DETERMINANTS AND EXTENT OF CROP DIVERSIFICATION AMONG SMALLHOLDER FARMERS IN SOUTHERN ZAMBIA

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DECLARATION

I, Kiru Sichoongwe, declare that this thesis is as a result of my own original effort and work, and that to the best of my knowledge, the findings have never been previously presented to the University of Malawi or elsewhere for the award of any academic qualification. Where assistance was sought it has been accordingly acknowledged.

Kiru Sichoongwe

Signature: _____

Date: _____

CERTIFICATE OF APPROVAL

We the undersigned, certify that this thesis is as a result of the authors own work, and to the best of our knowledge, it has not been submitted for any other qualification within the University of Malawi or elsewhere. The thesis is accepted in form and content, and that satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate through an oral examination held on 5th May 2014.

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DEDICATION

This thesis manuscript is dedicated to my late Mother (Aggnator Chikambwe) whom I loved and adored.

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ABSTRACT

Agriculture is an important sector of Zambia's economy, serving as the main source of income for the rural population. Its production is mainly dependent on rain-fed hoe cultivation and maize remains an important staple food crop. In order to improve food security, generate income and minimize risks associated with heavy dependence on maize, the government of Zambia has been promoting crop diversification. This study was carried out with the objectives of : i) to determine the extent of crop diversification, ii) to compare the demographic and socio-economic characteristics of diversifiers and non-diversifiers, and iii) to identify the major determinants that influence farmer's decisions to diversify in crop production. The Crop diversification index (CDI) was used to measure the extent of diversification while the Tobit model was used to analyze the determinants of diversification. Bivariate statistical analysis and mean comparisons were used to compare socio-economic characteristics of diversifiers against their non-diversifying counterparts.

The extent of crop diversification among the smallholder farmers was relatively low since the majority of the diversifiers had a lower CDI value; 42.35% had a CDI greater than zero but less than or equal to 0.49; 5.87% had a CDI equal to 0.5 and 20.78% had a CDI greater than 0.5. On the other hand, the non-diversifiers constituted 31% of the total sample. The size of landholding, quantities of fertilizer, distance to the market, tillage time and tillage (using a plough) were found to significantly determine crop diversification.

Based on the study findings, the following recommendations were drawn; the need for the government to undertake policies that will improve farmers' access to and control over land, encouraging farmers to use agricultural implements such as ploughs and supporting policies oriented towards bringing trading markets closer to the farmers.

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LIST OF ABBREVIATIONS AND ACRONYMS

CDI	Crop Diversification Index
CEI	Composite Entropy Index
CFS	Crop Forecast Survey
CSA	Census Supervisory Areas
CSO	Central Statistical Office
FAO	Food and Agriculture Organization
FNDP	Fifth National Development Plan
GDP	Gross Domestic Product
GLS	Generalized Least Square
HI	Herfindahl Index
JAICAF	Japan Association for International Collaboration of Agriculture & Forestry
JCTR	Jesuit Center for Theological Reflections
MACO	Ministry of Agriculture and Co-Operatives
MoFNP	Ministry of Finance and National Planning
MoLGH	Ministry of Local Government and Housing
OLS	Ordinary Least Square
PPS	Probability Proportional to Size
SEA	Standard Enumeration Area
SID	Simpson Index of Diversification
UNDP	United Nations Development Programme
VIF	Variance Inflation Factor
VSO	Voluntary Service Overseas
WTO	World Trade Organization

CHAPTER ONE

INTRODUCTION

1.1 Background

Agriculture is an important sector of Zambia's economy, to the extent that the livelihoods of the majority of the population depends on it and serves as the main source of income for the rural population (Mucavele, 2010). It accounts for 18% of Gross Domestic Product (GDP) and some 39% of earnings from non-traditional exports. There is an agreement throughout literature that Zambia's large potential in agriculture has not yet been fully exploited (Mucavele, 2010). Thus, if well managed, the sector could potentially contribute to substantial improvements in GDP, employment, and tax collections (Food and Agriculture Organization Zambia [FAO], 2005). It is in this regard that the Zambian government positions the agricultural sector as one of the driving forces for the anticipated economic growth that is required to reduce poverty (Gibson, 2005).

The agricultural sector in Zambia is in three categories; commercial, medium, and small scale (Chomba, 2004). The Commercial farmers cultivates a land area of twenty hectares and above and are characterized by mechanization which is extensive, use of modern technology and management, rearing of breeds of livestock which are exotic and relying so much on hired labor. Nearly two thirds of agricultural land and a large share of the national herd are held by smallholder farmers. The smallholder farmers are classified as small-scale farmers and medium scale farmers. The former, cultivates a land area of less than five hectares whilst the latter cultivates an area between five and twenty hectares. Most of these farmers depend largely on rain-fed hoe cultivation, on unpaid family labour and are characterized by low use

of modern inputs. Currently, agricultural productivity is being affected by a number of factors such as inadequate access to assets like oxen and farm implements, limited access to inputs, inadequate access to agricultural credit support, pests and diseases on both crops and livestock (Chomba, 2004).

In the year 2004 following a couple of drought cycles in Zambia ,the government through the Ministry of Agriculture and Co-operatives introduced the programme of promoting crop diversification and it was captured in the 2006-2010 Fifth National Development Plan (FNDP) for Zambia. The 2006-2010 FNDP is the first point in the articulation of the long-term alternative development policy (The National Long Term Vision 2030) for Zambia. By definition, crop diversification is the growing of two or more crops on a piece of land by a farmer. The crops to be considered in the diversification programme included; cassava, sweet potatoes, groundnuts, sunflower, soya beans, cowpeas among other crops. The programme of crop diversification aimed at offering farmers alternative ways of generating income and increasing food security and nutrition status at household level thus improving their living standards. Additionally, to offer the best alternative to farmers unlike depending on just one crop which can have grave consequences and leave smallholder farmers open to needless hazards (Ministry of Agriculture and Cooperatives [MACO], 2004).

The crop production season for Zambia is mostly rainfall dependent with a production season that runs from November to April (MACO, 2004). The major determinant of crop performance in any given year is the performance of the rainfall. The country is divided into three distinct agro ecological regions and are differentiated by the patterns of rainfall and the type of soil (see Figure 1.1)

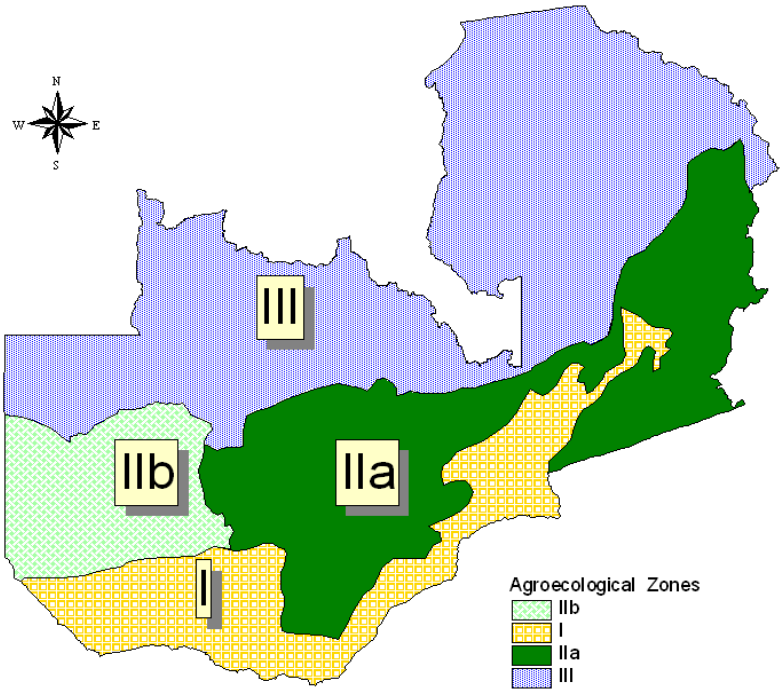

Figure 1.1 Zambia's Agro-Ecological Regions

Data source: Dept. of Meteorology (2005)

Region I It covers the valley areas situated in the extreme western and southern parts of the country. This area is best suitable for production of small grains and livestock rearing and is generally dry with less than 800mm of annual rainfall. Maize is still grown at subsistence level even though it is unsuitable. Most households depend on food from outside this region to meet their needs for part of the year since crop production in the region is mostly at subsistence level.

Region II is subdivided into two and has annual rainfall in the range of 800mm to 1000mm and covers the central part of Zambia. The plateau areas of Eastern, Southern, Lusaka and Central Provinces which are the most productive areas in the country in both food and cash

crops make up region IIa. Region IIb which is less productive covers the Zambezi flood plains and the Kalahari sand plateau. It has high potential for rice and cassava production as well as cattle rearing.

Region III is a high rainfall area with amounts exceeding 1000mm per year and it covers Luapula, North western, Copperbelt, Northern and northern parts of Central province. This region is high in terms of cassava growing and consumption. Because of the nature of the rainfall pattern, soils here are to a large extent highly acidic limiting the production potential. The rains start from the north progressing south with the south having the shortest season whereas the north has the longest growing season. Consequently, some variability in the start and duration of the season exists. Usually, planting is done from November to December, though early planting (October) is practiced in parts of the country especially the north. The main harvesting takes place from April to June for all rain-fed crops apart from cassava which is harvested all year round. The end of seasonal hunger period is characterized by the green (early) harvest that takes place between February and March (MACO, 2004).

1.2 Statement of the Problem

Zambia is better placed, to leverage agriculture as an engine for poverty reduction, improved nutrition and to become the breadbasket of southern Africa. Compared to other countries in the region, it has abundant fertile soils, water and a generally favourable climate for agricultural production. Also, Zambia has a fast growing urban population that creates opportunities for rural-urban development synergies which may not exist in other countries. Despite these endowments, the growth of agriculture is stagnant, with rural poverty rates at 80% of the population (Sitko et al., 2011). Given the poverty levels, addressing food challenges in rural

areas is of importance for fostering economic growth, poverty reduction, and improving the nutritional status of the population. The crop diversification programme in place, is one of the solutions, thereby encouraging farmers to reduce their over-dependency on maize production and to lessen the effects of drought in the case of southern province. The Southern province of Zambia is one of the main maize producing areas with an estimated production of about 18.25% of the national output and maize production in the area is prone to droughts (Ngoma, 2008).

A study by Simwambana (2007) reported that most farmers did not diversify in crop production. Furthermore, another study by Jesuit Center for Theological Reflections Zambia (JCTR) (2008) reported that despite extension education being provided by the agricultural extension workers to the farmers in order to ensure diversification, the levels of crop diversification are still low. From available literature, it is clear that research on why farmers have not diversified is scanty and poorly documented. As a result, there is a general lack of understanding as to why farmers have not diversified.

It is against this background that this study looked at the determinants and extent of crop diversification among the smallholder farmers of southern province**.** Knowing the factors that determine crop diversification was vital because it enlightened the policy makers on how crop diversification among the farmers can be promoted via the factors that determines it.

1.3 Study Objectives

1.3.1 General Objective

The general objective of this study was to measure the extent of diversification and identify factors that affect the decision to diversify crop production among smallholder farmers in Southern Province of Zambia.

1.3.2 Specific Objectives of the Study were:

(i) To determine the extent of crop diversification among smallholder farmers.

(ii) To compare the demographic and socio-economic characteristics of the diversifiers and non- diversifiers.

(iii) To identify the major determinants that influence farmer's decisions to diversify in crop production.

1.4 Hypothesis

The following null hypotheses were postulated for the study:

(i) The extent of crop diversification among the smallholder farmers who diversified is not high.

(ii) There is no difference in the demographic and socio-economic characteristics of diversifiers and non-diversifiers.

(iii) Demographic, socio-economic and institutional factors do not influence farmers' decisions to diversify in crop production.

1.5 Justification

Although the Zambian government has a crop diversification programme in place, broad literature shows that crop diversification is low with maize continuing being the dominant staple food crop. As a commitment to the programme, the government has been providing extension education through the agricultural extension workers to the farmers in order to ensure crop diversification (JCTR, 2008). The available literature does not provide information as to why the farmers have maintained the status quo by not diversifying resulting in low levels of crop diversification. Besides, studies done on diversification have focussed only on cassava and sweet potatoes ignoring the other crops and have limited themselves to few districts, within the province as in the case of Simwambana (2007).

This study is worth undertaking since it complements previous studies on crop diversification by looking at the factors influencing farmer's decisions to diversify in crop production. The findings from this study, if taken into consideration, will help policy makers put in place necessary measures to see to it that farmers in the province adhere to crop diversification.

1.6 Organization of the Thesis

The content of this thesis has been grouped into five chapters. Chapter One deals with an introduction encompassing the background, statement of the problem and objectives. In Chapter Two, a brief and preliminary overview of the literature and research done in the field of crop diversification, hence finding out relevant information available on the topic of study as well as the state of the art as far as research on the determinants and extent of crop diversification is concerned. Chapter Three describes the methodological approach including

the theoretical framework and the specification of the empirical model. Chapter Four deals with results and discussions of the study. Lastly, Chapter Five talks about the conclusion and some policy recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to provide a brief and preliminary overview of the literature and research done in the field of crop diversification. It will find out relevant information available on the topic of study as well as the state of the art as far as research on the determinants and extent of crop diversification is concerned.

2.2 Agricultural Sector in Zambia

Agricultural is the main source of livelihood for most rural households and is the biggest employer of Zambia's labour force, accounting for 73% of total employment in 2005 (Central Statistical Office [CSO], 2007). It continues to be dominated by smallholder farmers who produces the bulk of the agriculture output and most of them are resource poor (Chiwele and Sikananu, 2004). Maize remains the staple food for most Zambians and it provides 60% of all calories consumed in Zambia (Japan Association for International Collaboration of Agriculture and Forestry [JAICAF], 2008). The country has an enormous potential in agriculture with 58% of the total land area suitable for arable farming, yet only 14% is being cultivated currently (Institute for African Studies, 2009). The sector provides raw materials for a good number of agro-processing enterprises and as mentioned earlier, it's contribution to a share of Gross Domestic Product (GDP) is significant. For this reason, it continues to be one of the economic sectors on which resources are focused, in order to promote sustainable economic growth, employment creation and poverty reduction thereby remaining a priority for achieving national development.

However, agriculture in Zambia is characterized by high input costs, low farm incomes, poor access to improved seed, poor access to fertilizer, limited involvement of the private sector in input and output markets (MACO, 2010). Furthermore, access to credit remains low among the smallholder farmers mainly due to the reluctance of commercial banks to give agricultural loans to farmers who have low collateral and a reputation of failing to repay loans, and the tendency of microfinance institutions to finance urban populations that are involved in non-agricultural income generating activities (Chiumya, 2006). Because of this, agriculture productivity among smallholder farmers is generally low.

2.3 Importance of Crop Diversification in Zambian Context

Given the fact that maize has continued to dominate in terms of production by smallholder farmers and under rain-fed cultivation, this implies that whenever there is a drought, it may entail food crisis. Therefore, the importance of crop diversification cannot be over emphasized. The tendency of farmers to depend on just one crop can have serious consequences thereby leaving farmers in a more vulnerable situation (Sitko et al., 2011). For example, the income of the monoculture farmer can be reduced as a result of a slump in the market value of a particular crop thus leaving the farmer in ruins. On the other hand, if farmers diversify, they can reduce over dependency on maize and they can avoid the risks associated with it. By diversifying, their crop output will be able to increase thereby improving nutrition by providing for their families and enhancing food security. Furthermore, with the increase in demand for food every day due to population increase, diversification can provide for the population hence fighting hunger, poverty and reducing malnutrition levels, which is still an issue of national urgency thus meeting the key Millennium Development Goals of reducing hunger and preserving natural resources and the environment for future generations (Chiwele and Sikananu, 2004).

Besides, diversification provides an opening to farmers through change in consumer demand. This is so because when consumers in developing countries become richer, their food consumption patterns change noticeably. They move away from a staple diet to one with a greater content of animal products, fruits and vegetables. This acts as an incentive for farmers to diversify in order to meet their needs. In addition, diversification adds value to the export potential of a country. Since smallholder farmers are the ones who produce in bulk, when they diversify, they are able to respond to market opportunities hence producing a variety of crops and meeting the export market demand (Felgenhauer, n.d).

2.4 Policies and Programmes promoting Crop Diversification in Zambia

In Zambia, the government has recognized agriculture as a main pillar for the overall economic growth. Even though maize has continued being the dominant crop in production and despite the bumper harvests realized from it, there has not been a significant decline in poverty and malnutrition among rural farming households. Many of these households continue to experience unstable food supplies and seasonal hunger (Sitko et al., 2011). In an effort to reduce poverty in rural areas and promoting rural development through improved agricultural productivity, the government in 2004 introduced the programme of promoting crop diversification. The programme was intended to provide smallholder farmers with alternative sources of income from other crops other than maize and enhancing food security. In addition, diversification is seen as another way of increasing agriculture production and productivity so as to raise the share of its contribution to GDP (MACO, 2004).

Furthermore, other private organizations have been complementing the government in its quest to better the lives of farmers. One such organization is the Voluntary Service Overseas (VSO) Zambia. It has a programme in place of targeting the poor and most vulnerable farming

households in rural communities, by providing seeds to them. Also, its integrated programme is to promote crop diversification among the smallholder farmers in an effort to ensure food security and secure livelihoods. Furthermore, it also works to improve farmer's access to credit and improved market linkages for their produce (Voluntary Service Overseas Zambia [VSO], 2008).

Besides, the Zambia National Farmers Union (ZNFU), founded in 1905 and historically one of the oldest agriculture union's in Zambia, whose aim is to support the conduct and the development of the agriculture sector, recognizes crop diversification as one of the ways in which smallholder farmers can be supported. In realizing that the government is key in the process of diversification, the union has been a strong advocate for the government to consider introducing seed distribution for free of many other crops to encourage farmers diversifying to other crops. Moreover, the union emphasize on the fact that providing support to poor rural farmers in form of agricultural inputs is an obligatory responsibility on the part of government and not to do so further condemns the farmers to poverty thereby putting the agriculture sector on a dangerous path. When farmers diversify, there are able to engage in productive farming and are able to produce thereby achieving household food security. Thus crop diversification is seen as a bridging measure to avert food security calamity, and a solution to challenges that smallholder farmers faces (Chipeta et al., 2012).

Other than that, the United Nations Development Programme (UNDP) has a programme in place in which crop diversification is emphasized. The programme is intended to encourage farmers to diversify so as to be able to adapt to the effects of drought and climate change in Zambia (United Nations Development Programme Zambia [UNDP], 2008).

Another Non-governmental organization, Caritas Zambia has been working to improve the lives of farmers in the country. Encouraging crop diversification to the farmers is one of its objectives. The organization provides seeds to the farmers to help increase agriculture production by encouraging farmers to diversify (Carital Zambia, 2006).

2.5 Determinants of Diversification and Methodologies used

A number of studies have been done on crop diversification especially in places like India, Nigeria and Malawi among others. For example, a study on the nature and extent of crop diversification in the Karnataka State of India done by Saraswati (2011) revealed that crop diversification was determined by a number of infrastructural and technological factors and that crop diversification influences production. The findings on the study suggested that the creation of basic infrastructural facilities like sustained supply of irrigation water, markets, fertilizer availability, proper roads and transportation was an essential pre-requisite for creating enabling conditions for fostering the process of agricultural development and crop diversification, as most of these parameters were found to influence the nature and extent of crop diversification. This study looked at secondary data for a period of 26 years from 1982-83 to 2007-08 and the data was analysed using the Composite Entropy Index (CEI) and a multiple linear regression analysis. The CEI for different crop groups showed that almost all the crop groups had higher crop diversification index during post-World Trade Organization (WTO) (1995-96 to 2007-08) than during pre-WTO (1982-83 to 1994-95) period, except for oilseeds and vegetable crops. The study also noted that there was a vast increase in diversification of commercial crops after WTO (Saraswati et al., 2011).

Another study by Kumar and Chattopadhyay (2010) on crop diversification by poor peasants and the role of infrastructure in West Bengal India studied intensively the nature and extent of crop diversification for the period of 1970 to 2005 in West Bengal, a rice growing state. They computed the Herfindahl index, Simpson index(SID), Entropy and Modified entropy indices for all the districts of West Bengal for the years 1970 - 1973, 1979 - 1982, 1989 - 1992 and 2002 - 2005. Thereafter, a ranking of the districts on the basis of the computed values of these indices was done so as to understand the spatial pattern of diversification. In an effort to check whether the ranking pattern of the districts on the basis of these different indices were consistent or not, a computation of the spearman's rank correlation coefficient was done by taking the pairs of different indices and testing their level of significance. Here, the rank correlations were observed to be positive and significantly high for each pair of observations. This ensured that without any loss of generality, any one of the indices could be used to describe the intensity of diversification. Moreover, to find out the impact of different factors on the level of diversification over time in different parts of rural West Bengal, a multiple regression was used. The findings revealed that marginal and small farmers played a positive role in determining crop diversification and that it has been supported by the growth of various infrastructure networks during the period under consideration. Besides that, relatively advanced districts always maintained their relative positions in terms of diversification, due to better availability of agricultural and supporting infrastructure, availability of fertiliser along with expansion of irrigation and agro-implements that assisted in raising the yields of crops. Agricultural infrastructure was found to be crucial in promoting diversification of crops and ensure sustainable income and employment of the farmers. In their conclusion, they noted that policies towards the expansion of infrastructure like road network, irrigation facilities through different modes wherever possible, marketing and storage facilities, power supply especially to

the minor irrigation setups, availability of fertiliser and facilitating or empowering those, especially, the poor farmers were the important preconditions for the diversification of crops across the districts. As the poor farmers took the leading role in diversification, markets and other infrastructure were supposed to be fair and competitive for their rational use. However, many of the poor farmers suffered from lack of capital, and thus provision of capital through cooperative and regional rural banks needed to be well warranted.

Another study of interest on crop diversification was carried out by Malik et al. (2002) in India. This study used the Herfindahl Index in order to measure the extent of crop diversification among smallholder farmers in the state of Haryana. The study revealed that crop diversification was a necessity for economies based on agriculture especially in Haryana, a region where staple foods cereals were grown. It acknowledged that cereals alone could not support the process of economic development and growth. Their study concluded that most of the districts that did diversify towards vegetables, fruits and flowers, was because of availability of markets. While districts that did not diversify was due to lack of proper markets, amount of risks involved and lack of availability of irrigation facilities. In other districts, diversification was due to the introduction of sprinkler-irrigation system.

Another study on crop diversification carried out in Pakistan by Ashfaq et al. (2008) revealed that factors affecting crop diversification included size of landholding, age of respondent, education level of respondent, farming experience of respondent, off farm income of respondent, distance of farm from main road, distance of farm from main market and farm machinery. In their study, entropy index was used to measure diversification and thereafter a multiple regression model to determine the factors that were affecting crop diversification.

Another study by Ibrahim et al. (2009) on crop and income diversification among farming households in a rural area of north-central Nigeria reported that crop and income diversification were strategies that were essential for reducing rural poverty and raising income. The study used Simpson Index of Diversification and Ordinary Least Square (OLS) regression to analyze the data. The results revealed that diversification into a number of income sources and crops grown was very high among the farmers. The study identified the determinants of income diversification as the number of adults above 60 years old, number of children less than 12 years old, distance from local market and availability of electricity in the household whilst the determinants of crop diversification as age of household head, level of education of the household head, number of extension visits, availability of tractor hiring services and returns from crop production.

In Malawi, Ndhlovu (2010) did a study that analyzed how fertilizer subsidies to maize production in Malawi affects farm households' crop choice, cropland allocation and crop diversification level. The analysis was based on a three-year household survey data collected in 2006, 2007 and 2009 from six districts across Malawi; two of the districts were in the central region while four districts were in the southern region. Crop choice and cropland allocation patterns were examined using the generalized least square (GLS) model. Empirical results indicate that farm households' access to fertilizer subsidy was associated with a decrease in the cropland allocation to maize and pulses while there was an increase in cropland allocation to groundnuts, roots-tubers and tobacco. In terms of crop diversification, the study findings suggested that farm households' access to fertilizer subsidies promote crop diversification. Furthermore, the results illustrated that fertilizer subsidies to maize positively contribute to promoting farm households' crop diversification levels through intensified maize

production and that crop diversification enhanced stability of household incomes through the mitigation of price and crop production risks and shocks.

A study by Simwambana (2007) in southern province of Zambia revealed that most farmers did not diversify in terms of crop production. The study used common rapid appraisal methods and it narrowed its focus to cassava and sweet potatoes whilst ignoring the other crops like groundnuts, sunflower, among others which are also important crops in the diversification programme. Furthermore, the study limited itself to three districts, out of eleven in the province.

Kankwamba et al. (2012) did a study on the determinants of crop diversification in Malawi and they used the Herfindahl Index. Their study acknowledged that the agricultural sector in Malawi was highly undiversified, with maize and tobacco being the dominant staple and export crops respectively. Despite this, the government had since the 2005/06 cropping season implemented the Farm Input Subsidy Program aimed primarily at increasing maize productivity and output. In fact, they found that although crop diversification had deteriorated nationally and regionally, beneficiaries of the subsidy program had indeed become more diversified. Their study concluded that while various policies in Malawi all encourage agricultural diversification in broad terms, there was a lack of strategic thinking around how exactly it can be achieved, and more importantly, how crop diversification could be promoted among different types of farmers with the aim of contributing to economic growth, risk reduction and nutrition security.

A recent study by Bhattacharyya (2008) on crop diversification as a search for an alternative income of the farmers in the state of west Bengal in India showed that the agricultural sector of West Bengal was gradually diversifying towards high value commodities, such as fruits, vegetables and flowers. The research also revealed that most of the diversification came through individual efforts of the small farms with little support from the government. This was so because food security issues were still critical in the state as well as the government policy was still obsessed with self-sufficiency in cereals. The major determinant of this change was the demand side factor which had induced farmers to shift towards production of high value crops. Other than that, the development of roads and the technology absorption have been a key determinant in this respect. Also, the study used the Simpson Index as the dependent variable in a simple regression equation so as to determine the separate effects of each individual independent variable on the dependent variable. Furthermore, the study revealed that crop diversification was more prominent in rainfed areas than in irrigated zones, and the rainfed areas were seen as becoming the hub of non cereals due to their low water requirement and abundant labour supply. The study did reveal also that the cost of crop cultivation was relatively low and that the high value crops were becoming popular among the small farmers who could not afford the cost of high investment like irrigation. However, proper institutional support was lacking and hence the speed of diversification was affected. It was therefore necessary to provide proper financial resources, guidance, encouragement and training for nursery raising on the part of the government to attract the farmers of the state towards the high value crop cultivation.

2.6 Research Gaps and Conclusion

It is clear from literature reviewed in this study that in spite of the government promoting crop diversification, much of the information on whether the farmers have diversified or not is based on few districts within the province, for example, the case of (Simwambana, 2007). Moreover, the study just focussed on crop diversification among farmers with a bias towards sweet potatoes and cassava while ignoring other crops. Much as the government is promoting crop diversification, knowing its determinants is vital so that they can be addressed. As far as literature is concerned and to our knowledge, no study has been conducted in Zambia on the determinants and extent of crop diversification among farmers in southern province. Therefore, this will be the focus of this study. In doing so, the Tobit model and the Crop diversification index will be used. Thus, the approach for this study is different from other studies done before it because the use of the Tobit model is appropriate since it permits the censoring of the dependent variable and is mainly suited to regression analysis of crop diversification indexes. When the dependent variable is censored, standard linear regression techniques like ordinary least squares estimation would yield estimates which are biased and inconsistent (Mesfin et al., 2011).

CHAPTER THREE

STUDY METHODOLOGY

3.1 Introduction

This chapter deals with the methodology of the study. It starts with the discussion on the conceptual framework and then the data sources, coverage and sample design. It also looks at the approaches used in data analysis and the definition of variables for the study.

3.2 Conceptual Framework

The conceptual framework on which crop diversification is anchored is depicted in Figure 3.2 below, in the form of a flow diagram.

According to the rational choice theory, human behaviour is motivated by the desire to make a gain. Most farmers are rational in their decision making and they oftentimes choose a choice that they anticipate will yield a gain on their part, otherwise they cannot undertake the endeavour. In the context of agriculture, crop diversification is the growing of two or more crops on a piece of land by a farmer**.** It is a strategy that is used to maximize the use of land, water and other resources thus providing the farmers with feasible options to grow different crops on their land (Ashfaq et al., 2008). The factors that lead to farmers' decisions to diversify are many, but include; reducing the risk of crop failure, responding to changing consumer demands, change in government policy and more recently, as a consequence of climate change. Crop diversification is one of the sub-sets of a large matrix of production option in the cropping sector. From an economic point of view, it is treated from two analytical viewpoints: as a problem of determining the optimal crop mix on a production possibility frontier; and second as a mechanism for incorporating risk aversion into a farmer's

decision making process in which crop specialisation may lead to highly unstable income due to variance in output or price for the particular crop (Hazell, 1987). In a broad manner, crop diversification is seen as having two main properties; it expands the production possibility set or area allocation frontier, thereby increasing food security and opportunities for income generation among farmers. Secondly, it reduces the risk of a farmer putting all of his resources in the production of a single crop with potentially high covariance risk (Samuelson, 1967). Thus the farmer's decision to diversify is considered to be one of the major economic decisions that has a strong bearing on his welfare in terms of income level and food security (Pope and Prescott, 1980).

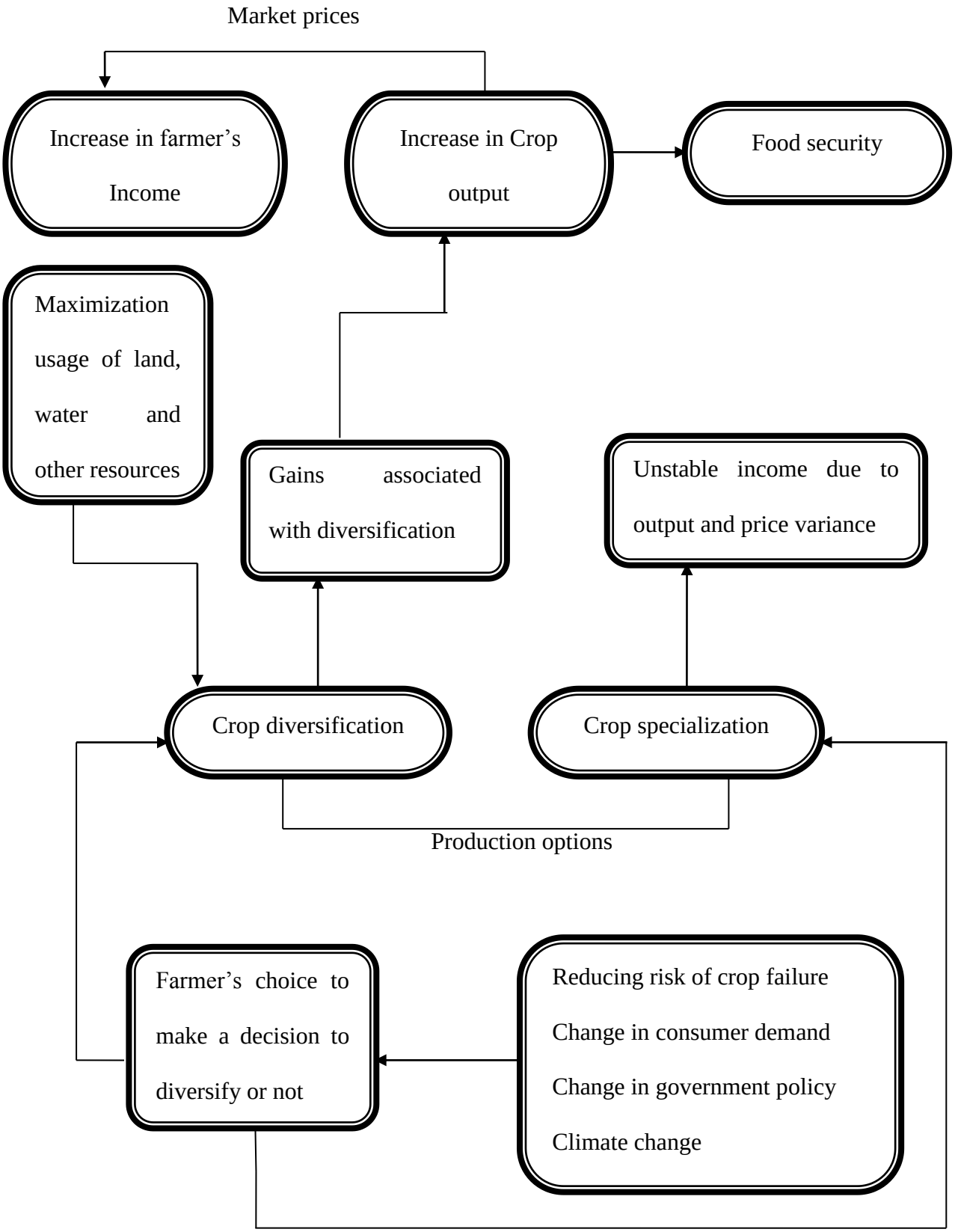

Figure 3.2 Conceptual Framework

Source: Adapted from FAO (2012)

3.3 Sources of Data

The data used for this study was secondary and it came from the Central Statistical Office (CSO).The CSO is a bureau of statistics in Zambia and it keeps information for most of the government departments of the country. Other than that, it conducts various research projects and surveys. The data for this study is based on the survey called Crop Forecast Survey (CFS) that CSO conducts every year. The survey is representative at the national level. This study used cross sectional data for the year 2010.

The purpose of the Crop Forecast Survey is to obtain information for the current agricultural season. In general, the data obtained every year usually relate to area planted to crops, expected and/or realized production, quantity and variety of seed, quantity harvested and type of fertilizer used, crop sales, crop marketing, carryover stocks and labour costs among other variables.

3.3.1 Coverage

Zambia administratively is demarcated into 9 provinces, 72 districts, 150 constituencies and 1,416 wards, with the ward being the lowest administrative unit in the country[1]. The CSO has further divided wards into Census Supervisory Areas (CSA) which have further been subdivided into Standard Enumeration Areas (SEA). The SEA is the smallest area with well-defined boundaries and is covered by an enumerator during enumeration. Each SEA contains approximately between 100 -150 households. The survey for crop forecast covers the whole country every year (CSO, 2010).

---

[1]Before October 2011, Zambia was demarcated into 9 provinces, 72 districts, 150 constituencies and 1,416 wards.

3.3.2 Sample Design and Sampling

A three stage sampling procedure is used to select work areas and households for data collection purposes (CSO, 2010). At the first stage, Census Supervisory Areas (CSAs) are selected using Probability Proportional to Size (PPS) with agricultural households as a measure of size. The CSAs are stratified by district within each province and ordered geographically within each district. A master sample of CSAs is selected systematically with Probability proportional to size within each district at the first sampling stage. Probability proportional to size (PPS) sampling takes into consideration the size of each stratum and takes off the imbalances of sample size in stratified sampling automatically so that unbiased and efficient estimates can be obtained from the sample. In addition to that, PPS method ensures that communities with larger proportion have a greater chance of containing a selected cluster than small communities. This type of sample is self-weighting, which simplifies the analysis and improves the representative of the sample.

At the second stage, Standard Enumeration Areas (SEAs) are selected using the same procedure described above on the selection of CSAs. The SEA is defined as the segment covered by one enumerator during enumeration. Only one SEA is selected within each sample CSA with PPS for the survey. Once a SEA is selected, an enumerator visits all the households within the SEA and collects a complete listing of basic demographic and agricultural information from all the households in the sampled SEA's. The information is collected on village name, name of household head, sex of household head, whether the household planted any crops in reference period, land under cultivation among other variables. This information then forms the basis for stratifying a household as being agricultural or non-agricultural and agricultural households are picked.

At the third stage, a count of households in selected work areas is conducted by listing all households resident in these areas before selection of sample households for data collection exercise. After a process of stratification, 20 (twenty) households are then sampled from each SEA using systematic sampling out of a maximum total of 100-150 households per SEA, for a detailed household interview. This represents approximately 20% of the total number of households in a SEA (CSO, 2010). In the case of southern province, 94 SEAs were selected. However, due to non-response and other challenges, usable data had 1,555 farmers and this was the sample for this study.

3.3.3 Study Site

Southern province is home to tourist attraction, the Victoria Falls. The province has 11 districts and Choma is the provincial capital since 2011. The province is confined between 16° 30' South and 27° 00' East. The southern plateau is the center of the province and has the largest area of farmland of any Zambian province. Moreover, the province's southern border is the Zambezi river and Lake Kariba which lies along the province's south-eastern edge. The Kariba Gorge is on the eastern border whilst the Kafue river is on the north-eastern border, dividing it from Lusaka province. Within the province's northern border with Central Province, lies the Kafue flats. The famous largest Kafue National Park lies in the north west (Ministry of Local Government and Housing [MoLGH], 2012).

This study focused on this particular province since it is a key player in Zambia's agricultural sector with maize as the dominant crop being grown for commercial and subsistence purposes. About 18.25% of maize production comes from southern province (Ngoma, 2008). Even though maize has continued being the dominant crop in production and despite the bumper harvests realized from it, there has not been a significant decline in poverty and malnutrition

among rural farming households. Many of these households continue to experience unstable food supplies and seasonal hunger (Sitko et al., 2011). Furthermore, this province is a drought prone area in the agro-ecological regions I and II and receives less than 1000mm of rainfall. Most of the farmers depend largely on rain-fed hoe cultivation and on low usage of modern inputs for crop production. Besides, the government of Zambia has been promoting crop diversification in the province so as to offer farmers alternative ways of generating income and improve food security by encouraging farmers to consider growing other crops apart from maize which has dominated for so long in the area. However, few farmers have responded to the practice of crop diversification (Simwambana, 2007).

3.4 Data Analysis

3.4.1 Measuring Diversification

In measuring the extent of crop diversification, the Crop diversification index (CDI) was used. The Crop Diversification Index (CDI) is obtained by subtracting the Herfindahl index (HI) from one. The CDI is an index of concentration and has a direct relationship with diversification such that its zero value indicates specialization and a movement towards one shows an increase in the extent of crop diversification (Malik et al., 2002). Hence, it was easy to identify those farmers who practiced crop diversification and those who did not (Malik et al., 2002).

3.4.2 Comparing Characteristics

Depending on the nature and objectives of a given study, there are objectives that require descriptive analysis and others may require econometric models that have the ability to estimate relationships and allowing for verification of theory or hypothesis of the study

(Cochran, 1977). In this study, descriptive statistics was used in finding out the socio-economic characteristics of the diversifiers and the non-diversifiers and the statistical significance of the variables in the descriptive part was tested using chi-square and t-test for both dummy and continuous variables respectively.

3.4.3 Analysing Determinants of Diversification

The Tobit model was used to establish the statistical relationship between the dependent variable and independent variables that were expected to determine crop diversification. The CDI was the dependent variable. The CDI was censored at 0 because a CDI of above 0 indicates crop diversification, and the Tobit model was appropriate to use because the sample consisted of observations both above and at the limit hence censoring the sample.

3.4.4 Theoretical Framework

The model developed in this section draws upon the theory of crop diversification among smallholder farmers. The Crop Diversification Indices (CDI), which is obtained by subtracting the Herfindahl index from one, helps in identifying farmers practising crop diversification and in assessing the extent of crop diversification (Singh et al., 2006). The CDI is an index of concentration, its lower value is an indication of specialisation of crop activities and its movement towards one indicates an increase in the extent of crop diversification (Malik et al., 2002).

The fundamental assumption of this study is that farmers decision on whether to diversify or not are based upon utility maximization. The expression $U(W_{ji}, L_{ji})$ non-observable underlying utility function, which ranks the preference of the i^{th} farmer for the j^{th}

diversification process (*j = 1, 2: 1* = diversification and *2* = no diversification) (Rahm and Huffman, 1984).

Following Rahm and Huffman (1984), the utility derived from crop diversification depends on *W*, which is a vector of farmer and farm specific attributes of the diversifier and *L*, which is a vector of the attributes associated with crop diversification. Even though the utility function is unobserved, the relation between the utility derivable from the j^{th} diversification process is postulated to be a function of the vector of observed farmer, farm and crop diversification specific characteristics and a disturbance term having a zero mean:

$$U_{ji} = \alpha_j F_i(W_i L_i) + e_{ji} \quad (1)$$

Since the utilities U_{ji} are random, the i^{th} farmer will select the alternative $j=1$ if $U_{1i} > U_{2i}$ or $y^* = U_{1i} - U_{2i} > 0$. The probability that Y_i equals one (i.e., that the farmer practices crop diversification) is a function of the independent variables:

$$
\begin{aligned}
P_i &= P_r(Y_i = 1) = P_r(U_{1i} > U_{2i}) \\
&= P_r[\alpha_1 F_i(W_i, L_i) + e_{1i} > \alpha_2 F_i(W_i, L_i) + e_{2i} \\
&= P_r[e_{1i} - e_{2i} > F_i(W_i, L_i)(\alpha_1 - \alpha_2)] \\
&= P_r(\mu_i > -F_i(W_i, L_i)\beta) \\
&= F_i(X_i\beta) \qquad (2)
\end{aligned}
$$

Where X is the n x k matrix of independent variables and β is a k x 1 vector of parameters to be estimated, *Pr(.)* is the probability function, μ_i is the random error term, and $F_i(X_i\beta)$ is the cumulative distribution function for μ_i and is evaluated at $X_i\beta$.

The probability that a farmer will diversify in crop production is a function of the vector of independent variables and of the unknown parameters and error term. Equation (2) cannot be estimated directly without knowing the form of F. It is the distribution of μ_i that determines the distribution of F (Rahm and Huffman, 1984). The Tobit model specifies the functional form of F, where μ_i is an independently, normally distributed error term with zero mean and constant variance σ^2:

$$
\begin{aligned}
Y^*_i &= \beta Xi + \mu_i \qquad Y_i = Y^*_i \qquad \text{if } Y^*_i > 0 \ (\textit{Diversifiers}) \\
Y^*_i &= \beta Xi + \mu_i \qquad Y_i = 0 \qquad \text{if } Y^*_i \le 0 \ (\textit{Non-Diversifiers}) \qquad (3)
\end{aligned}
$$

In finding out the determinants of crop diversification, the Tobit model, a special case of censored regression models is appropriate and the CDI serves as the

dependent variable. This is so because censoring of the dependent variable means that standard linear regression techniques like ordinary least squares estimation would yield estimates which are biased and inconsistent. The model permits censoring of the dependent variable from above and/or below, and is mainly suited to regression analysis of crop diversification indexes (Mesfin et al., 2011). It uses maximum likelihood estimation techniques to estimate both the likelihood of (in this case) crop diversification (i.e., taking into consideration zero versus non-zero *CDI* values) and the intensity of crop diversification. It is a limited dependent variable model that is continuous over strictly positive values but is zero for a nontrivial fraction of the population and explains the relationship between a positive latent (or unobserved) dependent variable and a vector of explanatory variables. The model supposes that there is a latent dependent variable Y^* that satisfies the classical linear model assumptions; in particular, it has a normal, homoskedastic distribution with a linear conditional mean (Amemiya, 1984). Because Y^* is normally distributed, it has a continuous distribution over strictly positive values. In addition, there is a normally distributed error term μ_i to capture random influences on this relationship (Wooldridge, 2009).

The maximum likelihood estimation of the Tobit model on which the model parameters are estimated is simple. Let $f(.)$ and $F(.)$ represent the density function and the cumulative density function for y^*. The model then implies that the probabilities of observing a non-zero y and a zero y are $f(y)$ and $p(y^* < 0) = F(0)$, respectively

(Sigelman et al., 1999). Following Sigelman et al. (1999), the log-likelihood function for the model is therefore;

$$\ln L = \ln\left(\prod_{y_i>0} f(y_i) \prod_{y_i=0} F(0)\right) = \sum_{y_i>0} \ln f(y) + \sum_{y_i=0} \ln F(0) \quad (4)$$

Because *y** is normally distributed, $f(.)$ and $F(.)$, and therefore the log-likelihood function, can be re-expressed in terms of the density function and the cumulative density function of the standard normal distribution, $\phi(.)$ and $\Phi(.)$, and the log-likelihood function can be written in the familiar form:

$$\ln L = \sum_{y_i>0} \left(-\ln \sigma + \ln \phi\left(\frac{y_i - x_i\beta}{\sigma} \right) \right) + \sum_{y_i>0} \ln\left(1 - \Phi\left(\frac{x_i\beta}{\sigma}\right)\right) \quad (5)$$

3.4.5 Marginal Effects

In the Tobit model, there are a number of marginal effects that are of interest. The marginal effect is the effect on the conditional mean of the dependent variable as an independent variable changes. The effect depends on whether we are interested in latent variable, censored or truncated means. The marginal effect for left censored is given as follows;

$$\frac{\partial \Pr(y > 0 \mid x)}{\partial x_k} = \phi\left(\frac{x\beta}{\sigma}\right)\frac{\beta_k}{\sigma} \quad (6)$$

3.4.6 Specification of the Empirical Model

In determining crop diversification, the Crop diversification index was used in this study. It therefore becomes easy to identify those farmers who are practicing crop diversification and those who are not.

The CDI index is calculated as shown below;

$$P_i = \frac{A_i}{\sum_{i=1}^{n} A_i} \tag{7}$$

where;

$P_i = proportion\ of\ i^{th}\ crop$

$A_i = area\ under\ i^{th}\ crop$

$\sum_{i=1}^{n} A_i = Total\ cropped\ area$

$i = 1,2,3,...n\ (number\ of\ crops)$

$$HI = \sum_{i=1}^{n} P_i^2 \qquad Herfindahl\ index \tag{8}$$

$$CDI = 1 - \sum_{i=1}^{n} P_i^2 = 1 - HI \qquad Crop\ diversification\ index \tag{9}$$

After identifying the number of smallholder farmers who practices crop diversification, the Tobit model is used, to analyze factors influencing farmer's decisions to diversify in crop production. The CDI acts as the dependent variable and it is censored at zero.

The general formulation of the Tobit model for this study is;

$$y_i = \begin{cases} y_i * & if \quad y_i * > 0 \\ 0 & if \quad y_i * \leq 0 \end{cases}$$

where

$$y_i * = \beta X_i + \mu_i \qquad \mu_i \sim N(0, \delta^2) \qquad (10)$$

Where:

y_i^* = dependent variable, in this case the CDI

X_i = the vector of factors influencing farmer's decisions to diversify in crop production.

β = the vector of unknown parameters.

μ_i = is the independent normally distributed error term assumed to be normal with zero mean and constant variance.

3.4.7 Definition of Variables for this Study

The choice of independent variables in this study was based on literature and data availability. Independent variables for this study include; age of the household head, gender of the household head, household size, education level of household head, size of landholding, number of fields/farm plots, tillage (using a plough),tillage time, distance to the market, quantities of fertilizer, access to fertilizer, source of fertilizer and hired labour. Table 3.1 below presents a summary of these variables.

X_1= Gender of the household head (GEND)

X_2= Age of the household head (HHAGE)

X_3= Household size (HSZE)

X_4= Education level of household head (HHEDU)

X_5= Size of landholding (SLAND)

X_6= Number of fields/farm plots (NPLOT)

X_7= Hired labour (HLAB)

X_8= Tillage time (TTYM)

X_9= Tillage (using a plough) (TPLOU)

X_{10}= Quantities of fertilizer (QFET)

X_{11}= Distance to the market (DIST)

X_{12}= Access to fertilizer (FERTACC)

X_{13}= Source of fertilizer (FETSRCE)

Gender of the Household Head (GEND): This is a dummy variable, which takes a value of 1 if the household head is male and 0 if female. Male as well as female headed households can choose to diversify or not based on their choice, preference and access to resources. Furthermore, it is important to bear in mind that access to resources such as land is an important indicator of welfare among rural farm households. It is especially critical for women with no use rights over a parcel of land. In Zambia and elsewhere in the region, women rarely own or have control over land and other assets (Shezongo, 2005). The inequality that exists in accessing and having resources between males and females determines how each household will respond to diversification. Hence the expected sign of the coefficient of the variable is expected to vary.

Age of Household Head (HHAGE): Age, measured in years is one of the factors that does affect production decisions on the part of the farmer. Elderly farmers look at farming as just a way of life while young farmers look at farming as a business opportunity for family sustenance (FAO, 2012). Hence as the young farmers do farming, they are business and profit oriented. Thus, it is expected that elderly farmers will not diversify, while the younger farmers will be able to diversify. Therefore, it is expected that the coefficient of the variable age will have a negative sign.

Household Size (HSZE): The size of the household, measured in terms of number of persons in a family plays a role in determining how much the household will be able to produce in order to sustain itself. Thus, the size of the household is expected to be positively related with crop diversification. The larger the household size, the more

likely that it will be able to diversify so as to increase its food production levels. Previous studies also support this hypothesis (Weiss and Briglauer, 2000; Benin et al., 2004).

Level of Education of Household Head (HHEDU): The higher the level of education a farmer attains, the more knowledge a farmer gains and the more likely a farmer is able to make constructive decisions. Thus the farming household heads who have a formal education determines the readiness for them to accept new ideas and this enhances their willingness to crop diversify. Thus the level of education of the household head measurement is taken from the following categories, namely, primary education, secondary education, tertiary education and none (illiterate). The excepted sign of the coefficient of the variable level of education is positive. Previous findings by Ibrahim et al. (2009) indicate a positive relationship between education level and crop diversification.

Size of Landholding (SLAND): This is a continuous variable referring to the total arable farmland that a farmer owns measured in hectares. It plays a crucial role in determining how many crops a farmer can produce, and previous findings shows that crop diversification depends on large farms, Weiss and Briglauer (2000) and Benin et al. (2004). Therefore, the excepted sign of the coefficient for the variable size of land holding is positive.

Number of Fields/Farm Plots (NPLOT): This refers to the total number of fields/farm plots that a farmer has at that particular agricultural season. This variable is continuous and it is expected to influence crop diversification in a positive way.

According to Benin et al. (2004), the more the number of farm plots a farmer has, the more he is able to diversify.

Size of Hired Labour (HLAB): In instances where farming households do not have enough domestic labour, hired labour is used as a supplement. In most cases, it (hired labour) is sourced within the village communities and the wage rate is either in kind or monetary form. The size of hired labour is measured in man-days. Man-days are computed according to the rule that one adult male, one adult female and one child (< 18 years) working for one day (8 hours) equal 1 man day; 0.75 man days; and 0.50 man days respectively, Battese et al. (1996) . A study by (Culas, 2006) reveals that a greater use of both family and hired labour is associated with more diversification. Therefore, the excepted sign of the coefficient for the variable size of hired labour is positive.

Tillage Time (TTYM): This refers to the time when tillage is done, either during or before the rain season. Tillage done during the rain season gives farmers a surety that the rains will be there for their crops since through the meteorological department, farmers are updated on the pattern of the rains falling for that particular season. For instance, a study in Malawi by Kankwamba et al. (2012) reveals that rainfall determines crop diversification. Also, Bhattacharyya (2008) reports that crop diversification is more prominent in rainfed areas than in irrigated zones. As a result, this variable is expected to positively influence crop diversification.

Tillage (using a plough) (TPLOU): This refers to land tilling using a plough. The farmers who use a plough for tilling their land are more likely to diversify because ploughing is relatively easy and a plough captures a good amount of an area once it is applied. For instance, studies indicates that there is a positive relationship between possession of farm implement/ machinery by a farmer and diversification (Mesfin et al., 2011 and Ashfaq et al., 2008). As a result, it is expected that this variable will positively associate with crop diversification.

Quantities of Fertilizer (QFET): In the life of a farmer, fertilizer is an important input because without it, most crops cannot do unless the ones which belong to the family of legumes. As a result, fertilizer usage by farmers on their crops has continued being an essential practice so as to enhance their crop production. Previous findings by Kumar and Chattopadhyay (2010) reveal that quantities of fertilizer obtained by farmers determine crop diversification. Therefore, the excepted sign of the coefficient of the variable quantities of fertilizer is positive.

Distance to the Market (DIST): Distance to the market is an indicator of access to markets and organized trade as well as proximity to economic resources. The nearer to the market the farmers are, the easier it becomes for them to diversify and to take their produce to the market. Studies on diversification highlight the importance of proximity to main roads and markets for development of other farm enterprises (Benin et al., 2004). In some instances, farmers located farther away from markets, economic areas which are vibrant like rural growth centers and main roads, do

diversify in order to meet their subsistence needs (Kankwamba et al., 2012). Hence, it is expected that this variable will negatively or positively associate with crop diversification.

Access to Fertilizer (FERTACC): This is a dummy variable and refers to whether farmers had accessed fertilizer or not during the farming season. One of the potential constraints to farming households in the production of their crops is not having access to inputs such as fertilizers (Xu, 2009). Thus it becomes difficult for them to increase the productivity of the farming sector if they cannot access fertilizer since the majority are resource poor. Access to fertilizer may enable farmers to crop diversify since they can easily apply it to their crops.Therefore, the excepted sign of the coefficient of the variable access to fertilizer is positive.

Source of Fertilizer (FETSRCE): The fertilizer farmers use in their fields is obtained from various sources. Thus this refers to where the fertilizer the farmer used for that particular agricultural season, was obtained from. Thus the level of measurement of the source of fertilizer is dummy and is taken from the following categories, namely, from government, from commercial and from gifts. The household can be a recipient of fertilizer from the government through a subsidy program called the farmers input support programme. Also, from commercial, this refers to the cash purchase of fertilizer from traders by farmers with ready cash. From gifts, the farming household can be a recipient of a fertilizer gift from a non-household member or a non-governmental organization which may assist farmers. Farmers who obtain fertilizer from the government and commercial are more likely to

diversify than those who obtain fertilizer from gifts. This is so because obtaining fertilizer from gifts may not be a guarantee from season to season as it depends on the willingness of the giver. Thus it is expected that the coefficient of fertilizer source (from the government and from commercial) will have a positive sign.

Table 3.1 Summary of variables for the study

Variables	Type	Description	Expected Sign
Gender	Dummy	Gender of head of household (male = 1).	+/-
Age	Continuous	Age of household head (years).	-
Household Size	Continuous	Number of people in household (proxy for labour supply).	+
Education	Dummy	Whether household head attended school (primary, secondary & tertiary=1).	+
Size of Land	Continuous	All land operated for agricultural purposes and owned by farmer (hectares).	+
Number of Fields	Continuous	Total number of fields or farm plots that a farmer has (number).	+
Hired Labour	Continuous	Number of people employed for wages during cropping season (man-days).	+
Tillage Time	Dummy	Whether tillage was done during or before the rainy season (during = 1).	+
Tillage Plough	Dummy	Land preparation using a plough (used a plough=1).	+
Access to fertilizer	Dummy	Whether household head had access to fertilizer during the farming season (yes=1).	+
Fertilizer source	Dummy	Source of fertilizer, the farmer used during the cropping season(government, commercial & gifts=1)	+/-
Fertilizer Quantity	Continuous	Amount of fertilizer obtained for crop production (kg).	+
Distance	Continuous	Distance from homestead to nearest market (km).	+/-

3.5 Diagnostic Tests

After fitting the Tobit model, the hypothesized independent variables were checked for the existence of multicollinearity and heteroskedasticity. Multicollinearity problem arises when two or more independent variables in a regression equation are highly correlated. When there is presence of multicollinearity between the independent variables, we cannot separate out the independent effect of each parameter estimate on the dependent variable. It is quite difficult for us to estimate accurately the effect of that variable. As a result, we may have little or no confidence in any policy prescriptions on these estimates. It is therefore important to test for the presence of multicollinearity for the variables. A measure of multicollinearity associated with the variance inflation factors is defined as:

$$\text{VIF (Xj)} = \frac{1}{1 - R_j^{\,2}} \qquad (11)$$

Where R_j^2 is the coefficient of determination when the variable X_j is regressed on the other independent variables (Gujarati, 1995). The variance inflation factor (VIF) was employed to detect the problem of multicollinearity for continuous variables. The value of VIF greater than 10 is taken as a sign for the existence of multicollinearity problem in the data. The VIF values of all the variables in the model were less than 10 showing that there was no problem of multicollinearity (see Appendix 1).

In the same way, there may also be interaction between two dummy variables which can lead to the problem of association or multicollinearity. To detect this problem,

pairwise correlation was used. A value of 1.00 between two or more variables indicates a stronger relationship or multicollinearity presence. Equally, there was no multicollinearity (see Appendix 2).

Heteroskedasticity is a phenomenon where the variance of the dependent variable is not the same for any independent observations or independent variables. If it is detected and is not taken care of, it leads to very high standard errors and inconsistent sample estimates which may lead to wrong hypothesis testing. In this study, heteroskedasticity was tested using the Breuch-pagan test and it was taken care of (see Appendix 3).

The normality test was done using the kernel density plot of residuals. The kernel density plot provided a fairly smooth curve that closely matched the normal curve. Hence the normality assumption was not violated (see appendix 4). Furthermore, the model specification was done using Ramsey Reset and the results revealed that they were no omitted variables in the model (see Appendix 5).

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents results of the thesis in three major parts. In the first part, it deals with the crop diversification index which made it easier to find out the extent of crop diversification. The second part deals with the results of the descriptive analysis. Whereas the third part deals with the results of the Tobit model used in identifying the major determinants that influence farmer's decisions to diversify in crop production.

4.1.1 Extent of Crop Diversification among Smallholder Farmers in Southern Province of Zambia

Using the CDI, the total number of farming households who diversified was 1,073 and those who did not was 482. The farmers who diversified constitute 69% while the non-diversifiers constitute 31% of the total sample. The farmers who diversified had a CDI greater than 0, while their non-diversifying counterparts had a CDI equal to 0. In the case of the non-diversifiers, their CDI equal to 0 means that they had completely specialised in crop production and grew only one type of crop. As for the diversifiers, 42.35% had a CDI greater than zero but less than or equal to 0.49; 5.87% had a CDI equal to 0.5 and 20.78% had a CDI greater than 0.5. Since a higher CDI value indicates a higher extent of crop diversification and a lower value of CDI indicates a lower extent of crop diversification, it means that the extent of crop diversification among the smallholder farmers is relatively low because the majority of the diversifiers had a lower CDI value.

4.2 Descriptive Analysis

Descriptive analysis made use of tools such as the mean, standard error, percentage, and the frequency distribution. Descriptive analysis gives a comprehensible picture of the characteristics of diversifiers and non-diversifiers sample units. By applying descriptive statistics, it enables one to describe, compare and contrast different categories of sample units (diversifiers and non-diversifiers) with respect to the desired characteristics. Needless to mention that crop diversification is determined by various attributes. Of these attributes, socio-economic, demographic and institutional characteristics are among them. Thus this part will discuss socio-economic, demographic and institutional factors which determine crop diversification.

4.3 Demographic, Institutional and Socio-Economic Characteristics of Farmers in Southern Province of Zambia

From Table 4.2 below, both tillage time and tillage (using a plough) were statistically significant and a chi-square test revealed that there was association between tillage time and crop diversification status as well as between tillage (using a plough) and crop diversification status. This entails that the majority of the diversifiers had used a plough as their mode of tillage compared to the non-diversifiers and most of them had done their tillage during the rain season. As for the other variables, the results were not statistically significant.

Table 4.2 Descriptive statistics of dummy variables

Characteristics	Diversifiers (n= 1,073)		Non-Diversifiers (n=482)		p-value
	Frequency	Percent	Frequency	Percent	
Demographic and/or socio-economic factors					
Gender (male=1)	1,063	99.07	474	98.34	0.215
Education Level (dummy) Illiterate(control)	69	6.43	34	7.05	
Attended Primary(yes=1)	1,005	93.66	447	92.74	0.498
Attended secondary(yes=1)	636	59.27	252	52.28	0.410
Attended tertiary(yes =1)	79	7.36	28	5.81	0.263
Used plough(yes=1)	934	87.05	393	81.54	0.004***
Tillage during rain season(yes=1)	197	18.36	55	11.41	0.001***
Institutional factors					
Access to fertilizer(yes=1)	723	67.38	287	59.54	0.300
Fertilizer from Government(yes=1)	178	16.59	82	17.01	0.836
Fertilizer from Commercial(yes=1)	623	58.06	285	59.13	0.693
Fertilizer from Gifts(yes=1)	272	25.35	115	23.86	0.530

Note: Significance level: *** ($p \leq 0.01$); ($p \leq 0.05$); ** ($p \leq 0.10$)*

From Table 4.3 below, the statistical analysis carried out using a t-test showed that there was significant difference in the mean distance to the market, size of land holding, quantities of fertilizer and number of fields between diversifiers and non-diversifiers. Furthermore, the results shows that on average, diversifiers had a greater size of land holding, more number of fields, they acquired more quantities of fertilizer and were located far away from the market than the non-diversifiers.

Table 4.3 Descriptive statistics of continuous variables

Characteristics	Diversifiers (n=1,073)		Non-Diversifiers (n= 482)		p-value
	Mean	Standard Error	Mean	Standard Error	
Age of Household Head	33.58	0.3012114	33.46	0.4456653	0.8260
Household Size	6.74	0.0962656	6.64	0 .1567282	0.5713
Distance	10.51	0.0891566	8.49	0.0831178	0.0000***
Size of Landholding (ha)	9.74	0.1120349	7.40	0.1753737	0.0000***
Number of Fields	4.02	0.0433912	3.86	0.0608231	0.0419**
Quantities of Fertilizer	41.73	1.185919	29.21	1.310554	0.0000***
Size of Hired Labour	1.87	0.0462151	1.79	.0716211	0.3368

Note: Significance level: *** ($p \leq 0.01$); ($p \leq 0.05$); ** ($p \leq 0.10$)*

4.4 Determinants of Crop Diversification in Southern Province of Zambia

4.4.1 Tobit Model Results

Results of the Tobit model (Table 4.4) shows that crop diversification is dependent on the size of landholding, quantities of fertilizer, distance to the market ,tillage time and tillage (using a plough). The variables size of landholding, quantities of fertilizer, tillage time and distance to the market were all statistically significant at 99% confidence level whereas the variable tillage (using a plough) was statistically significant at 95%. Moreover, the study revealed that crop diversification is not dependent on the gender of the household head, age of the household head, household size, education level of household head, number of fields/farm plots, access to fertilizer, fertilizer source and hired labour.

Table 4.4 Tobit regression for the determinants of crop diversification (Dependent Variable: Crop Diversification Index)

Variable	dy/dx	Coef.	Std. Err.	p-value
Gender (male = 1)	-0.0129	-0.0175	0.0719	0.8080
Age of household head (in years)	-0.0020	-0.0027	0.0058	0.6420
Age squared	0.0031	0.0041	0.0086	0.6310
Household size (labor supply proxy)	-0.0017	-0.0023	0.0025	0.3640
Hired labour (man-days)	-0.1418	-0.1911	0.5630	0.7340
Education level (base = "illiterate")				
Attended Primary(yes=1)	0.0210	0.0282	0.0303	0.3520
Attended secondary(yes=1)	0.0060	0.0081	0.0150	0.5880
Attended tertiary(yes =1)	0.0173	0.0234	0.0295	0.4280
Number of fields/farm plots	0.0054	0.0073	0.0059	0.2160
Tillage plough (used a plough=1)	0.0254	0.0342	0.0157	0.0290**
Tillage time (during rain season=1)	0.0446	0.0601	0.0198	0.0020***
Size of land (ha)	0.0143	0.0193	0.0020	0.0000***
Distance to the main market (km)	0.0145	0.0196	0.0027	0.0000***
Access to fertilizer(yes=1)	0.0249	0.0335	0.0224	0.1340
Fertilizer source (base = "from gifts")				
Fertilizer from Government(yes=1)	0.0083	0.0112	0.0232	0.6300
Fertilizer from Commercial(yes=1)	-0.0017	-0.0023	0.0175	0.8970
Quantities of fertilizer (kg)	0.0146	0.0197	0.0022	0.0000***
District dummy variables (base = Sinazongwe)				
Choma (1=yes)	-0.0489	-0.0660	0.0408	0.1060
Gwembe (1=yes)	-0.0178	-0.0240	0.0446	0.5910
Itezhi_tezhi (1=yes)	0.0963	0.1298	0.0514	0.0120**
Kalomo (1=yes)	0.0152	0.0204	0.0416	0.6240
Kazungula (1=yes)	-0.1328	-0.1790	0.0429	0.0000***
Livingstone (1=yes)	-0.1532	-0.2065	0.0454	0.0000***
Mazabuka (1=yes)	-0.0186	-0.0251	0.0401	0.5320
Monze (1=yes)	0.0437	0.0589	0.0399	0.1400
Namwala (1=yes)	0.0817	0.1101	0.0416	0.0080***
Siavonga (1=yes)	0.1254	0.1690	0.0316	0.0000***
Constant		-0.2045	0.1283	0.0111**
Number of obs = 1555 LR chi2(27) = 399.30				
Prob > chi2 = 0.0000 Pseudo R2 = 0.6770				
Log likelihood = -521.13693				
Obs. summary: 482 left-censored observations at CDI<= 0				
1073 uncensored observations				

Note: Significance level: *** ($p \leq 0.01$); ($p \leq 0.05$); ** ($p \leq 0.10$)*

Size of Landholding

The study results show that the variable, size of landholding was significant at 1% and its coefficient had a positive sign, as expected. The results imply the existence of a direct relationship between size of landholding and crop diversification such that increasing the size of landholding of a farmer by **1%**, will result in an increase in the probability of a farmer engaging in crop diversification by **1.4%**, *ceteris paribus*. The possible explanation for this is that an extra size of landholding further expands the amount of landholding that a farmer has and this gives a farmer an incentive to allocate his landholding to growing of other crops, thus diversifying. Furthermore, the study results are in agreement with findings by Ashfaq et al. (2008) in which they reported that the more access to additional land that a farmer has, the more he will be able to engage in crop diversification. Consequently, the policy implication is that for crop diversification to be more realised among the farmers, there is need for the government and traditional leaders through their statutory and customary system of land distribution respectively, to support policies that will improve farmers' access to and control over land given the fact that diversification is still being promoted by the government via agricultural extension workers.

Quantities of Fertilizer

The variable sign for quantities of fertilizer was positive, a priori and was significant at 1%. The results indicate that, a **1%** increase in the quantities of fertilizer will increase the probability of a farmer to engage in crop diversification by **1.5%**, *ceteris*

paribus. The explanation for this is that availability of quantities of fertilizer will give a farmer an incentive to diversify since most of the farmers lack fertilizer among other inputs in crop growing which results in crop failure and poor yields. Furthermore, fertilizer availability enables a farmer to enrich his land (which oftentimes is exhausted) thus making it suitable for him to invest in the production of various crops, thus diversifying. The study results concur with findings from India by Kumar et al. (2010) and Singh et al. (2006) and from Malawi by Ndhlovu (2010), in which they found that the quantity of fertilizer a farmer uses is a significant determinant of crop diversification. The implication for policy is that there is need for the policy makers and other stakeholders to encourage farmers to take a holistic approach so as to consider using other means of enriching their land, such as using cow dung and composite manure apart from using chemical fertilizer considering that most of them are resource poor and may not afford buying significant quantities of fertilizer for their crops. Furthermore, the use of cow dung and composite manure is cheap, natural and very effective at enriching soils just like the use of chemical fertilizers. In Zambia, most of the chemical fertilizer farmers' use come from the government since for too long, the farmers have depended on the fertilizer subsidy which quiet often is not adequate and does not meet the needs of every farmer.

Tillage (using a plough)

The study results indicate that tillage (using a plough) significantly determines the probability of a farmer to participate in crop diversification and that the probability of a farmer who uses a plough engaging in crop diversification is **2.5%** higher than for a farmer who does not use a plough. Thus a farmer who uses a plough will more likely diversify because tillage using a plough reduces the drudgery of land preparation, it is

not labour intensive and it captures a good amount of land compared to using a hand hoe. The study results are in agreement with findings by Mesfin et al. (2011) and Ashfaq et al. (2008) in which they reported the existence of a positive relationship between possession of farm implement/machinery by a farmer and crop diversification. The implication for policy is that there is need for technologies encouraging farmers moving away from using hand hoe to better tools to till their land so as to reduce the time and energy they spend in their fields. The government, as the main stakeholder that seeks to improve the welfare of its farmers can help to bring about this. Ox-ploughs are a good example given that most farmers will not have the money to hire tractors.

Distance to the Market

The variable distance to the market was significant at 1% and its coefficient had a positive sign. This therefore means that there is a direct relationship between distance to the market and crop diversification. If distance to the market is increased by **1%**, it increases the probability of a farmer to engage in crop diversification by **1.5%**, *ceteris paribus.* Thus the results suggest that farming households located farther from the nearest market will diversify for food security due to higher transport costs in accessing market incentives to diversify for commercial purposes. This concurs with findings by Ibrahim et al. (2009) in which they reported that farming households that are farther away from the main markets face high costs of transportation and marketing costs to get their produce to the market and in such instances, they opt to grow crops only for subsistence purposes because their market participation becomes

difficult. The policy implication of this is that for farmers to diversify for commercial purposes so as to generate income rather than meeting the needs of food security alone, there is need for the government to consider bringing trading markets close to the farmers and this means investing in reliable and adequate market infrastructure thus fostering agricultural trade for farmers. The presence of market infrastructure will ensure that farmers get their due profit from the selling of their crops thus playing a vital role in poverty reduction and agricultural growth.

Tillage Time

The variable tillage time was found to be significant at 1%. The results entails that the probability of practicing crop diversification by the farmers who did their tillage during the rain season is **4.5%** higher than for those farmers who did their tillage before the rain season. The possible explanation for this is that the rain season offers farmers a surety that the rains will be available for their crops and hence farmers work to utilize the season. For instance, a study in Malawi by Kankwamba et al. (2012) reported that rainfall determines crop diversification. Also, Bhattacharyya (2008) reported that crop diversification is more prominent in rainfed areas than in irrigated zones. However, this has policy implications in that there is need for the policy makers to encourage farmers to do their tillage during the rain season. This can be done with the help of extension workers. Also, due to unpredictable rainfall patterns in the face of climate change, there is also need for policy makers to substantially invest in weather information dissemination system so as to provide farmers with reliable and correct information pertaining to climatic conditions given the fact that crop diversification is largely dependent on it.

District Dummy Variables

With respect to the district dummy variables, Kazungula, Livingstone, Namwala and Siavonga were significant at 1% while Itezhi_tezhi was significant at 5%. In the case of Kazungula and Livingstone, the coefficients were negative and for the other districts, they were positive. Furthermore, the results entails that the probability of farmers located in Kazungula and Livingstone to engage in crop diversification is **13.3%** and **15%** lower than that of the farmers located in Sinazongwe district, respectively. Also, the probability of farmers located in Namwala, Siavonga and Itezhi tezhi district to engage in crop diversification is **8.2%**, **13%** and **9.6%** higher than that of the farmers located in Sinazongwe district, respectively. Besides, a joint test of the district dummy variables shows that the districts are significantly different from zero at 1% level and therefore contribute to crop diversification.

CHAPTER FIVE

CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Conclusion

The study was conducted with the specific objectives; to determine the extent of crop diversification among smallholder farmers, to compare the demographic and socio-economic characteristics of the diversifiers and non- diversifiers and to identify the major determinants that influence farmer's decisions to diversify in crop production.

The field data was analyzed to produce descriptive statistics. The results shows that on average, diversifiers had a greater size of land holding, more number of fields, they acquired more quantities of fertilizer and were located far away from the market than the non-diversifiers. Additionally, the study revealed that, the extent of crop diversification among the smallholder farmers was low since the majority of the diversifiers had a lower CDI value.

Using the Tobit model, the study found that, size of landholding statistically determines crop diversification and hence the need for policies that will increase farmers' access to and control over land. Furthermore, the study showed that distance to the market is an important determinant of diversification, thus the need for policies oriented towards bringing trading markets closer to the farmers. Evidence also showed that tillage (using a plough) and tillage time increasingly determines diversification.
In line with this, there is need for the government to encourage farmers to use agricultural implements such as ploughs and the need for farmers to be encouraged to do their tillage during the rainy season.

5.2 Policy Recommendations

5.2.1 Improve Farmers Access and Control over Land

From the study results, the fact that the size of landholding determines crop diversification in a positive way, there is need for the government and relevant stakeholders to undertake policies that will improve farmers' access to and control over land so that farmers can invest in it by using it for various crop production activities (diversification) thus enhancing food and nutrition security thereby reducing poverty levels. Since land distribution is done by the government through statutory instrument as well as by the traditional leaders through customary arrangement, the two (government and traditional leaders) can work in tandem in identifying farmers who critically need additional amount of land to crop diversify thus helping farmers in moving away from dependency on maize production only. In the case of Zambia, additional land allocation to some farmers is possible since the country has an enormous potential in agriculture with 58% of the total land area suitable for arable farming, yet only 14% is being cultivated currently (Institute for African Studies, 2009).

Alternatively, the government should encourage land use intensification where with the already land available to the farmers, the farmers must continuously be persuaded to allocate some of it to diversification. One of the benefits of land use intensification is that it promotes efficient and sustainable use of land resource thus protecting farmers land rights.

5.2.2 Alternatives to using Chemical Fertilizer

The study results established the importance of quantities of fertilizer with regard to crop diversification. The implication for policy is that there is need for the government (policy makers) and other stakeholders to encourage farmers to consider using other means of enriching their land, such as using cow dung and composite manure apart from relying on chemical fertilizer given the fact that most of them are resource poor and may not afford buying significant quantities of fertilizer for their crops. The use of cow dung and composite manure is cheap, natural and very effective at enriching soils. For too long, the farmers have depended on the fertilizer subsidy from the government which oftentimes does not serve all of them, is delivered late and farmers are forced to scramble for the fertilizer at the pinnacle of their production season such that they cannot use it at the right time (Muleba, 2008). Thus the need for farmers to move away from this dependency syndrome given the fact that very few of them benefit from the subsidy and since the use of cow dung and composite manure is cheap, readily available and sustainable.

5.2.3 Encouraging Farmers to use Agricultural Implements such as Ploughs

The results of the study established that the probability of a farmer who uses a plough engaging in crop diversification is higher than for a farmer who does not use a plough. Thus the policy implication is that there is need for technologies encouraging farmers moving away from using hand hoe to better tools to till their land so as to reduce the time and energy they spend in their fields. Ox-ploughs are a good example given that most farmers will not have the money to hire tractors since the majority of small-scale farmers are resource poor, have low levels of agriculture production and are usually

food insecure (Ministry of Finance and National Planning [MoFNP], 2006). The government and the private sector can thus work in tandem to encourage and assist the farmers where possible considering that the farmer's welfare is their concern.

5.2.4 Bringing Trading Markets closer to the Farmers

Since this study established that the farmers further away from the main market are able to diversify for food security purposes, food security is not everything. Farmers need financial resources (income) to send their children to school, to buy inputs and so on. This can mostly be realised if they are able to sale their produce at the nearest market. In view of the fact that distance to the market is an indicator of access to the market and organized trade as well as proximity to economic resources, the policy implication is that there is need for the government to promote and support policies oriented towards bringing trading markets closer to the farmers. This can be done by investing in reliable and adequate market infrastructure thus fostering agricultural trade for farmers. In most cases, a lack of market infrastructure drives a wedge between the market price and the prices that farmers receive for their output, thus lowering the profits associated with crop production. Other than that, the transportation of the farmer's produce to the market normally account for almost half of the cost of agricultural output marketing thus a considerable fraction of the value of the product is lost by the time it reaches the market. Thus market infrastructure will improve farmers' access to markets, thereby increasing their earnings and improving their livelihoods. The government can promote market infrastructure development by encouraging the private sector participation in developing agricultural markets of both input and output since input and output markets comprise an important

component along the value chain for farmers. By developing agricultural output and input markets for farmers, a conducive business environment for farmers will be realized thus adding value to their produce, increasing their profits and building on their capacity to produce more to contribute to the food security efforts being made by government. For example, a study by Kumar and Chattopadhyay (2010) revealed that policies towards the expansion of infrastructure like road network, marketing and storage facilities are important preconditions for the diversification of crops and are crucial in ensuring sustainable income and employment among farmers. Therefore, the nearer to the market the farmers are, the easier it becomes for them to take their produce to the market and to continue to diversify, not only for food security purposes, but for commercial purposes as well.

5.2.5 Sensitizing Farmers on the appropriate Time for Tillage

The study results established that the probability of practicing crop diversification by the farmers who did their tillage during the rain season is substantially higher than for those farmers who did their tillage before the rain season. It is therefore incumbent upon the policy makers (government) as well as other stake holders to ensure that they sensitize the farmers to do their tillage during the rain season since during that season, crops for the farmers receive water from the rains. Ultimately, this entails the need for policy makers to substantially invest in weather information dissemination system so as to provide farmers with reliable and correct information on weather forecast thus helping farmers to suitably plan for their farm on whether to

withhold or undertake sowing activities. Information provision to farmers can be done through various ways such as print and electronic media (radio), extension workers and so forth.

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APPENDICES

Appendix 1: Test for Multicollinearity for Continuous Variables

VARIABLE	VIF	1/VIF
Age	1.06	0.943490
Household Size	1.15	0.870701
Size of Land	1.02	0.982955
Number of Fields	1.12	0.889578
Distance	1.06	0.944283
Hired Labour	1.02	0.982621
Quantity of Fertilizer	1.01	0.986175

Source: Research's Computation

Appendix 2: Test for Multicollinearity for Dummy Variables

	GEND	TTYM	TPLOU	PRIEDU	SECNEDU	TEREDU	GOVTSRCE	COMSRCE	FERTACC
GEND	1.0000								
TTYM	0.1931	1.0000							
TPLOU	0.015	-0.0003	1.0000						
PRIEDU	0.0195	0.0358	-0.0162	1.0000					
SECNEDU	-0.0331	0.0118	0.0497	-0.0062	1.0000				
TEREDU	-0.0418	0.0121	0.0666	-0.1728	-0.0211	1.0000			
GOVTSRCE	-0.016	0.0006	0.004	-0.0054	-0.0051	-0.0061	1.0000		
COMSRCE	0.0306	0.0079	0.0172	-0.0097	0.0065	0.0078	-0.5308	1.0000	
FERTACC	0.0087	0.0499	0.0121	-0.0873	-0.0756	0.1198	0.0113	0.0034	1.0000

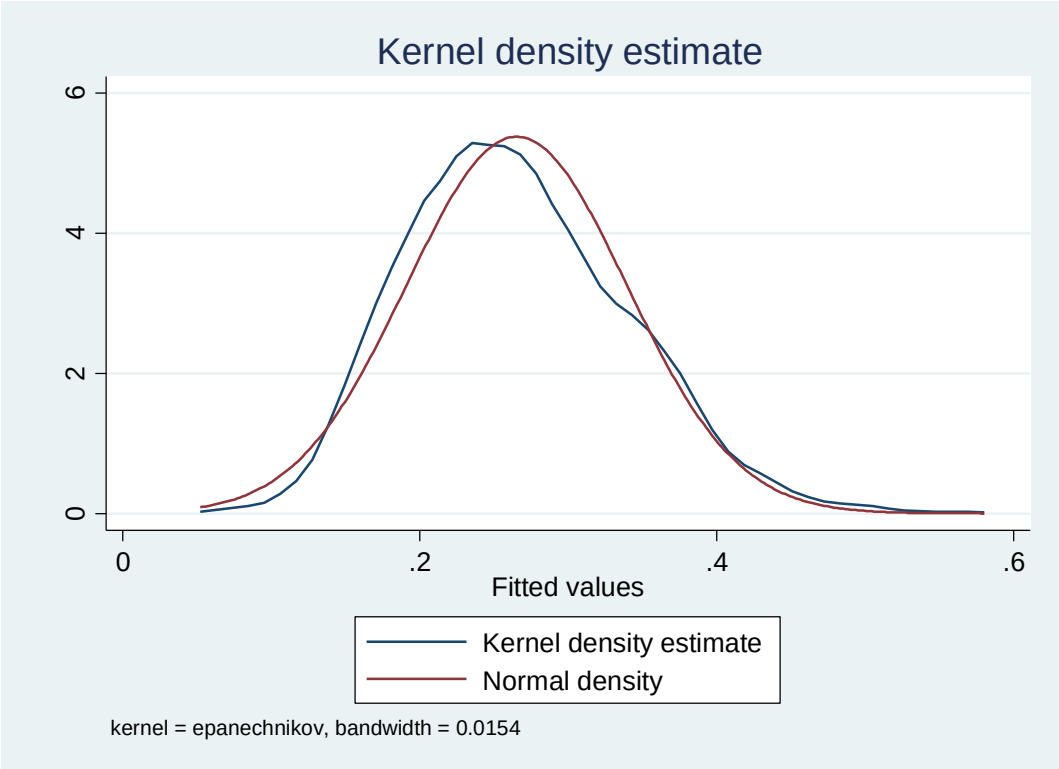
Source: Research's Computation

Appendix 3: Test for Heteroskedasticity

Test	Null Hypothesis (Ho)	Test Statistics	Prob>Chi^2
Breusch-Pagan/Cook Weisberg test for heteroskedasticity	Constant Variance	Chi2(1) = 1.83	0.1764

Source: Research's Computation

Appendix 4: Test for Normality



Source: Research's Computation

Appendix 5: Test for Model Specification

Test	Null Hypothesis (Ho)	Test Statistics	Prob>Chi^2
Ramsey RESET test	model has no omitted variables	F(3, 1536)= 1.22	0.3021

Source: Research's Computation