ADOPTION AND COMMERCIALIZATION OF SOYBEAN AMONG SMALLHOLDER FARMERS IN CHIPATA DISTRICT OF ZAMBIA

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Adoption and Commercialization of Soybean among smallholder farmers in Chipata District of Zambia

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DECLARATION

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

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DEDICATION

This thesis is dedicated to my mom; Josephine Kahenge and Wife; Maureen Mwanza. This work would not have been a success had it not been for your investment and sacrifice in time, resources and encouragement.

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ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
CSO	Central Statistical Office
FAO	Food and Agriculture Organization
FtF	Feed the Future
GRZ	Government of the Republic of Zambia
NASFAM	National Smallholder Farmers Association of Malawi
NAP	National Agriculture Policy, Zambia
OLS	Ordinary Least Squares
SDG	Sustainable Development Goals
USA	United States of America
USAID	United States Agency for International Development
NGO	Non-Governmental Organization
COMACO	Common Markets for Conservation

ABSTRACT

Promotion of sustained increase in agricultural production and productivity of crops with comparative advantage such as soybean is one of the focus areas for the Zambian agricultural sector. The soybean sub-sector has been identified to possess immerse opportunities and benefits which if harnessed could contribute a lot in uplifting living standards of smallholder farmers. However, to realize these potential benefits, enhanced adoption and commercialization of soybean among smallholder farmers is critical. This study was conducted to assess how demographic, socioeconomic, institutional and attitudinal factors affect adoption, intensity of adoption and commercialization of soybean among smallholder farming households. The study used data from 160 household interviews, 8 focused group discussions and 8 key informant interviews conducted in Chipata district of eastern Zambia. The area was identified due to its high agricultural potential but also because it has in the recent past received a lot of development support towards promotion of legumes. Analysis on soybean adoption and intensity of adoption was conducted using Double Hurdle regression analysis. Results established that age, household size, ownership to livestock and access to credit significantly affected soybean adoption. Results further showed that the extent/intensity of soybean adoption was influenced by the presence of off-farm income, size of land holding, ownership to livestock, access to credit, gender and the marital status of the farmer. Tobit regression analysis was used to assess soybean commercialization. Results indicated that gender; household size, ownership to livestock and size of land holding were significant factors that influenced soybean commercialization. Lastly, Factors analysis was used to identify latent dimensions underlying the different variables that measured respondents' attitudes towards soybean adoption and commercialization. Results showed that after extraction, the variables were loaded around three factors which were named; Seed access and crop diversification, Soybean pricing and marketing as well as Gender relations and food processing. The three factors generally explained 79 percent of the variance in the model. The study concluded demographic characteristics such as age and gender as well as access to production resources such as land, labour; and institutional factors such as access to agricultural extension services and access to credit significantly influenced Soybean adoption and commercialization. The study further concluded that farmers were generally had negative attitude towards Soybean as they were not eager to adopt and commercialize the crop. By implication, there is need for policy makers to revise policies that govern land allocation in order to make land more available to smallholder farmers. There is also need to engage the private sector to find ways of reducing the cost of credit to make it more available as well as find ways of providing subsidized production inputs. This would make Soybean attractive and positively influence its adoption and commercialization. There is also need to improve and revise the agricultural extension system by employing more staff and using more bottoms-up and participatory approaches such as Farmer Field Schools. This will improve the farmer's knowledge and skills about Soybean which would ultimately influence its adoption and commercialization. Lastly, given the high level of variability across districts in eastern province future research should increase sample size in order to ensure that results are more representative. Further, studies on crop adoption should not just end on assessing adoption but go further to assess commercialization. This is because improvement in livelihood would only come about due to increased incomes from large scaled crop production. The study also recommends that there is need for further research to ascertain why land is a significant constraint to crop adoption and commercialization.

CHAPTER ONE

INTRODUCTION

1.1 Background

Zambia is among African countries in sub-Sahara with low crop productivity and high levels of poverty (UNDP, 2016). Central Statistical Office [CSO], (2015) estimates that approximately 40.8 percent of the population live in extreme poverty. The majority of the poor are found in rural areas were poverty levels have remained stubbornly high at rates of over eighty (80) percent (Sitko et al., 2011). With over seventy (70) percent of this rural population dependent on agriculture as a source of livelihood (UNDP, 2016), the government has recognized that the pathway out of poverty will largely depend on the growth and development of the agricultural sector (United Nations Development Programme [UNDP], 2016). In this vein, and in a quest to meet the sustainable development goals (SDGs number 1, 2 and 8) of eradicating poverty and hunger and promoting sustainable economic growth, the country has sought to promote diversification of agricultural production and export away from the traditional crops such as Maize to other crops in order to accelerate economic growth, and expand employment opportunities. This policy shift identified grain legumes such as soybean, beans and cowpea as crops that present immense opportunities to reverse the declining trends in productivity, poverty and food insecurity (Ministry of Agriculture [MOA], 2012).

Soybean (*Glycine max*) is one of the world's major crops which has been grown for nearly 5000 years due to its commercial, agronomic and nutritive value (Date, 2013). Global soybean production has been estimated to be 261 million metric tonnes with the major producers of the crop in order of importance being the USA (90.6 million metric tonnes), Brazil (68.5 million metric tonnes) and Argentina (52.6 million metric tonnes) while the major consumers include USA, Chile, Canada and the European Union (Food and Agriculture Organization [FAO], 2012). Masuda and Goldsmith, (2009) using an exponential smoothing model predicted that global production will increase by 2.2 percent annually to 371.3 million tons by 2030.

When compared to world production, Africa is a very small producer of soybean. Chianu et al. (2008) noted that in the last decade, Africa accounted for 0.4 – 1 percent of global production of soybean. Africa’s total Soybean production was estimated at 1.5 million metric tonnes. Major producers include Nigeria (48.9 percent), Uganda (16.8 percent), South Africa (14.9 percent), Zimbabwe (8.4 percent), Ethiopia (2.7 percent), Rwanda (2.0 percent), Egypt (1.7 percent), and Democratic Republic of Congo (1.4 percent). Others are Cameroon (0.8 percent), Benin (0.7 percent), Cote d’Ivoire (0.3 percent), Liberia (0.3 percent), Burkina Faso (0.3 percent), Zambia (0.2 percent), Gabon (0.2 percent), Tanzania (0.2 percent) and Morocco (0.1 percent) (Chianu et al., 2008). Though Zambia’s contribution to Africa’s production is negligible, the quantity of the crop produced has increased over time due to increased demand. This is evidenced by a notable increase in soybean production from 50,000 metric tonnes in 1999 to 350,000 metric tonnes in 2016 (CSO, 2016).

Zambia’s agricultural potential remains largely unexplored. Endowed with agricultural land accounting for 58 percent of the 750 million hectares of total land, only 14 percent is utilized indicating that the potential to expand the area under production is immense (Joala, 2018). Further, given its location, Zambia has the ability to increase Soybean production and export both the grain and processed foods to neighboring regional markets such as Zimbabwe and South Africa. The importance of the Soybean sub-sector to the country's economic growth and employment creation is well documented. For instance, ZASR, (2017) noted that the subsector contributed 4.8 percent to gross Domestic Product and employed at least 48 percent of the rural population nationally.

While many parts of the country produce Soybean, most of the production particularly by smallholder farmers is done in the eastern province of Zambia. On average the province produces 42 percent of the national output annually (Lubungu et al,, 2013). As shown in Figure 1.1 below, over 5000 metric tonnes on 8000 hectares of land was produced in eastern province in 2012. This amounted to 40 percent of total annual production by smallholder farmers in the country. Central province produced 4000 metric tonnes that represented 27 percent of annual production while the remaining eight (8) provinces produced 33 percent of the crop.

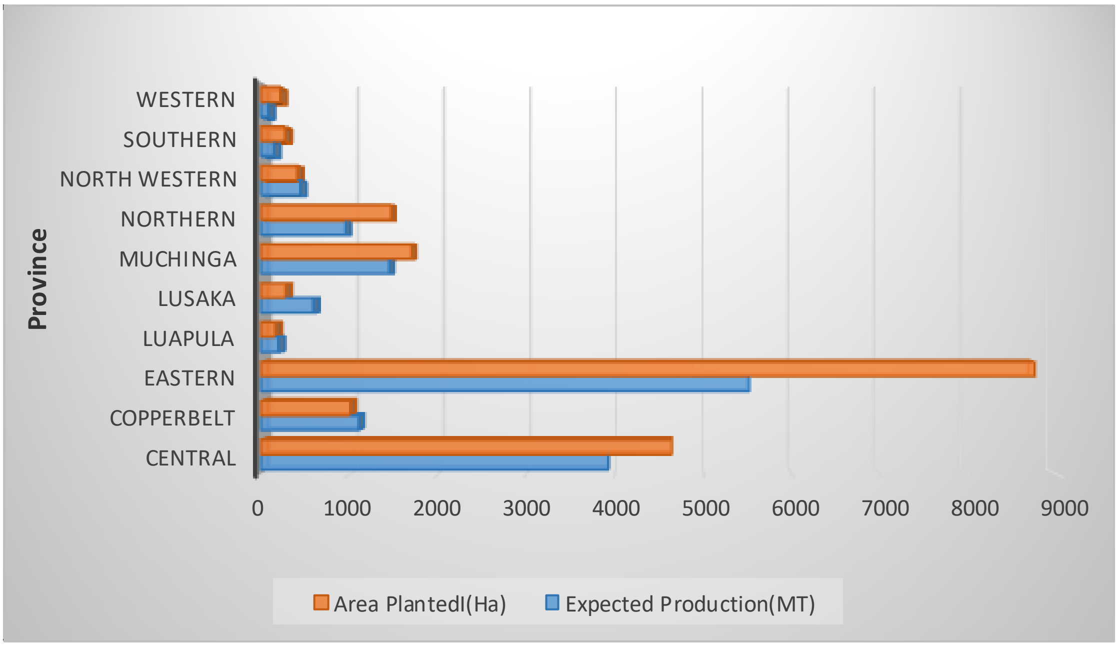

Figure 1.1: Soybean area under production by Province in Zambia, 2012

Source: CSO Post harvest reports, (2015)

Average annual production in the province ranges from 2000 tonnes to 9000 tonnes. The fluctuation results mainly from changes in area under production and the number of farmers growing the crop (Lubungu et al., 2013). Given the vast expanses of unexploited arable land and the high farmer population (109,000), there is huge potential of improvement in Soybean production within the province.

For decades however, smallholder production has encountered a myriad of challenges. These range from unfavorable maize biased government policies options, low uptake of improved farm inputs, weak links to markets, high transportation costs, lack of market information, lack of access to extension services and fewer farmer's organization (Kalinda & Chisanga, 2014; Okemute et al., 2014a). These challenges have resulted in low crop productivity, locked farmers to subsistence production and has contributed largely to stagnation of the sector (Asfaw et al., 2011; Shiferaw & Teklewold, 2007). The cumulative effect of these factors is low adoption of the crop, low commercialization and inability to penetrate high value markets that offer premiums for quality (Asfaw et al., 2010).

Recently, research and development efforts by government and partners have attempted to understand these constraints in order to increase adoption and commercialization of the crop to meet the increasing domestic, regional and international demand. One such intervention is the Feed the Future Research and Development (FtF) project under the auspices of the United States Agency for International Development (USAID). The project was aimed at promoting adoption, production and commercialization of selected value chains including soybean through breeding of improved varieties, on-farm research and linking farmers to output markets (USAID, 2013). Despite these efforts, a study in the province by Lubungu et al., (2013) commissioned by USAID concluded that Soybean production remained low despite the project partly due to the belief that output prices for the crop were low leading to low farmer participation. Figure 1.2 below shows the level of farmer participation and soybean production against other legumes between 2010 and 2015. It can be seen that the number of farmers adopting and growing the crop has remained very low. About 100,000 farmers grew soybean in 2015 compared to 700,000 for Groundnuts and 230,000 for mixed beans respectively. It is also evident from the figure that increase in farmer participation was insignificant during the period 2010 to 2015. Similarly, during the same period soybean production remained relatively stagnant at 20,000 metric tonnes compared to Groundnuts and Mixed beans whose production rose to 200,000 and 250,000 respectively.

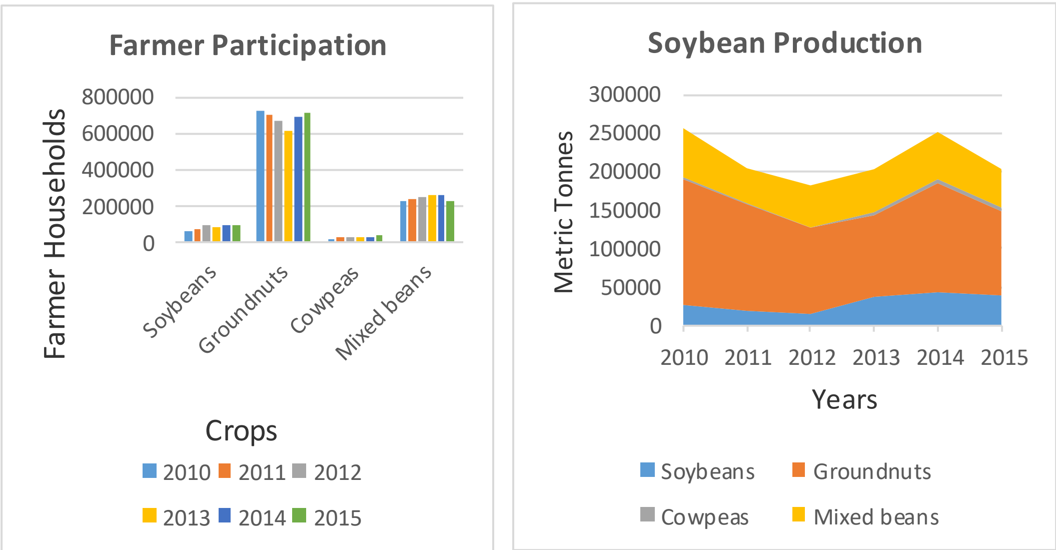

Figure 1.2: Annual Soybean and Farmer Participation between 2010 and 2015

Source: CSO Post harvest reports, (2015

From the argument above, there are enormous concerns that the low soybean adoption and commercialization constrains smallholder farmers to take advantage of the government's crop diversification agenda. These concerns are worsened by the low productivity levels of 0.9 metric tonnes per hectare compared to potential of 2 metric tonnes per hectare and the limited number of farmers that are joining the soybean sub sector (Lubungu et al., 2013). There is thus an urgent need to understand the underlying factors and recommend possible solutions.

1.2 Statement of the Problem

The major challenge facing Zambia like many other developing countries is food insecurity and improvement of the quality of livelihood of rural dwellers that are predominantly smallholder farmers. As a consequence, Zambia's agricultural sector has been identified to be key in livelihood improvement as well as a pillar to support the rural economy (Siamabele, 2019). Dependence on rain fed agriculture, inadequate access to production inputs, unfavorable crop marketing environment and limited access to land made it exceedingly difficult to achieve and sustain the needed socio-economic welfare. To counter these challenges, government developed policies and strategies that were mostly maize –centered which failed mostly due to the crop's poor economic prospects (Hichaambwa & Jayne, 2012). Hence, revisions to policy were done after realization that the desired socio-economic improvement in rural livelihoods will largely depend on crop diversification and commercialization (MOA/GRZ, 2012). In this policy, emphasis was put on strategies that promoted production of legumes such as Soybean.

Soybean was identified as a crop with immense potential following its growing demand locally and regionally particularly in the livestock industry. The poultry sector which accounted for 89 percent of Soybean consumption in 2010 was poised to grow by an average 20 percent annually for the next decade. In addition, human consumption mostly in the form of chunks and oil, accounting for the remaining 11 percent was also estimated to grow by 8 percent annually till 2020 (Hichaambwa et al., 2014). This anticipated ever increasing demand for the crop promised better prospects for farmers to adopt and commercialize Soybean production.

However, despite these lucrative prospects, the Soybean sub - sector remains dominated by commercial producers with smallholders producing only an average of 15 percent of the crop. Some studies by Lubungu et al., (2013) and Hichaambwa et al., (2014) aimed at understanding the low farmer adoption concluded that smallholder farmers were largely constrained by perceptions that output markets were low, poor access to improved inputs and rainfall dependence. These studies were however qualitative and did not go beyond adoption to understand what was constraining the few smallholder producers commercialize their agricultural activities. Thus, it's hoped that through this study, the factors influencing adoption and commercialization of soybeans among smallholder farmers will be understood. It's further hoped that understanding of these factors will influence development of policies that would encourage soybean adoption and commercialization among other crop enterprises within the framework of crop diversification.

1.3 General objective

The general objective for this study is to determine the factors influencing adoption and commercialization of soybean in Chipata district of Zambia

1.3.1 Specific objectives:

The specific objectives of this study are:

1. To examine the socio-economic and institutional factors that determine adoption of soybean among smallholder farmers in Chipata district
2. To determine the socio-economic and institutional factors that influence the level of commercialization of soybean among smallholder farmers

3. To determine the effects of farmers' attitudes towards adoption and commercialization of soybean.

1.4 Hypothesis

The study tested the following hypothesis:

1. Farmer's personal and socioeconomic characteristics have no influence on adoption and commercialization of Soybean.

1.5 Justification

Agricultural diversification has been identified as one of the cardinal factors for agricultural development given Zambia's rich resource endowment (Kalinda & Chisanga, 2014). Crops such as Soybean, important for improved nutrition, income generation and soil improvement have been critical in improving nutrition, income and soil enrichment (Chianu et al., 2008). Despite the clear benefits, soybean production in Zambia remains very low in that only 15 percent of farmers produce marketable surplus and that at least half of these sell little or no crops and hence derive virtually no cash benefits from agriculture (Lubungu et al., 2013b; (Hichaambwa & Jayne, 2012). Hence, understanding the constraints militating adoption and commercialization will help improve the social and economic wellbeing of smallholder farmers

1.6 Scope and Limitations of the Study

The study was conducted in Chipata district of Eastern province of Zambia. Data was collected from key informants and sample households within the district. Hence, the study was limited to the district only. Although Zambia has diverse agro ecologies, organizations and environmental conditions, results from the study and inferences thereof are applicable to most of the country but especially in areas with similar geographical and institutional characteristics.

1.7 Definition of Terms

Smallholder farmer also called small scale farmer: For the purpose of this study, smallholder farmers refers to both small scale and medium scale farmers producing less than 5 hectares and 5 to 20 hectares of total arable land annually respectively. They are characterized by their reliance on rain fed hoe cultivation, low improved input use, use of family labor and focus mostly on growing maize (Chomba, 2004).

Commercialization: is taken as synonymous with market participation and is thus defined as the integration of smallholder farmers into soybean output markets (Abera, 2009).

Agricultural household: A household where at least one of the members is engaged in

growing crops, livestock/poultry rearing or fish farming or a combination of these (CSO, 2010)

Total farm size: amount of land under control of a household as understood according to the norms of the customary tenure system.

Adoption: the ability of a farmer to apply an innovation and sustainably use it over time to better their lives. Hence, adoption is viewed as the choice to allocate land to a new or old technology which in this case is soybean (Yirga & Alemu, 2016). Particularly for this study, adopters refer to farmers who grew soybean in 2015/2016 agricultural season in the study area.

1.8 Organization of the Thesis

This thesis report is organized into five chapters. The first constitutes the introduction, which encompasses mainly on the statement of the problem, objectives, hypotheses, significance and the scope of the study. Review of the theoretical and empirical literature is presented in Chapter 2. The third chapter describes the research methodology adopted in this study including study design, description of the study area, data collection procedures and analytical techniques. Chapter 4 presents the results and discusses the study findings. Finally, a summary of the major findings, conclusion and recommendations are presented in chapter five.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Introduction

This section reviews literature on adoption and commercialization of soybean. It starts by exploring the theories surrounding technology adoption and agricultural commercialization and ends by reviewing empirical methods used across the vast array of literature to study adoption and commercialization in the agricultural sector.

2.2 Technology adoption

2.2.1 Overview of Technology Adoption

Adoption has been defined in several ways by various scholars. Loevinsohn et al. (2012) defined adoption as the integration of new technology into existing practice which is followed by a period of trial and adaptation. It has also been defined as a mental process for an individual from the first time you hear of an innovation/technology to the time you practice it (Mwangi & Kariuki, 2015). Classical work by Rogers, (2003) defined adoption as not being instantaneous but a six (6) step sequential process from the initial state of the farmer, acquisition of knowledge about the innovation, persuasion to take it up, deciding whether to adopt or reject it, implementation of the innovation and confirmation. Knowledge occurs when an individual is first exposed to the innovation existence and gains understanding of how it operates. Persuasion occurs when an individual forms a favorable or unfavorable attitude towards the innovation. Decision occurs when an individual consciously engages in activities that lead to a choice to adopt or reject the innovation. Implementation is when the innovation is put into practice while confirmation occurs when an individual seeks reinforcement of a decision already made. This adoption model can be broadly collapsed into a two-step decision making process at individual farmer level subject to resource constraints, and involves deciding whether to practice the technology and to what degree or level (Lawal, 2009).

Agricultural research and technological improvement are crucial in meeting the demand for food and reducing poverty and hunger (Asfaw et al., 2010). Major agricultural research efforts in the last decades have focused on development of new innovations such as introduction of new crop types, improved seed, fertilizers, new varieties of crops and machinery in order to increase productivity (Mwangi & Kariuki, 2015). Due to the improved input - output relationship, Challa, (2013) concluded that new technology ends up raising output and reducing average costs of production. Wandji et al. (2012) also noted that adoption of improved agricultural technologies is associated with improvement in nutrition status, higher income earnings, reduced poverty and a general rise in economic and social wellbeing of smallholder farmers.

Despite the many benefits associated with introduction of new technology, research has shown that adoption of most new innovations in Africa has met partial success. Constraints such as lack of credit, limited access to information, aversion to risk, inadequate farm size, and inadequate incentives associated with farm tenure arrangements and insufficient human capital. Others include absence of appropriate equipment to relieve labor shortages, chaotic supply of inputs and inappropriate transportation infrastructure. All these constraints hinder successful adoption of most technologies when introduced to farmers (Feder et al., 1985).

2.2.2 Conceptual Framework of Technology Adoption

Many conceptual models have been used in literature to model technological adoption decisions among farmers (Feder, 1984; Abadi & Pannell, 1999; Negatua, 1999; Isham, 2002; Rogers, 2003). Classical economic analysis of technology adoption has often explained adoption as a process from knowing about the technology, deciding to adopt it, implementing it and reinforcing the innovation subject to individual constraints such as household resource endowment, imperfect information, risk and uncertainty associated with the technology, institutional constraints, availability of inputs and existence of infrastructure to support the technology/innovation being introduced (Feder et al., 1985; Koppel, 1994; Rogers, 2003). This understanding in essence, is based on the theory that the farmer's decision to adopt an innovation was more-less conditioned by the dynamic interaction between characteristics of the technology itself and the conditions and circumstances prevailing at that particular time (Mwangi & Kariuki, 2015). As such, adoption of a technology is assumed to be the final stage in a series of decision making processes that involved weighing the costs and benefits of doing with or without the technology by smallholder farmers.

Numerous researchers have categorized the factors affecting technology adoption in different ways. Akudugu et al. (2012) aggregated the factors into economic, social, and institutional factors. Negash, (2007) in a study on determinants of adoption of Haricot beans in Ethiopia grouped the factors into household personal and demographic characteristics, household resource ownership, household economic variables, psychological factors and institutional factors. In a similar manner, McNamara et al. (1991) categorized the factors into farmer characteristics, farm structure, institutional characteristics and managerial structure. Against this background, Mwangi & Kariuki, (2015) while reviewing the factors determining adoption of new agricultural technologies by smallholder farmers in developing countries concluded that technological, institutional, economic and household specific factors have significant impact on the farmer's decision to adopt technologies and the intensity of adoption.

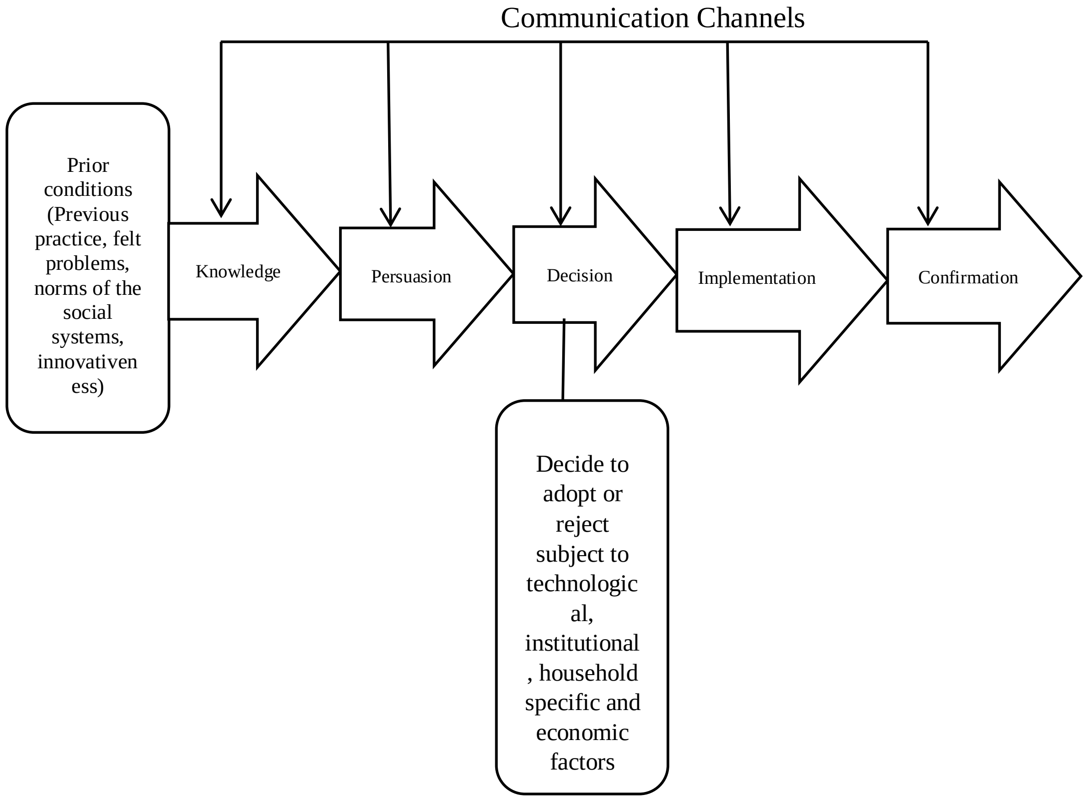

Figure 2.1: Conceptual Framework of soybean adoption by smallholder farmers

Source: Adapted and Modified from Rogers, (2003)

Figure 2.1 above conceptualizes that the smallholder farmer's ability to adopt growing of soybean as well as the intensity of adoption follows a six (6) step process from the initial condition, acquiring knowledge about the attributes of the innovation, persuasion to try it, deciding to adopt or reject, Implementation and confirmation of the innovation. Step four (4), the decision making stage is affected by technological, institutional, economic and household specific factors. Characteristics of a technology play a crucial role in the adoption decision making process. The extent to which farmers can try a technology and get the desired results determines the perceptions that farmers develop about the new technology (Mwangi & Kariuki, 2015). Mignouna et al. (2011) argued that farmers who perceive a technology to be consistent with their economic and social aspirations are more likely to adopt a technology. For instance, some recent key technological factors in soybean production are use of inoculants, pesticides and fertilizers (Bashan, 1998). However, smallholder farmers in developing countries usually practice low-input agriculture in which fertilizers, pesticides and machinery are scarce. This scenario constrains productivity and results in low yields particularly for legumes.

Resource endowment is also a critical factor in technology adoption. Resource endowed farmers have easy access to land, improved seed, fertilizers, inoculum and manure and hence experience higher crop productivity (Chikowo et al., 2014). On the other hand, resource constrained farmers have limited access to land and modern inputs and often have to rely on off-farm opportunities such as selling their labor to their resource endowed neighbors. Land being vital in agriculture, farmers with larger farm sizes are more likely to adopt new technologies as they can afford to devote land to try out the innovations (Uaine et al, 2009). In other instances, small land holding can also provide an incentive to adopt input-intensive innovations such as labor saving technologies (Mwangi & Kariuki, 2015). In addition, innovations with a high establishment cost or very low prospects of earning income are less likely to be adopted. This is because the net gain to the farmer from adoption inclusive of all the costs of using the technology is negative.

Belonging to social groupings enhances social capital allowing trust, idea and information exchange which are critical in the adoption decision making process (Mignouna et al., 2011). Reliable, consistent and accurate information about a technology increases positive attitude towards an innovation. Thus, access to extension services as a source of information is also critical for success of adoption (Uaine et al, 2009).

Household specific characteristics are also crucial in the adoption decision making process. Education, age, gender and household size are among some of the household factors that affect adoption. Older farmers assumed to have vast experience are better able to evaluate innovations compared to their younger counterparts and hence are more likely to adopt technologies (Mignouna et al., 2011). Labor is another factor that has a huge bearing on adoption. Technologies that are labor intensive are less likely to be adopted by smallholder farmers who are characterized by low resource endowment. Thus, larger households are more likely to adopt innovations with huge labor requirements. It can be concluded that inadequate information on market prospects, access to credit, access to land, farming experience, labor availability, cost of production, farmer knowledge and interpretations of production practices can affect technology adoption both positively and negatively depending on the state of affairs at the time the technology is introduced.

2.2.3 Empirical Models on Technology Adoption

Several econometric approaches have been used to empirically model technology adoption behavior of farmers as well as to identify the key factors that determine adoption decisions (Lawal, 2009; Asfaw et al., 2010 ; Akpan et al., 2012). A common issue about most adoption studies among smallholder farmers is that farmers adoption decisions are made subject to a number of socio – economic constraints ranging from imperfect market conditions to missing labor markets (Amare et al., 2012). Assuming that farmers make adoption decisions rationally and that their decision to adopt is guided by the desire to maximize utility subject to an imperfect market, impartial or missing credit and labor markets, a technology 2(t_2) is preferred to technology 1(t_1) so long as the utility derived from t_2 is greater than the utility derived from technology t_1. Rahm & Huffman, (1984) hypothesized that the utility function ranking the i_{th} farmers' preference for technologies is represented as follows:

$$U(R_{ti}; A_{tj}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(Equation 2.1)}$$

Where utility U depends on a vector R_{ti} describing the distribution of net returns for technology t_j, and a vector A_{tj}, corresponding to other attributes associated with the technology t_j. The variables R_{ti} and A_{tj} are not observable, but a linear relationship is postulated for the ith farmer between the utility derived from the tj technology and a vector of observed farm and farmer characteristics X_i and a zero mean random disturbance term µt:

$U_{ti} = X_{it} + \mu t$ where $t = 1, 2$ and $i = 1, 2 \ldots .n.$ ….. (Equation 2.2)

As mentioned previously, the ith farmer adopts t_2 if U_{t2} is greater than U_{t1}.

The decision to adopt a technology and the extent of adoption can be made individually or jointly. The Tobit model has been frequently used in literature to model binary adoption decisions. Developed by Tobin in 1958, the Tobit estimator fits conceptually well when it is assumed that the decision to adopt and the extent of adoption are made simultaneously. It also means that the factors affecting adoption and the extent of adoption are one and the same (Greene, 2003).

In cases were dis-adoption is assumed to be a decision made by the respondent, Heckman, (1979) proposed a model that addressed misspecification errors that arise due to non- participation decisions arguing that an estimation on a subsample (censored estimation) results in sample selection bias. The model overcomes the sample selection bias problem by running a two-step estimation procedure known as a heckit. In the procedure, a full sample probit is followed by a censored estimation on the selected subsample. While the first step estimates the probability of observing a positive outcome (known as the selection or participation equation), the second estimates the level of participation conditional on observing positive values (known as the conditional equation) (Dow & Norton, 2003). The model assumes that different sets of variables could be used in the two-step estimations.

Unlike the Tobit that assumes that the decision to adopt and the extent of adoption are influenced by the same factors, and the Heckman model that assumes none existence of zero observation (none-adopters) in the second hurdle, Craig (1971) improvement on the aforementioned models was built on the realization that in reality factors affecting the two steps (hurdles) may be different. In essence, the main principal of the double hurdle model is that adoption and the extent of adoption are assumed to steam from two separate individual choices and the determinants of the two decisions are allowed to differ (Burke, 2009). The model assumes that two separate hurdles must be passed before a positive level of adoption can be observed. The first hurdle being the decision to adopt Soybean or not, and the second hurdle involving the extent of adoption (Craig, 1971). The model is usually appropriate in cases where it's assumed that the factors affecting the farmer's adoption decision may not affect the decision on the level of adoption. Since results showed that the decision to adopt and the decision on the level of adoption were affected by different factors, a double hurdle model was preferred for the study to model the factors affecting both adoption and the factors influencing the level of adoption.

2.2.4 Prior studies on Technology Adoption

Several methods have been used to empirically study adoption. Lawal (2009) in a study on the status of adoption of improved rice varieties and its impact on rice production among smallholder farmers in south-western Nigeria employed an adoption index, logit model and a stochastic frontier model. Results showed that farmers responded appreciably to intervention programmes that promote the use of improved rice varieties with an adoption rate of 68.7% compared to local varieties. Further, the mean yield for improved varieties was found to be significantly higher than that of non-adopters. Land area under rice, frequency of extension visits and yield rating of varieties were significant determinants of farmer's decision to adopt improved rice varieties. They concluded that rice farmers have room to increase their productivity by increasing their farm size, quantity of improved seed and fertilizer.

Asfaw et al. (2010) examined the causal effect of technology adoption on output market participation of 700 farmers in Ethiopia. A double hurdle model was applied to analyze the determinants of the intensity of technology adoption conditional on overcoming seed access constraints. Results showed that knowledge of existing varieties, perception about the attributes of improved varieties; household wealth and availability of active labor were major determinants of adoption of improved varieties. Results also showed that adoption of improved agricultural technologies has a significant positive impact on farmers' integration into output markets. It was concluded that technology adoption leads to higher productivity which translated into higher market integration.

Rahman (2010) studied the factors underlying the probability of Bangladeshi farmers adopting a diversified cropping system and or modern rice technology using a bivariate probit model. Results showed that irrigation is the most important determinant of the decision to adopt modern rice technology, and adoption is higher among tenant farmers compared to land owners. It also revealed that farmers in areas with improved infrastructure have a higher chance of diversifying cropping systems compared to those in primitive areas. In addition, education, farming experience, farm assets and off-farm income all positively influenced crop diversification. The study showed that crop diversification can be promoted by investing in farmer education and rural infrastructure. Further, land ownership policies should be tailored at making land available to marginal farmers as they had a higher likelihood and motivation to diversify their cropping systems.

Chiputwa et al. (2011) in a study on assessing underlying factors important in determining farmer's adoption of zero tillage, crop rotation and contour ridges technologies used a Tobit application. The study utilized data from 100 farmers in rural Zimbabwe. It was observed that adoption and use intensity of each of these technologies is affected by a set of distinct household factors. In particular, variables like labor capacity, cattle ownership and disposable income have significant but contrasting effects on adoption decisions depending on the type of technology in question. Evidence also showed complementarities in adoption and use of the technologies indicating the importance of targeting as one develops technology meant for a particular group of farmers.

The literature reviewed highlighted several important socio-economic and demographic variables critical in technology adoption. The review also showed that different factors affect smallholder farmer's adoption differently across time and space. Several methodologies and approaches used in the various studies reviewed outlined the various options available for application in this study.

2.3 Agricultural Commercialization

2.3.1 Overview of Agricultural Commercialization

A large proportion of Zambians lives in rural areas and depends on agriculture as a source of livelihood and income. Characterized by inadequate physical infrastructure and poor institutions, these areas offer few prospects for industrialization such that smallholder agriculture remains the engine of rural growth and livelihood improvement (Govereh et al., 1999). Hence, it's essential that smallholder farming systems transform the predominant subsistent to a more commercial system.

Several definitions have emerged from various scholars in an attempt to understand agricultural commercialization. Hazell et al. (2007) defined commercialization as the degree of participation in output markets with the purpose of increasing incomes by smallholder farmers. This is also in line with Moono (2015) who reiterated that increased market participation among smallholder farmers is key in commercialization because of its ability to unlock the farmer's productivity thereby increasing incomes and reducing poverty.

Govereh & Jayne (2003) defined agricultural commercialization as the proportion of agricultural production that is marketed. This definition views commercialization as a process involving production, consumption and marketing. This orientation also adds the dimension of the process of transition from predominant subsistence to producing surplus output for sale (Sokoni, 2008). Abera (2009) contended that agricultural commercialization exceeds just selling output. He claimed that a household's marketing decision, both in output and input choice, should be based on profit maximization.

There are many benefits of agricultural commercialization. Timmer (1997) associated agricultural commercialization to higher productivity, greater specialization and higher incomes. The result being improvement in food security, poverty reduction and general improvement in economic welfare of farmers. Commercialization also acts as a bridge which farmers use to attain welfare goals (Hailua et al., 2015). The improvement in welfare is achieved through the role that agricultural commercialization plays in creating employment opportunities, increasing agricultural rural productivity, increasing income, expanding food supply and improving nutrition (Zhou et al., 2013)

From the literature above, it can be concluded that agricultural commercialization should address issues pertaining to input and output markets and how these affect the quantity of output sold on the market. But for the purpose of this study, commercialization was defined by the level of participation of smallholder farmers in soybean output markets (Abera, 2009). The assumption made was that the higher the level of participation in soybean output markets, the higher the level of soybean commercialization by the farmers.

2.3.2 Conceptual framework of Agricultural Commercialization

Successful smallholder agricultural commercialization largely depends on the ability of farmers to participate in input and output markets. To bring about the desired benefits and improve social and economic welfare, factors that influence success by affecting the farmer's ability to participate in markets have to be in place (Govereh et al., 1999). Leavy and Poulton (2007) identified market access, access to foods and asset accumulation to be crucial in agricultural commercialization. They contended that smallholder farmers can have better access to the market as a consequence of agricultural growth and better infrastructure development. In their view, market access needs to include access to market information, strong farmer organizations and promotion of contract farming.

The other issue that Leavy and Poulton (2007) pointed out is that to achieve success, farmers needed to decide whether to grow food or cash crops. Literature has revealed mixed views on this issue. Proponents of food crops argue that concentrating on cash crops possess a high risk of food insecurity and price variations given the imperfections of rural markets. On the other hand, opponents also argue that farm households producing cash crops to the market would most likely integrate food crops in their production systems and are thus less susceptible to food insecurity. The third component of levy and Poulton analysis involved the importance of land and animal traction in success of rural agricultural commercialization. The duo pointed out that a cap on land availability and inadequate labor limits the farmer's ability to expand the area under production. In consequence, the farmer's ability to produce surplus produce and participate in output markets is curtailed.

Jalet et al. (2009) identified population change, availability of technology, infrastructure and market creation, and macroeconomic and trade policy as some of the most important factors for agricultural commercialization. Similarly, agro-economic conditions and risk, access to market and infrastructure, community and household resources and endowments, social and cultural factors, laws and institutions also affect agricultural commercialization. Others include consumption preferences, production, market opportunities and constraints, development of local communities as well as input and factor markets. All these factors were identified to be critical in successful commercialization (John Pender & Alemu, 2007).

Based on the background above, we postulated in Figure 2.2 below that for smallholder farmers to successfully commercialize soybean, factors related to market access, access to food and asset accumulation have to be in place. Lack of physical infrastructure, lack of appropriate laws and institutions, poor contractual arrangements, lack of membership to organizations and consumption patterns skewed to cereal diets will negatively affect the quantity of soybean produced. Other crucial factors include availability of land and labor, access to credit as well as the farmer decision to embark on subsistent or commercial production of soybean. Cumulatively, these factors determine how much soybean is produced by the farmers. Once the surplus soybean is sold, the income realized leads to improvement in the social and economic welfare of the smallholder farmers. The income is also used to improve market access, purchase food or accumulate more assets consequently resulting in increase in output and a higher intensity of soybean commercialization.

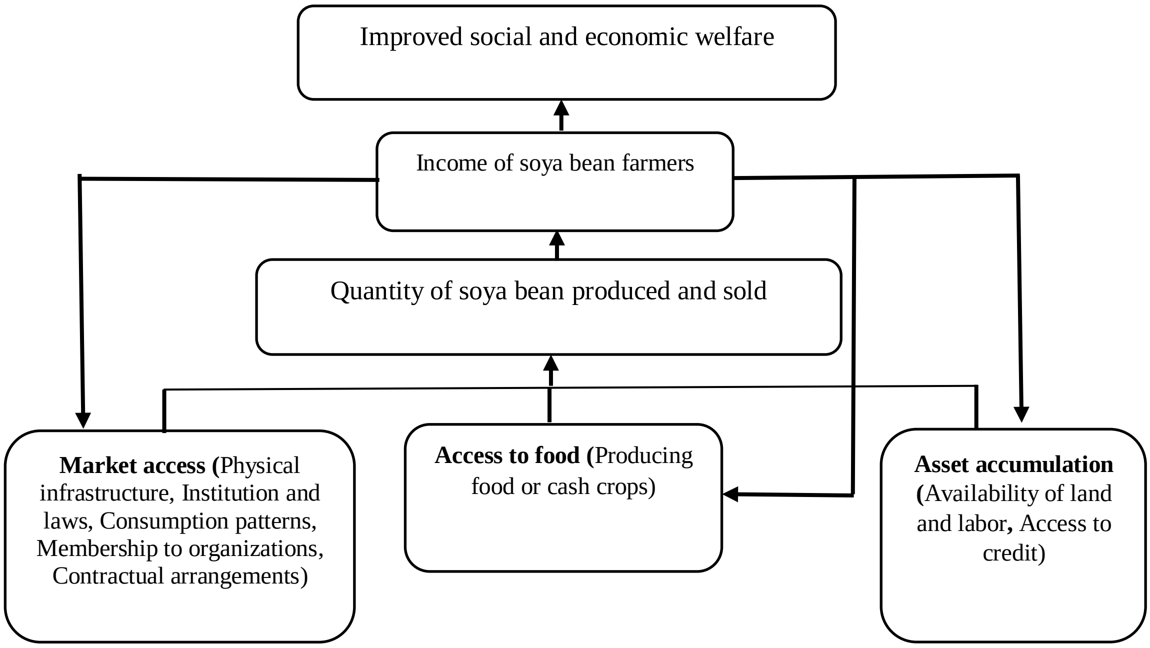

Figure 2.2: Conceptual framework of agricultural commercialization of soybean

Source: Author's Construct, 2017

Commercialization is measured in many ways. According to Govereh & Jayne (2003), commercialization can be measured on a continuum from zero (total subsistence oriented production) to unity (100 percent production is sold). Typically, It is viewed from the output side as Household Crop Commercialization Index (HCI) given as (Value of agricultural sales in markets divided by the agricultural production value). It is also measured from the input side as (Value of inputs acquired from markets divided by agricultural production value). Others view it as commercialization of the rural economy (Acquired through market transactions divided by total income), or as the degree of integration into the cash economy (Acquired by cash transactions divided by total income).

When viewed from the output side, crop commercialization is generally viewed by the proportion of agricultural output that is marketed as alluded earlier. It is thus usually measured by the level of participation of farmers in output markets (Abera, 2009). Literature has shown that there are a myriad of both macro and micro factors that influence and determine the farmers' decisions to participate and also determine the level of participation in output markets (Govereh et al., 1999; Hichaambwa & Jayne, 2012). One proxy that has been used to quantity the level of farmer's participation in output markets is the Household Commercialization Index (Abera, 2009; Kabiti et al., 2016). The index is given by the ratio of the gross agricultural sales in markets and the gross production value and measures the extent to which crop production is oriented towards the markets. HCI is the dependent variable in this study. Assuming that Y represents the dependent variable and X_i the independent variables, their relationship will be given by equation 2.3 below.

$$Y = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki} + u_i \quad \text{.......... (Equation 2.3)}$$

Where: Y represents Household Commercialization Index (HCI)

X represents socioeconomic and institutional factors determining HCI

β_0 and β_{1-k} are estimable parameters

u_i Is the error term

Since the dependent variable HCI is a percentage and as such can only range between 0 and 100 percent, the researcher opted to use the Tobit model for determining the factors that influence the farmers' decision to commercialize their crop production. The Tobit model is the most common censored regression model preferred for analyzing dependent variables with upper or lower limits (Greene, 2003). The model was thus preferred for this study as HCI is lower censored at zero (0) and upper censored at one (1). Farmers who do not sell any of their crops had HCI equal to zero (0) while those who sold everything had HCI equal to one (1).

Smallholder commercialization is assumed to be successful when it results in increased incomes, stimulates rural growth, increased productivity, expanded food supply and improved nutrition (Leavy & Poulton, 2007). Achieving these requires more than just efficiently functioning markets, but also efficient factor markets that truly reflect the opportunity cost of farm inputs which is usually a huge challenge for smallholder farmers due to poor resource endowment.

2.3.3 Prior Studies on Agricultural Commercialization

Mongoso et al. (2015) investigated determinants of soybean market participation decisions and level of participation between smallholder National Smallholder Farmers Association of Malawi (NASFAM) members and non-members in Mchinji district of Malawi. The study used a two tired Market participation model aimed at determining key factors influencing the farmer's decision to participate in input and output markets, extent of their participation and whether they participate more within farmer groups or not. The two tiers consisted of Logistic and Linear regression respectively. Logistic regression was preferred for the first tier which involved the farmers deciding whether to participate or not because the sample size (124) was sufficiently large enough for normality to be assured. Assuming that the output sold was a linear function of household characteristics, linear regression was used to model the degree of participation once farmers have decided to participate in the output markets. The study found out that price of output and off farm income was affecting both decision to participate and intensity of household participation in both input and output markets. The study concluded that transition from subsistence to commercial farming is very likely with involvement of farmer organizations where benefits of access to inputs and markets of output are assured to members.

Moono (2015) investigated the factors that affect smallholder rice farmers' participation in output markets in western Zambia using the Heckman two stage econometric model. The study involved 390 smallholder producers within the province. The results suggested that the decision to enter the rice market is positively influenced by the household's asset endowment such as livestock, membership in farmer organizations, access to knowledge about output prices prior to sell, output price and quantity of rice produced. The results further suggested that intensity of market participation is directly influenced by ownership of assets such as size of land owned, access to credit and output produced. The study concluded that pricing and productivity enhancing policies should be implemented to stimulate production for the market and also increase output produced which will eventually increase yields.

Abera (2009) focused on identifying the micro level factors determining market participation, the level of commercialization as well as evaluating the welfare outcomes of smallholder participants in Enderta district of Tigrai. The study involved a sample of 125 households and used the two stage model specification procedure. The first stage involved modelling determining factors that influence the farmer's decision to participate in output markets using the Probit model, while an Ordinary Least Squares (OLS) regression model was used to determine the second stage involving determination of factors influencing the degree of commercialization. ANOVA was used to assess the effect of commercialization on social and economic welfare of smallholders. Overall results from statistical analysis showed that landholding size and land slope, irrigation use, number of oxen owned, and membership in extension package program have positive and significant association with commercialization while participation in non-farm activities has significant but negative association with commercialization. Results from the Probit regression analysis revealed that the value of production, use of improved seeds, use of irrigation and total landholding size are the most important factors affecting the ability of a smallholder to participate in output markets, while the OLS regression showed that the level of food and value of cash crop production, gender, technology use (irrigation, improved seeds), use of fertilizer and the number of oxen owned per household are important factors determining the level of commercialization of smallholder farms. ANOVA results indicated that farm households with a high degree of commercialization enjoyed better welfare outcomes.

Agricultural commercialization has been identified world over as key to transforming subsistence oriented agriculture to a market oriented one. In this vain, Aman et al. (2014) conducted a study involving 160 farmers in West Hararghe zone of Ethiopia. The study aimed at identifying household level determinants of the output side of commercialization decision and the level of commercialization in horticultural crops in Gemechis district. The study used the double hurdle model to assess the two tiers. In the first hurdle, results of the Probit analysis revealed that gender, distance to the nearest market and cultivated land played a significant role in smallholder commercialization decisions. In the second hurdle, the truncated regression model revealed that household education, household size, access to irrigation, cultivated land, livestock ownership and distance to nearest market were the key determinants of the level of commercialization.

Sebatta et al. (2014) studied smallholder farmers’ decision and level of participation in the potato market in Uganda. The study used the Heckman model for analysis. First tier results showed that proximity to a village market positively and significantly influenced decision to participate in the potato market. In the second tier, it was found that non-farm income negatively and significantly affected the potato farmer’s level of market participation. In essence, these results indicated the importance of physical infrastructure such as roads in successful agricultural commercialization. It was also concluded that despite the volatility of rural markets, farmers should make efforts to sell their crop at the highest possible prices.

Zamasiya et al. (2014) examined the determinants of soybean market participation by smallholder farmers in Zimbabwe. The study was aimed at establishing key policy entry points for increasing farmer incomes as it was noted that market linkages were critical to the success of legume production in southern Africa. A total of 187 smallholder farmers were involved and the study used the Heckman's model for analysis. Findings showed that the use of inoculum and improved seed varieties are significantly correlated with participating in soybean markets. It was also discovered that ownership of radio has a positive effect on the household's decision to participate in output markets. The results further showed that male headed households are less likely to participate compared to female headed households as the crop is seen as a pro female crop in Zimbabwe.

Aderemi et al. (2014) studied the determinants of output commercialization among crop farming households in South Western Nigeria using the HCI as the dependent variable in a probit regression. The study found that access to price information, household size, farm size, farming experience and access to agricultural extension services were statistically significant in determining crop commercialization.

The above overview of commercialization studies has shown consensus on the importance of agricultural crop commercialization in transforming rural economies. The review has also outlined several approaches that involve household's decisions to commercialize their agricultural activities. Note that even though most of the reviewed studies conceptualized commercialization as a two stage process, the current study adopt the methods by Aderemi et al. (2014) in which commercialization is measured as a continuous variable through the use of HCI. The HCI will then be used as a dependent variable in a Tobit regression to determine the factors influencing adoption. This method assumes that the decision to commercialize and the extent of adoption are affected by the same variables.

2.4 Studies on Factor Analysis

Factor analysis has for decades been used as an analytical tool particularly in educational research (Distefano & Mîndril, 2009). Recently its application has expanded to other areas such as agriculture in a quest to understand psychological factors that influence agricultural activities (Olunga, 2013). The method is appropriate where a researcher is faced with a large number of variables which should be reduced to a fewer number of variables with the strongest association (Distefano & Mîndril, 2009). Although factor analysis has been a major contributing factor in advancing psychological research, a systematic assessment of how it has been applied is lacking (Ford-Kevin, MacCallum, & Tait, 1986). The method was adopted for this study as it provided a standard way of analyzing farmer's attitudes towards Soybean adoption and commercialization.

Olunga, (2013) used Factor analysis to assess the factors affecting forest conservation in Kipini division of Tana delta district of Kenya. The study concluded that the majority of the respondents had negative attitude towards forest conservation and recommended that there was need or information on the importance of forest conservation in order to improve the people's willing to conserve the forests.

Kimambo, (2015) used factor analysis to assess the attitudes of farmers towards consumption of traditional African vegetables in Tanzania. The study concluded that people's attitudes towards consumption of traditional African vegetables were associated with health benefits, personal perceptions and personal taste. The implication was that people consumed traditional African vegetables particularly for health benefits.

Samian et al., (2015) used factor analysis to identify optimal ways of managing agricultural water in Hamadan area. The study concluded that institutional and legal factors, technical and knowledge factors, economic as well as social factors were crucial in management of irrigation water. Since these factors are interrelated, the study concluded that policy makers needed to find a balance of these factors when in order to properly manage agricultural water.

2.5 Conclusion

Literature reviewed has shown the scope of methodologies and variables used in adoption and commercialization studies. This has helped in shaping the current study which is being done in a different setting. The study used some of the methodologies used in adoption and commercialization as in other studies.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the research methodology used in the study including the theoretical framework, location and description of the study area, data types and data sources, methods of sampling, methods of data collection and analysis.

3.2 Characteristics of the Study Area

The study was conducted in Chipata district of eastern province of Zambia. The district is located in agro ecological zone II; an area that receives between 800mm – 1000mm of rainfall which is ideal for most field crops including Maize, Sunflower, and Soybean, Groundnuts, beans and Cotton among others. The main economic activity in the district is agriculture production. The district was selected because it lies within the highest soybean producing province in Zambia, eastern province but also because the district is within a region which has shown a high adoption of improved technologies and has received a lot of assistance from a number of NGOs, donor organizations and the government (Manda, 2016). The district has a population of over 437,000 people (Tembo et al., 2013). Of these, 173,782 are farming households comprising 90,038 males and 83,744 females (MOA, 2016). The district which is also the largest by size in a province with a total population of about 1.5 million, has great potential for commercialization (Manda, 2016).

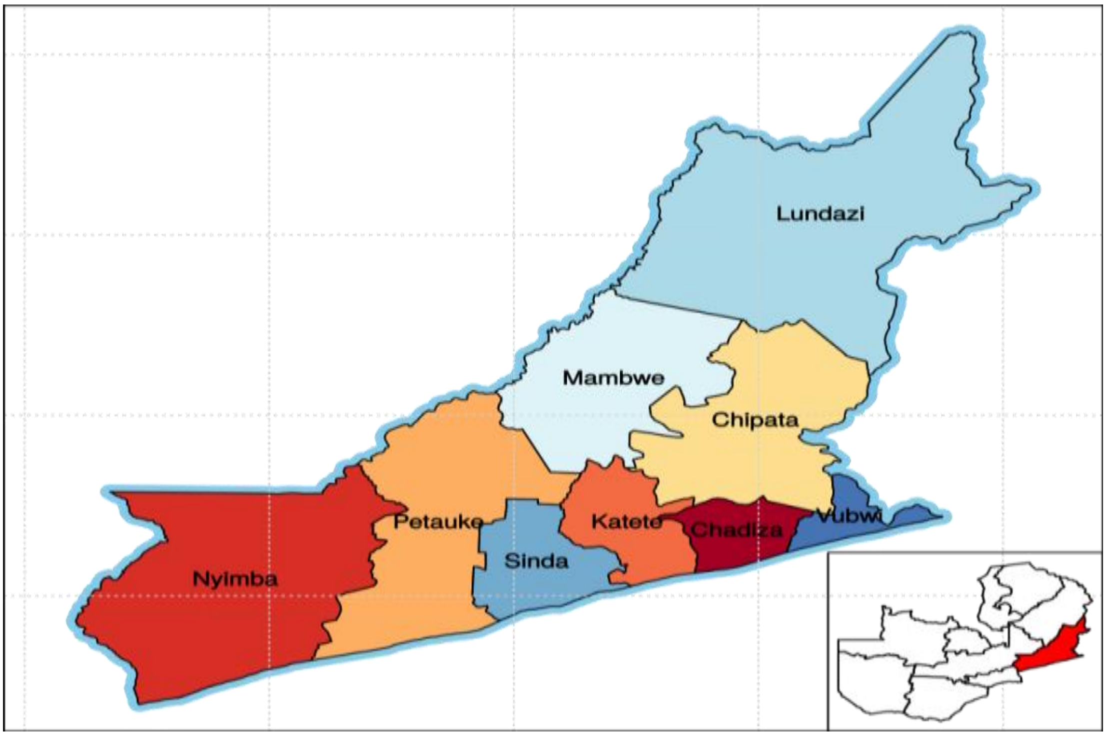

Figure 3.1: Map of Zambia showing Eastern Province

Source: Google Maps (2017)

From the agricultural point of view, the district is divided into 8 agricultural blocks and 58 agricultural camps. An agricultural block refers to the highest level of delineation of a district were areas with similar geographical and crop production characteristics are grouped together. An agricultural camp is the smallest unit of delineation at district level which is usually divided to make it easy and convenient to be manned by a single field agricultural extension officer. The number of camps within a block and the number of villages within a camp as well as farmer population varies from one block and camp to the other.

3.2.1 Sampling Procedure and Data

The study targeted smallholder farmers in the selected villages within the four (4) sampled agricultural camps and blocks respectively. Primary data was used for the study. The data was collected using a structured household questionnaire and key informant interviews. In order to ensure that a representative sample was selected, multi-stage sampling was used at agricultural block, agricultural camp, village and individual level to select sample households.

Firstly, four (4) agricultural blocks were purposively selected to ensure that two were picked from each of the Ngoni and Chewa ethnic groupings. Thereafter, one (1) agricultural camp was purposively selected from each of the sampled blocks based on high soybean production. This ensured that results obtained are representative of both ethnic groups and as such allow for generalization to the whole district. Thereafter, random sampling was used to select the villages and households. Village registers specifically generated for this study served as sampling frames during selection of individual households. The registers were generated particularly for the study since no farmer register specifically for soybean producers existed at camp level at the time of the study. To generate the registers, a request was made with the district agricultural administration which tasked its field extension agents in the sampled camps to facilitate generation of the list.

Assuming that the farmer population is normally distributed, with level of statistical significance at 5 percent, while also bearing in mind that at least 12 percent of the farmers grow soybean, Fisher, (1998) formula was used to compute the required sample size of 160 farmers as follows:

$$N = Z^2pq/d^2$$

Where: N is the required sample size

Z is the standard normal deviate which in this case is 1.96

p is the proportion of farmers from the population estimated to grow soybean (12 percent)

q is the rest of the population (88 percent)

d is the level of statistical significance adopted for the study (5 percent)

$$N = [1.96^2 * 0.12 * 0.88]/0.05^2$$

N = 160 farmers.

The planned sampling framework was that 20 adopters (farmers who grew soybean in 2015/16 agricultural season would be sampled alongside 20 non-adopters (farmers who have never grown soybean before). In essence, the foregoing implied that forty (40) farmers would be sampled in each camp on average. The resultant sample was ultimately selected as shown in table 3.1 below. Note that Chanje, Chiparamba, Southern and Eastern were selected agricultural blocks while Chanje 1, Kalichelo, Manjakazi and Makwe were the selected agricultural camps respectively.

Table 3.1: Sampled Households by Camp

Agricultural Block	Agricultural Camp	Farmer Population	Gender of Respondents		Total
			Females	**Males**	
Chanje	Chanje 1	2600	10	31	41
Chiparamba	Kalichelo	1872	4	36	40
Southern	Manjakazi	3458	19	21	40
Eastern	Makwe	1700	17	22	39
Total		9,630	50	110	160

Source: Survey findings 2015

Further, eight (8) focused group discussions and eight (8) key informant interviews were also conducted with farmers and key individuals at policy level respectively. The key stakeholders interviewed included village leaders, cooperative leaders, and District Agricultural Officer and their Camp Extension staff. These interviews were targeted to further clarify issues that arose during household interviews but could only be understood at a higher level of agricultural activity such as at district level.

3.2.2 Pilot Testing of Data Collection Tools

Pretesting plays an essential role in identifying and potentially reducing measurement errors that damage statistical estimates in research (Caspar et al., 2016). According to Mugenda & Mugenda (2003) a pretest of 10 percent of the sample size is adequate to provide recommendations for the study. As such, 20 households in agricultural camps near the study area were interviewed during pretesting.

The community was engaged with assistance of the Ministry of Agriculture at district level and the traditional leadership at village level. The results of the pretest provided the foundation for correction of errors in the data collection tools. These enhanced the researchers understanding on the time required for the study and also gave an indication of the quality of the data which was intended for collection.

3.3 Adoption and Intensity of Adoption

3.3.1 Theoretical Framework of Technology Adoption.

According to the economic theory of household decision making, households will choose to allocate their resources such as skill, labour and equipment to choices that promise the highest satisfaction (Ellis, 1988). This implies that the household's decision on technology adoption will be largely affected by consumption decisions (consumer preferences, location and demographic composition) as well as the socio – economic factors affecting them. Under these conditions, a household decides whether to adopt an agricultural innovation or not.

As earlier discussed most adoption studies have used the Tobit (Tobin, 1958) to analyze the determinants of technology adoption and the extent of adoption. Being an extension of the Probit model, the Tobit was developed to deal with the problem of censored dependent variables and is used for analysis under the assumption that the two decisions (adoption and extent of adoption) are affected by the same factors (Greene, 2003). This assumption is sometimes limiting as literature has shown that the factors affecting the two decisions in some cases are different. Due to these statistical inadequacies, recent studies have opted to use the Double Hurdle model for analysis (Beshir et al., 2012; Eakins, 2014; Musah, 2013; Mongoso et al., 2015)

Based on the works of Beshir et al. (2012), the double hurdle model is a parametric generalization of the Tobit model in which two separate stochastic processes determine the decision to adopt and the level of adoption of technology. The Double-Hurdle model has an adoption (D) decision with an equation as shown in equation 3.1:

$D_i = 1 \ldots\ldots if \ldots\ldots D_i^* > 0 \ldots\ldots and$

$D_i = 0 \ldots\ldots if \ldots\ldots D_i^* \leq 0$

$D_i^* = \alpha' Z_i + U_i$ …………………………………………..…. (Equation 3.1)

Where D_i^* a latent variable that takes the value 1 if a farmer adopts' Soybean and zero otherwise, Z is a vector of household characteristics and α is a vector of parameters.

The level or extent of Soybean adoption (Y) decision has an equation as in equation 3.2:

$Y_i = Y_i^* \ldots\ldots if\ Y_i^* > 0 \ldots\ldots and\ D_i^* > 0$

$Y_i = 0 \ldots\ldots otherwise$

$$Y_i^* = \beta' X_i + V_i \quad \ldots,\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(Equation 3.2)}$$

Where Y_i^* is the observed amount of soybean harvested by the sampled households in the study year of 2015, X_i is a vector of household socioeconomic characteristics and β is a vector of parameters.

The double hurdle model is estimated using maximum likelihood technique with the log likelihood given as follows:

$$LL_{DoubleHurdle} = \sum_0 ln\left[1 - \Phi(w_i\alpha)\Phi\left(\frac{x_i\beta}{\sigma_i}\right)\right] + \sum_+ ln\left[\Phi(w_i\alpha)\frac{1}{\sigma_i}\emptyset\left(\frac{y_i - x_i\beta}{\sigma_i}\right)\right] \ldots.$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(Equation 3.3)}$$

It can be noted that the standard Tobit model is actually a nested version of the Cragg model when $w_i\alpha$ is equal to 1 (ie the log likelihood of the Tobit equates that of the Cragg model when there is no adoption (participation) equation). Thus the Cragg model is effectively a Tobit model that allows for estimates of the adoption equation to be made separately from the extent of adoption equation (Beshir et al., 2012).

Assuming independence between the error terms V_i and U_i the double hurdle model is equivalent to a combination of the Probit (equation 3.1) and the truncated regression (equation 3.2) models. Further, estimates of the Double Hurdle cannot be expressed directly like is done with a linear regression model. Marginal effects are computed and used to estimate the impact of the regressors on the dependent variable. This involves decomposing the unconditional mean into the effect on the probability of adoption and the effect on the conditional level of adoption and differentiating these components with respect to each explanatory variable. The conditional mean can be written as shown in equation 3.4:

$$E(y|x_i) = P(y_i > 0)E(y_i|y_i) > 0 \text{.................................... (Equation 3.4)}$$

The probability of adoption and the extent of adoption conditional on participation are as in equations 3.5 and 3.6 respectively (Jensen & Yen, 1996; Yen & Jones, 1997):

$$P(y_i > 0) = \Phi(w_i' \alpha)\left(\frac{x_i' \beta}{\sigma_i}\right) \text{.................................... (Equation 3.5)}$$

$$E(y_i|y_i > 0) = \Phi\left(\frac{x_i \beta}{\sigma_i}\right)^{-1} \int_0^{\infty} \left(\frac{y_i}{\sigma_i \sqrt{1+\sigma^2 y_i^2}} \, \sigma\left(\frac{T(\theta y_i) - x_i' \beta}{\sigma_i}\right) \right) dy_i \text{.... (Equation 3.6)}$$

For the continuous explanatory variables, these marginal effects are used to calculate elasticities at the sample means, while for discrete categorical variable; the marginal effects are used to calculate percentage changes in the dependent variable when the variable shifts from zero to one assuming all other factors are constant.

3.3.2 Econometric Model Specification

Economic theory has not provided explicit guidance on which explanatory variable to include in the first hurdle and the second hurdle of the double hurdle models. Including the same set of regressors in both models makes it difficult to identify the parameters of the model correctly and so exclusion restrictions must be imposed (Jones, 1992; Jensen & Yen, 1996). A generally applied assumption is that the first hurdle is a function of non-economic variables determining households' decision to participate. As such, variables such as off-farm income are excluded from the first hurdle. Therefore, the following dependent and independent variables were included in the adoption and extent of adoption equations in the model and specified as follows:

Grow Soybean in 2015 (Adoption) (d) = f (age, gender, marital status, household size, distance to market, ownership to oxen, education, membership to farmer organization, access to extension, access to credit, size of landholding) + error term…………………………………………….…………………..(Equation 3.7)

While the extent of adoption equation was specified as follows;

Amount of Soybean harvested in 2015 (extent of adoption) (y) = f (age, gender, marital status, household size, distance to market, Off-farm income, ownership to oxen, membership to farmer organization, access to extension, access to credit) + error term……………………………………………….…………(Equation 3.8)

3.3.3 Variable Description

The following are the variables identified from literature to have an effect on adoption and level of adoption of soybean and the nature of the relationship with the dependent variables.

Adoption/Non-adoption dummy variable – Adoption and non-adoption of soybean was treated as a dummy variable with 1 indicating adoption and 0 otherwise. Adopters referred to farmers that had grown soybean on their land in 2015/2016 agricultural season. This was the dependent variable in assessing factors affecting soybean adoption.

Quantity of Soybean harvested in 2015 – was the dependent variable for determining the factors affecting the extent of soybean adoption. The variable was measured as a continuous variable in Kilograms.

Age (+/-) – was measured as a continuous variables. It is usually assumed that older farmers have more knowledge and experience over time and are thus better able to evaluate technology information than younger farmers (Kariyasa & Dewi, 2011). On the other hand, other scholars have reported that younger farmers are generally risk averse and hence more likely to try out new technologies (Adesina, 1993).

Genders of household head (+/-) – studies have reported mixed evidence on the influence of gender on technology adoption. Morris & Doss (2004) found no significant association between gender and probability to adopt improved Maize in Ghana. They concluded that gender was irrelevant in adoption decisions. However, since males are primary decision makers in Africa and hence have more access and control to resources, they are more likely to adopt new technologies compared to females headed households (Diagne et al., 2013). It was measured as a dummy variable in this study.

Household Size (+) – was measured as the number of people in a household and was used as a proxy to measure availability of labor. Labor is important in developing countries where moral hazard associated with hired labor is common (Asfaw et al., 2010).

Education of household head (+) - education of household head has been used in adoption studies as a surrogate for the farmer's ability to comprehend technology and access information (Rahman, 2010). In this study, education was measured as a continuous variable of years of formal education.

Access to extension services (+) – Extension has been observed to be a reliable source of information directly related to farming for resource poor farmers and thus has a positive influence on adoption (Adesina, 1993). It was measured by the frequency of extension visits in the year.

Access to credit (+) – has been found to stimulate technology adoption (Moono, 2015). It's believed that the variable relaxes liquidity constraints and hence makes it possible for farmers to try out risky technologies. It was measured as a dummy variable.

Size of land holding (+) – In a study on determinants of crop choices in Bangladeshi, land ownership was found to be a surrogate for a large number of factors as it is a major source of wealth and influences decisions to choose crops (Rahman, 2010). Many studies have reported a positive relationship between farm size and adoption of agricultural technologies (Kasenge, 1998; Uaiene, 2009). This is because availability of land has a huge influence on the extent to which a farmer can expand production. It was measured as the total land holding in hectares.

Livestock ownership by household (Oxen) (+) – refers to weather the farmer owns livestock for draught power or not and hence will be captured as a dummy variable.

Distance to markets (Time) (+/-) – refers to the number of kilometers from the household to the nearest agricultural output selling point. In this particular study, distance to markets was measured by the time in minutes taken to walk to the nearest output markets.

Off-farm income: When the resources earned from off-farm activities are significant, households tend to invest less into farming activities that are usually associated with higher risk. Off-farm income was measured as a continuous variable in Zambian Kwacha (ZMW).

Membership to farmer organization: farmer organizations improve household's ability to access improved inputs and lucrative markets. It has been shown that when farmers are organized into groups, their bargaining power improves. The variable was measured as a dummy with 1 given to households affiliated to farmer organizations and 0 otherwise.

Marital Status: the variable was measured as a dummy for the different marital status categories that included single, married, divorced and separated. It was expected to have both a positive and negative influence on adoption of soybean.

3.4 Soybean commercialization

3.4.1 Theoretical Framework of commercialization

Agricultural commercialization refers to the process of increasing the portion of agricultural output that is sold by farmers (Martey et al., 2012). It occurs when a farmer participates in the agricultural markets either as a buyer of agricultural inputs or as a seller of agricultural produce (Agwu et al., 2013). In essence, agricultural commercialization can be viewed from the input or output side. It was however viewed from the output side as HCI in this study.

To determine the factors affecting soybean output commercialization measured by the HCI, a Tobit which is a form of a censored limited dependent variable regression model was used. Several studies with binary dependent variables have used the Tobit regression model to empirically analyze their data (Adesina, 1993; Martey et al., 2012). The model was preferred for the study since HCI which is the dependent variable is lower censored at 0 (farmers who do not sell any crop) and upper censored at 1 otherwise. The Tobit model was estimated as below in equation 3.9:

$$Y = \max(Y^*, 0) \quad \text{(Equation 3.9)}$$

Where Y* are latent variables generated by the linear regression model:

$$Y^* = \beta_0 + X\beta_1 + \mu \quad \text{(Equation 3.10)}$$

Where: Y^* = latent variable of the dependent variable and that $Y = Y^*$

when $Y^* \geq 0$, and $Y = 0$ when $Y^* = 0$

β = estimable parameter

μ = error term and

X = explanatory variable

Since Tobit parameters do not respond directly to changes in the dependent variable brought about by changes in the explanatory variable, the marginal effect in the intensity of soybean commercialization due to changes in the explanatory variables will be given as in equation 3.11:

$$(\delta\varepsilon\ [y_i / x_i\ ]) / (\delta x_i) = \beta\varphi\ [\beta x_{ij}) \quad \text{(Equation 3.11)}$$

3.4.2 Econometric Model Specification

Literature evidence has shown that smallholder agricultural commercialization is affected by both macro and Micro level factors. Some of the macro factors include population change, availability of new technology, infrastructure, market creation as well as macroeconomic and trade policy (Von Braun et al., 1994). This study however focused only on the micro level factors that affect smallholder agricultural commercialization (Leavy & Poulton, 2007;Abera, 2009;Pender & Alemu, 2007). Thus, Given HCI as the dependent variable, the implicit form of the regression equation was stated as follows:

Household Commercialization Index (Y) = f(Age, Gender, Education, Household size, Quantity of soybean output harvested,, Livestock ownership by household, Household Off-farm income, Size of land holding, access to extension, access to credit, Membership to farmer Organizations, Distance to markets, access to information, farming experience)………………..(Equation 3.12)

3.4.3 Definition of Variables

The following are the variables identified from literature to determine intensity of smallholder crop commercialization with the dependent variable Household Commercialization Index. Also indicated is the direction of the relationship between the dependent and independent variable.

Household Commercialization Index: The HCI which was used as the dependent variable in the model was computed by dividing the Gross value of soybean sold by each household in the year under review to the Gross value of all soybean produced by the same household in the reference year. The resulting index was then multiplied by 100 to get the respective percentage of soybean commercialization.

Age of household head (+/-): is defined as the number of years of the household head from birth and was collected as a continuous variable. Moono, (2015) found that age is negatively related to market participation and intensity of participation. It was expected that older farmers with a richer resource endowment would have a higher likelihood of commercializing production.

Gender of household head (+/-): was defined and captured as a binary variable of either male or female. As observed by Zamasiya et al. (2014b), male headed households are less likely to participate in soybean markets compared to female headed households as the crop is seen as a pro-female crop in Zimbabwe. It was however hypothesized that gender would have a positive relationship with commercialization as male headed households are anticipated to have more access to production technology and market information. This argument is also supported by Doss (2010) who argued that female farmers grow crops mainly for subsistence than for cash.

Education of household head (+): was also captured as a continuous variable of number of years of formal school. Since the number of years of formal education influences an individual's ability to understand and make decisions, it was expected that respondents with more years of formal education will be more likely to commercialize than otherwise.

Household size (+): refers to the number of members in a household. It was expected to positively influence commercialization as it is treated as a proxy measure of availability of labor. Thus, households with a higher number of members would produce more output and have more surpluses to sell. In contrast Martey et al. (2012) as cited by Moono (2015) found that household size can also negatively influence the decision to participate in cereal markets as it reduces marketable surplus to meet household needs.

Quantity of Soybean output produced (+): was measured as the quantity of soybean grain produced by the household in 2014/15 season in kilograms. Households with higher yields are expected to have a higher probability of selling higher volumes (Chilundika, 2011). Thus output was hypothesized to be positively related with both the decision commercialization.

Livestock ownership by household (Oxen) (+): referred to whether the farmer owned livestock for draught power or not and hence was captured as a dummy variable. Moono (2015) in a study of Rice producers found that farmers who owned either Cattle or Donkeys for traction had a higher probability of participating in output markets. It was thus hypothesized that livestock ownership would have a positive effect on commercialization.

Off-farm household income (+/-): a key determinant of decision to participate and the level of participation in output markets is the net gain in income from the activity. A farmer is more likely to participate to a high degree if the expected income from the venture is high. Sebatta et al. (2014) found that off farm income earned by Potato farmers significantly affected their participation in the market. This was because by earning more income off-farm, farmers dedicated less time to production and marketing of crops. As such, income was measured as a continuous variable from off-farm activities and was anticipated to be negatively related to commercialization.

Size of land owned by household (+): Land ownership serves as a vector for a large number of factors as it is a major source of wealth and influences the number of crops a farmer can grow (Rahman, 2010). Being the primary resource for agricultural dependent households, land ownership is an important factor that influences agricultural production and market participation of households (Abera, 2009). Thus, it's expected that the higher the amount of land a household holds, the higher the probability of participating in the market. The variable was measured as the total land owned by a household in hectares.

Access to radio or cell phone (Access to information) (+): was used as a proxy to measure access to marketing information. Market information is important as it enables farmers to make informed decisions on selling of surplus output and prices. It was hypothesized that access to information through ownership of radio and or cellphone would have a positive relationship with both commercialization and the degree of commercialization.

Access to extension services (+): Extension is an important source of information dissemination on agricultural production and marketing particularly in developing countries (Rahman, 2010). Yaron et al. (1992) noted that access to extension can help counter balance the negative effect of lack of formal education in the overall decision making process of farmers. As such, farmers with high access to extension were hypothesized to have a positive relationship with commercialization. Extension was captured as the frequency of extension visits in the year under review.

Access to credit services (+): was captured as a binary variable of weather the farmer has access to credit or not. Generally, it is believed that access to credit relaxes liquidity constraints that hinder the farmer's ability to increase output and is hence expected to positively affect participation in output markets (Simutowe & Zeller, 2006)

Membership in farmer organizations (+): Membership to farmer organizations has the potential of increasing the farmer's access to information which is crucial in decision making over production and marketing of agricultural produce (Agwu et al., 2013). It is with this background that the variable was expected to have a positive relationship with commercialization. It was measured as a binary variable depending on weather the farmer is a member or otherwise.

Distance to markets in kilometers (+/-): refers to the number of kilometers from the household to the nearest agricultural output selling point. Literature has shown that the effect of distance on commercialization has been mixed. Mongoso et al. (2015) found that distance to market was not a significant predictor of a farmer's decision to sell soybean in Malawi. To the contrary, Diagne et al. (2013) found that longer distances to markets increased transaction costs which reduced gross profits. As such, it was expected that longer distances will negatively affect farmer's participation in output markets. The variable was captured as time in minutes taken to walk to the nearest output market from the respondent's household.

Farming experience (+/-): is defined by the number of years the household head has been engaged in farming. It was expected that farmers with more experience would have a higher likelihood of commercializing production.

3.5 Assessing Farmer/household attitudes towards soybean production

Farmers' attitudes towards agricultural technology also have a huge bearing on their ability to adopt and intensify the technologies. A study by Adesina (1993) showed that farmer's perceptions of characteristics of modern rice varieties significantly influenced their decision to adopt. Similarly, in a study on adoption of fish farming, farmers' perceptions influenced their ability to adopt (Wandji et al., 2012). Farmers' attitudes towards agricultural technology have a huge bearing on their ability to adopt and intensify the technologies. A study by Adesina (1993) showed that farmer's perceptions of characteristics of modern rice varieties significantly influenced their decision to adopt. Similarly, in a study on adoption of fish farming, farmers' perceptions influenced their ability to adopt (Wandji et al., 2012). In most typical attitude analysis studies, two main approaches are used to assess attitudes. These include descriptive and inferential statistics. The descriptive statistics include summing up the responses and obtaining a score or using the percentage of respondents in a given Likert scale category or scale average for the particular question responses (Shibia, 2010).

Other scholars have used factor analysis for attitudinal analysis (O'Shea et al., 2018). Factor simplifies data analysis by reducing an excessive number of observed variables to allow for a meaningful summarization of data for analysis. Factor analysis also provides a practical, standardized and straightforward method of extracting relevant information from confusing data sets, reducing the dimensionality of the data set and identifies meaningful underlying variables (Paul et al., 2013). The Factor analysis approach uses a list of factor loadings or eigenvalues of the correlation matrix where a factor loading represents the amount of variance captured by a given component. The loadings give an indication of how much a given variable has contributed to a given factor and hence its relative importance to the factor. At the end of the analysis, when all the variance in the component has been accounted for, the last step is to determine how many components should be retained for interpretation (Young & Pearce, 2013). The general rule is that components capturing low amounts of variance are not retained.

In this study, a combination of descriptive and inferential statistics was used to examine household's attitudes towards soybean production. Descriptive statistics (percentages and mean scores) were used to describe respondents' attitude towards soybean. On the other hand, factor analysis was used to identify latent dimensions underlying the different variables that measured respondents' attitudes towards soybean adoption and commercialization.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Research Findings and Discussions

This chapter presents the results of the various analytical approaches and their discussions. Both descriptive and analytical approaches were used to present the research finding about soybean adoption and commercialization.

4.1.1 Characterization of Respondents

Table 4.1 shows the demographic and socioeconomic characteristics of soybean adoption and production in 2015/2016 agricultural season. The distribution shows that adopters had lower levels of average education of 6.64 years compared to non-adopters with 6.67 years. This could be attributed to the fact that the majority of the adopters were older and experienced farmers who had limited access to education facilities in the past decades. The average age among adopters was 45.01 years and 43.68 years among the non-adopters. The results indicated that the youthful farmers with minimal farming experience seldom engage in new crops whose market opportunities are not assured.

Survey results also showed that although soybean is generally regarded as a ‘female’ crop, the majority 39 percent of the adopters were male. This indicates that males are slowly replacing females in growing soybean due to the increasing economic prospects for the crop. In addition, since soybean is a labour intensive crop, larger households with an average size of 6 persons adopted the crop compared to non-adopting counterparts with 5 persons. The finding was consistent with Moono, (2015) who found that lad size was significantly influential in determining participation in rice production for smallholder farmers in Western province. Descriptive results also showed that over 81 percent of the respondents were married comprising 46 percent adopters and 35 percent non-adopters. It was evident during data collection that farmers growing larger areas of soybean were married with large family sizes which could be attributed to availability of family labour. A Chi-square value of 9.16 showed that the differences in marital status between the two groups were statistically significant.

Table 4.1: Demographic Characteristics of Respondents

Demographic Characteristics	**Adopters (85)**	**Std Er**	**Non-Adopters (75)**	**Std Er**	**T-Value/ X^2 Value**	**Overall (160)**
Education (mean)	6.64	0.41	6.67	0.461	- 0.03	6.65
Age (mean)	45.01	1.38	43.68	1.59	0.64	44.39
Gender (%)					2.43	
Females	13.75		17.5			31.25
Males	39.38		29.38			68.75
Household Size (mean)	6.21	0.26	5.17	0.249	2.9	5.73
Marital Status (%)					9.16*	
Married	46.25		35.63			81.88
Single	0.63		0.63			1.25
Widowed	2.5		4.38			6.88
Divorced	0.63		5			5.63
Separated	3.13		1.25			4.38
Soybean Production and Income						
Size of landholding (mean)	8.14	0.91	7.69	0.66	0.24	7.93
Land allocated to soybean (mean)	1.89	0.34	0	0.08	4.81**	1.89
Quantity of soybean harvested (mean)	1,595.26	232.19	0	0	6.87**	1,595.26
Amount of soybean sold (mean)	1,517.93	231.91		0	6.55**	1,517.93
Amount of soybean retained (mean)	77.33	16.86	0	0	4.59**	77.33
Soybean output price (mean)	3.82	0.05		0	- 1.62	3.82
Total Income (ZMW)	28,312	2,160	13,311.99	515.06	4.02**	41,623.99
Access to Institutions and Infrastructure						
Access to agriculture extension services (%)	48.13		35.63		10.62***	83.75
Access to credit services (%)	10.63		9.38		0.00	20.01
Membership to farmer organization (%)	32.08		27.67		0.05	59.75
Time (minutes) to output markets (mean)	56.24	10.65	55.17	8.42	0.76	55.74
Time (minutes) to input markets (mean)	161.2	22.52	171.12	25.1	- 0.295	165.85
Access to soybean production technology						
Access to improved soybean seed varieties (%)	77.65				9.11***	77.65
Access to organic fertilizer (%)	0.07				5.03**	0.07
Access to Inoculum (%)	18.82				2.44	18.82
Access to herbicides (%)	0.12				3.24	0.12
Asset Ownership						
Ownership to livestock for draught (%)	51.76		37.33		3.35*	45
Ownership to bicycle (%)	64.71		51		0.19	66.2
Ownership to radio (%)	57		48		0.17	65.6
Ownership to Phone (%)	65		45		5.03**	68.8

*, **, *** Significant at 10%, 5%, 1% respectively. Source: Survey Data, 2017. US$1:ZMW10 at the time of Survey

Further, descriptive assessment showed that adopters owned more land (8.14 hectares) compared to non-adopters (7.93 hectares). Land ownership between the two groups was statistically significant at 5 percent level of significance. The larger land size made it easier and flexible for the adopters to explore emergent crop types as they diversified their crop production. However, on average, 1.89 hectares of the total 7.93 hectares was actually allocated to soybean, harvesting 1.6 metric tonnes from which 1.5 metric tonnes was sold at ZMW 3,800 per kilogram. This is in contrast to the Central Statistical Office which estimates that smallholder own between 5 to 20 hectares of land (CSO/GRZ, 2017). Descriptive statistics further showed that there significant difference in total income between the two groups. The differences in income resulted largely from Soybean sales and this finding was consistent with (Joala, 2018) who in a study on the Soybean sub-sector in Zambia concluded that the main benefit to farmers was in the form of increased cash income. A larger proportion of the remaining 0.1 metric tonnes was retained for seed while the remainder was consumed and or used for in-kind labour payments as shown in Figure 4.1 below.

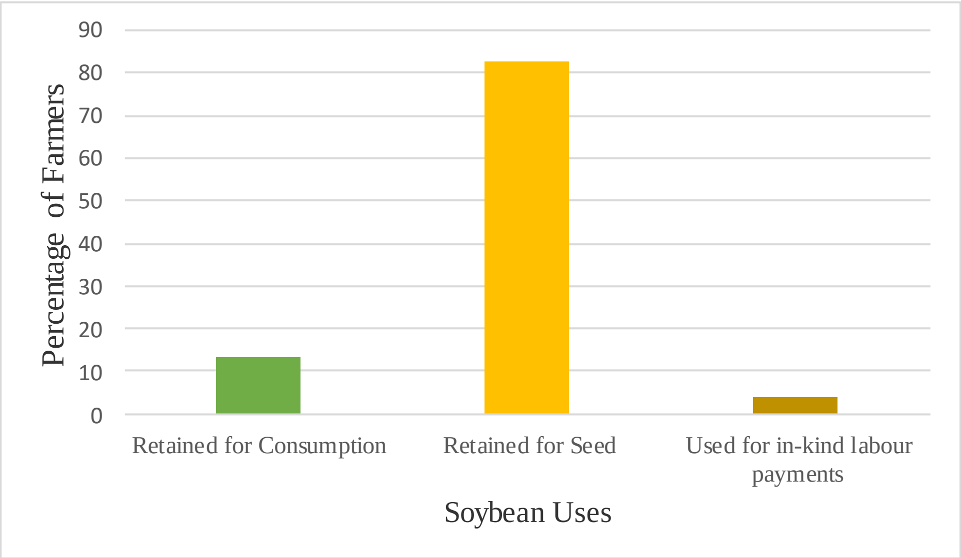

Figure 4.1: Use of the Retained Soybean among respondents

Source: Source: Survey Data, 2017

Access to institutional factors such as extension services, credit and membership to organizations are crucial factors as they support the sector and also act as avenues through which farmers are informed of existing opportunities within the agricultural sector. The distribution in Table 4.1 showed that there were significant differences between adopters and non-adopters in terms of access to agricultural extension. 48 percent of adopters and 35 percent of non-adopters had access to extension services in the reference year. This could be indicative of the fact that adopters were more informed about new trends in the agricultural sector compared to non-adopters. The data also showed low access to credit for both categories of farmers (11 percent of adopters and 9 percent of non-adopters) implying that adopters generally had better credit access which allowed them to invest. The two aforementioned results resonated with Joala, (2018) who postulated that strategies to promote Soybean were premised on the assumption that farmers would utilize conservation agriculture methods and intensify use of improved inputs. The realization of this required an efficient agricultural extension system and improved access to credit.

A majority (60 percent) of the respondents (32 percent adopters, 28 percent none adopters) had membership to farmers organizations. When checked to see if these groups had any influence on soybean production, 152 respondents said that there was no presence of soybean farmer groups in the area. The remaining 8 respondents indicated that the soybean groups helped them by improving their access to soybean inputs while other minimal benefits included access to marketing information and production technology.

Input and output markets are another key component of development in all agricultural value chains. They are crucial in promoting access to inputs for production as well as access to output markets for disposal of agricultural produce. Though the time taken to walk to both input and output markets were not statistically significant, as shown in Table 4.1, it took farmers less time to walk to output markets to sell their produce (56 minutes) than to walk to input markets to purchase their inputs (166 minutes). It is also evident from the results that it took non-adopters more time to access input markets (171 minutes) than the adopters who took 161 minutes. Further assessment of the descriptive results showed that the majority (76 percent) of the respondents sold their soybean to local traders within Chipata district. A considerable 17 percent sold to traders from distant markets while a minority (5 and 2 percent) sold to government and traders from neighboring towns respectively.

Technology is critical in improving return per unit of inputs as well as in reducing the cost of production. In reference to soybean production, critical technology includes improved seed, inoculum and herbicides. Survey results showed that the majority (78 percent) of the adopters had access to improved soybean seed varieties while the rest used recycled seed. Another 19 percent had access to inoculum while less than 1 percent had access to organic fertilizers and herbicides. Overall, only 0.08 percent had access to all the critical inputs. The low access was largely attributed to the higher prices of the inputs and their non-availability.

Results further showed that 52 percent of adopters had access to oxen for draught compared to 37 percent among the non-adopters. This situation implies that it is easier for adopters to grow labour intensive crops since they have draught oxen. Moreover, a majority (65 percent) of the adopters had bicycles compared to 51 percent of the non-adopters. When it came to access to information, adopters had more access to radio and phone (57 and 65 percent) compared to their non-adopting counterparts with 48 and 45 percent respectively. Additionally, adopters generated more overall annual income of more than ZMW 28,000 compared to ZMW 13,000 among the non-adopters. This income was a sum of on-farm and off-farm activities. This finding contrast with Hichaambwa et al., (2014) who as cited by Siamabele, (2019) concluded that stallholders are unable to realize attractive returns from Soybean, perceiving the crop as more risky compared to maize.

4.1.2 Distribution of Assets among Respondents

Ownership of assets among respondents was shown in Table 4.2. Results showed that 66 adopters owned iron sheet housing compared to 49 non-adopters while 30 non-adopters had grass housing compared to 20 adopters. The results also showed that a majority (44 adopters) had cattle/oxen and ox-ploughs for labour compared to 28 non-adopters. There was little difference between the two groups in terms of ownership to hoes in that almost all households owned the equipment indicating that the equipment was the primary tool for crop production activities. However, 48 adopters compared to 41 non-adopters had sprayers to control pests and diseases as well as for herbicide application. Another 57 and 65 adopters indicated ownership to radio and cellphone respectively. This was in comparison to 48 and 45 non-adopters.

In terms of access to transport facilities, 55 adopters had bicycles compared to 51 non-adopters. Another 9 and 6 adopters owned motorbikes and cars compared to 7 and 3 non-adopters respectively. Further, at least 1 adopter had ownership to a truck, tractor and trailer compared to none among their non-adopter counterparts. Generally, it was evident that adopters had a richer asset base that allowed them more flexibility to re-invest into other agricultural activities.

Table 4.2: Distribution of Assets among respondents

Type of Asset	Non-Adopters (85)	Adopters (75)
Grass Thatched House	30	20
Iron Roofed House	49	66
Cattle/Oxen	28	44
Donkeys	0	4
Ox-Plough	27	44
Hoes	69	66
Sprayer	41	48
Radio	48	57
Cellphone	45	65
Television	19	26
Bicycle	51	55
Motorbike	7	9
Car	3	6
Truck	0	1
Tractor	0	1
Trailer	0	1

Source: Survey Data, 2017

4.1.3 Distribution of Farmers by type of Crops Grown

This section identified the main crops grown by farmers in the area. The results showed that the crop mix was not different among respondents in the four sampled study sites and hence was grouped together. Figure 4.2 showed that all the farmers grew Maize, followed by Groundnuts grown by 100 farmers, soybean with 85 and Sunflower with 83 farmers. The other crops such as Cotton, Beans, Cassava, Sweet and Irish potatoes including an assortment of vegetables were grown by less than 30 farmers respectively. In particular, only 11 respondents indicated having grown at least one type of vegetable on their farm. Maize, Groundnuts and Soybean are grown primarily for food while the surplus crop is sold. Cotton on the other hand is grown mainly for cash. All these crops are grown using conventional methods under rain fed agriculture.

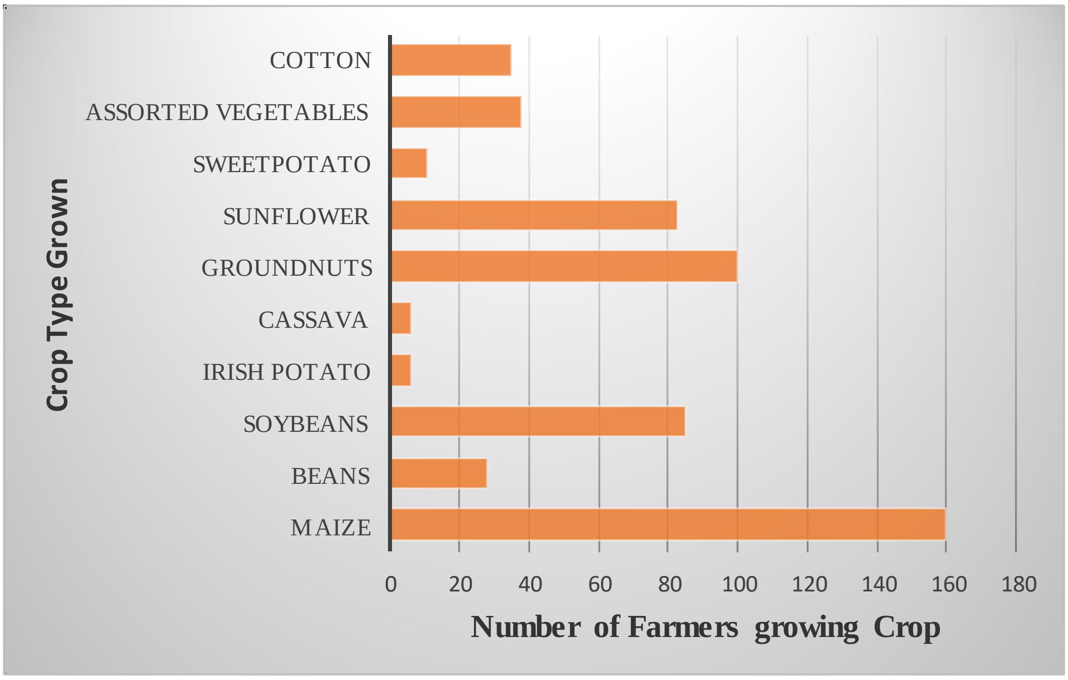

Figure 4.2: Distribution of Respondents by Type of Crops Grown

Source: Survey Data, June 2017

Thereafter the income realized from all on-farm and off-farm activities was computed and tabulated in Table 4.3. It can be seen that income from Maize was ZMW 4,377.22 among adopters compared to ZMW 2,683.07 among non-adopters. Average income from Soybean was ZMW 6830.68 for the adopters while that for Groundnuts was ZMW 401.24 and ZMW 293.53 among adopters and non-adopters respectively. Results also showed that average income from Cotton was ZMW 4,312 among adopters and ZMW 1,500 among non-adopters. Note that adopters had a higher off-farm business income of ZMW 4,000 compared to ZMW 585 among non-adopters.

It is evident that adopters had more income from Maize, Groundnuts, Sunflower, Cotton, Off-farm business, and off-farm casual labour. Non-adopters surpassed adopters in livestock and wage income. This is as expected since farmers with higher income from wages and livestock tend to put little emphasis on crop production (Moono, 2015). Note that Soybean had the largest income compared to all other income sources for adopters.

Table 4.3: Distribution of Income Sources among respondents

Gross Income from sales	**Adopters (85)**	**Non-Adopters (75)**
	Mean (ZMW)	**Mean (ZMW)**
Maize income	4377.22	2683.07
Soybean income	6830.68	-
Groundnut Income	401.24	293.53
Sunflower income	329.82	17.20
Cotton income	4312.25	1502.5
Livestock income	1176.46	1566.92
Off-farm casual labour income	741.44	585.71
Off-farm business income	4000	750
Wage income	2750	3366.67

Source: Survey Data, June 2017: US$1:ZMW10 at the time of Survey

4.2 Socio-economic factors determining Soybean adoption

The previous section dealt with the description of the study population and the significance of association between the dependent and the multiple independent variables. However, description and association on its own is inadequate for policy recommendation as it fails to explain the relative importance and direction of influence for variables. As such, the Double Hurdle model was used to assess the relative importance of the various socio-economic, institutional and demographic factors on soybean adoption and the extent of adoption respectively amongst smallholder farmers.

The hypothesized variables were checked for existence of multicollinearity using the Variance Inflation Factor (VIF). VIF shows how the variance of an estimator is inflated by the presence of multicollinearity. A VIF value of less than 5 indicates absence of multicollinearity (Alauddin & Nghiemb, 2010). Hence as shown in Appendix 1, all the variables had VIF values less than 5 signifying the absence of multicollinearity.

The parametric results of the Double hurdle model (Probit and Truncated repression shown in equation 3.1 and 3.2) are shown in Table 4.4. In both analyses the overall models were significant (Prob > chi2 = 0.0414 for the Probit and Prob > chi2 = 0.0000 for the Truncated Regression). Further, the log likelihood test statistics for both cases suggested that the models fitted the data well.

The results in Table 4.3 showed that the decision to adopt soybean was affected by the age, household size, livestock ownership and access to agricultural extension of the respondent. Results further showed that the decision on the extent of adoption was influenced by presence of off-farm income, land size, livestock ownership, and access to credit services, gender and the marital status of the respondent.

Age had a significant ($p<0.1$) and positive relationship with adoption. Older farmers were more likely to adopt soybean into the farmers' cropping system. This result was in line with *apriori* expectation in that older farmers are expected to be more open to new innovations or ideas due to experience. Older farmers are usually better positioned to adopt innovations due to their comparative advantage in terms of capital accumulation, number of extension visits/contacts and credit worthiness (Langyintuo, 2008). The result however contradicted with Moono, (2015) and Alabi et al. (2014) who found that older farmers when compared to young farmers tend to be risk averse with limited access to information which are necessary requirements for adoption.

Table 4.4: Factors determining adoption & Extent of Adoption of soybean among smallholder farmers in Chipata District

	Adoption (Probit)				Extent of Adoption (Truncated Regression)			
Variables	**Coefficient**	**Robust Standard Error**	**Marginal Effect**	**P>|z|**	**Coefficient**	**Robust Standard Error**	**Marginal Effect**	**P>|z|**
Age (Years)	0.0154	0.0084	0.0052	**0.066***	4.5604	6.0842	4.5604	0.454
Education (Years)	-0.0225	0.0342	-0.0076	0.511	-16.1939	20.1070	-16.1939	0.421
Household Size	0.0874	0.0560	0.0297	**0.019****	-31.7991	28.6033	-31.7991	0.266
Off-farm Income (ZMW)					-0.1091	0.0942	-0.1091	**0.042****
Land Size (Hectares)	-0.0113	0.0182	-0.0038	0.535	11.5236	9.2065	11.5236	**0.051***
Membership to Farmer Organizations	-0.3361	0.2448	-0.1119	0.17	-25.9068	130.8770	-25.9068	0.843
Livestock Ownership	0.3126	0.2599	0.1075	**0.029****	479.5427	153.8965	479.5427	**0.002*****
Distance to Markets (Walking Time in Minutes)	-0.0003	0.0012	-0.0001	0.823	0.6017	0.6971	0.6017	0.388
Access to Agricultural Extension Services	0.9537	0.3520	0.3252	**0.007*****	304.8046	264.1728	304.8046	0.249
Access to Credit	0.0201	0.2904	0.0068	0.945	-655.0440	196.3909	-655.0440	**0.001*****
Gender of Respondent	0.2232	0.2493	0.0768	0.371	250.0040	222.9879	250.0040	0.262
Marital Status of Respondents								
Married	-0.1350	1.0057	-0.0470	0.893	792.3564	185.4371	792.3564	**0.001*****
Widowed	-0.6823	1.0522	-0.2398	0.517	729.7038	433.6591	729.7038	**0.092***
Divorced	-1.3106	1.1831	-0.4236	0.268	1396.4430	304.9060	1396.4430	**0.001*****
Separated	0.7601	1.1885	0.2213	0.522	756.4712	350.5731	756.4712	**0.031****
Constant	-1.5706	1.1488		0.172	501.9458	384.7073		
Number of Observations	160				85			
Prob > chi2	0.0414				0.0000			
Log pseudo likelihood	-94.6045				-629.3060			

*, **, *** Significant at 10%, 5%, 1% respectively. Source: Survey Data, June 2017. US$1:ZMW10 at the time of Survey

Household size in the study was used as a proxy measure of labour availability and had a significant ($p<0.05$) and positive relationship with soybean adoption. The probability of adopting soybean increased with increase in household size. The finding confirms that for labour intensive crops such as soybean, labour availability is a critical factor for adoption. It is also consistent with Alabi et al. (2014) who while studying the factors affecting adoption and use of agrochemicals concluded that labour availability increased the probability of agrochemical adoption. Other comparable results include Asfaw and Shiferaw (2010); Chiputwa et al. (2011) who found that larger households had a higher probability of adopting agricultural technologies and conservation agriculture practices respectively.

Ownership to livestock was significant and positively influenced both the decision to adopt soybean ($P<0.05$) and the extent of adoption ($p<0.01$). The probability of adopting soybean increased with increase in the number of animals a farmer owned. Livestock ownership is considered as an asset that is either used directly in the production process or could be exchanged for cash for the purpose of securing inputs whenever need arose (Beshir et al., 2012). As a result, livestock ownership increases both the probability to adopt technologies and expansion of the technology after adoption.

Access to agricultural extension services had the expected positive and significant effect ($p<0.01$) on soybean adoption. Access to agricultural extension increased the probability of adopting Soybean. Agricultural extension services are a major source of information for improved agricultural technologies. This result was consistent with Teklewood (2006) who found that one means by which farmers access information about improved technologies is by contacting agricultural extension agents.

Off-farm income was also significant ($p<0.05$) and negatively related with the extent of adoption of soybean. This result was as expected in that as the income realized from off-farm activities increases, the probability of investing in crop production activities reduces. The possible explanation is that farmers opt to replace crop production with off-farm economic activities. This result was consistent with Alabi et al. (2014), who found that an increase in off-farm income reduced the likelihood of farmers adopting use of agrochemicals noting that higher returns off-farm justified investment when compared to the risks associated with crop production in Africa.

Land availability was significant ($p<0.1$) and positively related to the intensity of adoption of soybean. The probability of adopting Soybean increased with increase in the amount of land a household owned. Land is an important factor in production and the larger the number of hectares produced, the larger the output (Hichaambwa & Jayne, 2012). This shows the importance of land availability in enabling households expand the area under production. Comparable results were also found by Handrina & Lwesya (2004) while investigating the factors influencing adoption of Treadle pump irrigation technology in Malawi. The pair concluded that households with large land holdings have a higher potential of increased production, which enable them to invest and gain more from the technology adopted.

Access to credit was significant ($p<0.01$) and negatively affected the intensity of soybean adoption. Increased access to credit services increased the probability of harvesting more Soybeans. This result was against apriori expectations were an increase in credit services is expected to increase intensity of production. Access to credit enables producers to increase the quantity of inputs and other productive assets acquired such as fertilizers and seed which in turn increase output produced (Sindi, 2008). However, the cost of accessing credit should be affordable to small holder farmers so they can benefit from the credit services. Thus, when credit is un-affordable it becomes prohibitive to increased crop yields (Moono, 2015).

Gender of the respondent significantly and positively influenced ($p<0.01$) the extent of adoption of soybean production. This implied that compared to females, male smallholder farmers yielded 250 kilograms more of soybean. This result was consistent with Beshir et al. (2012) male farmers had a higher probability of adopting chemical fertilizers compared to their female counterparts. The justification for this is that male farmers might have more access to information and land which are crucial in crop production.

Marital status of the respondents was also significant (Married ($p<0.01$), Widowed ($p<0.1$), Divorced ($p<0.01$), Separated ($p<0.05$)) and positively affecting the extent of soybean adoption by smallholder farmers. This meant that the married households were more likely to harvest more Soybeans. Married respondents yielded 792 kilograms, widowed yielded 729 kilograms, and the divorced yielded 1,396 kilograms while those separated yielded 756 kilograms. This result is consistent with Dogbe et al. (2013) who found that marital status had implications on access to farm land, control of production resources and marketing of output as well as availability of family labour. This might justify why divorced farmers with more control over their agricultural activities and better access to land yielded more soybean compared to the other marital status categories.

4.3 Socio-economic factors that influence the level of commercialization of soybean among smallholder farmers

Firstly, Household Commercialization Indices (HCI) were computed to measure the extent of commercialization for the identified four major crops (Maize, Soybean, Groundnuts, Sunflower) in the study area. The index is a ratio of the gross value of crop sales and the gross value of all crops expressed as a percentage. Table 4.5 shows that Maize with gross crop sales value of Zambian Kwacha (ZMW) 3,583.09 and a Gross mean value of all crops produced of ZMW 5,214.91 had an HCI index of 47 percent. Soybean on the other hand had the highest index of 89 percent. This was because 95 percent of the soybean produced at household level is sold. The HCI for Groundnuts and Sunflower were however low at 25 and 29 percent respectively since they were mainly grown for subsistence although a little surplus is sold. In addition, few respondents grew the crop in the review period as only 49 and 26 farmers grew groundnuts and Sunflower respectively.

Table 4.5: Distribution of the extent of commercialization of the major crops in the study area

Crop	Gross Value of crop sales (ZMW)	Gross Value of all crop sales (ZMW)	Percentage Ratio
Maize	3,583.09	5,214.91	47
Soybean	3,628.8	3,813.67	89
Groundnut	350.75	655.49	25
Sunflower	183.28	332.45	29
Average Household Index	1,239,347	1,602,642.64	62

Source: Survey Data, June 2017: US$1:ZMW10 at the time of Survey

The average commercialization index for the study area was 62 percent, with an average gross crop sales value of ZMW 1,239,347 and average gross crop production value of ZMW 1,602,642.64. This indicated that on average; most of the households were commercialized to some degree. Further, though soybean had the highest index, maize is the frequently produced and marketed crop as all the sampled farmers produced it in the year under study

4.3.1 Tobit Analysis of Socio-economic factors affecting Soybean commercialization

This section presents Tobit analysis results of factors affecting soybean commercialization among smallholder farmers particularly in Chipata district of eastern Zambia. Table 4.6 shows the results of the Tobit regression analysis for assessing the factors affecting soybean commercialization in Zambia. The model was statistically significant at 1 percent level of significance (p = 0.0062) and that it fitted the data well (Pseudo R^2 =0.4922).

The results showed that the household soybean commercialization was significantly affected by the gender, size of the household, whether the household owned draught oxen, the amount of land that the household owned and the affiliation of the household head to farmer organizations. Gender of the respondent was significant ($p<0.05$) and positively influenced the extent of soybean commercialization. This implied that the probability to commercialize soybean was higher for male headed households. This finding contradicted with Okemute et al. (2014) and Zamasiya et al. (2014) who concluded that being male negatively affects participation of households particularly in Africa were legumes are culturally viewed as women's crops. The finding is however consistent with Cunningham et al. (2008) who found that men produce and trade more as the profitability prospects of a particular crop increases. A probable explanation could be that men are slowly dominating in the soybean value chain as the economic prospect of the crop improves on the market (Muriithi, 2015). In effect, men are highly involved in producing crops such as soybean which are highly commercialized.

Household size was significant ($p<0.05$) and positively influenced soybean commercialization. Household size was used as a proxy measure of availability of labour which is a vital input in crop production. The probability of commercializing Soybean increased with increase in the size of the household. This resonates with Kibiringe (2016) who found that households with more members had a higher likelihood of producing a larger market surplus.

Table 4.6: Factors affecting soybean commercialization in Chipata District

Variable Name	Coefficient	Standard Error	T-value	P-value
Age (years)	-0.0037	0.0076	-0.49	0.628
Gender (1=male,0=female)	0.1355	0.0649	2.09	0.040**
Education (years)	0.0026	0.0089	0.29	0.771
Household Size (persons)	0.0495	0.0206	1.20	0.019**
Soybean harvested (kg)	0.0017	0.0810	1.35	0.182
Own draught oxen (number)	0.1485	0.0738	2.01	0.048**
Off-farm income (ZMK)	0.1430	0.1370	-0.91	0.367
Land ownership (hectare)	0.0112	0.0058	1.94	0.056*
Access to extension services	0.0228	0.1203	0.19	0.85
Access to credit services	-0.1066	0.0833	-1.28	0.205
Membership to farmer organizations	1.0462	0.54931	1.32	0.061*
Time to walk to output markets (min)	-0.0002	0.0003	-0.54	0.588
Access to Information	0.0333	0.0840	0.40	0.693
Farming experience (years)	0.0059	0.0085	0.69	0.495
Constant	0.7674	0.1936	3.96	<0.001***
Number of Observations	85			
Prob > chi2	0.0062***			
Pseudo R2	0.4922			
Log likelihood	-15.819744			

*, **, *** Significant at 10%, 5%, 1% respectively **Source: Survey Data, June 2017. US$1:ZMW10 at the time of Survey**

Ownership to draught oxen was also significant ($p<0.05$) and positively influenced the extent of commercialization. The probability to commercialize Soybean increased with the number of draught oxen that a household owned. This finding is consistent with Okemute et al. (2014) who observed that conditional on market participation, resource endowed households (own livestock) can use the animals for traction and transport; a development which reduces production and market related costs. These households are also more likely to have finances from animal sales and or animal hire proceeds to hire labor, purchase improved seeds, purchase herbicides/pesticides, purchase fertilizer, and rent additional land which enables them to grow soybeans on larger pieces of land compared to their resource constrained counterparts. Further, households with better resource endowment tend to practice better and sustainable agronomic practices by applying organic manure in their fields which increased soybean yields due to the importation of significant quantities of nutrients during the dry season at the expense of poorer farms (Zingore, 2007).

Land ownership had a significant $p<0.01$) and positive effect on the extent of commercialization among the smallholder farmers. The probability of commercialization of Soybean increased with increase in land ownership. This was in agreement with *a priori* expectations that farmers with larger farm sizes were expected to produce beyond their subsistent requirements for household and livestock consumption. The result was also consistent with the findings of Mignouna et al. (2015) who noted that smallholder farmers with smaller farm sizes are usually constrained to produce basically for home consumption and rarely have the ability to produce marketable surplus. Hichaambwa & Jayne (2012) studied smallholder commercialization trends as affected by land constraints in Zambia. They found that despite vast expanses of the country's land currently being uncultivated, a large proportion of smallholder households face land constraints that limit their ability to produce a marketable surplus and participate in output markets. These constraints are a lot to do with governance of land allocation than availability as 95 percent of the land is owned by traditional leadership and not government. Further, his analysis of national data discovered that in the 2010/11 agricultural season, 54 percent of the smallholder households in Zambia cultivated all the land they owned while only 41 percent cultivated less land than they owned and 5 percent cultivate more than they owned through renting in. They concluded that even though the countries land resource is adequate, institutional structures governing access to land by smallholder farmers negatively affect the farmer's ability to access adequate land for commercial crop production.

The coefficient of membership to farmer organizations was significant ($p<0.1$) and positively influenced soybean commercialization. The results showed that household heads who had membership in farmer organizations such as agricultural cooperatives, farmer groups and women groups increased their likelihood of commercialization by 1.05 percent. Membership to organizations improved farmers' access to market information and input use but also increased farmer's bargaining power (Moono, 2015).

4.4 Analysis of farmers' attitudes towards adoption and commercialization of soybean

Farmer attitudes towards farming activities have an effect on their ability to invest their time and resources in adoption, production and commercialization. The respondents were asked to rank their opinion on a Likert scale ranging from 1 (strongly disagree) to 5 (Strongly agree) on particular attitudinal dimensions about soybean production, marketing and consumption. Rank points for each attribute were added from each statement and divided by the total sum of possible ranking to calculate a score in percentage terms. For the sake of analysis, the 50 percent mark was assumed to be the boundary for positive and or negative attitude orientation for a specified attitude dimension (Olunga, 2013). The attitudinal dimensions were classified into two categories. The first category included attitudes associated with soybean input acquisition and production while the other category involved attitudes associated with soybean marketing, processing and consumption.

Results in Table 4.7 showed that 64 percent of farmers were willing to invest their time and resources into soybean production. This was because despite the expensive seed, the crop had higher returns on the market as evidenced by 61 percent of the farmers who agreed that soybean contributes significantly to their livelihoods. When it came to marketing and processing, 51 percent agreed while 34 percent strongly agreed that soybean is a profitable crop. Another 49 percent agreed that the crop was important for food security and that it was also a reliable source of protein (45 percent). Regarding knowledge on production aspects, 48 percent of the respondents disagreed that they did not know how to grow the crop. This was consistent with 51 percent who equally disagreed that soybean yields were low.

In contrast, 67 and 25 percent of the farmers strongly agreed and agreed respectively that soybean seed is expensive to acquire. The results further indicated that there were some institutional challenges that made the crop unattractive as evidenced by 26 and 36 percent of respondents who agreed and strongly agreed that the crop lacks institutional support in terms of agricultural extension and agricultural credit services. Attitudes were however neutral on the importance of gender in production, marketing and consumption of the crop. The attitudes were also neutral on the status of markets and prices.

Table 4.7: Attitudes related to soybean Production

Dimension of Attitude	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
Attitudes related to soybean input acquisition and production					
Soybean seed is too expensive	6	2	0	25	67
Am willing to invest resources and time to soybean	2	5	0	64	29
There is no advantage to use improved against recycled seed	29	33	16	15	7
Soybean fertilizer demand is too high	21	39	5	28	7
Soybean is inferior to Maize	19	46	6	16	13
Lack of Institutional support makes soybean unattractive	14	22	2	26	36
Soybean is labour intensive	4	24	0	39	33
Soybean yields are very low per hectare	6	51	3	33	7
Limited land limits expansion of area under soybean	11	38	5	36	10
I don't know how to grow soybean	15	48	11	22	4
Attitudes related to soybean marketing and processing					
Soybean is a profitable crop	1	7	7	51	34
Soybean is less profitable compared to Maize	22	36	4	26	12
Soybean contributes to improvement in livelihoods	1	13	1	61	22
Soybean prices are perceived to be low	1	33	2	33	31
Markets for soybean are not available	9	31	3	36	21
Soybean is an important crop for women	9	38	7	26	20
Soybean is an important crop for men	11	32	8	34	15
Soybean is important for food security	0	8	28	49	15
Soybean is easy to process into food	8	18	22	41	11
Soybean is a reliable source of protein	4	4	15	32	45

Source: Survey Data, June 2017

Assuming that there could be some common but latent factors causing the variations in the attitudes of the respondents towards soybean production, marketing and consumption, as measured by their responses to the asked attitudinal dimensions, Factor analysis with promax rotation was used to identify the latent factors with an aim of reducing the dimensions to a few that accurately reflected the relationships among the inter-related dimensions. An Eigen value greater that 1 rule was used to identify the factors. The variables with high factor loadings were grouped together and named. Considering that factor loading of 0.5 or more are generally taken to be normal and significant, a solution of three (3) factors were retained and accounted for 79.3 percent of the variance in the model.

Table 4.8: Results of Exploratory Factor Analysis

Factor and Dimension of Attitude	Factor loading
Factor 1: seed access and crop diversification	
There is no advantage to use improved against recycled seed	0.51
Soybean is inferior to Maize	0.59
Variance accounted by factor 1	**32**
FACTOR 2: SOYBEAN PRICING AND MARKETING	
Soybean prices are low	0.50
Markets for soybean are not available	0.79
Variance accounted by factor 2	**26**
FACTOR 3: GENDER RELATIONS AND FOOD PROCESSING	
Soybean is an important crop for women	0.71
Soybean is an important crop for men	0.70
Variance accounted by factor 3	**21**
OVERALL VARIANCE EXPLAINED BY THE THREE FACTORS	**79**

Source: Survey Data, June 2017

Prior to extraction of factors, it is recommended that a Kaiser-Meyer-Olkin (KMO) test is conducted to ascertain sampling adequacy for the methodology. The KMO index ranges from 0 to 1 with 0.5 considered suitable for factor analysis. The KMO index, in particular, is recommended when the cases to variable ratio are less than 1:5 (Brett, Onsman, & Brown, 2010). Thus, a KMO value of 0.61 realized in the study made use of factor analysis appropriate.

Survey results in Table 4.8 showed two variables associated with use of improved seed and crop diversification were loaded on factor 1 with factor loadings of 0.51 and 0.59 respectively for the two variables. Factor one accounted for 32 percent of the variance and was named seed access and crop diversification. Factor 1 symbolized the importance of promoting improved soybean seed as well as the need to promote soybean production as a component of a crop production package to ensure diversification in production while reducing risks associated with crop failure.

The second factor accounting for 26 percent of the variance was called soybean pricing and marketing. The factor comprised of variables associated with soybean prices and marketing mechanisms which had 0.50 and 0.79 loadings respectively. The factor was indicative of the importance of efficient marketing and pricing of produce in promoting increased production especially that very little proportions of soybean are consumed at household level.

The third factor was named Gender relations and food processing and accounted for 21 percent of variance. The factor highlighted the importance of soybean to men and women with factor loadings of 0.71 and 0.70 respectively. This finding emphasized the need to mainstream gender issues in soybean promotion as some gender and cultural related factors had both positive and negative effects in production, marketing and consumption of soybean. Overall, the model explained 79 percent of the variance amongst the variables. Factor analysis results pointed out the key attitudes related to improved seed access, pricing and marketing and gender mainstreaming during production, marketing and consumption of soybean.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

This chapter summarizes the study results established in the previous chapters and draws conclusions and policy recommendations.

5.2. Conclusions

This study assessed factors affecting household's decisions to adopt, intensify and commercialize soybean production as well as establish fundamental attitudes that influence farmer behavior towards soybean production in Chipata district of eastern Zambia. The study used data from 160 households in four agricultural camps. The sites was selected because of its high agricultural potential and also because past agricultural interventions targeting legume intensification such as the USAID funded feed the future development initiative were implemented in the area. Regression techniques were used to assess adoption and commercialization. Double Hurdle regression analysis was particularly used to determine both the factors that influence the adoption decision as well as the extent, rate or speed of adoption. With the Household Commercialization Index as the dependent variable, Tobit regression analysis was used to identify prominent factors affecting soybean commercialization. Thereafter, Factor analysis was used to identify the latent factors that accurately reflected the relationships among the identified inter-related attitudinal dimensions.

The study established that the factors that significantly affected soybean adoption included the Age of the household, household size, ownership of livestock and the respondents' access to agricultural extension services. Further, Size of available land, presence of off-farm income, Ownership to livestock, access to agricultural credit services, the gender and marital status of the farmer significantly influenced the extent of soybean adoption. The study found that the commercialization Index of soybean (0.89) was higher than that of maize (0.47) and Groundnuts (0.25). This was because very little soybean (1 percent) is consumed at household level. The analysis also indicated that commercialization is affected by the gender of the respondent, ownership to oxen and the size of the land owned by a household. The overall results on the attitude of farmers towards soybean adoption and commercialization was negative. The farmer attitude was associated with lack of diversity in the local diet which made soybean nutritionally unimportant. Households also exhibited little knowledge on soybean processing options into food probably due to the low education status associated with the majority of the respondents. The negative attitudes were also attributed to higher input and low output prices. Thus, the null hypothesis that farmers have neutral attitudes towards soybean adoption and commercialization was rejected.

The study concluded that overall household characteristics related to demographics such as age and gender as well household characteristics related to productive resources such as access to labour, access to land; and institutional factors such as access to agricultural extension and credit services are critical determinants in adoption of Soybean among smallholder farmers. It was further concluded that access to labour and access to land were also crucial determinants in Soybean commercialization.

The study further concluded that farmer attitudes have a huge impact on soybean adoption and commercialization. One key attitude was that farmers did not feel confident in growing Soybeans suggesting a knowledge and skill gap. This could be plugged up through bottom-up extension approaches such as promotion of group learning and learning through Farmer Field Schools. There is also need to fully understand farmer attitudes before introducing new crops and technologies. This ensures that the introduced crops conform to farmer needs and aspirations which enhance adoption and commercialization.

5.3 Recommendations

The study recommends that in order to enhance adoption and commercialization, there is need to revise policies governing allocation of land in order to make it more available to smallholder farmers for growing of emergent crops and commercialization of scale of production. Policy makers also need to engage the private sector in order to reduce the cost of agricultural credit. This will enhance farmer's access to crop inputs and labor saving technologies through subsidized inputs or low interest credit. There is also need to enhance access to agricultural extension by employing more agricultural extension agents in order to make the service more available to farmers. The study recommends participatory extension approaches that would build the farmer knowledge, skill and confidence to engage in Soybean production.

In addition, given the high level of variability across districts in eastern province, the study recommends that future research should increase sample size in order to ensure that results are more representative of the province. Further, studies on crop adoption should not just end on assessing adoption but go further to assess commercialization as well. This is because improvement in livelihood would only come about due to increased incomes from large scaled crop production. The study also recommends that there is need for further research to ascertain why land is a significant constraint to crop adoption and commercialization despite having huge expanses of unexploited land.

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APPENDICES

Appendix I: VIF Values for hypothesized variables

Variable	VIF	1/VIF
Land Size (Hectares)	1.48	0.67462
Livestock Ownership	1.47	0.678401
Education (Years)	1.36	0.735520
Household Size	1.23	0.810098
Access to Credit	1.23	0.810943
Membership to Organizations	1.22	0.816589
Marital Status	1.22	0.819581
Gender of Respondent	1.18	0.849741
Access to Agricultural extension	1.13	0.887203
Age of Respondent	1.11	0.901352
Off-farm income (Zambian Kwacha)	1.10	0.912133
Distance to Markets (Walking time in Minutes)	1.07	0.935930
Mean VIF	1.23	

Source: Survey Findings, June 2017

Appendix II: Household Survey Questionnaire

Questionnaire for Assessing Adoption & Commercialization of Soybean in Chipata District of Eastern Zambia

This study is purely for academic purposes and data collected is treated as confidential. If you have any questions concerning the research, please call Ziko Kahenge on 0977122909 (mobile) or Email kahenge5@yahoo.com. Thanks for your anticipated cooperation

1. GENERAL INFORMATION

Questionnaire no: ☐

Name of enumerator	
Date of interview (DD/MM/YYYY):	
Checked by (supervisor's name)	
District	
Block	
Camp	
Village	
GPS: Waypoint ID:________Latitude:______________Longitude:________________Altitude:____________	

2. RESPONDENT INFORMATION

2.1. Name of respondent: ____________________ ☐ __________________________

2.2. Gender of respondent: ☐ (1=Male 2=Female)

2.3. Age of respondent (in years):

2.4. Is the respondent head of the household? (1=Yes 2=No)

2.5. Size of the household (Number)____

2.6. Marital Status (1=Single 2=Married, 3=Widowed, 4Divorced, 5=Separated)

2.7. Farming experience (in years)

3. HOUSEHOLD DEMOGRAPHIC CHARACTERISTICS (Start with household head)

No.	**Name of HH members**	**** Relationship**	**Sex**	**Age**	***Education**

*Education of HH members (Indicate number of years)

**Family relationship to HH head (1. Husband, 2. Wife, 3.Son, 4.Daughter, 5.Relative 6=Any other (Specify---------------------------)

4. ADOPTION AND NON-ADOPTION OF SOYBEANS ENTERPRISE

4.1. Have you ever grown soybean? 1=Yes, 0=No

4.2. If YES in 4.1 go to question 4.3. If NO, why have you not adopted growing of soybean?

(1=Limited available land, 2=soybean not profitable, 3=No knowledge on the crop's agronomic practices, 3=Inputs are very expensive, 4=No market for the crop, 5=Lack of government support, 6=Limited uses for the crop, 7=Crop not vital in the local diet, 8=others specify___________________________________)

4.3. What year did you start growing soybean? ____

4.4. Who introduced you to soybean production?

(1=Fellow farmer, 2=Government [illegible]s/Development Projects, 4=others specify___________________________________)

4.5. Why did you start growing soybean?

(1=Consumption, 2=Sell 3=Animal feed 4=Others specify____)

4.6. What was you initial area you first planted of soybean in hectares?___________________________

4.7. What is the highest area you have ever grown of soybean in hectares?_________________________

4.8. Do you grow soybean every year? 1=Yes, 0=No

4.9. If the answer is NO in 4.7, why don't you grow the crop in some years?

(1=Limited available land, 2=soybean not profitable, 3=No knowledge on the crop's agronomic practices, 3=Inputs are very expensive, 4=No market for the crop, 5=Lack of government support, 6=Limited uses for the crop, 7=Crop not vital in the local diet, 8=others specify____)

4.10 Did you grow soybean in the 2015/2016 season? 1=Yes, 0=No

4.11. What was the area under soybean in the 2015/2016 season in hectares?___________________________

5. SOYBEAN PRODUCTION IN THE 2015/2016 AGRICULTURAL SEASON

5.1. I would like to ask you about inputs used to grow soybean during the last cropping season of 2015/2016

Input	*Type/Varieties of input	**Nature of input	***Source of Input	Quantity	Price/unit	Total cost of inputs
Planting seeds						
Fertilizer						
Inoculum						
Pesticides						
Herbicides						

***Type/Varieties of Input**: 1=D compound 2=Urea, 3=Lukanga, 4=Dina, 5=Magoye, 6=Pesticides, 7=Safari, 8=others specify______________

****Nature of Input:**1=local, 2=improved, 3=Recycled improved, 4=Local and improved, 5=Local and recycled improved, 6=Improved and recycled improved

*****Source: 1**= Government (FISP), 2= Private trader in local market/village, 3= Private trader in district market, 4= Fellow farmer, 5= Neighbor/ Relative, 6=NGO, 7=Farmer Group, 8=Cooperative, 10=Own

5.2 LABOUR USAGE IN SOYBEAN PRODUCTION IN THE 2015/2016 AGRICULTURAL SEASON

5.2.1. I would like to ask you about the labour requirement for activities related to soybean production during the last cropping season of 2015/2016

ACTIVITY	No OF MAN DAYS	UNIT COST/MAN DAY (ZMW)	TOTAL COST (ZMW)
Land preparation			
Planting			
1st & 2nd Weeding			

Pest and disease control/spraying			
Harvesting			
Marketing			

5.3 SOYBEAN MARKETING IN THE 2015/2016 AGRICULTURAL SEASON

5.3.1. What was the total amount of soybeans harvested in the 2015/2016 season______________________Kgs

5.3.2. Did you sell some soybean during the 2015/2016 harvest season (1=Yes, 2=No)

5.3.3. How many Kgs of soybean did you sell____?

5.3.4. If quantity harvested is not same as volume sold how was the remaining quantity used?

(1=Retained for home consumption 2=Used for animal feed 3=Retained for seed 4=Used for in-kind labour payments 5 =others specify______________)

5.3.5. In what form was the Soybean sold?

(1=Grain, 2=Soya meal, 3=Soya flour, 4=Animal feed, 5=others specify ____)

5.3.6. What was the mode of sale for the soybean?

(1=individually to random buyers, 2=individually to a contractual buyer, 3=collectively to random buyers, 4= collectively to a contractual buyer 5=other (Specify___________________)

5.3.7. Who bought the largest quantity of soybean sold?

(1=local trader, 2=trader from distant town, 3=trader from neighbouring country, 4. Government, 5. Others specify___________________)

5.3.8. What was the major use of soybean by the buyer?

(1=Export, 2=Consumption, 4=Processing 5=Sold locally 6= Others specify____________________)

5.3.9. What was the nature of the buyer?

(1=Supermarket, 2=NGO, 3=Consumer, 4=Agro dealer, 5=10=Hotel/Restaurant), 6=other specify_________________________________)

5.3.10. How many minutes does it take to walk to the point of sale (buyer)? ______________________________

5.3.11. What was the unit price per kg in ZMK? ____

5.3.12. What was the total marketing cost incurred to sell the crop in ZMK? ____________________________

(Add the costs for the items listed in the table below and indicate the total cost in 5.3.12)

Item	**Number of Units**	**Price (cost) per unit**	**Total cost**
Bagging			
Loading			
Transport			
Police bribes			
Unloading			
Storage			

6.0. PARTICIPATION IN THE SOYBEAN VALUE CHAINVALUE CHAIN

6.1. I would like to ask you about your participation in the soybean value chain during the last cropping season of October 2015-April 2016 (inputs, production, marketing, processing & consumption)

VALUE CHAIN STAGE	**ACTIVITY**	**SOYBEAN**	
		*Who participates in [ACTIVITY]	*Who is primarily decision maker for [ACTIVITY]
Input acquisition	Determining variety to purchase		
	When and where to plant the soybean		
	Quantities of inputs required		

	Where to buy		
	Amount of land to grow		
Production	Land preparation		
	Planting		
	Weeding		
	Pest and disease control/spraying		
	Harvesting		
	Threshing/winnowing		
Marketing	Bagging		
	Transportation		
	Sourcing for market		
	Bargaining for Prices		
	When and where to sell the crop		
Processing and Consumption	How to use the proceeds from the crop		
	Processing into flour		
	Processing to animal feed		
	Preparation of meals for consumption		

*Codes 1=Household head, 2=Spouse (Wife), 3=Household head and spouse 4=Son, 5=daughter, 6=other household member

6.2. SOYBEAN VALUE CHAIN CONSTRAINTS

6.2.1. I would like to find out about the challenges that you experience in the soybean value chain

VALUE CHAIN STAGE	WHAT IS YOUR EXPERIENCE WITH SOYBEANS IN REGARD TO THE FOLLOWING:	RESPONSE
Input acquisition	Seed cost (1=too expensive, 2= Affordable)	
	Seed Availability (1=Available 2=Scarce)	
	Improved seeds (1=Available 2=Not available)	
	Inoculum (1=Expensive 2=Affordable)	
	Fertilizer Cost (1=Expensive 2=Affordable)	
Production	Inoculum (1= Available 2=Scarce)	
	Fertilizer (1=Available 2=Scarce)	
	High incidence of diseases (1=Yes, 0=No)	
	High incidence of pests (1=Yes, 0=No)	
	Low productivity (limited surplus for sale) (1=Yes, 0=No)	
	Crop is labour intensive for smallholders (1=Yes, 0=No)	
	There is lack of knowledge of how to grow soybean (1=Yes, 0=No)	
	Use of recycled seed (1=Yes, 0=No)	
Marketing	Soybean has low demand (1=Yes, 0=No)	
	Markets for soybean are far (1=Yes, 0=No)	
	Soybean prices are low (1=Yes, 0=No)	
	Unstandardized packaging (1=Yes, 0=No)	
	Lack of reliable buyers (1=Yes, 0=No)	
	Lack of storage facilities for soybean (1=Yes, 0=No)	
	Quality standards on the market are too high for smallholder farmers (1=Yes, 0=No)	
Processing and Consumption	Processing is too labour intensive (1=Yes, 0=No)	
	Fewer uses for the crop at household level (1=Yes, 0=No)	
	No equipment to process soybean at household level (1=Yes, 0=No)	
	Soybean is not a key component of local diet (1=Yes, 0=No)	

6.3. ATTITUDES TOWARDS SOYBEAN VALUE CHAIN

(Tick appropriate, 5=strongly agree, 4=Agree, 3=Not sure, 2=Disagree, 1=strongly disagree

Items	5	4	3	2	1
Input acquisition					
Soybean seed is too expensive					
Am willing to invest my resources and time to grow soybean					
There is no advantage in using improved seed vs recycled seed					
Fertilizer requirement for soybean is too high					
Soybean Production					
Soybean is an inferior crop to Maize and is only grown when a farmer fails to grow Maize					
Though soybean is a potentially profitable crop, lack of institutional support makes it less attractive to grow					
Soybean is too labour intensive					
Yields for soybean are very low to guarantee profits					
Land is limited to expand area under production					
I don't know how to grow soybean					
Soybean Marketing & Commercialization					
Area under soybeans is increasing rapidly in this district					
Soybean is a profitable crop					
Soybean is less profitable compared to Maize					
Soybean contribute to the livelihoods of the people					
Soybean prices are very low					
Markets for Soybean are not available					
Soybean processing & Consumption					
Soybean is an important crop for women					
Soybean is an important crop to men					
Soybean is important for food security					
Soybean is easy to process					
Soybean is a strong source of protein for the family					

7.0. OTHER FARM ENTERPRISES

7.1. CROP ENTERPRISES

7.1.1. Which crop enterprises including vegetables, fruits and other perennial crops did your household have on the farm in the last cropping season of 2015/2016 (October 2015 to April 2016)? What was the **MAIN** purpose of these crops?

***Crop enterprise**	**2. MAIN Purpose** 1=Consumption, 2=Sell 3=animal feed 4=Others specify____________________

*Crop Enterprise: 1=Maize, 2=Beans, 3=Soybeans, 4=Irish potato, 5=Cassava, 6=Groundnuts, 7=sunflower,

8= sweet potato, 9=Eggplant, 10=Kales, 11=Rape, 12=Okra, 13=Chinese cabbage, 14=Cabbage,

15=Tomato, 16=Onions, 17=Cucumber, 18=other (specify

7.1.2. Are there new crop enterprises that you [ ] our farm in 2015/2016 season that you did not have in the previous season of 2014/2015? (1=Yes, 0=No)

***Crop enterprise**	**2. Reason for introducing new crop enterprise** 1=Consumption, 2=Sell 3=animal feed 4=Others specify____________________

1=Maize, 2=Beans, 3=Soybeans, 4=Irish potato, 5=Cassava, 6=Groundnuts, 7=sunflower, 8= sweet potato, 9=Eggplant, 10=Kales, 11=Rape, 12=Okra, 13=Chinese cabbage, 14=Cabbage, 15=Tomato, 16=Onions, 17=Cucumber, 18=other specify____________________)

7.2. LIVESTOCK ENTREPRISES

7.2.1. Which livestock enterprises including bee keeping and fish farming did your household have on the farm in the last cropping season of October 2015 to April 2016? What was the **MAIN** purpose of these livestock enterprises?

***Livestock Enterprise**	**Livestock type** 1=Local, 2=Exotic	**Name of breed**	**MAIN Purpose** (1=Consumption, 2=Sell 3=animal feed 4=Others specify_________________)

*Livestock Enterprise: 1=Dairy cattle, 2=Goats, 3=Local chicken, 4=Broilers, 5=layers, 6=Bee keeping, 7=Fish farming,

8=Beef cattle, 9=sheep, 10=Pigs 11=other (specify________________)

7.2.2. Are there new [ ] enterprises that you had on your farm in 2015/2016 that you did not have in 2014/2015? (1=Yes, 0=No)

***Livestock Enterprise**	**Livestock type** 1=Local, 2=Exotic	**Name of breed**	**Reason for introducing new livestock enterprise** (1=Consumption, 2=Sell 3=animal feed 4=Others specify_________________)

*Livestock Enterprise: 1=Dairy cattle, 2=Goats, 3=Local chicken, 4=Broilers, 5=layers, 6=Bee keeping, 7=Fish farming,

8=Beef cattle, 9=sheep, 10=Pigs 11=other (specify________________)

8. HOUSEHOLD INCOME SOURCES

8.1. I would like to ask you about the different sources of income for household in the last 12 months. Please mark as appropriate if you or any member of the household received income from the sources listed in the table in last 12 months. How would you rate the different sources of income in terms of their importance to your household's livelihood?

Source	**Did the household receive income from this source? 1=Yes, 0=No**	**Total quantity sold**	**Total Value of quantity sold**	**Rate this source** 1= Not important (income is negligible) 2=Somehow important (income received was intermittent) 3=Important (Income is reliable but not sufficient to meet the household needs) 4=Very important (income is reliable and sufficient- is the main source) (remain as last column)
Sale of crop produce (General)				
Sale of Soybeans				
Sale of livestock (e.g. poultry, goats, sheep, pigs)				
Sale of livestock products (e.g. milk, meat, eggs, hides, skin, ghee)				
Fishing/fish farming				
Sale of charcoal				
Off-farm income from casual work				
Off- farm income from business				
Wages and salaries				
Remittances from family members and others				
Rent from assets including land				
Others Specify				
Others specify				
Others specify				

9.0. LAND HOLDING THAT THE HOUSEHOLD OWNS

9.1. Do you or anybody in your household own land? (1=Yes, 0=No)

9.2. What is the size of land that the household owns in hectares? ______________________

9.3. What is the size of land that the household owned in the 2015/2016? _________________________

9.4. Did the household **lease out** land in th**e**2015/2016 season? (1=Yes, 0=No)

9.5 If the answer is YES in 9.4, how much was raised? ZMW__________________________

If the answer is NO, jump to 9.7

9.6. If YES in 9.4, what is the size of land that the household **leased out** in the previous cropping season of October 2015 to April 2016 in hectares? _______________

9.7. Did the household **rent in** land in the previous cropping season of October 2015 to April 20

(1=Yes, 0=No)

9.8. If the answer is YES in 9.7, how much was paid for the rent in land? ZMW__________

9.9. If YES in 9.7, what was the size of land that the household **rented-in** in the previous cropping season of October 2015 to April 2016? _________________________

9.10. Did the household cultivate any land in the previous cropping season of October 2015 to April 2016**?** (1=Yes, 0=No)

8.10. What is the size of land that the household cultivated in the previous cropping season of Octoberc2015 to April 2016 including that rented in (where appropriate)? ________Hectares

10.0. PARTICIPATION IN PRODUCER GROU

10.1. Are there soybean groups in this area? (1=Yes, (

10.2. If Yes in 10.1, what's the main purpose for the soybean group?

(1=Access to inputs (seed, fertilizer, inoculum), 2=Improved marketing by aggregating output, 3=access to soybean related benefits from donors/government, 4=Access to soybean information and technology, 5= others specify____)

10.3. If No in 10.1, would you join if they were established? (1=Yes, 0=No)

10.4. Do you belong to any other group or farmer organization? (1=Yes, 0=No)

10.5. How many groups are you a member? ____________________________________

10.6. If YES in 10.4., what was the main reason for joining the group?

1=Increased income generation, 2=Social (meet people and support each other)

3=Access to information and technology, 4=access to benefits (donors/government), 5=Coerced or pressured by government/neighbours 6=Any other (Specify----------------------)

10.7. If answer to 10.4 is NO, what was the main reason for not joining the group?

1=No group to join, 2=Do not have time for group activities, 3=Groups are not beneficial, 4. Others specify____

10.8. If response to 10.4 is YES, Please answer the following questions

i.	Name of group	
ii.	Status of group registration? (1= Formal 2 Informal)	
iii.	*What is the composition of the group (see codes below)	
iv.	**What type of group is this? (see codes below)	
v.	***If agricultural, what's the main enterprise that the group deals (see codes below)	
vi.	****What services do you get from the group? (see codes below)	

***Composition of Group**: 1=Men only, 2=Women only 3=Youths only 4=Mixed

****Type of Group**: 1=Agricultural, 2=Livestock, 3=aquaculture, 4=Financial/savings & credit, 5=others specify………………………..

*****Main agricultural enterprise**: 1=Soya, 2=Maize, 3=Poultry, 4=Beef, 5=G/nuts, 6=others specify

****Services gotten from group: 1=Credit/loans, 2=Marketing, 3=Input purchases, 4=Savings, 5=Extension services, 6=Marketing information, 7= others specify……………

11.0. HOUSEHOLD ASSETS AND EQUIPMENT

Asset	Number (if no equipment put zero)	Original purchase price (ZMW) (if more than one item reported in column 2 take average price)	If you would sell [….] how much would you receive from the sale? (ZMW) (if more than one item reported in column 2 take average price)
1	2	3	4
1. Grass thatched house			
2. House with iron sheets			
3. Oxen for draught power			
4. Donkeys for draught power			
5. Ox-plough			
6. Sickle			
7. Pick Axe			
8. Axe			
9. Hoe/Jembe			
10. Knapsack sprayer			
11. Spade or shovel			
12. Radio, cassette or CD player			
13. Cell phone			

14. TV set			
15. Improved charcoal/wood stove			
16. Kerosene stove			
17. Bicycle			
18. Motorbike			
19. Cars			
20. Picks-ups			
21. Trucks (lorry)			
22. Tractors			
23. Trailers			

12. TRANSPORT SERVICES, ROAD SYSTEMS AND OTHER INFRASTRUCTURE

12.1. Who is the major buyer of your farm produce?

(1=local trader, 2=trader from distant town, 3=trader from neighbouring country, 4. Government, 5. Others specify__________________)

12.2. How many minutes does it take to walk to the market where you sell produce? _____________ (minutes)

12.3. How many minutes does it take to walk to the market where you purchase inputs?___________ (minutes)

12.3. What is the commonest mode of transport used to reach the nearest market?

1= Walking, 2= Taxi (car), 3= Ox-Cart, 4= Bus/minibus, 5= Motorcycle, 6= Bicycle, 7= Other (Specify____________________

12.4. Is the road usable/operational all year round? 1=Yes, 0=No

13.0. ACCESS TO AGRICULTURAL INFORMATION

13.1. How do you acquire agricultural information pertaining to markets, output & input prices, seed, loans & grants most often?

SNo	Means of accessing Information	Have been using as a means		Degrees of dependence as a source of information 1=High, 2=Medium, 3=Low	Reliability of the source 1=High, 2=Medium, 3=Low	Rank as 1st,2nd or 3rd according to frequency of use
		1=Yes	2=No			
1	Radio					
2	Government Extension					
3	TV					
4	Mobile Phone					
5	Traders/Middlemen					
6	Neighbours					
7	Others (specify)					

14.0. ACCESS TO AGRICULTURAL EXTENSION SERVIC

14.1. Do you get advisory services from Extension agents? (1=Yes, 2=No)

14.2. If Yes, which crops did you get advice on in the 2015/16?

(1=Maize, 2=Beans, 3=Soybeans, 4=Irish potato, 5=Cassava, 6=Groundnuts, 7=sunflower, 8= sweet potato, 9=Eggplant, 10=Kales, 11=Rape, 12=Okra, 13=Chinese cabbage, 14=Cabbage, 15=Tomato, 16=Onions, 17=Cucumber, 18=other specify__________________)

14.3. How frequently do the extension agents visit you?

(1=Once in a year, 2=Once in six months, 3=Monthly, 4=Twice a month, 5=weekly)

14.4. During which farm operations do extension agents visit you?

(1= land preparation, 2=Input provision, 3=planting, 4= herbicide application, 5=marketing, 6=others specify)

14.5. Do you visit extension agents? (1=Yes, 2=No)

14.6. If yes in 14.5, how often do you visit?

(1=Once in a year, 2=Once in six months, 3=Monthly, 4=Twice a month, 5=weekly)

14.7. Do you get advisory services targeted at soybeans? (1=Yes, 2=No)

14.8. If Yes in 14.7, during which farm operations do you get advisory services targeted at soybean?

(1= land preparation, 2=Input provision, 3=planting, 4= herbicide application, 5=marketing, 6=others specify)

15. ACCESS TO CREDIT SERVICES

15.1. Did you borrow money for crop production in 2015/16 season? (1=Yes, 0=No)

15.2. If Yes in 15.1, for what crops?

(1=Maize, 2=Beans, 3=Soybeans, 4=Irish potato, 5=Cassava, 6=Groundnuts, 7=sunflower, 8= sweet potato, 9=Eggplant, 10=Kales, 11=Rape, 12=Okra, 13=Chinese cabbage, 14=Cabbage, 15=Tomato, 16=Onions, 17=Cucumber, 18=other specify____________________)

15.3. If YES in 15.1, from where and for what purpose did you collect the credit for?

No	Source	Purpose (Write codes)	
	Micro Finance		1. Payment for hired labour 2. Purchase of fertilizer & seed 3. Purchase of equipment 4. Payment of rented oxen 5. To rent in land to extend crop production
	Cooperative/Farmer group/Club		
	NGOs specify_________________		
	Bank specify__________________		

	Relative		**6.** Others specify______________
	Others specify________________		
	Others specify________________		

15.4. If your answer is No in 15.1 but you needed the credit, what was the problem?

(1=Limited supply of credit, 2=Huge bureaucracy, 3=Interest was too high, 4=Others specify_______________________)

15.5. If the answer is YES in 15.1, have you paid the loan? (1=Yes, 0=No)

15.6. If No in 15.5, what was the reason?

(1=Interest too high, 2=Poor harvest, 3=Inadequate revenue from crop sales, 4=Others specify_____________________________)

15.7. Did you face any problems in accessing credit? (1=Yes, 0=No)

15.8. If your answer in 15.7 is YES, what were the problem?

(1=Limited supply of credit, 2=Huge bureaucracy, 3=Interest was too high, 4= others specify_______________________)

15.7. How did you solve these problems?

(1=Sold livestock, 2=Reduced area under crop production, 3=sold stored produce, 4= did nothing, 5=Others specify____)

15.8. Did you require credit particularly for soybean production? (1=Yes, 2=No)

15.9. If Yes, is it accessible anytime you need it? (1=Yes, 2=No)

END OF QUESTIONNAIRE