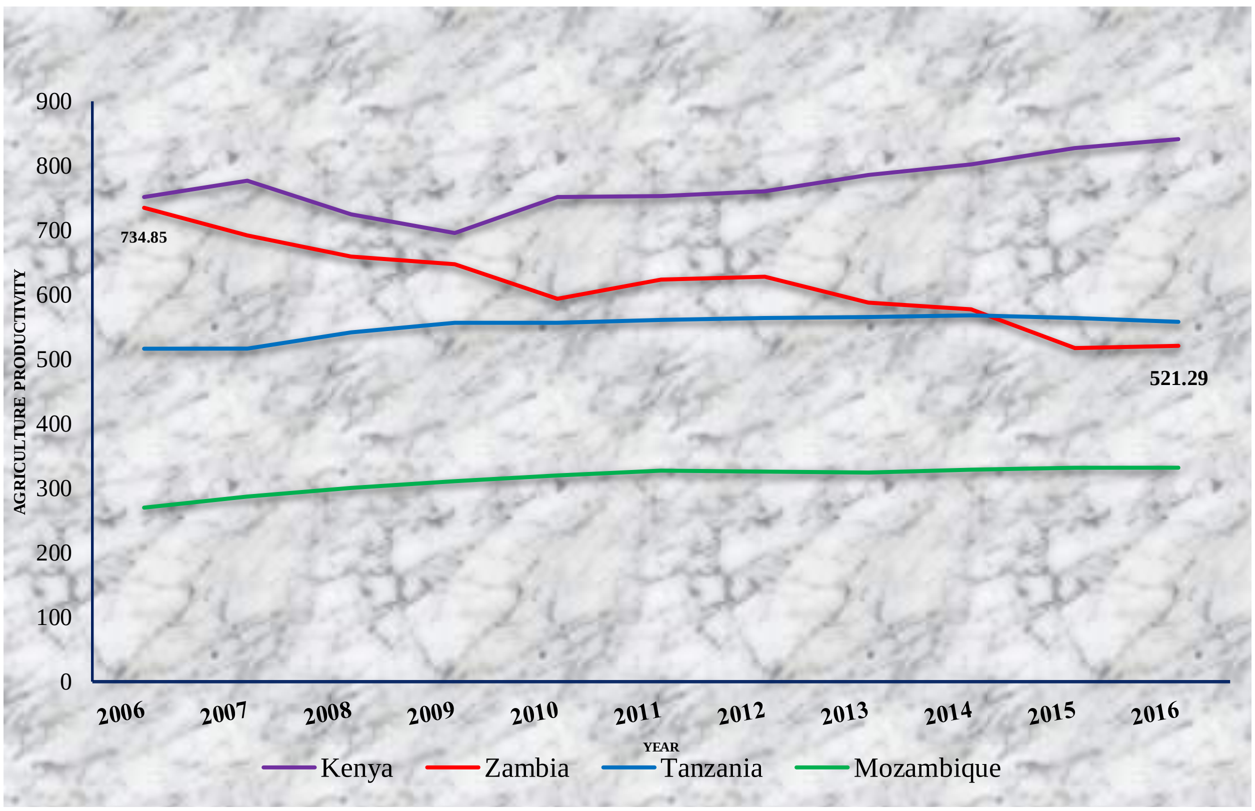



*Figure 1.4: Agriculture Productivity per worker in US Dollars*

The figure shows that agricultural productivity for Zambia has been declining over the past 10 years while it has been rising in Kenya, Tanzania, and Mozambique. Since independence, the agricultural sector recorded the maximum productivity of 1012.96 US dollars per worker in 1981

[1] TheGlobalEconomy.com, The World Bank

and the minimum productivity of 517.23 US dollars per worker in 2015. In the past three decades, agricultural productivity has declined by almost 50% yet the population of the country has increased from 6.09 million to 16.6 million (World Bank, 2017).

Despite the downward trend in agricultural productivity in the past three decades, the sector has continued to be the major source of employment in Zambia. In 2010 the agriculture, forestry and fisheries sector absorbed about 67% of the population in the labour force while in 2015 about 59% of the total active labour force still derived their livelihoods from the sector (CSO, 2015). The major concern is that the sectorial comparison show that the sector has been marred with low productivity. Figure 1.5 shows the comparison of the employment with value added per worker among the three sectors. The figure shows that the value addition per worker in the agriculture sector has been consistently below US$1000, making it difficult for rural households to escape poverty. As a result, most of rural dwellers have been locked in the low productivity subsistence farming, who accounts for majority farmers. Though the industry sector has been the most productive sector in the country , it only absorbs a negligible proportion of the population compared to agriculture and services sector.

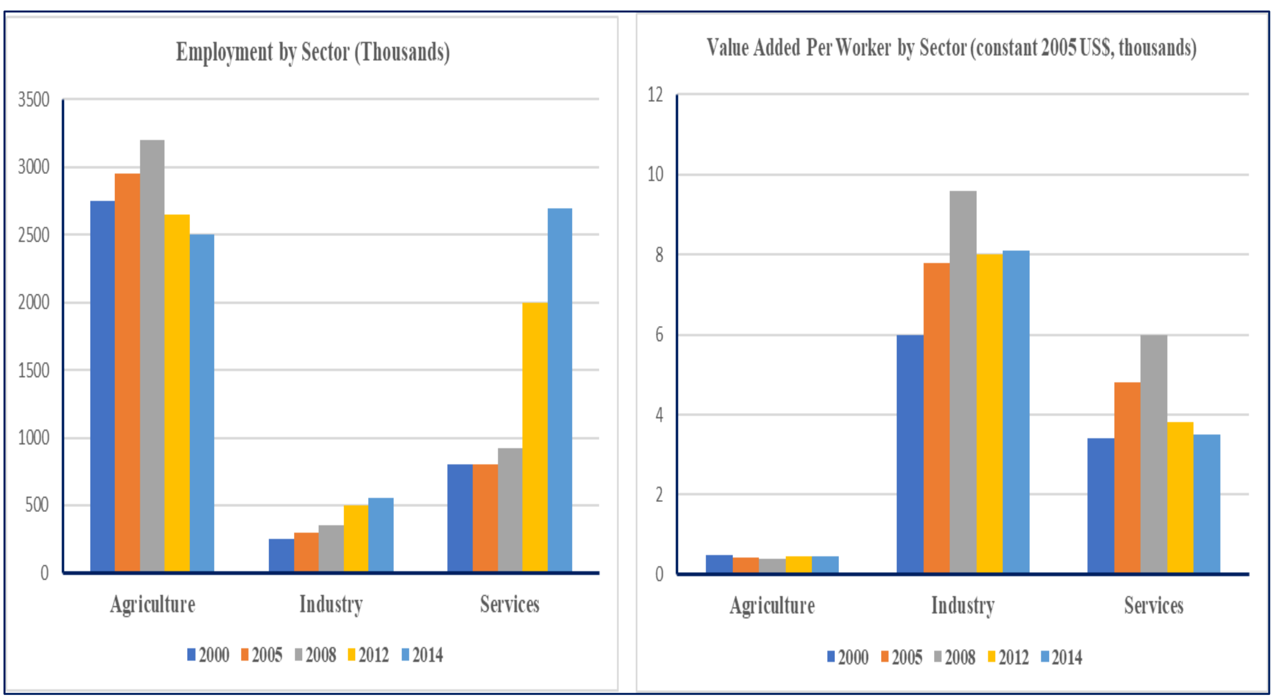



*Figure 1.5 Distribution of employment from the major sectors*

The Zambian economy experienced a steady growth between 2004 and 2014 at an annual growth rate of 7.4%. This implies that between 2004 and 2014 the Zambian economy more than doubled. However, the growth rate of the agriculture sector has been on the downward trend. On the other hand, the population has been growing rapidly at 2.8% per year. This implies that the population is expected to double in approximately every 25 years. The major concern is that despite the downward trend in the growth rate in the agriculture sector, Zambia is expected to continue experiencing significant population growth as the large youth population enters the reproductive age (CSO 2014). Figure 1.6 shows the comparison of population growth rate with the growth rate of the agricultural sector for the previous 5 years.

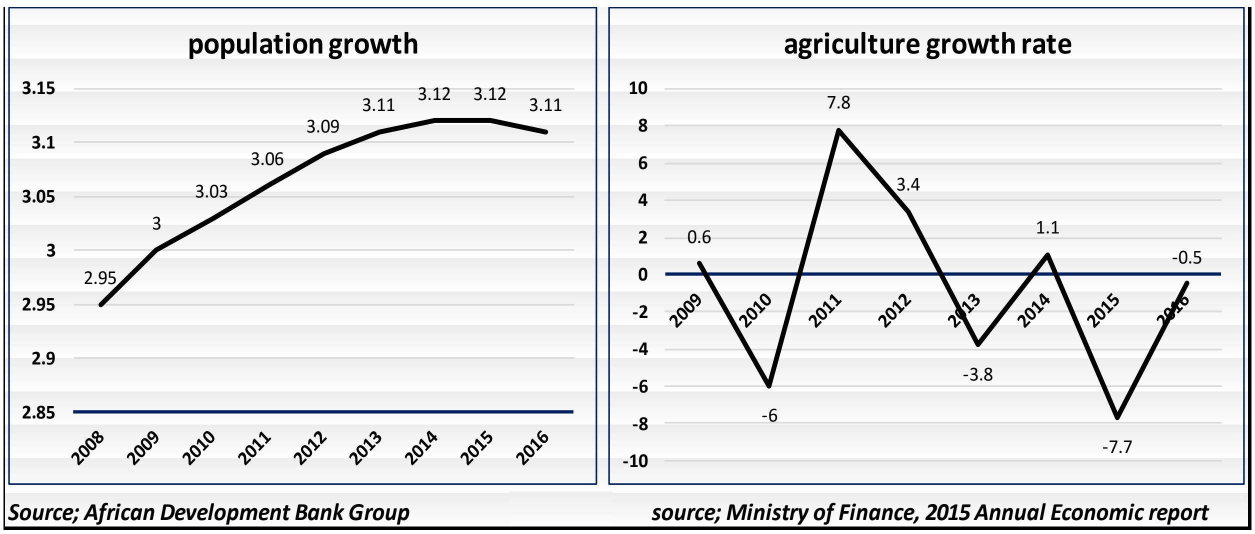



*Figure 1.6: Comparison of population growth and the growth rate of the agricultural sector.*

If the present agriculture growth rate remains unchecked, the sector is unlikely to sustain the growing demand for the food for final consumption as well as for intermediate inputs for the manufacturing industry and other sectors of the economy which may force the country to imports dependent even for inputs which would be produced locally. Thus, developing interventions that would boost the agricultural growth remains critical if the country has to avoid food insecurity and being import dependent even for the agricultural merchandises that would be produced domestically.

Zambia has made some progress towards achieving the growth and spending objectives of Comprehensive Africa Agriculture Development Program (CAADP). Since 2003, about half of the Zambia's budgetary allocation to agriculture has been above the CAADP target of 10%. However, a closer examination of the agricultural sector's quality of expenditure raises significant concerns. This is based on the observation that the distribution of the agricultural budget in past years has not placed enough emphasis on the broad-based public investments necessary to stimulate agricultural growth and transformation (Chapoto & Chisanga, 2016).

Though the major share of the budget allocated to the agriculture sector accounts for Poverty Reduction Programs (PRP), it is mainly dominated by Farmer's Inputs Support Program (FISP) and the Food Reserve Agency (FRA). Figure 1.7 shows the breakdown of the budget allocated to agricultural sector in 2016 budget. The figure shows that 58% of the agricultural budget was allocated to Poverty Reductions Programs (PRPs). However, 56% and 42% of this was taken up by FISP and FRA respectively. This depletes the actual budget leaving other important areas within the sector such as credit provision in substantial arrears (World bank, 2017). Furthermore, the agricultural budget lacks credibility and the government frequently over-commits itself and do reallocates away from agricultural production. For instance, since 2010, the actual expenditure in the agriculture sector has averaged only 80% of the total initial budget allocation (World Bank, 2017).

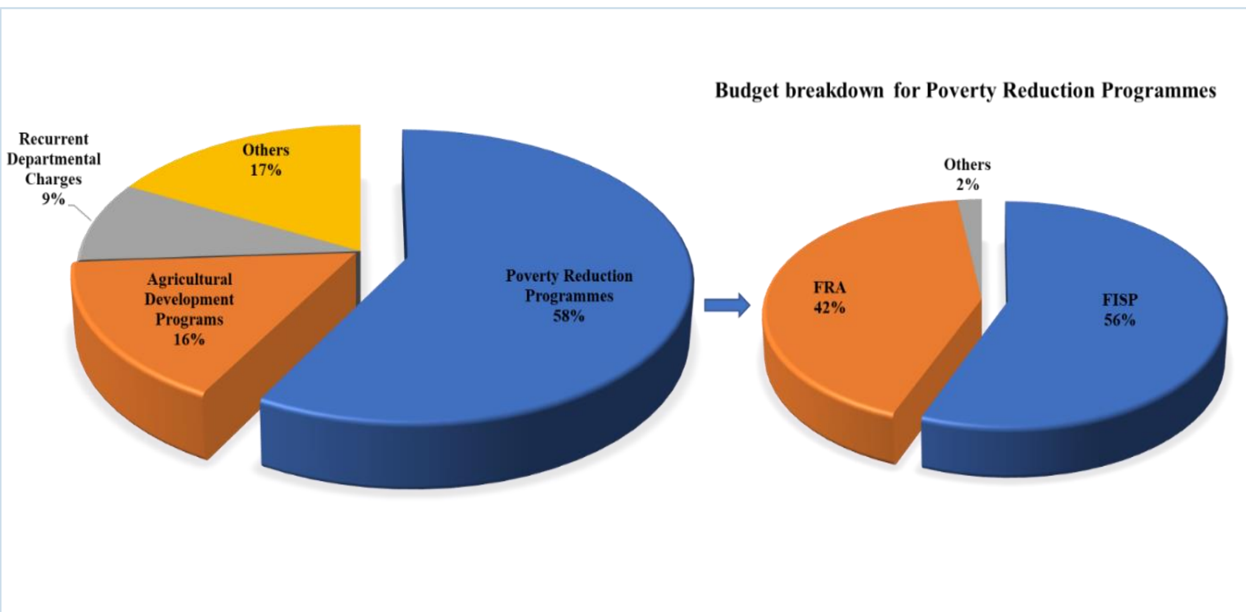



*Figure 1.7: Breakdown of the 2016 Budget Allocated to Ministry of Agriculture*

## 1.2 Statement of the Research Problem

Zambia is endowed with the total land area of 39 million hectares which is potentially good for agricultural production. However, most of this arable land is yet to be fully utilized in an attempt to increase the contribution of the agricultural sector to the growth of the economy (CSO, 2016). The main concern is that even the area currently being utilized for agricultural production is characterized by low productivity. This may be due to pervasive constraints such as lack of agricultural knowledge and inputs, poor access to services, low infrastructural development and poor access to proper markets (Calzadill, et al., 2009). The systematic country Diagnostic report (2018) for zambia shows that low agricultural productivity is among the main contributor to high poverty incidences that rural dwellers have continued to face in Zambia. Additionally, the Rural Agricultural Livelihood Survey report (2016) shows that most of smallholder farmers in rural area remain credit constrained. Could access to credit help in raising the low agricultural productivity?

Empirical studies show that there is an emerging conclusion showing that there is a positive correlation between credit, productivity and poverty reduction (Thilak et al. 2010; Bashir et al., 2010; Rahman et al. 2011; de Castro and Teixeira 2011; Rezaei and Mohammadi, 2011). Thus, it is contended that improvement in agricultural productivity and output levels can be achieved through the introduction of new production technology, of which improved access to agriculture credit is a necessity to gain access to such technology particularly for the smallholder maize farmers (Awunyo-Vitor & Abankwa, 2012).

Although there has been the emergence of literature on the impact of credit on agricultural productivity [Effa & Hering, 2007; Morvant-Roux, 2008; Adams & Bartholomew, 2010; Girabi & Mwakaje, 2013], there seems to be limited literature on the impact of access to credit on the agricultural productivity in Zambia. Of the 110 papers that have been done between 1995 and 2015 on agriculture credit from various journals and working papers, no study is cited to have been done in Zambia (Yadav & Sharma, 2015). Furthermore, even those studies that have been done in other countries, their findings remain inconclusive on the issue of access to credit by farmers and its impact on agricultural productivity (Baffoe, et al., 2014). Thus, this paper aims to contribute to the limited literature on agricultural credit by assessing the impact of access to credit on agricultural productivity among smallholder maize farmers in Zambia. To achieve this, the paper intends to provide answers to the following pertinent questions; what are the main factors affecting smallholder maize farmers' access to credit in Zambia? What is the impact of access to credit on agricultural productivity? What other factors influence the agricultural productivity of smallholder maize farmers in Zambia?

### 1.3 Objective of the Study

The main objective of this study is to assess the impact of Agricultural credit on the agricultural productivity of smallholder maize farmers in Zambia. The specific objectives to be achieved by the study include:

1. To assess the impact of access to credit on agricultural productivity of smallholder maize farmers in Zambia.
2. To evaluate the potential effect of access to agricultural credit on agricultural productivity among smallholder farmers in Zambia
3. To explore the factors that affect smallholder maize farmers' access to credit in Zambia.

### 1.4 Research Hypotheses

To simplify the study, the following three hypotheses were tested;

1. Agricultural productivity in Zambia is independent of farmer's access to credit
2. Access to credit by smallholder maize farmers in Zambia is not influenced by economic, demographic and other factors such as membership to local loan/saving society, etc.

### 1.5 Significance of the Study

With the objective of diversifying the economy, promoting the agriculture sector is one of the Government's priorities with the main goal of moving away from over-reliance on the traditional products and exports, such as copper and cobalt. Thus, the Zambian government is keen on exploring ways that would lead to establishment and promotion of improved Agricultural productivity and output in rural areas (7NDP). Can access to agricultural credit be the key to raising agricultural productivity in rural areas? According to Freeman et al. (1998) it is very crucial to specifically evaluate the extent of the expected gains in productivity arising from the provision of agricultural credit. If the marginal contribution of credit to farm productivity is zero or relatively small then re-allocation of credit to other activities or sectors with higher marginal productivity may actually lead to an improvement in the welfare of the society. However, there is thin empirical evidence (if at all there is any) that have explored the link between access to agricultural credit and agricultural productivity in Zambia using widely accepted impact assessment methodologies that are able to deal with selection bias and endogeneity. Hence, the findings from this study does not only provide empirical support but are also critical to the government and non-government organization as they plan to eradicate poverty in Zambia.

### 1.6 Organization of the Study

The rest of this study is organized as follows; Chapter 2 presents the theoretical and literature review, Chapter 3 presents analytical framework, Chapter 4 presents the research methodology that was used in this paper. Chapter 4 presents the results while chapter 6 presents discussion of results and chapter 7 presents the summary, conclusion and recommendations based on the findings of this study.

# CHAPTER TWO

# THEORETICAL AND LITERATURE REVIEW

## 2.1 Introduction

This section starts by looking at the summary of the literature on the transition mechanism of access to credit on the agricultural productivity. Then, the review of empirical studies on the impact of access to agricultural credit on agricultural productivity is delved on. Thereafter, summary of literature on both the supply and demand sides of the credit market is then delved on. Then review of pertinent theories related to demand and supply of credit, and empirical review on the determinants of access to agricultural credit is done.

## 2.2 Does rural Credit play any role among poor smallholder farmers?

Agriculture sector is one of the key sectors of any economy and it is for this reason that credit facilities should be made available and accessible to rural areas in order to raise agricultural productivity (Adera, 1995). Access to credit by the poor farmer enable them to acquire new machinery, improved seeds, fertilizers and other necessary inputs needed to expand the scale of production (Akwaa-Sakyi, 2013) . Additionally, access to credit enables poor rural farmers to venture into new areas of economic activities, broaden their sources of capital and manage shocks and stress that are unavoidable and difficult to mitigate for (Ahma, 2010). Other than increasing farmer’s agricultural productivity and income, access to credit accord rural households the opportunity to have access to improved health and education services and in turn improve their social well-being (Miller & Ladman, 1983).

Furthermore, access to credit could raise the income status of the low-income rural households during off farming seasons or after poor harvest (IFAD, 2007). This is because it would allow them to engage in economic activities such as small business trading in fish, poultry, etc. Additionally, credit may be used as a tool to bridge income disparities between smallholder farmers and large holder farmers. Oyateye's (1980) argues that persistent case of low productivity leading to low income and saving capacity of poor rural farmer could only be offset when access to credit facilities is guaranteed. Additionally, access to credit improves the capacity of the smallholder farmers to have access to extra labour and help in strengthen their asset building capacity.

### 2.3 Empirical studies on the Impact of Agricultural Credit on Output and Productivity

Duy (2012) used the sample of rice farmers in the Mekong Delta of Vietnam to determine the effect of both formal and informal institutional credits on a production level and production efficiency of rural rice farmers. From applied stochastic frontier analysis and quantile regression, he found a positive impact of institutional and non-institutional credit on farm output and production efficiency. Thus, both sources of credit had a positive impact on agricultural production efficiency (productivity) in Vietnam.

Likewise, Obilor (2013) examined the impact of agricultural credit on agricultural productivity using applied regression analysis and found that credit allocation to agriculture had a significant positive effect on agricultural productivity in Nigeria. These findings were consistent with the findings of Owuor and Shem (2012) who employed the switching regression model which is estimated by employing the Heckman sample correction method. To assess the effects of credit constraints on productivity and rural household income in China, Dong et al. (2010) used probit models and concluded that agricultural productivity can be improved with the increased use of credit.

Binam et al. (2004) estimated technical efficiency of various categories of smallholder maize farmers in the slash and burn agriculture zone of Cameroon. The findings show that efficiency differences were significantly affected by the amount of agriculture credit used in the given farming season. Furthermore, a number of studies show that agriculture credit has positive and significant impact on agricultural output and productivity[ (Bashir, et al., 2010); (Saleem & Jan, 2011); (Ekwere & Edem, 2014); (Rima, 2014)].

Contrary to the above findings, Ahmad (2011) and Raza and Siddiqui (2014) insist that it is an indirect credit to agriculture which has a significant impact on agricultural output and not direct credit based on the data from Pakistan. The direct access to credit refers to the case where the borrower is directly responsible for its payment to the lending agency. This includes short-term, medium and long-term loans given for agriculture and related activities. While indirect credit refers to agriculture credit obtained by farmer through some intermediary agency/institutions which are responsible for payment.

Furthermore, other studies show that agricultural credit has no impact on the agricultural output and agricultural productivity (Oyakhilomen et al., 2012; Musuna & Muchapondwa, 2008). While, some studies [ (Hussain, 2012); (Sriram, 2007); (Sjah, et al., 2003); (Zuberi, 1986)] conclude that the impact of agriculture credit on agricultural output cannot be directly established. Hence, the literature on the impact of agriculture credit on agricultural output seems to be inconclusive.

Though a good number of studies have used access to credit as an independent variable in the agricultural production function, some scholars have challenged its use. It has been challenged on the ground that it does not affect the output directly; rather it has an indirect effect on output by easing the financial constraints of the farmers in purchasing the necessary inputs (Carter, 1988). Commenting on the importance of credit, Sial (2011) postulated that improved seeds, tractors, fertilizer and biocides that may be acquired using credit money play an important role in agricultural production and these can be directly influenced by the availability of credit.

## 2.3 Credit Supply

### 2.3.1 What the literature says on credit supply

The popular assumption in the literature on access to credit is that demand for credit by farmers exceed supply by far and as a result, most financial institutions tend to ration it. This assumption implies that all or most rural households have a positive demand for credit facilities, and participation in credit service is usually determined by the availability of credit. Thus, most of the theoretical and empirical literature on rural credit and government policies have largely focused on the supply-side constraints, with little attempt to explore household's or firm's demand for the services [ (Mpuga, 2010) , (Karlan, et al., 2011)].

A study by Muayila and Tollens (2012) in the Democratic Republic of Congo (DRC) reported that 71% of the farm households were credit constrained. Similarly, studies carried out in China [ (Rui & Xi, 2010), (Bing, et al., 2008)]revealed that over three-quarters of rural households were credit-rationed, or their demand was not satisfied. Several studies [Bastin & Matteucci, 2007, Pombo & Herrero, 2001] conclude that credit rationing, limited access to credit and participation in credit services are common challenges faced by smallholder farmers across different regions of the world. The underlying assumptions of these studies are based on the capital constraint model.

### 2.3.2 Capital Constraint Model

This model is often used to describe how financial institutions, particularly banks, behave to restrain advancing loans to borrowers because of the limitation in the available financial resources from the bank. This problem arises because commercial banks are subject to market and capital requirements imposed by the Central Banks. Banks are required to maintain their capital at a certain level set by the central bank of the country (Obamuyi, 2007). In Zambia, the liquidity ratio to deposits for commercial banks is pegged at 50.38% as of 2016. Thus, banks are limited to providing loans to agribusiness entrepreneurs because of the nature of their operations and the fact that they are fragmented. This model is very important in understanding the supply side of the agricultural credit in the Zambian agricultural sector.

Additionally, traditional financial institutions are unwilling to serve the poor because they lack physical collateral (Li et al., 2011; Al-azzam et al., 2011). With the presence of information asymmetry and incomplete markets, poor households are not likely to get the amount of money they demand at the correct price (Magri, 2002). The tradition economics models posit that interest rate (cost of capital) which tend to bring the credit market into equilibrium, fails to work in the imperfect market conditions. Increase in the interest rate, because of information asymmetry, is likely to attract the riskiest farmers (adverse selection) or induce farmers to implement the most difficult projects with the greatest return variability (moral hazard). Thus, this gives rise to two problems.

### 2.3.3 Adverse Selection

Financial institutions have no full information about the farmers (borrowers), this makes it difficult to distinguish high-risk borrowers from low-risk ones. Additionally, this makes it difficult for the lenders to discriminate against the risky borrowers by increasing the interest rate and push out the low risks farmers from the credit market. Therefore, adverse selection leads to credit rationing and only a few already well to do farmers are likely to have access to credit (Braverman and Guasch, 1986; World Bank, 2000; Zeller, 1994).

### 2.3.4 Moral Hazard

Moral hazard refers to the difficulty of monitoring borrowers' actions once they receive the loan from lenders. This problem arises because the lenders are unable to monitor the actions (unobservable) or efforts taken by borrowers after the loan has been given but before project returns are realized. Furthermore, the lender cannot observe the borrower's profits. Thus, the lenders are not able to know clearly whether farmers (borrowers) made profits or losses and even if they know, they cannot force the borrower (farmer) to repay the loan (Aghion & Morduch, 2004).

## 2.4 Demand for Credit

### 2.4.1 What the literature says on demand for credit

Some researchers argue that the demand for loan among the rural households might not be that strong due to several obstacles that hinder the transformation of potential demand to actual demand. A number of authors [Komicha, 2008; Dohcheva, 2009; Chaves et al, 2001] show that even if the rural households have access to a particular source of credit, some tend to lack sufficient capital for their investment project. Thus, they may decide not to participate in borrowing from that particular source even if the credit is accessible. Diagne *al* (2000) argue that participation in a credit program is something households or firms choose to do, while access to credit service is a limiting constraint put upon them by the financial institutions.

Klerk (2008) contends that due to their limited economic activity and capacity, farmers in the marginal lands do not need much capital. His findings are consistent with the conclusion of Admasu and Paul (2010) who found that only 43% of the respondent farmers needed credit, while the majority (57%) did not express the need for credit in Ada‟aLiben district of Central Ethiopia. Likewise, Berhanu (2005) concludes that microfinance institutions were struggling to secure sufficient demand for their existing loan products mainly due to the mismatch between what they offer and what the customers need in Ethiopia. Below are the few theories on demand for credit.

### 2.4.2 Pecking order theory

This theory was initially developed by Myers (1984) and Myers and Majluf, the pecking order theory considers market imperfections in the form of asymmetric information between firms and capital markets about presently held assets and investment opportunities. Central to the pecking order theory is that firms use internal funds (e.g., free cash flow) first because they are less costly than external funds. In a situation where external funds are used, the ranking of the costs is debt then followed by equity, even though external equity (e.g., issuing shares) is rarely used. These ideas were formulated into testable hypotheses and confirmed by many studies (Baskin, Hubbard, and Jensen, Solberg, and Zorn). This theory is very important to this study because farmer's choice of credit rather than other forms of financing is influenced by several factors among then is asymmetric information and associated costs. Thus, the farmers' preference for cooperative societies over other formal financial institutions for obtaining credit or vice versa is dependent upon their assessment of their financial condition and severity of information asymmetry between the farmers and possible lenders.

### 2.4.3 Investment theory

Central to this theory is the assumptions that farmers maximize their utility subject to the production function. They need the flow of output, labour and capital accumulation. Though farmers know that there is a profitable investment opportunity, they are not able to utilize this opportunity because of limited savings (Jorgenson, 1967). They will invest rather by using credit/loan which depends on the chargeable interest rate and the expected rate of return (Modigliani and Miller, 1958). Generally, the farmer will invest in the project if the expected returns are greater than the cost of accessing credit. Thus, the demand for credit depends on the profitability of the agribusiness the farmer wants to undertake which in turn depends on productivity.

### 2.4.4 Cobb Douglas production function theory

Several scholars posit that the demand for credit follows the production function of a company/an individual. In a famous Cobb Douglas production function theory, the main objective of the firm is to maximize profit from the given production function. This theory asserts that production is a function of mainly labour and capital for a given level of technology (Zellner et al., 1966).

$$Q = A[f(K, L)]$$

The above functions show how production is affected by labour and capital, and how their variation affects the production and the income distribution of the smallholder maize farmers (Felipe and Adams, 2005). This capital can be obtained from credit institutions at different costs of capital (interest rate). This implies that the demand for credit by farmers is also affected by the desired amount of output of a farmer and the cost of capital.

### 2.5 Determinants of access to Agricultural Credit

Obisesan (2013) investigated the determinants of access to agricultural credit using the logistic model in Nigeria. The results showed that gender, age, main occupation, participation in off-farm activities, membership of farmers' association and crop yield had a significant impact on access to credit of a given farmer. That is male and youthful farmers were more likely to have access to credit as compared to their counterparts. While farmers with formal employment were more likely to have access to credit than those who are not. Furthermore, the results show that smallholder farmers without access to credit had higher poverty incidences compared to those who had no access to credit. He did conclude that cooperatives served as the major source of agriculture credit for most rural households.

Chauke et al (2013) investigated the factors that affect smallholder farmer's access to credit in Limpopo Province of South Africa using a sample of 250 smallholder maize farmers by employing a stratified sampling technique and the logistic regression model to carry out the analysis. Findings from the study showed that the demand for credit, attitude towards risk, the distance between lender and borrower, perceptions on loan repayment and lending procedures and the total value of assets had a significant impact on access to agriculture credit.

Using a sample of 100 applicants for agricultural credit in five towns of Abura Asebu Kwamankese district of Ghana, Dzadze et al (2012) attempted to identify the factors that limit or increase smallholder farmers' access to formal credit using the descriptive statistics and a binary logistic model. The results from the logistic model revealed that extension contact, education level, and saving habit had a significant positive influence on farmers' access to formal credit. Furthermore, results show that the farmers' odds of accessing credit were 10.98 higher if a farmer had a higher education compared to no education. Similarly, the odds of accessing credit were 371.40 more among those who had contact with extension workers compared to those who did not and 601.09 higher for the farmers who had the habit of saving compared to those who did not.

Gaisina (2010) employed a bivariate probit model to analyze the factors that affect access to credit in Kazakhstan. The aim of the study was to predict the probability that corporate farms have received credit from commercial banks, in the presence of an opportunity to receive credit from rural credit partnerships, and to describe the factors influencing the choice of the farmers. The results showed that there three key factors that affect farmer's access to credit. These includes farm size, farm's productivity in the previous year, and collateral.

Based on the commons-attributes from the empirical studies, the determinants of access to credit can be grouped into three categories; namely individual, social economic and other factors. The individual specific factors include education, marital status, caste, gender, extension contact, experience, age, size of household, social status, affiliation to the political party, membership with farmers association and contact with large landholders. While the economics factors include income level, collateral value, the rate of interest, transaction cost, the total cost of production, land size, the incidence of past savings, participation in off-farm activities, the value of livestock, healthcare expenditure, expenses on child education, repayment capacity and net margins. Factors such as irrigation facilities, access to basic infrastructure facilities, purpose and duration of the loan, type of crop, distance from lending institution and status of land records were classified as other factors etc[ (Aliero & Ibrahim, 2011), (Akudugu, 2012); (Akpan, et al., 2013)), (Dzadze, et al., 2012)].

Other than the socio-economic and demographic factors, this paper seeks to assess the role of a number of factors that have received less attention in the literature on the determinant of access to credit. Among others, these factors include the ownership of the bank account, the amount of free agricultural inputs such as fertilizer received in kilograms, the number of household members in the prime age, membership with a local loan saving society, the flow of information on agricultural commodity prices and use of manure as an alternative to fertilizer. Furthermore, the paper included the farmer's input support programmes (FISP) as one of the control variables based on the trade-off theory to control for the imapct of access to FISP on productivity.

# CHAPTER THREE

# ANALYTICAL FRAMEWORK

## 3.1 Introduction

The two concepts used in the literature of credit are access to credit and participation in the credit program. Though they are frequently used interchangeably in many credit studies, these two concepts do not carry the same meaning. The fundamental difference lies in the fact that participation in a credit program is something that households choose to do freely, on the other hand, access to a credit program involves constraints such as availability and eligibility of the credit program placed on households. Thus, participation depends mostly on the demand-side of the market relying on the potential borrower‘s choice of the optimal loan size whereas access is more of a supply-side issue related to the potential lender‘s choice of the maximum credit limit. Participation depends on the borrower's optimal choice while access to credit depends on the lenders spending power and not the borrower. Then *lack of access to credit* is said to occur when the maximum credit limit for that source of credit is zero. While one is said to have access to credit when the maximum credit limit for the given credit type is strictly positive. Access to credit is said to improve when someone’s access to a given type of credit increases (Abdul-Jalil, 2015).

Figure 3.1 shows credit demand decision processes of an agricultural households’ demand for credit. To obtain credit from any given financial institution, the household’s decision for credit demand plays a fundamental role. A farmer may demand credit or not in a given agriculture season. If a farmer has demand for credit, he may or not choose to apply for credit or may be discouraged to apply for credit. Then, those households who are not discouraged can apply for credit and face one of the two outcomes. That is either get access to credit(loan) or get rejected by the lender. If the farmer obtains the full credit, he/she had applied for, he is said to be unconstrained. But, if he obtained only part of the credit he had applied for or rejected or discouraged to apply, that farmer is said to be constrained. However, in this paper a farmer is said to have access to credit if he or she has a partial or full access to credit. This is due to data limitation where the data available focused on access to credit regardless where it was partial access or full access to credit.

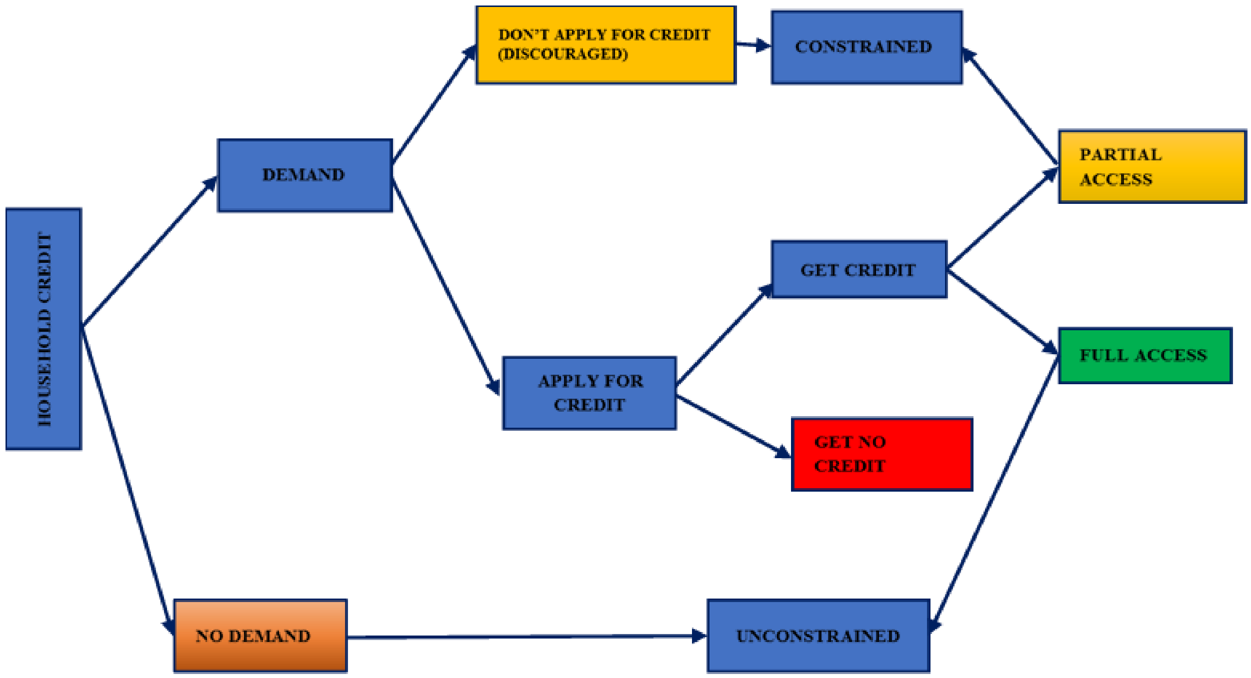



*Figure 3.1 Credit demand decision process*

Access to credit is deemed to be one of the major tools used to alleviate poverty (Bashir, et al., 2010). This is because they assist smallholder maize farmers in their farm activities and non-farm activities throughout the year. With access to sufficient credit, farmers can acquire high-quality seeds and other farming inputs at the right time resulting into increased Agricultural productivity.

The mechanism through which access to credit affects productivity and ultimately household welfare is illustrated using pathway as shown in Figure 3.3. A household potentially has three possible sources of credit; informal, formal, and and semi-formal. It then uses this fund to invest in either or both farming and non-farm activities, depending on the preference of the household. For farming, these funds are used to buy inputs, such as fertilizer and improved seed, which increases productivity and ultimately contributes to reducing the household vulnerability to poverty. Some of the credit could be invested in non-farm businesses. This could increase the household liquidity and generate more resources for reinvestment in agriculture. Both increased income from non-farm business and income from increased yield can reducing a household's vulnerability to poverty.

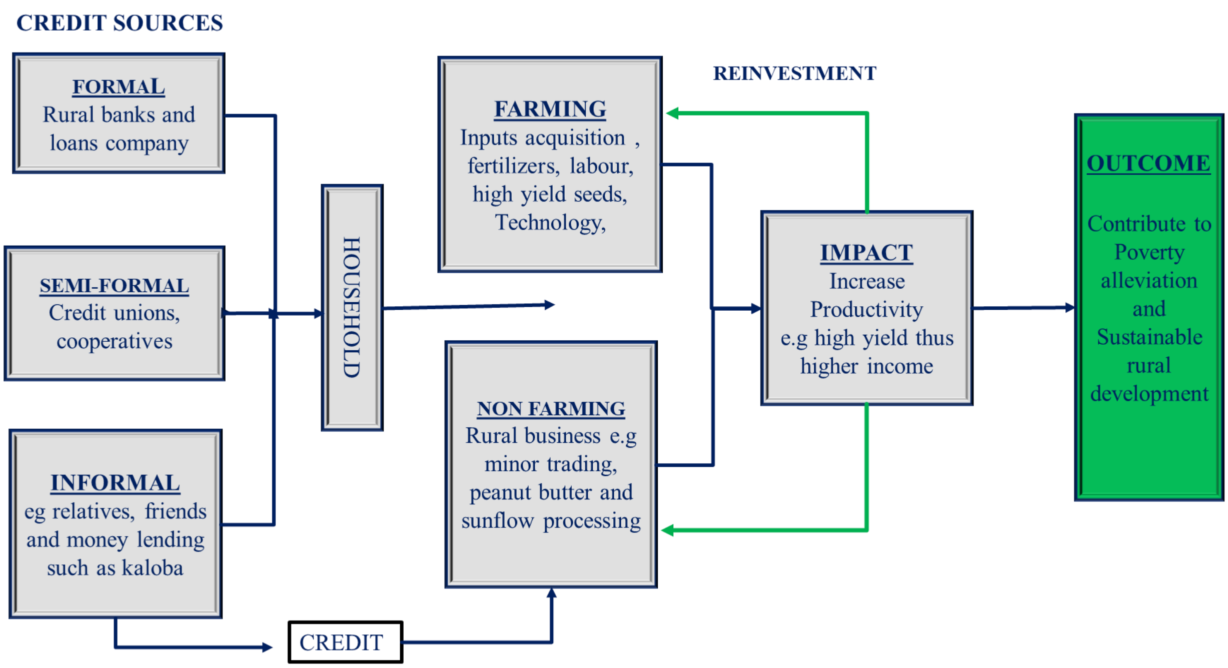



*Figure 3.3 analytical framework*

## 3.2 Access to Credit and Agricultural Productivity

In traditional agriculture economics, farmers economically make rational decisions in the context of the available resources and technology in the agricultural sector (Schultz, 1964). Smallholder Maize farmers allocate the available resources in the manner that leads to profit maximization using the neo-classical model. The decision of the maize farmers whether to access credit or not hangs on the assumption of expected Agricultural productivity under each of the two states. So, when making a decision on whether to borrow money or not they compared the expected Agricultural productivity of borrowing with the one obtained without borrowing. Furthermore, the decision of the maize farmer to borrow is influenced by several socioeconomic and demographic factors. Let the expected Agricultural productivity of farmer i with access to credit be given by

$$E(Prdvity_{1i}) = Z_i\beta_{1i} + \mu_{1i} \quad (1)$$

And, the expected Agricultural productivity of a farmer without access to credit be given by

$$E(Prdvity_{2i}) = Z_i\beta_{2i} + \mu_{2i} \quad (2)$$

Where in both cases, ***Z*** denotes the Maize farmer's socioeconomic, demographic and institutional factors, and $E(Prdvity_i)$ represents the expected Agricultural productivity of a given farmer. Then $\mu$ is a random disturbance which is assumed to be independently and identically distributed with mean zero. The difference in the expected Agricultural productivity of the maize farmers with access to credit and those with no access to credit is given by

$$E(Prdvity_{1i}) - E(Prdvity_{2i}) = Z_{\boldsymbol{i}}\beta_{1i} + \mu_{1i} - Z_{\boldsymbol{i}}\beta_{2i} - \mu_{2i}$$

$$E(Prdvity_{1i}) - E(Prdvity_{2i}) = Z_{\boldsymbol{i}}(\beta_{1i} - \beta_{2i}) + (\mu_{1i} - \mu_{2i})$$

$$E(Prdvity_{1i}) - E(Prdvity_{oi}) = Z_{\boldsymbol{i}}\beta + \mu_i$$

$$\Delta E(Prdvity_i) = Z_{\boldsymbol{i}}\beta + \mu_i \qquad (3)$$

Thus, it is expected that if $[E(Prdvity_{1i}) - E(Prdvity_{2i})] > 0$ , the maize farmer would find it more reasonable to borrow money. Hence, the difference in the expected Agricultural productivity between access to credit and non-access to credit is seen as a potential factor that affect the decision of the farmer to borrow or not. Thus, this paper aims at determining the factors influencing access to Agricultural credit and assess the impact of access to credit on agricultural productivity among smallholder maize farmers in Zambia.

# CHAPTER FOUR

# METHODOLOGY

## 4.1 Introduction

This section contains the description of the data used in the study and data analysis technique for this study. The section starts by describing the nature and sources of data used, data analysis tools; estimation of the decision model and impact analysis model and then conclude by looking at the estimation of the treatment effects using four (4) methods.

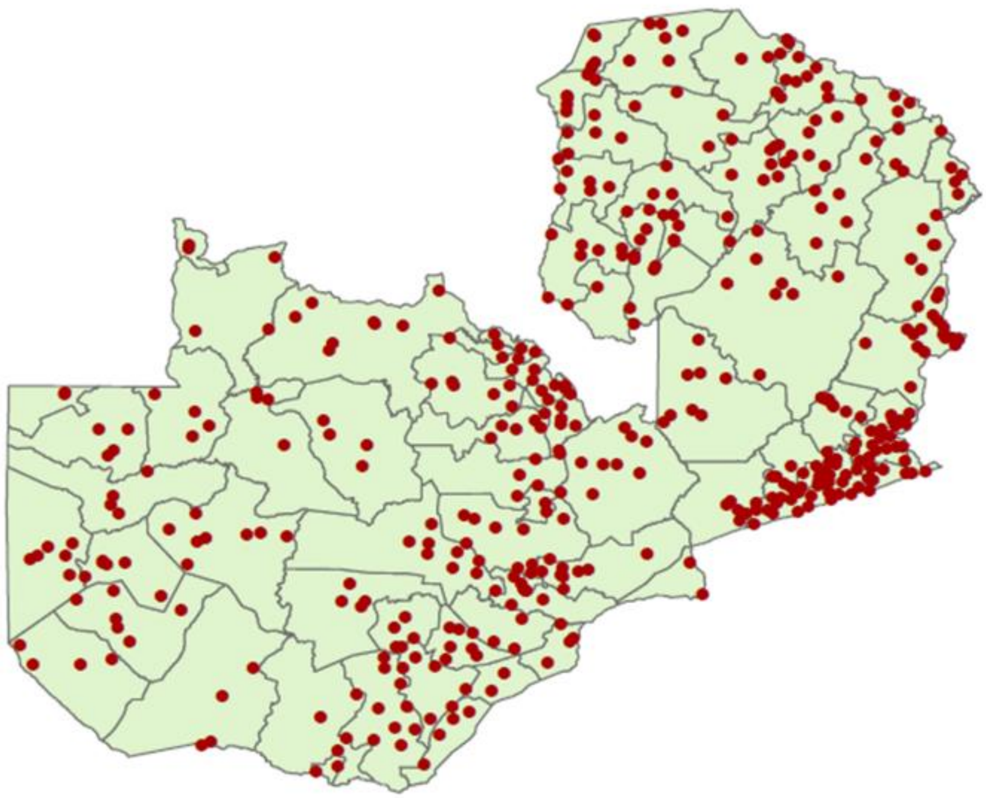
## 4.2 Research Design

In this paper, the ex-post facto research design was adopted. According to Kerlinger (1970), the ex-post facto research design also called causal-comparative research is used when the researcher intends to determine the cause-effect relationship between the dependent and independent variables with a view of establishing a causal link among the variables of interest. In this case, the paper aims at establishing whether there is a link between access to agriculture credit and productivity in Zambia.

## 4.3 Nature and Sources of Data

The source of data used in the empirical analysis is from the Rural Agricultural Livelihood Survey (RALS 2015) from the Indaba Agricultural Policy Research Institute (IAPRI). RALS is a survey that is conducted every 3 years with the main goal of collecting data on rural agricultural households in Zambia. The survey collects data on more than 300 variables ranging from demographic, socio-economic, institutional and among many other factors. The RALS 2015 covered 476 Standard Enumeration Areas (SEAs) across the 10 provinces and a total of 7,934 households as shown on the map (Figure 4.1). This sample was expected to yield reliable estimates at provincial and national level.

The RALS 2015 survey employed the sampling frame of 2010 Census of Housing and Population based on the stratified two-stage sample design. The first stage involved identifying the Primary Sampling Unit (PSU) which was defined as one or more Standard Enumeration Areas (SEAs) with a minimum of 30 agricultural households. At the second stage, all households in selected SEAs were listed and then only agricultural households were maintained on the second list. Based on the second list, agricultural households were then stratified into three categories, A, B, and C, based on total area under crops; the presence of some specified special crops; numbers of cattle, goats, and chickens raised; and sources of income. Then, systematic sampling was then used to select 20 households distributed across the three strata in each SEA.



*Source: RALS 2015*

*Figure 4.1: Distribution of Standard Enumeration Areas, RALs 2015*

## 4.4 Definitions of Variables

**Access to Credit:** Access to credit by smallholder farmers in this paper is defined as the ability of a smallholder farmer to obtain the amount of capital or funds s/he needs to acquire the agricultural inputs, in the absence of price and non-price barriers when acquiring and using of loans or credit. In this paper, any loan to agriculture and allied sector is defined as agriculture credit. Theoretically, the problem of access to credit for firms exists when a project that would be internally financed if resources were available, does not have external financing. In this paper the variable Access to Credit was generated from the following key question from the survey;

*Did any member of your household borrow money or obtain a loan/credit (cash or in-kind) to support agricultural production during the 2014/15 agricultural season?*

If the answer to the question is yes then it is coded "1", otherwise=0 which is the requirement of the treatment variable in the endogenous switching framework. This variable is based on pure credit as was the intention of the survey. The paper has controlled for Fertilizer Input Support Progromme (FISP) which is used as a variable. For robustness check the credit variable and FISP were combined and the average treatment effects were computed.

**Agricultural Productivity:** The term *agricultural productivity* refers to a measure of efficiency in an agricultural production system which use land, labour, capital, seeds and other inputs. This study employed the definition of Dewett (1966) who explains it as, "productivity expresses the varying relationship between agricultural output and one of the major inputs, like land, labour or capital, other complementary factors remaining the same…….''. Hence, in this paper agricultural productivity is defined as the total output of 50 kilograms bags of Maize per hectare in the 2014/2015 farming season. A number of studies have also used harvest per hectare for a number of crops from different countries[ (Awotide, et al., 2015), (Baffoe, et al., 2014)]. The agricultural productivity variable was constructed based on the following two key questions;

*Gross value of maize harvested; How much of this crop did the household harvest from this field?*
*Hectares; what portion of the area planted was harvested (Hectares)?*

Then *agricultural productivity* is given by 50 kilograms bags per hectare harvested in the 2014/2015 farming season.

**Smallholder farmers:** Jari (2009) defines Smallholder farming as producing agricultural yields on relatively small areas of land mainly located in rural areas of the provinces. In this study, the smallholder farmers are defined as all the farmers with farm size up to twenty hectares (0-20 ha) (CFS[2],2016). Thus, this paper focusses only on rural smallholder farmers who constituted of about 99.4% of the RALS 2015 survey data base.

[2] CSO (2016), Crop forecast Survey report

Among the key control variables are Access to FISP and information, value of productive assets, total livestock units, Off-farm income, Free inputs, Membership to local loan saving society and other demographic variables such as the gender of the head of the household, years of formal education, and household characteristics based on the literature review.

The definition of other dependent variables that were used in this study are summarized in the Table 4.1. Furthermore, the table shows the expected signs of each coefficients of all the variables that were used in the study. Based on the literature and inductive logic, *bank* and *rheadman* variables were not expected to have any direct link with agricultural productivity even though they may influence the smallholder farmers' access to credit.

**Table 4.1: Variable Definition and Description.**

| Variable | Description | Expected Sign | |
|---|---|---|---|
| | | prdvty | Credit |
| prdvty | 50 Kg of maize harvested per Hectare | n/a | n/a |
| credit | if the farmer accessed credit (yes=1) | + | n/a |
| **Demographic Variables** | | | |
| malehead | is the Head of the household male (yes=1) | + | + |
| eduhead | Years of education of the head | + | +/- |
| hhage | Age of the head of household | + | +/- |
| rheadman | is the head of the hh related to headman (yes=1) | n/a | + |
| age15_59 | hh members in prime age | + | + |
| edu_max | most educated member of hh | + | - |
| numdep | number of dependents in the hh(not in prime age) | +/- | + |
| **Socio-Economic Variables** | | | |
| offincome | average monthly off farm income (K) | +/- | - |
| prodasst | monetary value of productive assets (K) | + | +/- |
| tlu | Total livestock units | + | +/- |
| bank | hh member have a bank account (yes=1) | n/a | + |
| **Other Variables** | | | |
| information | hh recieves regular market prices updates (yes=1) | + | + |
| lslsociety | Membership with local /saving society(yes=1) | + | + |
| freeinputs | monetary value of free inputs received (K) | + | - |
| manure | if hh applies manure in fields (yes=1) | + | - |
| fisp | did this hh receive fisp (yes=1) | + | +/- |
| virgin_land | if part of the field was virgin_land (yes=1) | + | - |
| hectmaize | number of hectares of maize harvested | n/a | n/a |

**K is the rebased Zambian Kwacha*

### 4.5 Data Analysis Techniques

A number of studies have attempted to assess the effect of credit on agricultural productivity using different methodologies. Some have used the Ordinary Least Square (OLS), but this approach ignores the possibility of endogeneity and heterogeneity. While, others have estimated separate production or supply functions for farmers that have access to credit and those without access and then compared the estimates using ordinary Least Square (Awotide, et al., 2015). However, this approach has also one major setback among others. It assumes implicitly that all farmers that have access to credit and those with no access are identical.

Additionally, this approach ignores the problem of endogeneity which arises from the fact that access to credit is either voluntary or some farmers are in a better position than others to have access to credit due to self-selection. For instance, wealthy, educated, or more productive farmers are more likely to have access to credit than their counterparts. Selection bias potentially occurs because farmers' decisions to access credit are non-random and the outcomes of choices, they have not made are never observed. Selection bias due to observables arises from sample differences that researchers can normally observe but cannot be controlled for. While, Selection bias due to unobservable arises from the unobservable and thus uncontrolled sample differences that affect farmers' decisions to access credit and their consequences (Tucker, 2011).

These two types of selection bias have serious consequences if not taken care of when conducting an impact analysis of the treatment variable. Baker (2000) asserts that to analyze the effect of the policy or decision variable successfully, there is a need to establish the counterfactual. That is, what would have happened to the productivity of the smallholder maize farmers with access to credit if they had no access to credit instead? Alternatively, what would have happened to the productivity of smallholder maize farmers with no access to credit if instead, they had access to credit? To deal with this problem, Friedlander and Robins (1995) suggest that a comparison group with similar observable characteristics would be used to estimate the appropriate counterfactual results. That is the outcome of the treatment is compared to the outcome of the control group.

In the context of this study, this is done by matching a group of smallholder maize farmers with no access to credit (comparison group) to those smallholder maize farmers with access to credit (treatment group) on the bases of the propensity score of X. Where X denotes the set of observable characteristics that determine access to credit in Zambia. To address the problem of endogeneity arising from selection bias due to observables, two non-parametric technique called Propensity Score Matching (PSM) and Covariable Matching (CVM) have been widely used by a number of researchers[ (Caliendo & Kopeinig, 2008); (Owusu, 2017), (Faulkender & Yang, 2010)]. These two techniques basically involve the comparison of the outcomes (productivity) between farmers with access to credit and smallholder farmers without access to credit based on matching score or covariates. One setback of these approaches is that they only mitigate selection bias due to observables but does not alleviate selection bias due to unobservables. Secondly, inferences of results from these methods have to be used with much caution; used with observations with characteristics that can be found in both the sample and control groups. These constraints can be overcome by using full information maximum likelihood estimation; Endogenous Switching Regression Model. One advantage of using the FIML is that it accounts for both heterogeneity and sample selection bias issues (Awotide, et al., 2015).

### 4.5.1 Endogenous Switching Regression Model (ESRM)

An ESRM was used in this paper to account for possible selection bias that may arise from any other intervention that would affect farmers productivity other than access to credit (Freeman, et al., 1998). The ESRM specifies a decision process and the regression models associated with each decision option that is available, and it is used when there is a problem of self-selection and non-random assignment of subjects to treatment and non-treatment groups (Alene & Manyong, 2007). The advantage of using the ESRM is that it helps to evaluate the direction and degree of non-random selection of maize farmers with access to credit and the implicit selection biases which the Ordinary Square (OLS) method fail to mitigate. Secondly, it is also possible to simulate how the farmers' productivity would be if they are under the alternative scenario (Mare & Winship, 1987). The study adopted the model from other studies on impact evaluation [Nyangena and Köhlin (2008), Asfaw *et al. (*2010), and Lokshin and Sajaia, (2004)].

In endogenous switching regression model, the first stage involves modeling of the behavior of smallholder farmers to access agricultural credit with the limited-dependent variable method. In the second stage, another decision variable (agricultural productivity) is estimated separately for each group (farmers with access to credit and those without access), conditional on credit access decision. So, a binary probit model is used in the first stage to model credit behavior, and in the second stage, separate regression models are used to model agricultural productivity function conditional on a specified criterion function.

So, the latent variable model (probit model) as a function of observable factors in this as follows:

$$c_i = \begin{cases} 1, & if\ X_i\beta + \varepsilon_i \geq 1 \\ 0, & if\ X_i\beta + \varepsilon_i < 0 \end{cases} \tag{4}$$

Where $X_i$ is the vector of observable factors that hypothetically influence the smallholder farmers' access to credit in rural area. Additionally, let Y be the agricultural productivity of a given smallholder maize farmer measured in 50 kilogram of maize in 2014/15 farming season and Z be the vector of exogenous variables that hypothetically affect Maize productivity in Zambia. As the result of selection bias, the farmers are believed to experience the following two productivity regimes;

**Regime 1; Maize farmers with access to credit ($c_i = 1$)**

$$Y_{1i} = Z_{1i}\theta_1 + \mu_{1i} \tag{5a}$$

**Regime 2; Maize farmers with no access to credit ($c_i = 0$)**

$$Y_{2i} = Z_{2i}\theta_2 + \mu_{2i} \tag{5b}$$

Where $\theta_1$, and $\theta_2$ are the parameters to be estimated and $\mu_{1i}$ and $\mu_{2i}$ are the error terms which are assumed to have a trivariate normal distribution, with zero mean and non-singular covariance matrix given by;

$$\Omega = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{1\varepsilon} \\ \sigma_{12} & \sigma_2^2 & \sigma_{2\varepsilon} \\ \sigma_{1\varepsilon} & \sigma_{2\varepsilon} & \sigma_\varepsilon^2 \end{bmatrix} \tag{6}$$

Where $\sigma_1^2$, $\sigma_2^2$ and $\sigma_\varepsilon^2$ are variances of $\mu_{1i}$, $\mu_{2i}$ and $\varepsilon_i$ [from equation (1) above] respectively. While $\sigma_{12}$=cov($\mu_{1i}$,$\mu_{2i}$) , $\sigma_{1\varepsilon}$=cov($\mu_{1i}$,$\varepsilon_i$) and $\sigma_{2\varepsilon}$=cov($\mu_{2i}$,$\varepsilon_i$). The fundamental issue is that the outcome functions in equations (2a) and (2b) are not observed simultaneously. So, the covariance between $\mu_{2i}$ and $\mu_{2i}$ is not defined (Maddala 1983). However, a significant inference of the error structure is that as the error $\varepsilon_i$ of criterion function is correlated with the error terms of the productivity functions in equations 5(a) and 5(b), the expected values of the error terms are non-zero, conditional on the sample selection, and expressed as;

$$E(\mu_{1i}/\varepsilon > -X_i\,\beta) = E(\mu_{1i}/c_i = 1) = \sigma_{1\varepsilon}\left[\frac{\pi(X_i\beta/\sigma)}{\varphi(X_i\beta/\sigma)}\right] = \beta_{1\varepsilon}\rho_1 \quad (7)$$

$$E(\mu_{2i}/\varepsilon \le -X_i\,\beta) = E(\mu_{2i}/c_i = 0) = \sigma_{2\varepsilon}\left[\frac{-\pi(X_i\beta/\sigma)}{1-\varphi(X_i\beta/\sigma)}\right] = \beta_{2\varepsilon}\rho_2 \quad (8)$$

Where $\pi$ and $\varphi$ are the probability density and cumulative distribution functions of the standard normal distribution, respectively. The ratio of $\pi$ and $\varphi$ evaluated at $X_i\beta$ , represented by $\rho_1$ and $\rho_2$ in equations 4 and 5 above are known as the Inverse Mills Ratio (IMR) which denotes selection bias terms. The IMR is very important because it provide the correlation between access to credit and the agricultural productivity. If the estimated covariance $\beta_{1\varepsilon}$ and $\beta_{2\varepsilon}$ are statistically significant, it implies that adoption decision and productivity outcome variable are correlated. So, we find the evidence of endogenous switching and reject the null hypothesis of no sample selection bias (Maddala and Nelson 1975).

### 4.5.2 Estimation of the models

This paper employed a single-stage approach proposed by Lokshin and Sajaia (2004) where the Full Information Maximum Likelihood model was estimated using the ***movestay*** command available in the STATA statistical software which has been also adopted by other studies [ (Alene & Manyong, 2007), (Asfaw, et al., 2010)]. The advantage of using the FIML is that it considers the complete system of equations, and all the parameters are jointly estimated. Furthermore, the estimators obtained also have all the properties of maximum likelihood estimators (consistency and asymptotically normally distributed). The FIML simultaneously fit the selection equation (1) and two agricultural productivity regimes (2a) and (2b) in order to yield consistent standard errors, thus making $\rho_1$ and $\rho_2$ in equation 7 and 8, respectively homoscedastic. This paper used a FIML's likelihood function for switching regression model similar to the one that was proposed by Lokshin and Sajaia (2004) as expressed below;

$$Prdvty_i = \sum_{i=1}^{N} \begin{bmatrix} P_i t_i \left[ lnF \left[ \frac{(X_i\beta + \rho_{1\varepsilon}(Y_{1i} - Z_{1i}\theta_1/\pi_1)}{\sqrt{1-\rho_{1\varepsilon}^2}} \right] + \ln[f(Y_{1i} - Z_i\theta_1/\pi_1)] \right] \\ +(1-P_i)t_i \left[ \left[ \frac{\ln(1-F(X_i\beta + \rho_{2\varepsilon}(Y_{2i} - Z_{2i}\theta_1/\emptyset_2)}{\sqrt{1-\rho_{2\varepsilon}^2}} \right] + \ln[f(Y_{2i} - Z_{2i}\theta_1/\emptyset_2)] \right] \end{bmatrix} \quad (9)$$

The sign of the correlation coefficients $\rho_{1\varepsilon}$ and $\rho_{2\varepsilon}$ have economic interpretations (Fuglie & Bosch, 1995).

i) *In the case where $\rho_{1\varepsilon}$ and $\rho_{2\varepsilon}$ happen to have opposite signs, then it implies that a farmer obtain credit based on their comparative advantage. That is smallholder maize farmers with access to credit have above average returns from access to credit and those who choose not to access credit have above-average returns from non-access to credit.*

ii) *If the $\rho_{1\varepsilon}$ and $\rho_{2\varepsilon}$ have the same sign, it implies that those farmers that have access to credit have above-average returns whether they have access to credit or not, nonetheless they are better-off if they have access to credit. On the other hand, those farmers without access to credit have below-average returns regardless of the state, but they are better off not having access to credit* (Awotide, et al., 2015).

The estimation of the equations (1) through equation (5) were done using an add-on command ***movestay*** in *stata* statistical package which was written by M. Lokshin (World Bank) and Z. Sajaya (Stanford University) in 2014. It was specifically designed for this type of endogenous switching regression model.

### 4.5.3 Estimation of Treatment Effects of access to credit: ATT, ATU and ATE

The Counterfactual outcome refers to what the outcome (Y) would have been for program participants if they had not participated in the program (c) and the converse is true. However, the counterfactual cannot be observed due to fact that one observation can never been a participant and non-participant at the same time. Therefore, it must be estimated using a comparison group (Paul, et al., 2016).

In this case Counterfactual outcomes refer to expected outcomes for farmers with access to credit had they not accessed credit and for farmers with no access to credit had they accessed credit. After estimating the model's parameters, the following unconditional expectations could be calculated:

$$E(Y_{1i}/z_{1i}) = Z_i\theta_1 \quad (10)$$

$$E(Y_{2i}/z_{1i}) = Z_i\theta_2 \quad (11)$$

While, the conditional expectations can be estimated by

$$E(y_{1i}/c_i = 1, z_{1i}) = \theta_1 Z_i + \frac{\sigma_1\rho_1 f(\beta x_i)}{F(\beta X_i)} \quad (12)$$

$$E(y_{1i}/c_i = 0, z_{1i}) = \theta_1 Z_i - \frac{\sigma_1\rho_1 f(\beta x_i)}{(1-F(\beta X_i))} \quad (13)$$

$$E(y_{2i}/c_i = 1, z_{2i}) = \theta_2 Z_i + \frac{\sigma_2\rho_2 f(\beta x_i)}{F(\beta X_i)} \quad (14)$$

$$E(y_{2i}/c_i = 0, z_{2i}) = \theta_2 Z_i - \frac{\sigma_2\rho_2 f(\beta x_i)}{(1-F(\beta X_i))} \quad (15)$$

Where all the variables are as defined in equation (1) through (3) earlier , $F$ is a cumulative normal distribution function, $f$ is a normal density distribution function, and $\rho_1 = \frac{\sigma_{21}^2}{\sigma_\varepsilon\sigma_1}$ is the coefficient of correlation between $\mu_1$ and $\varepsilon$. While, $\rho_2 = \frac{\sigma_{1\varepsilon}^2}{\sigma_\varepsilon\sigma_2}$ are the coefficients of correlation between $\mu_2$ and $\varepsilon$.

Following Heckman, et al., (2001), we estimate the average treatment effect on the treated (ATT), the average treatment effect on the untreated (ATU), and the average treatment effect (ATE). The ATT is the difference in agricultural productivity between the smallholder maize farmers with access to credit (12) and the productivity of smallholder maize farmers with access to credit if they had no access to credit (14). While, the average treatment effect on the untreated (ATU) for households that did not access credit is the difference between the expected maize productivity in equations (13) and (15), which is the difference between what would have been the agricultural productivity of maize farmers with no access to credit had they accessed credit and what is actually their productivity with no access to credit. On the other hand, the average treatment effect (ATE) is the difference between the average maize productivity of farmers with access to credit and that of smallholder farmers without access to credit. This is given by the difference between equation (13) and equation (14).

The sample t-test would be used to estimate the effect of credit by comparing the productivity of the farmers with access to credit (treated) and the outcomes of those with no access to credit. Though sample t-test is fine with random experiments, the results can be biased in observational studies especially if the treated and control observations are not very similar. But estimation of the ATU and ATT simultaneously using FIML in stata was a major limitation even with much consultations. Hence, Mahalanobis Matching which is more less complicated was used to estimate ATT, ATU and ATE simultaneously after ESRM estimation.  While, Propensity Score Matching and Covariate Matching were used to carry out sensitivity analysis. However, before proceeding to estimating the treatment effect on the treated the test for common support region was done using the kernel density plot.

## 4.6 Limitations of the Study

Due to data limitation, this study was unable to explore the factors that affect credit supply and demand for credit separately as this would help determine whether there is just insufficient demand for credit to support the rural financial market or the supply is insufficient. This would help the policy makers to develop sound policies. Thus, a study on the determinants of agriculture credit supply would be an interesting area of research. Furthermore, the study could not use alternative measures of agricultural productivity as output per labour unit due to data limitations. So, it is recommended that other studies could assess the impact of access to agricultural credit using output per workers and see whether causal effect would still hold.

# CHAPTER FIVE

# STUDY FINDINGS AND RESULTS

## 5.1 Descriptive Statistics

Table 5.1 shows the descriptive statistics of all the variables that were used in this study. The sample data comprises of 7,886 households that were randomly sampled across the country in 2015 in rural areas. Only farmers with farm size of maize up to 20 hectares were included in this study. Thus, only 48 households were dropped from the sample which is just about 0.6% of the initial sample size of 7,932 households due to the fact that these had farm size that would fall under commercial farming.

**Table 5.1 Descriptive Statistics of the Variables**

| Variable | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|
| **Outcome variables** | | | | |
| prdvty | 49.19207 | 38.41876 | 0 | 216 |
| **Treatment variable** | | | | |
| credit | 0.187 | 0.39 | 0 | 1 |
| **Demographic Variables** | | | | |
| malehead | 0.7885396 | 0.40837 | 0 | 1 |
| eduhead | 7.908595 | 3.607205 | 0 | 19 |
| hhage | 48.62475 | 14.77818 | 17 | 96 |
| rheadman | 0.4549949 | 0.498002 | 0 | 1 |
| age15_59 | 3.184584 | 1.804761 | 0 | 14 |
| edu_max | 5.98073 | 3.700446 | 0 | 18 |
| numdep | 3.067064 | 1.800551 | 0 | 19 |
| **Socio-Economic Variables** | | | | |
| offincome | 1348.388 | 2294.038 | 0 | 45000 |
| prodasst | 26.428 | 257.547 | 0 | 20391 |
| tlu | 3.635 | 10.300 | 0 | 250 |
| bank | 0.141 | 0.348 | 0 | 1 |
| **Other Variables** | | | | |
| information | 0.7101927 | 0.4537016 | 0 | 1 |
| lslsociety | 0.0599645 | 0.2374361 | 0 | 1 |
| freeinputs | 21.1973 | 46.6999 | 0 | 2000 |
| manure | 0.0600913 | 0.2376709 | 0 | 1 |
| fisp | 0.5508367 | 0.4974404 | 0 | 1 |
| virgin_land | 0.336714 | 0.4726161 | 0 | 1 |
| hectmaize | 1.401 | 1.710 | 0.010 | 20 |

The results from table 5.1 show that about 79% of the households were headed by the males with the average age of 48.3 years with the minimum age of the head of the household of 17 years. The education level of the head of the household averaged around 7.9 years while the highest level of education was 19 years (Postgraduate level of education). Additionally, only about 5% of farmers reported to have had a tertiary level of education and 22% had reached the Senior secondary level of education in Zambia (Figure 5.1).

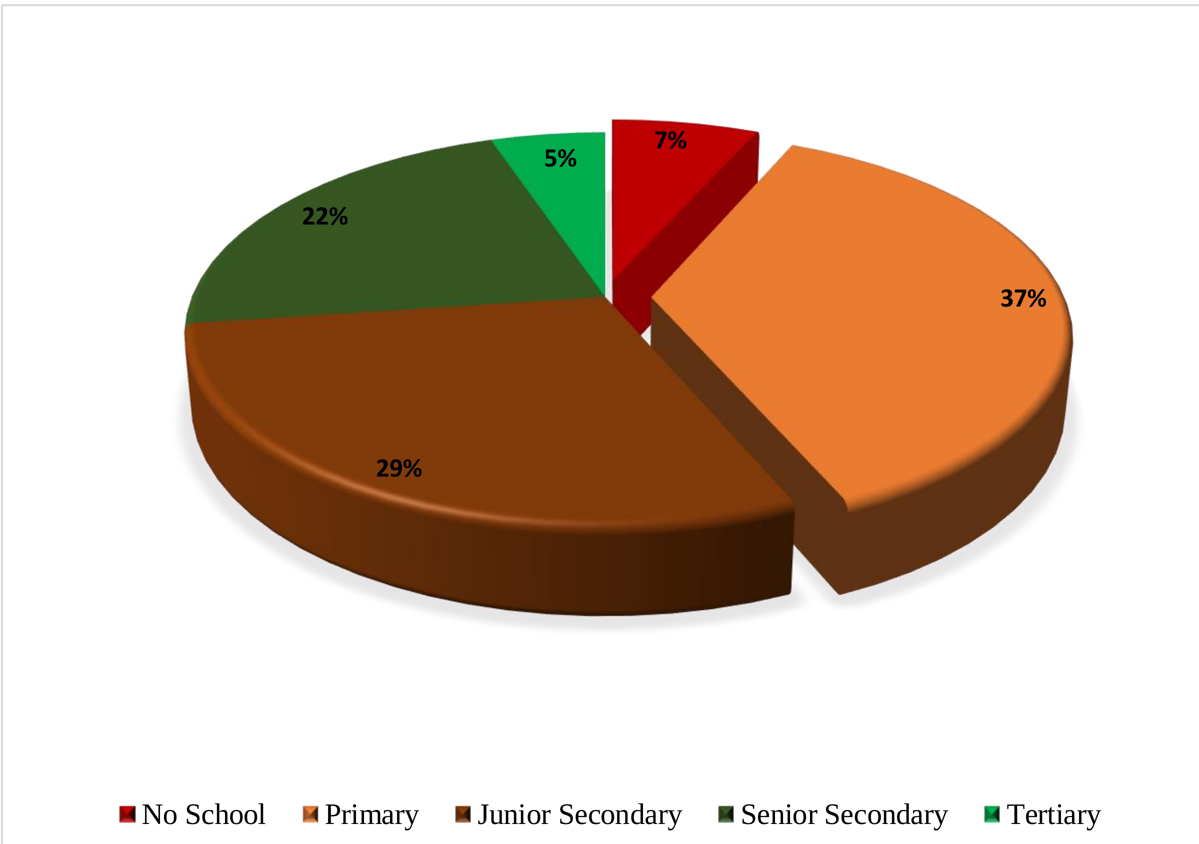



*Figure 5.1: Education level of the head of the household*

Additionally, the results show that about 44% of the head of households has only a primary level of education, and about 29% have only attained junior secondary level education as the highest level of education. This shows that most farmers (73%) in the rural areas only have a junior secondary level of education in Zambia and about 95% fail to proceed for tertiary education on average.

About 46% of the head of the households sampled were related to the headman (or they were headmen themselves) of their locality while the average number of the household members (other than the head of the household) in the prime age (15-59 years) is about 3 members. Additionally, the average number of dependents per household was 3 with maximum number of 19.

The average amount of monthly off-farm income was K1,348 and the average of the productive asset of an agricultural household was about K26,500 but with a large standard deviation of K257,500. This implies that the value of productive assets varies greatly among smallholder maize farmers in Zambia. The results also show that only about 14% of the agricultural households reported having had an account with any of the commercial banks. Besides, about 71% of the households reported to have had access to information on agriculture commodity prices while about 6% indicated the use of manure as an alternative to fertilizer at least in one crop. Thus, an average number of crops where manure was applied as an alternative to fertilizer or compliment was about 0.08.

## 5.2 Comparison of the farmers with Access to Credit with those without Access

Table 5.2 shows the comparison in the characteristics of farmers with access to credit and those without access to credit in the 2014/2015 farming season. The results from the table show that 85% of the household with access to credit were headed by males compared to 78% of those with no access to credit, this is statistically significant at 1% level of significance. The difference in age of the head of the household is also significant at 1%, the mean age of maize farmers with access to credit was 46 years whereas that of maize farmers without access to credit was 49 years.

Additionally, 54% of farmers with access to credit were related to headman or where the headmen of the village compared to 44% of the respondents without access to credit. The difference in the number of household members in the prime age (age15_59) is statistically significant at 1%, given the average number of household members of farmers with access to credit of about 3.33 compared to an average of 3.15 for those without access to credit.

The difference in the monthly off-farm income between households with access to credit and those without access to credit is statistically significant at 1% level of significance. The average off-farm income for farmers with access to credit was K980 compared to K1,432 for those with no access to credit. Additionally, the difference in the productive assets of farmers with access to credit is statistically higher than those without access to credit at 10% level of significance. The average productive asset value of farmers with access to credit was about K36,608 compared to K24,132 for those without access to credit.

**Table 5.2 Comparisons of characteristics between maize farmers with access to credit and those without access to credit.**

| Sample | Access to Credit (1) | | No Access to Credit (2) | | Mean difference (1–2) | |
|---|---|---|---|---|---|---|
| size | 1473 | | 6415 | | n/a | |
| | Mean | Std dev | Mean | Std dev | Mean | T- stat |
| **Outcome variables** | | | | | | |
| prdvty (50kg/ha) | 56.24502 | 37.53869 | 47.57259 | 38.4386 | 8.69 | 7.86*** |
| **Demographic Variables** | | | | | | |
| malehead | 0.848 | 0.359 | 0.775 | 0.418 | 0.073 | 6.19*** |
| eduhead | 7.969 | 3.281 | 7.895 | 3.678 | 0.070 | 0.71 |
| hhage | 46.146 | 13.415 | 49.194 | 15.017 | -3.048 | -7.17*** |
| rheadman | 0.537 | 0.499 | 0.436 | 0.496 | 0.100 | 7.05*** |
| age15_59 | 3.327 | 1.773 | 3.152 | 1.811 | 0.170 | 3.34** |
| edu_max | 6.011 | 3.550 | 5.974 | 3.734 | 0.040 | 0.33 |
| numdep | 3.122 | 1.814 | 3.054 | 1.797 | 0.070 | 1.33 |
| **Socio-Economic Variables** | | | | | | |
| offincome | 980.271 | 1665.342 | 1432.914 | 2407.580 | -452.160 | 6.84*** |
| prodasst | 36.608 | 535.293 | 24.091 | 125.596 | 12.480 | 1.68* |
| Tlu | 4.748 | 11.069 | 3.379 | 10.099 | 1.370 | 4.60** |
| bank | 0.153 | 0.360 | 0.138 | 0.345 | 0.015 | 1.45 |
| **Other Variables** | | | | | | |
| information | 0.822 | 0.383 | 0.684 | 0.465 | 0.140 | 10.58*** |
| lslsociety | 0.094 | 0.291 | 0.052 | 0.222 | 0.040 | 6.01*** |
| freeinputs | 20.703 | 65.508 | 21.311 | 41.192 | -0.590 | 0.44 |
| manure | 0.060 | 0.050 | 0.219 | 0.062 | 0.242 | 2.22** |
| Fisp | 0.590 | 0.591 | 0.492 | 0.542 | 0.498 | 3.46*** |
| virgin | 0.324 | 0.468 | 0.340 | 0.474 | 0.016 | 1.1603 |
| hectmaize | 1.630 | 1.757 | 1.348 | 1.695 | 0.285 | 5.78** |

*, **, *** imply statistically significant at 1%, 5% and 10%, respectively; K is Zambian Kwacha,

Other control variables that were statistically different between the smallholder farmers with access to credit and those without access to credit are information variable, the variable capturing whether the farmer belonged to local loan or saving society(lslsociety), manure variable, FISP, and the number of hectares of maize cultivated(hectmaize). On the other hand, four variables were not statistically significant even at 10% level of significance. These include the level of education of the head of the household, the maximum level of education of any member of the household and amount of free inputs received in kilograms.

Figure 5.2 shows the comparison of the characteristics of the smallholder maize farmers with access to credit and those without access to credit based on the propensity score. The figure shows that the common support condition to implement the Propensity Score Matching is satisfied. Additionally, the pstet results shows that the balancing was effective as non of the t-statistic was significant at 5% after matching as shown in appendix 4 and region of common support is [0.01564098, 0.77290316] which provide suffecinct overlap. Thus, Full Mahalanobis Matching was employed to estimate the average treatment effect on the treated (ATT), the average treatment effect on the untreated (ATU) and average treatment effect (ATE). Then Propensity Score Matching and Covariate matching were used to carry out the robust checks and seinsitivity analysis.

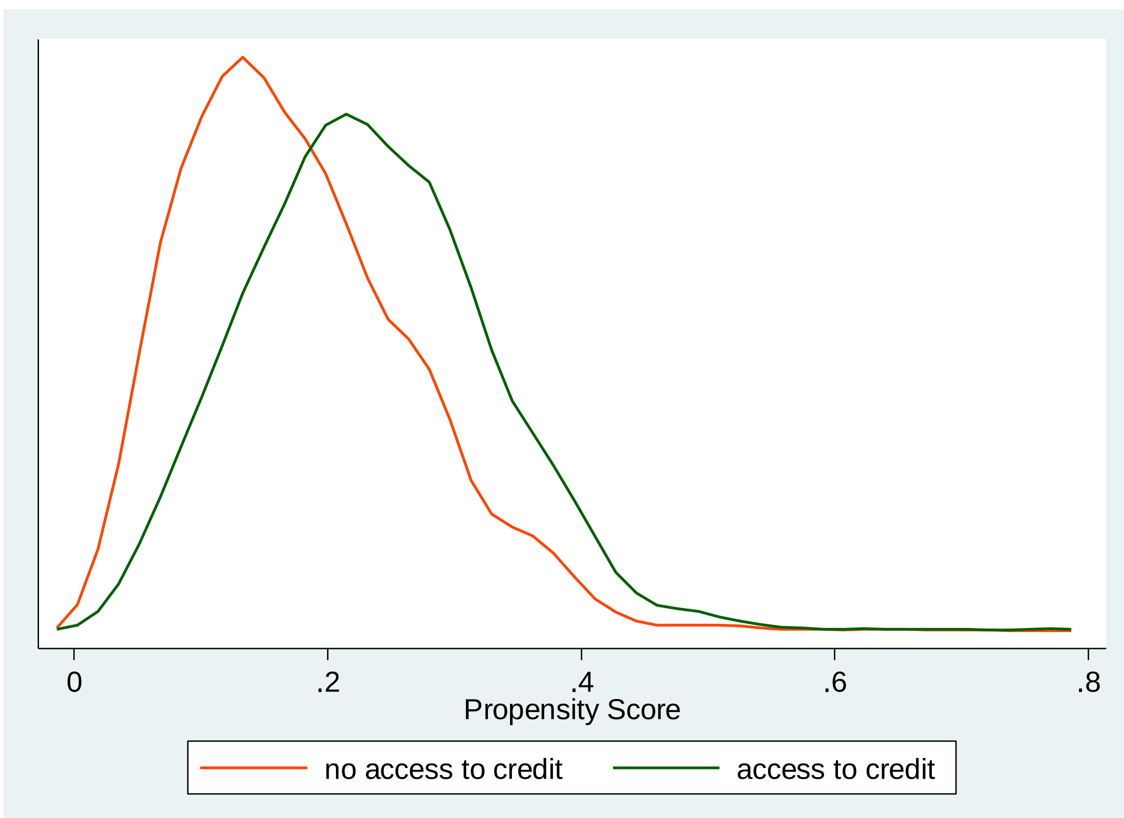



*Figure 5.2: Kernel density base on propensity scores*

The comparison of the credit access rate with Maize productivity shows that Eastern province had the highest proportion of smallholder farmers with access to agricultural credit (43%). Though Muchinga province recorded the third highest proportion of smallholder farmers with access to agricultural credit (16.5%), it had the highest maize productivity with an average of 60 bags (50 kilograms) per hectare followed by Central province with 57 bags per hectare which had the second proportion of smallholder farmers with access to agricultural credit (24.8%). This was expected as Central and Muchinga provinces are among the most fertile provinces for farming and favourable rain pattern in Zambia. While, Western province had the lowest average maize productivity of 25 bags per hectare harvested. This could be explained by the fact that Western province is mainly sandy making it less conducive for maize farming compared to other provinces. Though Copperbelt is known for mining industry, it was among the top 4 provinces in terms of maize productivity in 2014/2015 farming seasons despite being among the bottom three province in terms of proportion of agricultural households with access to credit (figure 2.5)

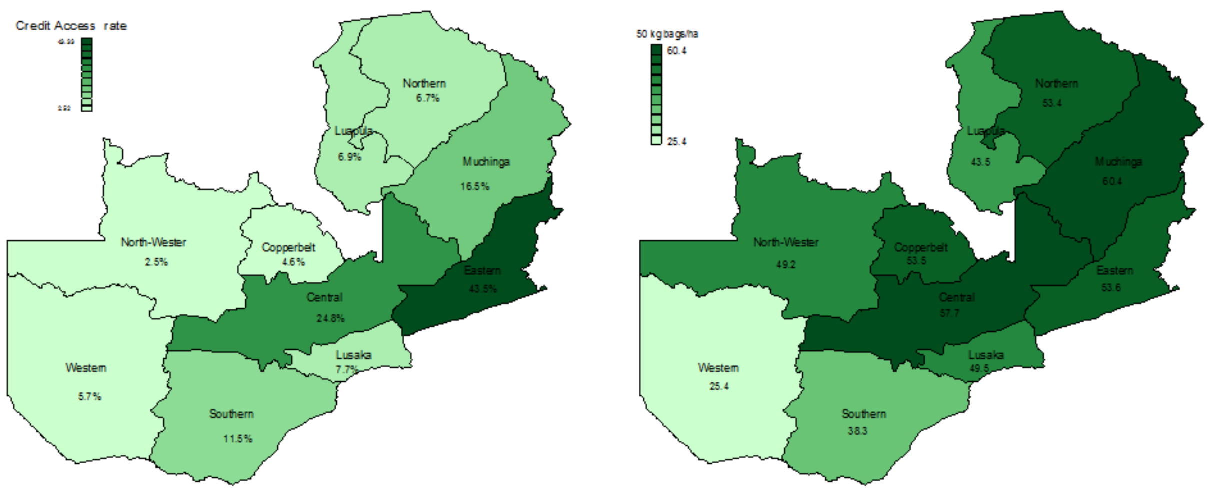



*Figure 5. 2: Access to Agricultural Credit and Maize Productivity by Province*

### 5.3 Impact of Agricultural Credit on Agricultural Productivity

Table 5.2 shows the coefficient estimates of the second stage switching regression model for the maize productivity (50 kilograms per hectare). The results of the productivity regressions among the farmers with access to credit are shown in the second column while those with no access to credit are shown in the third column of Table 5.2.

**Table 5.3 Results from the second stage of Endogenous Switching regression model.**

| Log likelihood | -43013.978 | | Number of obs | 7888 |
|---|---|---|---|---|
| | | | Wald chi2(25) | 132.97 |
| | | | Prob>chi2 | 0.000 |
| **Regime** | **Farmers with Access to Credit** | | **Farmers with No access to credit** | |
| **Variable** | **Coef.** | **Std.Err.** | **Coef.** | **Std.Err.** |
| malehead | 2.3044 | 2.9074 | 3.7250*** | 1.29576 |
| eduhead | 0.9464* | 0.5353 | 1.0702*** | 0.2359235 |
| hhage | 0.1230 | 0.4606 | 0.0787 | 0.2065633 |
| hhagesq | -0.0009 | 0.0045 | -0.0003 | 0.0019346 |
| age15_59 | 0.2839 | 0.6824 | 0.8533*** | 0.3372338 |
| edu_max | -0.0679 | 0.6904 | 1.2191*** | 0.3001013 |
| edu_inte | 0.0628 | 0.0662 | -0.0474 | 0.0277227 |
| numdep | 1.2438** | 0.5454 | -0.0517 | 0.2617257 |
| offincome | -1.5740*** | 0.6561 | -0.6472*** | 0.2627247 |
| prodasst | -0.0024 | 0.0019 | 0.0038 | 0.0038606 |
| Tlu | 0.3107*** | 0.0922 | 0.1780*** | 0.0509978 |
| lslsociety | -0.1648 | 3.4885 | 9.3598*** | 2.297985 |
| information | 3.7422 | 2.8441 | 7.7965*** | 1.270002 |
| freeinputs | -1.4018 | 0.8101 | 1.1306 | 0.7885258 |
| manure | 2.7982 | 4.5311 | 1.1045 | 1.945889 |
| Virgin_land | 5.6161*** | 2.0515 | 5.1357*** | 0.9757281 |
| Fisp | -2.7648 | 2.1257 | 3.8564*** | 1.293449 |
| Control for province | Yes | | Yes | |
| _cons | 33.2956*** | 14.7662 | 0.6840 | 5.691794 |
| /lns1 | 3.6087 | 0.037 | | |
| /lns2 | | | 3.5847 | 0.009 |
| /r1 | -0.3249 | 0.133 | | |
| /r2 | | | 0.0135 | 0.181 |
| sigma_1 | 36.9177 | 1.357 | | |
| sigma_2 | | | 36.0427 | 0.320 |
| rho_1 | -0.3140 | 0.120 | | |
| rho_2 | | | 0.0135 | 0.181 |
| LR test of indep. Eqns | | chi2(1) =4.09 | Prob> chi2(1) = 0.0432 | |

*Standard errors in parentheses;***Significant at 1%, **Significant at 5% and *Significant at 10%*

The correlation coefficients rho_1 and rho_2 have opposite signs, however are statistically significant only for the correlation between the credit access choice equation and the yield of smallholder farmers with access to credit. Since only rho_1 is negative (-0.3249) and statistically significantly different from zero, the results from the model imply that farmers who have access to credit have higher productivity than a random smallholder maize farmer from the population. In addition, the likelihood ratio test for joint independence of the three equations from the endogenous switching regression model (FIML) is statistically significant at 5%, this implies that these three models are not jointly independent and should not be estimated separately.

The estimated coefficient for the education of the head of the household and maximum level of education of the most educated member of the household other than the head of the household are positive and statistically significant for both farmers with access and those without access to credit. On average, each addition year of education is expected to increase agricultural productivity by about 2.3 and 3.7 bags of 50Kg maize for farmers with access to credit and those without access to credit respectively.

Additionally, the estimated coefficient for the total livestock units is positively and statistically significant. Among farmers with access to credit, each unit increase in the number of total livestock units is expected to lead to an increase in agricultural productivity by about 0.31 bags of 50 kg of maize. For smallholder maize farmers with no access to credit, each unit increase in the total livestock units is expected to increase agricultural productivity by only 0.18 bags of 50 Kg.

On the other hand, the estimated coefficient of off-farm monthly income has a negative and statistically significant coefficient whether a farmer has access to credit or not. A rise in the off-farm monthly income by K1 is expected to reduce agricultural productivity by about 1.57 and 0.65 bags of 50 Kg for farmers with access to credit and those with no access to credit respectively.

Besides, the results show that estimated coefficient of the number of dependents in the household is positive and statistically significant in explaining the variations in maize productivity among smallholder farmers with access to credit. For each extra dependent member of the family is associated with 1.24 bags of 50 Kg of maize. Among smallholder farmers with no access to credit, gender of the head of the households, the number of household members in the prime age, membership with loan/saving society, access to information on agricultural commodity prices, amount of free inputs and FISP have positive coefficients and are statistically significant in explaining the variation in maize productivity among the smallholder farmers without access to credit. The results show that households who are headed by male produces about 3.7 bags of 50 Kg more per hectare compared to those households headed by females.

Additionally, each extra household member in the prime age is expected to increase agricultural productivity by about 0.93 bags of maize. As for those who have membership with the loan/saving society produces on average 10.13 bags of maize per hectare than their counterpart. Farmers with access to information on agricultural commodity prices produces about 8.9 bags more per hectare than their counterparts. Furthermore, each kilogram received by a farmer with no access to credit is likely to raise productivity by 1.54 bags of maize and those with access to FISP have their agricultural productivity higher than their counterparts by about 4.8 bags on average.

## 5.4 Estimation of Treatment Effects

Table 5.4 shows the results from the estimate of the impact of credit on maize productivity of smallholder farmers in Zambia using different estimation techniques. The results show that the average treatment effect on the treated (ATT) which measures the impact of agricultural credit among on smallholder maize farmers with access to credit is 5 bags of 50 Kg of maize.

**Table 5.4: Estimated Effect of Credit on Agricultural Productivity (Kg/Ha)**

| Sample | Treated | Controls | Difference | Std.Err | T-Stat |
|---|---|---|---|---|---|
| ATT | 56.22 | 51.67 | 4.55 | 1.13411 | 4.01 |
| ATU | 49.24 | 56.26 | 7.02 | . | . |
| ATE | | | 5.78 | . | . |
| Unmatched | 56.25 | 47.57 | 8.67 | 1.11 | 7.84 |

Furthermore, the average treatment effect for the untreated (ATU) which measures the potential impact of agricultural credit among on smallholder maize farmers without access to credit is 5 bags of 50 Kg of maize. The average treatment effect (ATE) which is the measure of impact of access to credit among smallholder maize farmers in Zambia 6 bags of 50 Kilograms and it is correctly between the ATT and ATU. While, the treatment effect among the unmatched smallholder maize farmers is about 9 bags of 50 Kg and statistically significant at 1% level of significance.

## 5.5 Robustness Checks

To check for the robustness of the results, the study used two of the most commonly used econometric tools developed to mitigate selection bias when carrying out an impact analysis. These includes propensity score matching (PSM) and Covariate Matching (Section 4.3).

Table 5.5 shows the results from the estimated effect of credit on maize productivity using Covariate Matching and Propensity Score Matching. The Sample Average Treatment Effect (SATE), Population Average Treatment Effect (PATE) and Sample Average Treatment Effect for the Treated (SATT) were used to estimate the impact of access to credit under covariate matching. The results from the covariate matching show that the farmers who have access to credit produce about 6 bags (50 kg) of maize more per hectare than those without access to credit. Instead of matching the farmers based on individual covariates, propensity score matching was employed in estimating the Average Treatment effect on the Treated (ATT). The results from four algorithms show that the Average Treatment effect on the Treated of credit ranges between 5.8 to 7.3 50kg bags of maize and are all statistically significant for all the three cases; normal, percentile and bias-corrected.

**Table 5.5 Estimated Effect of Credit on Agricultural Productivity (Kg/Ha) based on the matchings**

**Covariate Matching**

| Productivity | Matching | Coef. | Std.Err | Z statistic |
|---|---|---|---|---|
| SATE | 4 | 5.9 | 1.194 | 4.98 |
| PATE | 4 | 5.9 | 1.196 | 4.97 |
| SATT * | 4 | 6.2 | 1.207 | 5.15 |

**Robust and Adjusted for Bias*

**Propensity Score Matching**

| Algorithm | Treated | Control | ATT | Std. Err. | T Statistic |
|---|---|---|---|---|---|
| Nearest neighbor matching | 1473 | 1161 | 4.2 | 1.55 | 2.69 |
| Radius matching * | 1473 | 6404 | 7.3 | 1.102 | 6.660 |
| Kernel Matching* | 1473 | 6404 | 6.2 | 1.282 | 4.812 |
| Stratification Matching* | 1473 | 6404 | 5.4 | 1.170 | 4.575 |

**Average Treatment Effect for the Treated (ATT) estimated via Bootstrapping (100)*

Table 5.6 shows the case where credit and FISP are combined to form a treatment variable. The results show that all the three treatment effects (ATT, ATU and ATE) and that of the unmatched sample remains statistically same though the impact is slightly higher across.

**Table 5.6: Estimated Effect of Credit (Combined with FISP) on Agricultural Productivity (Kg/Ha)**

| Sample | Treated | Controls | Difference | Std.Err | T-Stat |
|---|---|---|---|---|---|
| ATT | 56.08 | 48.89 | 7.19 | 1.89305 | 3.8 |
| ATU | 47.69 | 56.14 | 8.45 | . | . |
| ATE | | | 7.82 | . | . |
| Unmatched | 56.38 | 45.08 | 11.30 | 1.71 | 6.62 |

## 5.6 Balancing checking

To test for the balancing on the covariates a *pstest* command proposed by Rosenbaum and Rubin (1985). The results for both are presented in appendix (1) and appendix (2). The results show that all the covariates are statistically insignificant at 5% are all the P-values are greater than 5% after matching(m) whether Agricultural Credit or the combined variable is used as the treatment effect. Thus, the matchings are effective in building a good control group in both cases. Furthermore, the common support restriction was imposed when estimating the treatment effect using the matching algorithms used for robustness.

## 5.7 Determinants of access to credit

The results from the estimation of the determinants of access to credit are presented in Table 5.5. Column 2 of Table 5.7 shows the estimated coefficients of the dependent variables while column 4 show the associated marginal effects of the probit model from the first stage regression of an Endogenous Switching Regression Model.

The results show that the coefficient of the *malehead* variable is positive and statistically significant at 1% level of significance. The study findings show that if the farmer is male the probability of accessing credit improves by about 6% on average.

The coefficient of *rheadman* is positive and statistically significant at 1%. This imply that farmers who are related to headman or are headmen of the locality are more likely to have access to credit than their counterparts. Specifically, being related to or being the headman of the locality improves the probability of accessing credit by 5% on average. While an increase in the education level of any member of the household other than the head of the household reduces the likelihood of an agricultural household accessing credit. The marginal effect coefficient of edu-max shows that each addition year of education by the most educated member of the household reduces the likelihood of an agricultural household accessing credit by about 0.3% on average.

In a similar manner, the coefficient of the off-income is positive and statistically significant at 1% level of significance. The results show that farmers with higher off-farm income are less likely to access credit and a K1 rise in off-farm monthly income reduces the likelihood of a farmer accessing credit by about 17% on average.

**Table 5.7 Results from the first stage of Endogenous Switching regression model.**

| Model | First stage probit model of ESRM | | Marginal effects from probit | |
|---|---|---|---|---|
| **Variable** | **Coef.** | **Std.Err.** | **dy/dx** | **Std. Err.** |
| malehead | 0.24383*** | 0.04754 | 0.05775*** | 0.01035 |
| eduhead | 0.01499 | 0.00935 | 0.0037367 | 0.00235 |
| hhage | 0.00519 | 0.00808 | 0.00136 | 0.00205 |
| hhagesq | -0.00013 | 0.00008 | -0.00003 | 0.00002 |
| rheadman | 0.21781*** | 0.03557 | 0.05467*** | 0.00894 |
| age15_59 | 0.00803 | 0.01249 | 0.00206 | 0.00316 |
| edu_max | -0.01713*** | 0.00682 | 0.00287 | 0.00300 |
| numdep | -0.00828 | 0.00973 | -0.00068 | 0.00028 |
| eduh.edumax_interaction | -0.00290*** | 0.00114 | -0.00213*** | 0.00247 |
| offincome | -0.06675 *** | 0.01028 | -0.01690*** | 0.00254 |
| prodasset (K'000) | 0.00009 | 0.00007 | 0.00002 | 0.00002 |
| tlu | 0.00529*** | 0.00159 | 0.00136*** | 0.00039 |
| bank | 0.13715* | 0.07368 | 0.02423* | 0.01482 |
| lslsociety | 0.35991*** | 0.06539 | 0.10513*** | 0.02119 |
| information | 0.34188*** | 0.04069 | 0.08093*** | 0.00885 |
| free inputs | -0.02379 | 0.01986 | -0.00625 | 0.00507 |
| virgin_land | -0.06659* | 0.03636 | -0.01697* | 0.00902 |
| num_crop | 0.07225 | 0.08484 | 0.01853 | 0.02144 |
| manure | -0.05105 | 0.20297 | 0.00314 | 0.01402 |
| fisp | 0.06884 | 0.04101 | 0.01711 | 0.01033 |
| Control for Province | yes | | yes | |
| _cons | -1.43889*** | 0.21240 | | |

*Standard errors in parentheses; ***Significant at 1%, **Significant at 5% and *Significant at 10%*

Additionally, the estimated coefficient of the total livestock unit is positive and statistically significant at 1%. The positive sign implies that farmers with more livestock units are more likely to access credit. That is for every unit increase in the total livestock units, the predicted probability of accessing credit by the smallholder maize farmers increases by about 0.16% on average.

Besides, farmers who have a membership with loan/saving society are more likely to access credit compared to those who don't belong to any loan/saving society in their locality. Specifically, having a membership with a loan/saving society, improve the farmer's probability of accessing credit by about 11% on average.

The estimated coefficient of information variable is positive and statistically significant at 1% level of significance. If the farmer receives information about agricultural commodity prices on a regular basis his probability of accessing credit would improve by about 8% on average.

# CHAPTER SIX

# DISCUSSION AND RECOMMENDATIONS

## 6.1 Discussions

The overall objective of this study was to analyze the impact of agricultural credit on agricultural productivity among smallholder maize farmers in Zambia. Additionally, the study focused on the determinants of access to credit among smallholder farmers. While pursuing the main objective, this study also paid special attention to other determinants of agricultural productivity among smallholder maize farmers with access to credit and those without access to credit.

The results from the second stage switching regression model for the maize productivity show that farmers who have access to credit have higher productivity than a random smallholder maize farmer from the population. Besides, the results from Mahalanobis Matching, PSM and Covariate Matching show that credit has a positive and significant effect on maize productivity among smallholder maize farmers in Zambia. These results are consistent with the finding of Awotide, et al. (2015) and Baffoe, et al., (2014) and several other studies [ (Bashir, et al., 2010); (Saleem & Jan, 2011); (Ekwere & Edem, 2014); (Rima, 2014)] who concluded that access to credit has a positive impact on agricultural productivity. Thus, results from this study reveals that access to credit could have prospect in raising agricultural productivity of smallholder maize farmers and contributing to uplifting the livelihoods of disadvantaged rural households in Zambia.

Additionally, the study finds that education level measured by number of years of formal education by the head of the household or the most educated member of household have a positive significant effect on the agricultural productivity among smallholder maize farmers whether they have access to credit or not. This implies that smallholder maize farmers with more years of education have a higher agricultural productivity. These results are consistent with findings of Paltasingh & Goyari (2018) and Alene & Manyong (2007) who concluded that education enhances the agricultural productivity of farmers.

The study also finds that farmers with more livestock units have higher agricultural productivity whether they have access to credit or not. Thus, the number of total livestock units have a positive effect on agricultural productivity of smallholder maize farmers in Zambia. This could be attributed to the fact that smallholder maize farmers with more livestock such as bullock are expected to be more efficient in terms of cultivation and weeding leading to higher agricultural productivity. This conclusion is consistent with the findings of Saboor, et al. (2009) who found that the number of animals at farm had a positive effect on agricultural productivity.

On the other hand, farmers with higher monthly off-farm income are associated with lower agricultural productivity whether they have access to credit or not. One possible explanation to this result is that farmers with high off-farm income are less likely to place their focus on agricultural activities given the opportunity cost associated with seasonal farming of maize. These results are similar to the findings of Mezid and Hundie(2014) who concludes that households' engagement in off-farm economic activities is inversely related to crop production and, to some extent, to land productivity. This is because rural non-farm economy competes with agriculture for labour, thus higher off-farm income implies that less labour would be allocated to agricultural activities leading to low productivity.

In addition, the results show that estimated coefficient of the number of dependents in the household is positive and statistically significant in explaining the variations in maize productivity among smallholder maize farmers with access to credit. The larger the household size, the higher the labour hours will be allocated to agricultural activities which in turn leads to higher agricultural productivity.

Interestingly, the study found that farmer's access to farmer input support programs is positively related to agricultural productivity only among smallholder maize farmers with no access to credit. Since farmer's input support programs theoretically targets the low-income and saving farmers, it is expected to have more effect on those smallholder maize farmers that are credit constrained compare to those who have access to credit. These results are consistent with the findings of Asfaw and Carraro (2016) who found that farmers input subsidy programs had a positive impact on agricultural productivity in Malawi.

Similarly, the study found that the amount of free inputs received was positively associated with agricultural productivity among smallholder maize farmers with no access to credit. This could be explained by the fact that free farming inputs received such as fertilizer and seeds are mainly targeted at low-income households with the goal of raising their productivity. Thus, these findings are consistent with prior expectation and general assumption of the expected effect of free farming inputs on agricultural productivity of credit constrained smallholder maize farmers.

Another interesting finding from the study is the relationship between gender of the farmer and agricultural productivity among smallholder maize farmers. Male farmers have a higher agricultural productivity compared to female farmers among farmers with no access to credit. However, the study finds no evidence of a relationship between sex and agricultural productivity among smallholder maize farmers with access to credit. This could be explained by the intuition that when farmers are not credit constrained, they are quite efficient and tend to have a higher productivity regardless of their gender.

Moreover, the number of household members in the prime age, membership with loan/saving society and access to information on agricultural commodity prices are positive and statistically significant in explaining the variation in maize productivity among the smallholder maize farmers with no access to credit. This could be explained by assertion that farmers with membership with a local loan/saving society are likely to be more exposed to improved methods and tips of farming, which in turn lead to efficient use of their limited resources than their counterparts.

Furthermore, the results from the first stage of endogenous switching regression model show that a number of factors ranging from social economic to institution factors do affects farmers likelihood of accessing credit.

The results indicate that agricultural households who are headed by males are more likely to have access to credit compared to those that are headed by the females. This is consistent with the findings of other studies [Devkota, 2006), (Nwaru, 2011) & Kaino (2005), Ugbajah (2011)] who conclude that male-headed households are more likely to have access to credit than female-headed agricultural households. However, this is contrary to the finding of Samuel (2017) who found that women were more likely to have access to credit than men on a study that was done in a small municipal city in the rural area of Ghana.

Farmers who are related to headman or are headmen of the locality are more likely to have access to credit than their counterparts. One possible explanation is that farmers who are related to headman would find it easy to use the headman to have access to credit from friends, out-grower schemes and other financiers. This is consistent with findings of Datta and Ghosh (2013) who concluded that farmers from the upper class in India were more likely to have access to credit than their counterpart.

Another key factor that influenced farmer's access to credit is the number of years of education of the head of the household. The results show that an increase in the education level of the head of the household reduces the likelihood of an agricultural household accessing credit. One possible explanation is that agricultural households who are headed by educated heads tend to engage themselves in off-farm economic activities and as a result, they have higher off-farm monthly income. This makes them less likely to demand credit to finance their agriculture externally. Furthermore, this could be explained by the fact that educated people have a better understanding of the loan regulation, and cost of borrowing as well as the borrowing procedures of the formal financial institutions and individuals (Lensink et al., 2007). Though contrary to the findings of Rui & Xi (2010) and Tang et al. (2010), the results are consistent with the findings of Chen and Chiivakul (2008) who found that farmers with moderate education were likely to demand credit compared to those with more years of education.

In a similar manner, the study found that farmers with higher off-farm income are less likely to have access to credit. This would be attributed to the fact that farmers with more off-farm monthly income would find it viable to acquire inputs using their off-farm income than borrowing and pay the potential interest. These results are consistent with Komicha (2007) who found that off-farm income had a negative influence on the farmer's access to credit.

Additionally, farmers with more livestock units are more likely to have access to credit. This is consistent with prior expectation as some farmers would use livestock as collateral when accessing credit. These results are consistent with findings by Ammani (2012) and Awotide (2015) who concluded that farmers with more livestock at the farm where likely to have access to credit. Besides, this is consistent with the commonly held assumption that very poor households are less likely to have access to credit than wealthier households in cases where collateral is required to access credit services (Nguyen, 2007).

Membership with local loan/saving society was one of the key variables that influenced farmer's access to credit among smallholder maize farmers. Farmers who have a membership with loan/saving society are more likely to have access to credit compared to those who don't belong to any loan/saving society in their locality. This could be attributed to the fact that farmers with membership with local loan/saving society are less likely to be discouraged from credit application (Koomson, et al., 2014).

Furthermore, the results show that flow of information has positive effect on smallholder maize farmers' access to credit. Agricultural households who have access to information regarding agricultural commodity prices are more likely to have access to credit than their counterparts. This finding is consistent with Komicha (2007) who postulates that flow of information positively influences farmer's access to credit.

In a nutshell, the results show that access to agricultural credit is one of the key tools for raising agricultural productivity among smallholder maize farmers in Zambia. However, the majority of rural households still continue lacking access to credit. Among the key determinants of access to credit are the gender of the farmer, his/her relationship with headman of locality, the number of livestock units, access to information and membership with the local loan/saving society.

### 6.2 Policy Implications and Recommendations

The first policy implication arising from this study is that the government should come up with policies that would improve smallholder farmers access to credit as this would help them to engage in economic activities throughout the year. However, credit alone should not be used as an intervention to combat poverty and empower smallholder farmers, but the government should also come up with programs that educate farmers on the efficient use of credit to maximize their productivity and diversify their source of income.

Secondly, farmers should be encouraged to keep livestock such as cattle, donkey and bullock as this would help them to transport fertilizer and other farming inputs and cultivation of their farms at a lower cost which in turn would help them to use the limited amount of credit and FISP more effectively and efficiently.

Thirdly, it is imperative that policymakers should design demand-driven services to address the low level of credit access by smallholder farmers in rural areas. Also, the government should consider scaling up the implementation of additional interventions such as facilitating the market for the agricultural products, training and skill development. It is also advisable that the government should come up with the appropriate educational system in such a way that rural farmers are sensitized on ways of accessing credit at a lower cost if the country has to boost agricultural sector. In developing countries like Zambia where the agriculture sector is a major source of livelihood, increasing production capacity of agriculture through increased productivity is an important policy goal.

# CHAPTER SEVEN

# SUMMARY AND CONCLUSIONS

## 7.1 Summary

Amid rising concerns about food security and population pressures, agriculture sector has assumed more importance in recent years as governments and organizations have been exploring ways of improving the living standards of the rural population. However, the rural population in Zambia is characterized with low agricultural productivity coupled with limited access to credit. Therefore, a study on the impact of access to credit on agricultural productivity is a topic of considerable interest in developing countries like Zambia where the majority of the labour force derive their livelihood from agriculture sector.

The study shows that farmers with access to credit and those without access to credit differ significantly in terms of their characteristics. This is an indication of potential selection bias in the sample which if not corrected would result in biased or wrong conclusion. Thus, the study employed the endogenous Switching Regression Model which accounts for endogeneity and heterogeneity.

## 7.2 Conclusions

The study results show that farmers who have access to credit have higher productivity levels compared to a random farmer from the sample. In addition, the results from the covariate matching and propensity score also suggest that farmers with access to credit have higher productivity compared to those with no access to credit. This implies that access to credit has a positive impact on productivity and remains an important factor in the pursuit of raising agricultural productivity and henceforth, contribute to the alleviation of poverty in the country which is currently high.

Additionally, the findings show that the years of education of the head of the household and household members, number of dependents in the household, the value of the monthly off-farm income total livestock units and amount of free inputs received by an agricultural household are statistically significant in explaining the variations in maize productivity among smallholder maize farmers with access to credit.

While, sex and education level of the head of the household, the number of household members in the prime age, education of the household members, value of the monthly off-farm income, total livestock units, membership with loan/saving society, access to information on agriculture inputs and products prices and amount of free inputs received are statistically significant in explaining the variation in maize productivity among smallholder maize farmers without access to credit in rural areas of Zambia. Furthermore, the results show that farmers with access to FISP have a higher maize productivity among farmers with no access to credit in rural areas. This implies that FISP plays a critical role in poverty alleviation among smallholder farmers who are credit constrained.

Furthermore, the results show that agricultural households who are headed by the male, whose heads are related to headman or are headmen, with more livestock units, bank account, with membership with loan/saving society and received information are more likely to access credit compared to their counterparts. While households with more educated household members and higher off-farm monthly income are less likely to access credit.

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# APPENDIX

## Appendix 1: Checking for Balancing in before matching and after matching

| Variable | Unmatched Matched | Mean Treated | Mean Control | %bias | %reduct \|bias\| | t-test t | t-test p>\|t\| | V(T)/ V(C) |
|---|---|---|---|---|---|---|---|---|
| malehead | U | .84793 | .7749 | 18.7 | | 6.20 | 0.000 | . |
| | M | .84689 | .83413 | 3.3 | 82.5 | 0.94 | 0.346 | . |
| eduhead | U | 7.9688 | 7.8948 | 2.1 | | 0.71 | 0.478 | 0.80* |
| | M | 7.9672 | 7.9939 | -0.8 | 64.0 | -0.22 | 0.827 | 0.96 |
| hhage | U | 46.146 | 49.194 | -21.4 | | -7.16 | 0.000 | 0.80* |
| | M | 46.167 | 46.792 | -4.4 | 79.5 | -1.25 | 0.210 | 0.99 |
| hhagesq | U | 2309.3 | 2645.5 | -22.3 | | -7.37 | 0.000 | 0.73* |
| | M | 2312 | 2371.3 | -3.9 | 82.4 | -1.15 | 0.250 | 0.98 |
| rheadman | U | .537 | .43617 | 20.3 | | 7.03 | 0.000 | . |
| | M | .53725 | .51809 | 3.9 | 81.0 | 1.04 | 0.299 | . |
| age15_59 | U | 3.3265 | 3.152 | 9.7 | | 3.35 | 0.001 | 0.96 |
| | M | 3.3165 | 3.2812 | 2.0 | 79.8 | 0.54 | 0.590 | 0.99 |
| edu_max | U | 6.0109 | 5.9738 | 1.0 | | 0.35 | 0.729 | 0.90 |
| | M | 6.0109 | 6.1222 | -3.1 | -200.3 | -0.85 | 0.395 | 1.00 |
| edu_inte | U | 54.891 | 55.666 | -1.6 | | -0.53 | 0.597 | 0.82* |
| | M | 54.77 | 55.928 | -2.4 | -49.6 | -0.67 | 0.502 | 0.97 |
| numdep | U | 3.1222 | 3.0544 | 3.8 | | 1.30 | 0.193 | 1.02 |
| | M | 3.1217 | 3.1399 | -1.0 | 73.1 | -0.27 | 0.786 | 0.98 |
| offincome | U | 980.27 | 1432.9 | -21.9 | | -6.85 | 0.000 | 0.48* |
| | M | 983.92 | 1014 | -1.5 | 93.3 | -0.48 | 0.633 | 0.92 |
| prodasst | U | 36.608 | 24.091 | 3.2 | | 1.68 | 0.093 | 18.16* |
| | M | 22.386 | 23.635 | -0.3 | 90.0 | -0.50 | 0.620 | 1.06 |
| tlu | U | 4.748 | 3.3794 | 12.9 | | 4.60 | 0.000 | 1.20* |
| | M | 4.5874 | 4.1904 | 3.7 | 71.0 | 0.93 | 0.351 | 0.57* |
| bank | U | .15275 | .1378 | 4.2 | | 1.49 | 0.137 | . |
| | M | .15174 | .15154 | 0.1 | 98.6 | 0.02 | 0.988 | . |
| lslsociety | U | .09369 | .05222 | 16.0 | | 6.06 | 0.000 | . |
| | M | .08886 | .07782 | 4.3 | 73.4 | 1.08 | 0.280 | . |
| information | U | .82213 | .68449 | 32.3 | | 10.57 | 0.000 | . |
| | M | .82092 | .80614 | 3.5 | 89.3 | 1.03 | 0.305 | . |
| freeinputs | U | 20.703 | 21.311 | -1.1 | | -0.45 | 0.653 | 2.53* |
| | M | 20.708 | 21.197 | -0.9 | 19.6 | -0.24 | 0.809 | 2.58* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| virgin | U | .32383 | .33967 | -3.4 | | -1.16 | 0.246 | . |
| | M | .32536 | .33515 | -2.1 | 38.2 | -0.56 | 0.573 | . |
| manure | U | .05024 | .06235 | -5.3 | | -1.76 | 0.078 | . |
| | M | .05058 | .05188 | -0.6 | 89.3 | -0.16 | 0.874 | . |
| fisp | U | .59131 | .54154 | 10.1 | | 3.47 | 0.001 | . |
| | M | .59057 | .58771 | 0.6 | 94.3 | 0.16 | 0.875 | . |
| central | U | .08893 | .08059 | 3.0 | | 1.05 | 0.293 | . |
| | M | .08886 | .09147 | -0.9 | 68.7 | -0.25 | 0.805 | . |
| copperbelt | U | .05974 | .07186 | -4.9 | | -1.65 | 0.099 | . |
| | M | .06015 | .07304 | -5.2 | -6.3 | -1.40 | 0.162 | . |
| eastern | U | .35098 | .23694 | 25.2 | | 9.06 | 0.000 | . |
| | M | .34792 | .31945 | 6.3 | 75.0 | 1.63 | 0.103 | . |
| luapula | U | .05295 | .09431 | -15.9 | | -5.10 | 0.000 | . |
| | M | .05332 | .05324 | 0.0 | 99.8 | 0.01 | 0.993 | . |
| lusaka | U | .05838 | .05581 | 1.1 | | 0.39 | 0.699 | . |
| | M | .05878 | .06348 | -2.0 | -82.3 | -0.53 | 0.596 | . |
| muchinga | U | .09233 | .09026 | 0.7 | | 0.25 | 0.803 | . |
| | M | .09296 | .08874 | 1.5 | -103.8 | 0.40 | 0.691 | . |
| northern | U | .07128 | .10694 | -12.5 | | -4.11 | 0.000 | . |
| | M | .07177 | .08191 | -3.6 | 71.6 | -1.03 | 0.303 | . |
| north_western | U | .05499 | .06797 | -5.4 | | -1.81 | 0.070 | . |
| | M | .05537 | .05256 | 1.2 | 78.4 | 0.34 | 0.737 | . |
| southern | U | .10591 | .11442 | -2.7 | | -0.93 | 0.352 | . |
| | M | .10595 | .10512 | 0.3 | 90.3 | 0.07 | 0.942 | . |

* if variance ratio outside [0.90; 1.11] for U and [0.90; 1.11] for M

| Sample | Ps R2 | LR chi2 | p>chi2 | MeanBias | MedBias | B | R | %Var |
|---|---|---|---|---|---|---|---|---|
| Unmatched | 0.060 | 457.17 | 0.000 | 10.1 | 5.3 | 63.5* | 0.78 | 73 |
| Matched | 0.004 | 15.91 | 0.967 | 2.2 | 2.0 | 14.8 | 0.93 | 18 |

* if B>25%, R outside [0.5; 2]

.

**Appendix 2: Region of Common Support**

```
Note: the common support option has been selected
The region of common support is [.01564098, .77290316]



Description of the estimated propensity score
in region of common support

                 Estimated propensity score
-------------------------------------------------------------
      Percentiles      Smallest
 1%     .0298203        .015641
 5%     .0568117       .0159443
10%      .074887       .0160111       Obs               7,877
25%     .1163284       .0162462       Sum of Wgt.       7,877

50%     .1757463                      Mean            .186897
                        Largest       Std. Dev.      .0928676
75%      .247575       .6602606
90%      .311921        .684062       Variance       .0086244
95%      .357813       .7071671       Skewness       .6750176
99%     .4228822       .7729032       Kurtosis       3.586928
```

| Inferior of block of pscore | credit 0 | 1 | Total |
|---|---|---|---|
| 0 | 1,367 | 106 | 1,473 |
| .1 | 1,455 | 186 | 1,641 |
| .15 | 1,307 | 265 | 1,572 |
| .2 | 1,676 | 584 | 2,260 |
| .3 | 518 | 273 | 791 |
| .4 | 77 | 56 | 133 |
| .6 | 4 | 3 | 7 |
| Total | 6,404 | 1,473 | 7,877 |

Note: the common support option has been selected