Accessibility of agricultural extension services and its impact on agricultural output a case study of Zambia

A Dissertation submitted in partial fulfilment of M Agric (Extension)

By

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DECLARATION

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ABSTRACT

Access to extension services plays a crucial role in connecting innovators with end-users across various sectors of the global economy. In the realm of agriculture, extension services act as a vital link between laboratories and farmers, translating complex technical language into a language comprehensible to farmers. However, the accessibility of extension services has been negatively affected by a low extension agent-to-farmer ratio, depriving farmers of the services they need. Furthermore, the long distances farmers often undertake to reach extension services (and vice versa) exacerbate the issue, limiting their overall access to extension services. It is imperative for farmers to have access to effective extension services since these services are essential for disseminating information and knowledge about technologies that can enhance crop production and promote diversity in farming practices.

This study uses Zambia as a case study to investigate the relationship between distance to the nearest extension offices (as a proxy for access to extension services), and crop diversity and production. The study uses data from the Rural Agriculture and Livelihood Survey (RALS) which covers 6,352 households and 66 districts across Zambia. The study employed a beta regression and Cobb-Douglas function to analyse the correlation between distances covered by farmers to reach extension offices and both crop diversity and production quantity, respectively. The lack of significant effect of distance to extension offices on crop diversity and crop production observed in this study suggests that extension services have no significant effect on both crop production and diversity. This could be due to the ineffectiveness of extension services attributed to the low ratio of extension agents to farmers, underscoring the importance of addressing this imbalance for improved effectiveness. However, the study observed a strong positive correlation between distances to tarmacs and crop diversity with every kilometre away from a tarmac resulting in a 0.001 (P-Value: 0.8256) unit increase in the crop diversity index suggesting the desire for food security and self-sufficiency among households located far from tarmacs. The study also highlights several factors influencing crop diversity and production, including household size, education, cultivated hectares, gender, age and farmer group membership.

In conclusion, the study emphasizes that distance to extension services alone does not significantly affect crop production and diversity. It calls for policy interventions to enhance the efficacy of the extension system by increasing the number of extension agents. Additionally, recognizing the influence of tarmacs and markets on crop production, policies should also consider strategies to improve farmers' proximity to these essential facilities.

Key words: extension services, distance to extension services, distance to tarmacs, Zambia , Crop diversity, Crop production, Food security.

DEDICATION

I am indebted and dedicate this effort to my parents, my wife, and most importantly, my daughter for their unending love, understanding, and encouragement. Their patience and support sustained me during the challenging moments of this academic journey. I want to thank my uncle, Dr. S. Hijazi, for his constant persuasion in continuing my education despite all the challenges.

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LIST OF ACRONYMS

8NDP	Eighth National Development Plan
AUDA-NEPAD	African Union Development Agency
BC	Before Christ
CDI	Crop Diversity Index
FISP	Farmer Input Support Programme
FRA	Food Reserve Agency
GFRAS	Global Forum for Rural Advisory Services
NAEASS	National Agricultural Extension and Advisory Services Strategy
NAT. LOG	Natural log
OLS	Ordinary Least Squares
RALS	Rural Agriculture and Livelihood Survey
RDA	Road Development Agency
SDGs	Sustainable Development Goals
UN	United Nations
VIFs	Variance Inflation Factor
WFP	World Food Programme
ZMW	Zambian Kwacha

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CHAPTER ONE: INTRODUCTION

1.1 Background

Access to extension services has gained a lot of attention in the different sectors of the global economy as it has become a bridge between innovators and end users (Ghimire et al., 2021). In agriculture, extension services bridge the gap between researchers, laboratories and farmers by breaking down technical language into a social language understood by farmers (Nedumaran and Ravi, 2019). Since laboratorists, owners of innovations and some of the researchers are not direct contact with farmers, extension agents also collect information and new challenges that farmers face and communicate them back to the researchers and laboratorists for further research. Furthermore, extension agents provides feedback from farmers on how the innovations would be working and any need for modifications (Jones and Kondylis, 2016). In this way, extension services facilitate effective communication and knowledge transfer, ensuring that farmers have the information and resources necessary to improve their agricultural practices.

The need for an agent linking the sources of innovations and the end users was observed even before the term agricultural extension was coined. Archaeological evidence shows that as far as 1800 BC, state actors in Mesopotamia provided advice to farmers on good agricultural practices such as irrigation and post-harvest loss (Mercier, 2018). In modern states such as the United States, extension work is said to have started around 1785 in Philadelphia where farmers were being given lessons on how to improve agricultural production (True, 1928). Over the years, the extension service has evolved and has had different names including university extension, extension movement, extension education, advisory services and agricultural advisory services with the use of the term determined by one’s understanding and purpose (Leeuwis, 2013, Mercier, 2018, Davis et al., 2020).

Although there is no agreed definition of extension in the present day, the understanding of its roles remains the same as the ancient understanding. Davis et al. (2020) define extension as “the entire set of organizations that support and facilitate people engaged in agricultural production to solve problems and to obtain information, skills, and technologies to improve their livelihoods and well-being.” In developing countries, agricultural extension means giving farmers knowledge of agronomical practices and techniques that improve livelihoods, food security and well-being (Syngenta foundation for sustainable agriculture, 2023). Recent years have criticised the term agricultural extension for viewing farmers and other producers as clientele through its top-down approach (Davis et al. (2020). As a result, the term agricultural extension is slowly being replaced by the term agricultural advisory services (Davis et al., 2020). Others criticised the term agricultural extension stating that it focuses on knowledge transfer for agriculture only as opposed to including other livelihoods and behaviours such as nutrition resulting in adopting terms "rural advisory services" and "nutrition and agricultural extension and advisory services" (Fanzo et al., 2015, Kuyper and Schneider, 2016).

Despite the recent improvement in understanding the role of agricultural extension, there is still a need to improve access to agricultural extension services by reducing the distances travelled by farmers to access the services. In certain parts of Africa, farmers cover an average of 16 kilometres to access agricultural extension services (Seward and Antwi, 2020). Additionally, extension agents service a large number of farmers suggesting that the quality of extension services could be compromised. Taking extension services closer to farmers could improve farmers' access to inputs, crop production and diversity among other advantages (Baba and Abdulai, 2021, Arslan et al., 2018, Lee et al., 2020, Seward and Antwi, 2020). According to studies conducted in Malawi and Ethiopia (Gebresilasse, 2023, Lee et al., 2023), the shorter the distance a farmer was located near a paved road the better the access to extension services.

Improving access to extension services, particularly among smallholder farmers could improve global food security. Currently, the global community is pursuing sustainable development goal number two which seeks to double agricultural production by 2030 (United Nations (UN), 2017). However, country-specific studies on access to agricultural extension could assist in advocating for policy changes for extension services and the government's commitment to investing in extension services. Therefore, this study uses the Zambian case to understand the relationship between access to agricultural extension and agricultural production measured as crop diversity and quantity produced.

1.2 Problem statement

Access to extension services is a critical component of agricultural production in Zambia, yet many farmers encounter significant obstacles in accessing these vital services. The ratio of one extension officer to 2000 farmers is evidence that there is insufficient access to extension services (Ministry of Agriculture, 2022). Ideally, an extension officer should serve between 400 and 500 farmers according to the World Bank's recommendations (Sennuga et al., 2020a, Ministry of Agriculture, 2022). With most farmers being sparsely located, covering more farmers than recommended implies that extension agents have to cover long distances to reach the farmers. Equally, farmers have to walk long distances to reach extension officers. A study by the Indaba Agricultural Policy Research Institute (2015) observed that smallholder farmers in Zambia often cover long distances, averaging 17 kilometres, to access extension services. The distances covered are even worse in remote areas such as North-Western provinces, where farmers may need to travel up to 40 kilometres. These challenges are more pronounced in Zambia compared to other African countries, where the average distance covered to access extension services is notably lower (Seward and Antwi, 2020).

In addition to the constraints on accessing extension services, Zambia's agriculture sector struggles with low productivity and monocropping, particularly among smallholder farmers. Using maize production as an example, most smallholders yield less than two and a half tonnes per hectare compared to the potential of 10 tonnes achieved by commercial farmers (Ministry of Agriculture, 2020). Several factors have been cited to contribute to this low productivity, including limited access to inputs, technology, finance, training, and the adverse effects of climate change (World Food Programme (WFP), 2020). Development partners such as the International Monetary Fund (IMF) advocate for improving access to extension services as a means to enhance farmer productivity, particularly in light of the challenges posed by climate change (International Monetary Fund. African Dept., 2023). Furthermore, monocropping, characterized by an over-reliance on maize production, poses significant risks to production stability, as the failure of the sole crop cultivated could lead to complete harvest failure. Extension services present an opportunity to promote crop diversity, thereby bolstering climate resilience and household nutrition (International Monetary Fund. African Dept., 2023, World Food Programme (WFP), 2020).

This study aimed to investigate the relationship between access to extension services, crop diversity, and crop production quantity in Zambia's agricultural sector. Drawing on similar studies conducted in Kenya (Mwololo et al., 2019), Ghana (Danso-Abbeam et al., 2018), Malawi (Lee et al., 2023) and Zimbabwe (Makate et al., 2016) which employed Tobit, Truncated Poisson, Cobb-Douglas production function, Fixed effects and Panel Autoregressive Distributed Lag Models to explore this relationship, this study will shed light on the critical role of extension services in enhancing agricultural productivity and promoting crop diversity.

The final result is for this study to advocate for increased government investment in an effective extension system to bolster food security and agricultural development in Zambia.

1.3 Objectives

The objective of this study was to assess the effect of farmer's access to extension services on crop diversity and production in Zambia.

1.3.1 Specific objectives

1. To determine the average distance farmers, travel to access public agricultural extension services, tarmac and markets
2. To determine the effect of distance to a public agricultural extension office on crop diversity and production.

1.4 Hypotheses

a. H1: β≠0; Farmers' distance to an extension office negatively affects crop diversity
b. H1: β≠0; Farmer' distance to an extension office negatively affects the quantity of crops produced by farmers

The justification of the above-stated hypotheses is that access to extension services increases farmers' access to information and technology (Wossen et al., 2017). Access to agriculture information and technology has increased crop production and diversity (Subramanian, 2021, Ndimbo et al., 2023, Onyeneke et al., 2023, Zheng et al., 2022). The justification also follows the findings of similar studies that argued that access to extension increases crop production and diversity (Mwololo et al., 2019, Danso-Abbeam et al., 2018, Lee et al., 2020, Makate et al., 2016, Lee et al., 2023).

1.5 Rationale

The importance of studying the role of access to extension services in crop production and diversity must be considered. Several studies have been conducted to understand the relationship between agricultural extension and crop production and diversity. Some of these studies were conducted in Kenya, Ghana, Malawi, and Zimbabwe (Mwololo et al., 2019, Danso-Abbeam et al., 2018, Lee et al., 2023, Makate et al., 2016). This study, with a different methodology, must be conducted to broaden the understanding of the role of agricultural extension in crop production and diversity. At the national or policy level, studying the Zambian context for which evidence is limited is crucial for the Zambian government and policy advocates. The results of this study could be used to back advocacy for increased investment in extension services to mitigate the current issues of concern in agriculture, such as climate change adaptation, productivity and diversity.

1.6 Outline of the dissertation

This dissertation started with Chapter One which provided a background to extension service and a brief history of agricultural extension. The problem statement was given stating in detail the major issues for which the study recommended solutions based on its findings. Following the statement of the problem, the objectives of the study were set out and the associated hypotheses were stated. Chapter Two covered literature related to this study. The Chapter started with an overview of agricultural extension and a theoretical justification of why proximity to extension services could be used as a proxy for access to agriculture services. The chapter also reviewed policies and challenges affecting agricultural extension at the global, continental and national levels were discussed in detail. In addition, the findings of similar studies that investigated the effect of agricultural extension on agriculture production and socioeconomic development together with their methodologies were discussed. Chapter three covered the methodology used to answer the objectives. The data, analysis procedures and models used in the study were discussed in the methodology chapter. Chapter four presented and discussed the results obtained from the analysis. In the final chapter, the study was concluded, and recommendations were provided.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter discusses literature related to the present study, focusing on access to extension services and its impact on crop diversity and quantity produced. The first section provides an overview of agricultural extension, while the second section links distance to extension services and access to extension services. The third section reviews international, continental, and national policies and how they support extension services. The fourth section examines studies and relevant literature on the connection between access to extension services and crop diversity and production. The chapter concludes by summarising methodologies employed in similar studies.

2.2 Overview of Agricultural Extension

Agricultural extension continues to be a critical element in the global agriculture sector, particularly in climate change and other challenges. Agricultural extension agents do not only transfer technology but also persuade farmers to adopt proven technologies (Hamasalih and Layeeq, 2023). In a country like Zambia, which is struggling with the severe effects of climate change, policy think tanks have contended that agricultural extension can persuade farmers to adopt climate-smart agriculture (PMRC 2020). Maka et al. (2019) also made a similar argument in the study conducted in the Eastern Cape of South Africa. Overall, the fruits of agricultural extension lead to increased productivity and income among farmers (Hamasalih and Layeeq, 2023). These benefits that result from agricultural extension have resulted in increased investment towards agricultural extension. This increased investment in agricultural extension has resulted in countries such as Ethiopia having an adequate extension agent-to-farmer ratio while in Uganda there has been an increase in private sector extension services (International Food Policy Research Institute, 2022).

Despite the critical role that agricultural extension plays in agricultural development, several factors affect the delivery of extension services rendering extension service delivery ineffective and inefficient. One of the most important challenges facing extension agents is the lack of competence to fully understand and explain the messages and information required to teach farmers (Asiedu-Darko, 2013, Antwi-Agyei and Stringer, 2021). Some of the methods of delivery of extension services are outdated and may not be compatible with current technology (Maoba, 2016). For example, some extension agents do not have smartphones and have poor internet access. In some cases, the methods used by extension agents are not participatory as observed by Asiedu-Darko (2013) in Ghana. Sometimes farmers prefer being consulted before, during and after the development of the technologies. Another very important challenge facing extension agents is the lack of adequate resources for them to execute their roles. Most extension agents are not provided with logistics such as transport yet they have to travel long distances to reach some of their farmers (Antwi-Agyei and Stringer, 2021). Also, the lack of resources such as audio-visual materials makes it challenging for extension agents to explain information clearly as some farmers learn by seeing pictures and videos (Antwi-Agyei and Stringer, 2021).

2.3 Proximity to extension services

Access to public services such as extension cannot be over-emphasised in the present day. In a country like Zambia, the reasonable distance to public services is a radius of five kilometres (Government of the Republic of Zambia, 2006). However, the World Bank through Transport & ICT Global Practice (2016) recommends a radius of two kilometres or accessing a public service within 30 minutes. The call for governments to invest in extension services by recruiting additional extension staff is meant to reduce the distance covered by farmers to reach extension services or extension service agents to reach farmers within an acceptable radius.

It is generally accepted that farmers closer to extension services are more likely to utilise information disseminated through extension services as observed by Mutambara et al. (2013) and Sumo et al. (2022). Developing countries could utilise extension services in their development agendas, as research has shown that proximity to extension services can contribute to socioeconomic progress (Mgalama, 2014, Sumo et al., 2022, Loki and Mdoda, 2023). One of the ways access to extension services can influence socioeconomic development is by providing farmers with easier access to new technologies and information, which can enhance agricultural productivity and, in turn, improve their income (Ranjan et al., 2024). Such information is vital for farmers to make informed decisions on production, pricing, and markets (Oakley and Garforth, 1985). Furthermore, extension services promote the adoption of advanced technologies by farmers (Wossen et al., 2015).

2.4 Farmer to extension staff ratio

One of the fundamental reasons for the inadequate access to extension services, especially among smallholder farmers, is the lack of sufficient extension staff in developing countries. The World Bank and other partners suggest that one extension agent should ideally serve between 400 and 500 farmers (Sennuga et al., 2020b, CESSA; Center of Excellence for Seed

Systems in Africa and AGRA Alliance for a Green Revolution in Africa , 2025). However, in many developing nations, the ratio of farmers to extension agents is excessively high, with a single officer responsible for a large number of farmers. In Africa, this ratio is particularly very high, with one extension agent serving between 2,000 and 10,000 farmers CESSA and AGRA, 2025). Zambia is one such country facing a very high farmer-to-extension ratio, leading the Ministry of Agriculture (2022) to recognize the necessity for more extension agents. These significant deviations from the ideal farmer-to-extension agent ratio may impact the quality and effectiveness of extension services, potentially resulting in poor adoption of agricultural technologies.

Agriculture constitutes a key livelihood source for over 75% of the rural households in Zambia. A total of 1,305, 783 households in Zambia are totally dependent on agriculture for their livelihood and are classified as agricultural households (CSO, 2000). Most (81.8%) of the population in agricultural households is based in rural areas of the country. Of the 1,305,783 agricultural households, 99.2% is engaged in crop production as a major agricultural activity. At national level, the sector's contribution to the gross domestic product (GDP) averaged over 18% in the past decade. The real growth rate in the sector has fluctuated significantly mainly due to heavy dependence on seasonal rain-fed crops, poor communication network and low farmer access to improved technologies that are resilient to some of the natural shocks such as drought, pests and diseases. Despite the evidence of the important contribution the sector makes to household food and nutrition security and the national economy, the sector faces a number of challenges to increased productivity. Other than the natural calamities and socio-economic factors such as access to agricultural inputs, credit facilities and markets, poor access to agricultural information remains a decisive challenge to increased agricultural productivity at household level. The prevailing low crop and livestock productivity among small-scale farmers could greatly be attributed to low farmer access to and utilization of agricultural technologies that are meant to enhance productivity. Utilization of such technologies has been poor among the illiterate farming community because such information is not available to such target groups in the right formats as some of the publications are either presented in a highly technical format which makes them too difficult to be understood by illiterate farmers. This situation is further worsened by the poor, inadequate and weak communication links between research, extension and farmers (Darlington Kahilu, 2011)

2.5 Extension service in global, continental and national policies

The global community recognises that access to extension services can contribute to the achievement of most Sustainable Development Goals (SDGs) (Davis, 2016). This is because extension plays a role in knowledge transfer between the innovators and the end users (Allahyari and Sadeghzadeh, 2020). For example, in the case of SDG two (zero hunger), extension services transfer agricultural knowledge from researchers and innovators to farmers in order to enhance agricultural productivity (Allahyari and Sadeghzadeh, 2020, United Nations (UN), 2015). Extension service can also contribute to SDG 13 (climate action) by promoting climate adaptation strategies that reduce the impact of climate change on agriculture production. Maponya and Mpandeli (2013) found a strong association between agriculture production and climate change information and adaptation strategies. An association of extension professionals through the Global Forum for Rural Advisory Services (GFRAS) recently developed a 10-year strategic framework and five-year operational plan. The two documents launched are to ensure that extension services at individual, organisation and system levels contribute to SDGs (Davis, 2016).

In Africa, policymakers at the continent level also understand that an effective extension service is crucial for the attainment of Modern Agriculture for increased productivity and production as stated in goal five of Agenda 63. The African Union Development Agency (AUDA-NEPAD) (2022) views extension as a vehicle through which the knowledge capacity of farmers can be built in response to challenges such as climate change and low productivity. The advent of technology such as smartphones is enabling farmers to access information on weather patterns, agro-markets, pests and diseases (Mtega and Msungu, 2013). Success stories of farmers' access to extension services have emerged from Kenya and Tanzania (African Union Development Agency (AUDA-NEPAD), 2022).

Meanwhile, extension services in Zambia's agriculture sector have been supported by five-year policies. The Eighth National Development Plan (8NDP) recognises agricultural extension as a strategy key to improving agricultural production and productivity (Government of the Republic of Zambia, 2021). The Second National Agriculture Policy launched in 2016 aims to improve the efficiency and effectiveness of the current extension service by retraining and providing resources to the extension agents (Ministry of Agriculture, 2016b). In 2016, the Ministry of Agriculture also the National Agricultural Extension and Advisory Services Strategy (NAEASS) whose overall objective was to develop an effective extension service to disseminate information and technology about sustainable agriculture in Zambia (Ministry of

Agriculture, 2016a). However, the implementation of the NAEASS came to an end in 2020 with the successor policy yet to be launched. Like other national policies, there has been little monitoring of the policy with the evaluation yet to be conducted.

2.6 Effect of farmers' access to extension service on agricultural production

Several studies have been conducted to understand the relationship between farmers' access to extension and agricultural production. A study conducted in Northern Ghana found that farmers that had contact with extension agents had higher crop diversity compared to farmers without extension contact (Baba and Abdulai, 2021, Arslan et al., 2018). Similar studies in Ethiopia, Malawi and Zambia found farmers' access to extension services had a positive effect on crop diversity (Arslan et al., 2018, Keba and Kedir, 2020). Arslan et al. (2018) explained that farmers who had contact with extension agents are informed about the need to diversify crops as a resilience strategy. Mussema et al. (2015) also contended that the influence of extension service on crop diversity is through the advice that farmers receive on technologies, inputs and varieties of different crops. A study from Kenya observed that although access to extension increased farm diversity, the type of extension mattered (Mwololo et al., 2019). Government and private extension services increased farm diversity compared to extension services offered by Non-governmental organizations and other sources (Mwololo et al., 2019).

A study conducted in Uganda found that the number of extension contacts had a positive effect on rice production but not an effect on maize and beans (Lee et al., 2020). Similarly, a study by Argaw et al. (2023) in Uganda observed that extension service increased farmer productivity as it increased the knowledge of farmers on good agricultural practices such as pest and disease control and resulted in increased adoption of technologies. Danso-Abbeam et al. (2018)in Ghana found that participation in extension programmes did not influence maize productivity. Maize and beans were reported to be the dominant crops consumed in the study area, with the farmers already knowing how to produce the crops. Thus, the extension did not affect maize and bean production (Lee et al., 2020). However, an earlier study in the same country found that both distances to the extension centre and the types of extension service providers affected household crop productivity (Hasan et al., 2013). Longer distances to extension offices deterred farmers from accessing information required for crop production resulting in reduced crop productivity (Hasan et al., 2013). Studies conducted in India and Africa found that Information and Communication Technology (ICT) positively affected agricultural production (Subramanian, 2021, Onyeneke et al., 2023). It argued that ICT's influence on agricultural production results from the fact that digital technology eliminates information inefficiencies among farmers, leading to improved product knowledge.

Access to extension can also affect other socioeconomic and health indices. Access to extension services can reduce household poverty and vulnerability since agriculture plays a key role in assisting households in escaping poverty￼. Households with access to extension services have also been found to have higher farm incomes than households with poor access to extension services (Danso-Abbeam et al., 2018). Similarly, farmers with better access to extension services make more profit than their counterparts with poor access to extension services (Lee et al., 2020).

However, the positive impacts of extension service may not be realised if the extension service is ineffective. For instance, in Uganda Sebaggala and Matovu (2020) who observed no significant effect of access to extension on crop production argued that it was due to the ineffectiveness of the extension service. In countries like Zambia, crop diversity and production are below their potential due to farmer's over-dependence on the main staple, maize. The current form of the traditional Farmer Input Support Programme (FISP) and Food Reserve Agency (FRA) is maize centric which undermines crop diversity and production (Hichaambwa and Mofya-Mukuka, 2016, Chapoto et al., 2015).

2.7 Other factors affecting crop diversity and quantity of production

The impact of road and market accessibility on crop diversity and production varies across regions, presenting a nuanced picture. In Ghana, a 10 per cent expansion in the road network led to a one per cent boost in agricultural output (Benin et al., 2008). Also, Tamene and Megento (2017) observed increased crop productivity in households situated near all-season roads and major markets. The observed influence of roads and major markets on crop production was attributed to the easy transportation of farm inputs and products to reach markets (Benin et al., 2008, Abdi, 2004). However, Fungo et al. (2017) contested this perspective, asserting that the proximity of households to roads did not significantly affect crop quantity. They emphasized that the poor condition of roads during specific seasons diminished their influence on crop production. Market access played a crucial role in influencing crop diversity. Households located farther from markets tended to cultivate a more diverse range of crops to meet consumption needs and avoid transactional costs, as highlighted by Kissoly et al. (2018).

A study by Paltasingh and Goyari (2018) in India found that the education level of the household head increased the quantity of crops produced by a household. The study attributed the observed relationship to the improved access to knowledge that is associated with educated farmers. However, Kankwamba et al. (2013) observed that in Malawi, higher levels of education were associated with reduced crop diversity, as more educated farmers specialized in specific types of crops, while less educated farmers had a broader focus. Furthermore, Paltasingh and Goyari (2018) observed that the size of cultivated land positively correlated with crop production as households that cultivated larger hectarage enjoyed economies of scale and production efficiency. Agricultural production could also be affected by social dynamics, especially in cases where agricultural programmes are implemented through farmer groups. For instance, a study conducted in Nigeria argued that membership of farmer groups was not enough to influence agricultural production due to group challenges such as conflicts and favouritism (Liverpool-Tasie, 2014). Lawin and Tamini (2017) argued that the age of a household head or farmer can have a negative influence on crop diversity. Younger farmers are more likely to be educated, have better access to agricultural information—including crop diversity—and may be willing to experiment with new crops (Lawin and Tamini, 2017).

2.8 Conceptual Framework

The conceptual framework of this study was based on the understanding that the farmer's proximity to extension services improved the farmer's access to information and technology for crop production (Maake and Antwi, 2022). This enabled the farmers to have access to technologies such as better varieties that enhanced the quantity of crop produced (Oakley and Garforth, 1985, Sumo et al., 2022, Mutambara et al., 2013). However, there were other factors such as access to farm input and output markets (Ma et al., 2024) and better access to transport facilities such as roads (Wondemu, 2015). Proximity to all season transport facilities like roads increases access to extension services which consequently lead to improved production (Lee et al., 2020, Argaw et al., 2023, Lee et al., 2023). In addition, crop production and diversity are affected by socioeconomic factors, demographics and other factors. Figure 2.1 below summarises the conceptual framework of this study.

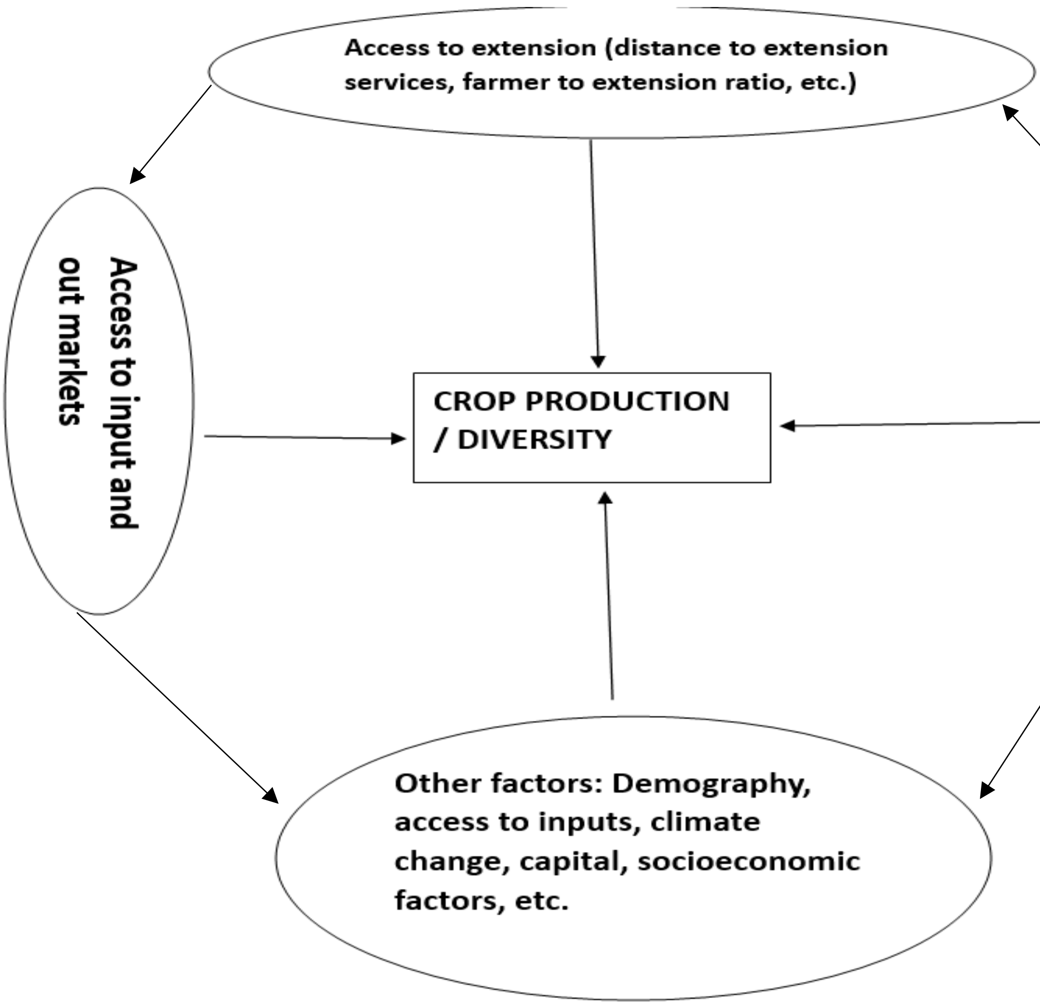

Figure 2.1: Study conceptual framework

Source: Author's understanding, 2024?

2.9 Statistical methods used by similar studies

The literature review showed that similar studies used different methodologies which are given in Table 2.1 below.

Table 2.1: Statistical analytical methods used by studies related to the effect of extension service on crop production and diversity

STUDY	STUDY LOCATION	DEPENDENT VARIABLE	METHODOLOGY	FACTORS FOUND SIGNIFICANT	RESULTS
BABA AND ABDULAI (2021)	Ghana	Herfindahl Index		occupation, technology adoption, labour, extension contact and farm size	Extension contacts significantly affected crop diversity.
Mwololo et al. (2019)	Kenya	Count of agriculture enterprises	truncated Poisson regression		Access to public and private extension services increased farm diversity.
Arslan et al. (2018)	Malawi and Zambia	diversification index		Age, household size, gender, land size, wealthy index, group membership, distance to the market, population density and number of extension agents in each district	Access to extension services has a positive relationship with crop diversity.
Lee et al. (2020)	Uganda	Quantity of crop produced	Cobb-Douglas production function	Number of extension contacts, gender, age, hired labour, fertiliser purchases and vehicle ownership	number of extension contacts had a positive effect on rice production but not effect on maize and beans
Hasan et al. (2013)	Uganda	Quantity of crop produced	Cobb-Douglas production function	Distance to extension centre, age, age squared, education, household size and training	distance to the extension centre and the types of extension service providers affected the household crop productivity

CHAPTER THREE: METHODOLOGY

The proposed study set out to understand the effect of agricultural extension services on agricultural production in Zambia.

3.1 Description of the study area

This study was conducted in Zambia, a landlocked Southern African country with 10 provinces. Of the 74 officially existing in 2015, 66 districts were included in this study. The location of the districts is shown on the map in **Error! Reference source not found.**. The selection of these districts was based on the availability of complete data required to execute this study. Additionally, many districts were selected to get a nationally representative picture with comparisons of access to extension services and the distribution of agricultural output. Furthermore, a national analysis provided a large sample size with advantages such as the preciseness of estimates (Biau et al., 2008).

3.2 Data sources

The study used the Rural Agricultural Livelihoods Survey (RALS) data collected from all ten provinces of Zambia by the Indaba Agricultural Policy Research Institute (IAPRI), a research institute based in Lusaka, Zambia. The RALS is a panel survey that has been conducted since the year 2012. The choice of the sample (in 2012) was based on the census of population and housing for 2010 with a stratified two-stage sampling design. Standard enumeration areas with at least 30 agricultural households were identified in the first stage. The second stage involved listing households in selected standard enumeration areas and stratifying the households into three groups based on crops grown, livestock raised and income. Systematic sampling was used to select 20 households distributed across the three groups in each standard enumeration area. In total, 8840 households were identified in 2012 while this was increased to 9520 households in 2015 (Indaba Agricultural Policy Research Institute, 2015). Data collected include demographics, socioeconomics, agriculture and livelihoods. The map below in **Error! Reference source not found.** shows the spotted distribution of the households that took part in the survey in 2015. In this study, the data will be cleaned by excluding data points with missing information on key variables and households not engaged in crop production. Through this process, the exact number of observations will be determined.

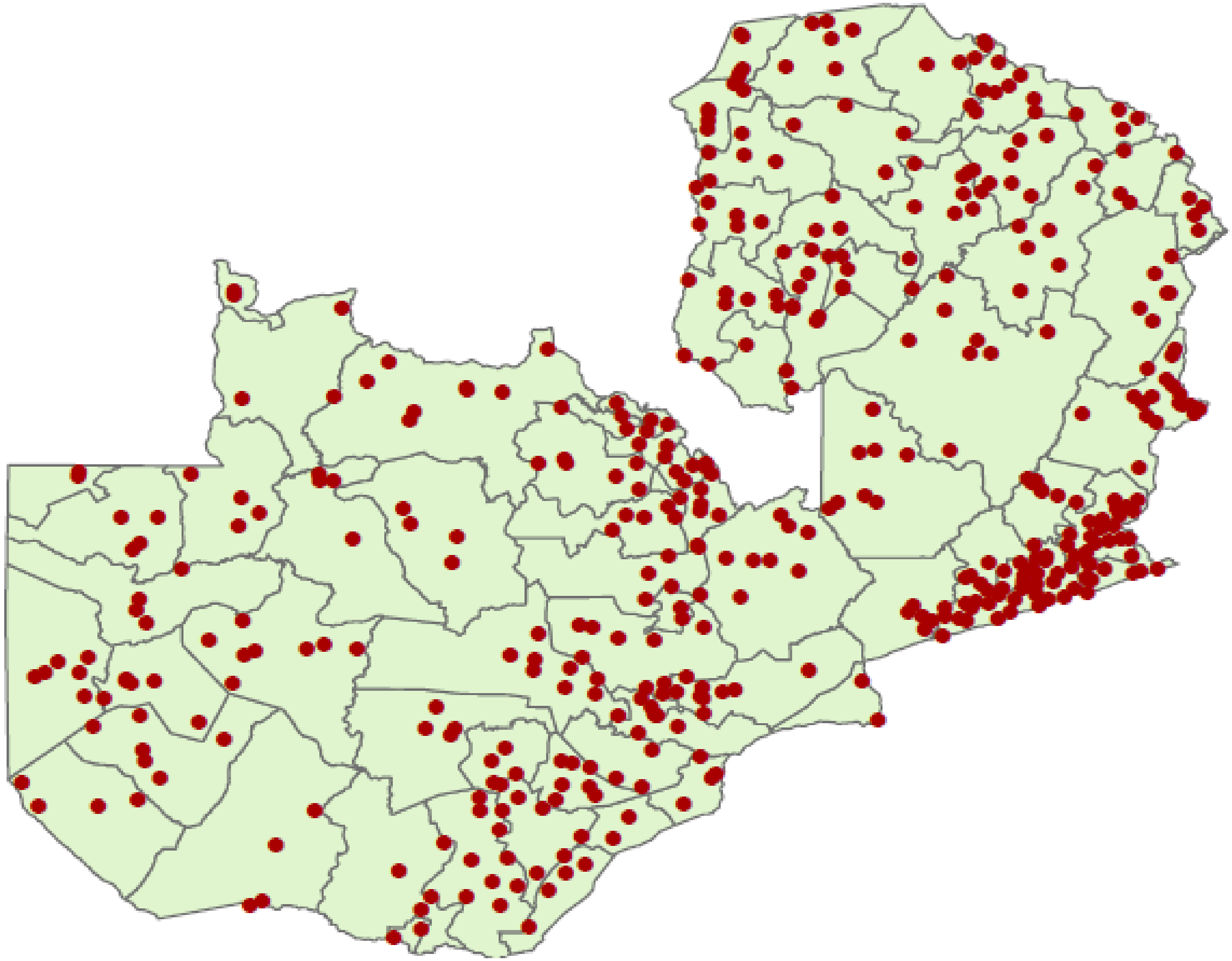

Figure 3.1: Location of households for RALS 2015

Source: Indaba Agricultural Policy Research Institute (2015)

3.3 Research Design, model and data analysis

3.3.1 Research design

This study employs a quantitative research design to investigate the impact of various factors on crop production. A cross-sectional approach is applied on the RALS 2015 data, allowing for the analysis of data at a specific point in time. This design is particularly effective for assessing relationships between variables and providing insights into the current state of agricultural practices.

3.3.2 Diagnostic checks

The data in the study was analysed using Stata 2017 and excel 2019. The analysis started by checking for outliers, multicollinearity and correlation before running models to ensure the quality of results. If not corrected, outliers can affect the magnitude of the coefficients of variables and the direction of the effect, i.e. positive or negative (Choi, 2009). Outliers were identified using boxplots and were corrected by the winsorisation method. Winsorisation was a preferred method to resolve outliers as opposed to other methods, such as deletion, to avoid loss of observations and maintain the statistical power of the data (Kang, 2013). Multicollinearity test was done using variance inflation factor method which was accompanied by spearman's correlation to check for any relationships between variables.

3.3.3 Data analysis and models

The study addressed each research objective as follows:

A. Objective one: To calculate the average distances a farmer travels to access agricultural extension services, markets and tarmac

This objective was addressed by calculating the mean of the distances reported by farmers as covered to reach the nearest extension office, market and tarmac. The following formula ($\text{Average distance to the nearest extension office} = \frac{\text{the sum of distances of all sampled households}}{Total\ number\ of\ households}$ Equation 3.1) was used:

$$\text{Average distance to the nearest extension office} = \frac{\text{the sum of distances of all sampled households}}{Total\ number\ of\ households} \quad \text{Equation 3.1}$$

The answer to this objective was reported as an aggregate average and supplemented by disaggregation by district. This provided information on which district has the longest distances covered by farmers to access offices or the most extended distances covered by extension agents to reach farmers. Additionally, distances to other public facilities such as feeder roads, tarmac, markets and boma offices were also reported to assess the level of remoteness for farming households.

B. Objective two: modelling the effect of distance to the nearest extension office on crop diversity

In modelling the effect of distance to the nearest extension block office on crop diversity, the study measured crop diversity using the Crop Diversity Index (CDI). CDI was determined using the following procedure.

.

$$P_i = \frac{A_i}{\sum A_i}$$ Equation 3.2

Where:

P_i Was the proportion of the ith crop

A_i Was the area in hectares covered by the ith crop

$\sum A_i$ Was the total cropped area

I=1, 2, 3, 4,.., nth crop

$HI = \sum P_i^2$ (Herfindahl Index) Equation 3.3

$CDI = 1 - HI$ (Crop diversification index) Equation 3.4

A. Source: Sichoongwe et al. (2014)

The values of the crop diversity index ranged from 0 to 1. The most suitable model for a dependent variable with a continuous variable ranging from 0 to 1 is the Beta regression. Traditional linear regression techniques like the ordinary least squares are not suitable for such data because they can produce predicted values outside the (0, 1) range. Beta regression overcomes this limitation by assuming that the response variable follows a beta distribution. It models the mean of the response variable as a function of the predictor variables, while also allowing for the modelling of the precision of the response.

$$y_i \sim Beta(\mu_i, \emptyset)$$ Equation 3.5

Where

- y_1 was the response variable (CDI) for observation of the i^{th}.
- μ_1 was the mean of the response variable, which is modelled as a function of the predictors:

$\mu_i = \alpha^{-1}(X_i, \beta)$ Equation 3.6

- Xi was the vector of predictor variables for i[th] observation.
- β was the vector of coefficients corresponding to the predictors.
- α was a link function (commonly the logit link).
- ϕ is the precision parameter, which can also be modelled as a function of predictor variables if needed.

C. $\alpha(\mu) = \log(\frac{\mu}{1-\mu})$ Equation 3.7

D. Objective two: modelling the effect of distance to the nearest extension office on the quantity of crop harvested

The study analysed the influence of household proximity to an extension block office on the total quantity of crops produced in the 2014/5 farming season. The quantity of crop produced in kilogrammes by a household was computed as follows:

$\text{Quantity of crop production}_i = crop_{1i} + crop_{2i} + crop_{3i} + \cdots + crop_{ni}$ Equation 3.8

Where the quantity of crop production is the summation of the quantities harvested by an i[th] household.

A Cobb-Douglas production function was used to determine the effect of distance to an extension office on the quantity of crop production. The general formula for the Cobb-Douglas function is expressed as:

$Y = AX_1^{\beta_1}X_2^{\beta_2}X_n^{\beta_n}$ Equation 3.9

Where Y is the output while X_1, X_2 and X_n are factors affecting output while A and β_1, β_2 and β_3 are constant. To suit the analysis of this study, Equation 3.10 above was transformed using a natural log resulting in the following equation.

$lnY = \delta + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_n lnX_n$ Equation 3.11

In analysing agricultural production where factors are substitutable, the Cobb-Douglas function becomes suitable compared to other functions that could be used to analyse production. Therefore, the Cobb-Douglas function was preferable in this study because it allowed for substitutability of factors (Reynès, 2017). For this reason, the related studies reviewed used the Cobb-Douglas function in analysing the relationship between access to agricultural extension and agricultural output.

3.3.4 Variables of study

The variables of the study were obtained from the literature reviewed. All variables that were found in the literature as affecting the dependent variables needed to be included in the models that were run to avoid endogeneity and other requirements that validate regression analysis (Fukushi et al., 2024). In other words, omitting certain regressors from the model would mean there would be a correlation between the error term and the dependent variable resulting in biased estimates or results (Hill et al., 2021). **Error! Reference source not found.** below shows the dependent and independent variables to be employed in modelling the relationships.

Table 3.1: List of independent variables to be used in the study

VARIABLE	DEFINITION	HYPOTHESIS (-/+)
Dependent variables		
Crop diversity index (CDI)	Index ranging from 0 to 1	
Quantity of crops harvested in kilogrammes	The sum of the quantities of all crops harvested by farmers	
Independent variables		
Age	Age in years of household head	-
Gender	1=Male 0=female	-
Household size	Number of household members	-
Kilometres to the nearest tarmac	Kilometres from a household to the nearest tarmac	-
Kilometres to nearest market	Kilometres from a household to the nearest market	-
Kilometres to nearest extension office	Kilometres from a household to the nearest extension office	-
Size of land cultivated (hectares)	Sum of hectares of land cultivated	-
Farm group membership	Farmer group membership 1=yes 0=No	-
Education level	0=up to grade 7 above grade 7 =1	-

3.4 Data validity and reliability

After data cleaning, diagnostic checks were conducted to ensure that the data was ready for analysis. If diagnostic checks were not conducted, the results were likely to be unreliable. Diagnostic checks in this study included checking and correcting for outliers and multicollinearity. The boxplot method detected the presence of outliers in several variables including age of the household head as shown in Figure 3.2. The process of winsorisation was applied to correct outliers as shown in Figure 3.3.

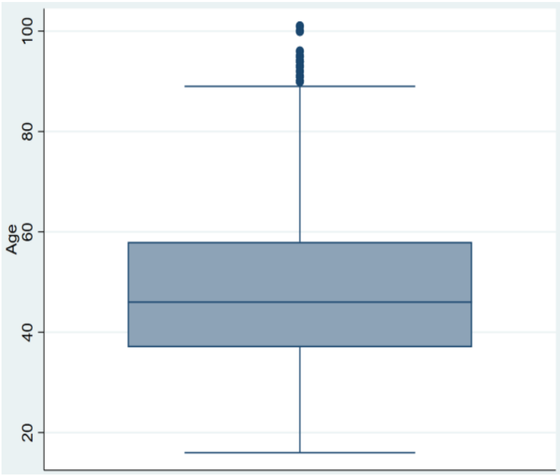

Figure 3.2: Boxplot for age before winsorisation

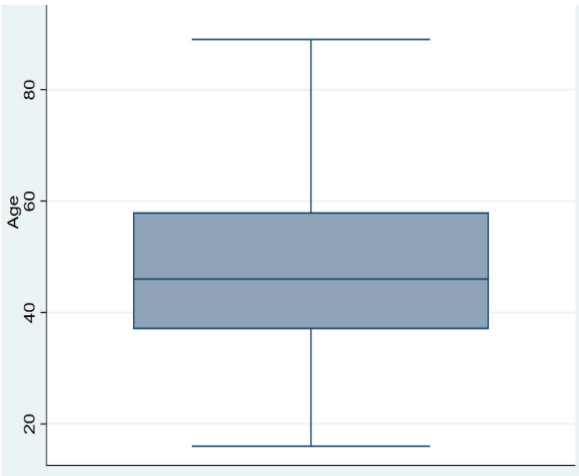

Figure 3.3: Boxplot for age after winsorisation

Source: RALS data, 2015

Correcting outliers meant that the data was clean and ready for analysis. The estimates of the models would be unreliable if multicollinearity and outliers were present but not corrected.

Multicollinearity was also checked before running models during data analysis. All variables had less than five Variable Inflation Factors (VIFs), indicating the absence of outliers. Table 3.2 below summarises the VIF values generated from the test for multicollinearity.

Table 3.2: Variable Inflation Factors

VARIABLE	VIF	1/VIF
Kilometres to the nearest market	1.34	0.75
Asset value kwacha	1.28	0.78
Kilometres to nearest tarmac	1.26	0.8
Size of land (hectares)	1.21	0.83
Kilometres to nearest block office	1.21	0.83
Household size	1.16	0.86
Education level	1.12	0.89
Farm group membership	1.12	0.9
Gender	1.11	0.9
Age	1.07	0.93
Mean vif	1.19	.

Source: RALS data, 2015

Spearman correlation was also used to check for relationships between the independent variables. The correlation coefficients given in APPENDIX E were all lower than 0.5 which implied that there was no significant relationship between the independent variables selected for the study. This observation was consistent with the findings in APPENDIX E in which no significant relationship was observed between the independent variables.

3.5 Ethical Approval

Ethical approval for the study was given by the Ethics committee of the University of Pretoria on 12th April 2024 under Protocol Number: NAS208/2023. All aspects of the study including methodology were included in the approval. Procedures were also followed to obtain the data from (IAPRI) the Indaba Agriculture Policy Research Institute, Zambia. The procedure included signing of consent forms that were going to ensure adherence to privacy of the data. And formal permission was obtained to use RALS (Rural Agricultural Livelihoods Survey, 2015) data, from IAPRI.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

This chapter presented and discussed the study's findings, addressing the goal of assessing how farmers' distance to extension services affected agricultural production. The first section addressed the second objective, determining the impact of access to extension services (measured as distance to a block office) on crop diversity. The second section explores the effect of access to extension services on yield (measured as a natural log of the quantity of maize produced). In the final section, the study was concluded, and recommendations were given based on the results obtained.

4.1 Descriptive statistics and the average distances covered to access extension services, markets, tarmacs and other public facilities

The finalised dataset, comprising 6,352 observations, represented households from 66 selected districts across the ten provinces of Zambia. A significant gender imbalance was observed, with 80 percent of the respondents being males, while females accounted for the remaining 20 percent. The predominance of male respondents indicated a potential bias in the representation of genders. In terms of age distribution, most respondents fell within the 35 to 65 years range, making up 65 percent of the total respondents. Youth (35 years and below) and individuals aged above 65 years constituted 20 percent and 15 percent of the respondents, respectively. The age distribution emphasizes a concentration of respondents within the working-age range (18-65 years), suggesting that this demographic group is more prevalent in the dataset, potentially influencing analyses focused on age-related factors. However, the smaller proportions of youth and older individuals might impact the generalizability of findings in these age categories.

In terms of household size, the majority ranged from five to eight members (average seven), constituting 55 percent of households, with the smallest household having one member and the largest accommodating 15 members. These findings shed light on the diverse range of household sizes in the sampled population, offering insights that could be pertinent for understanding socio-economic dynamics or planning interventions that account for varied household sizes.

The extension office, essential for agricultural services, was, on average, 14 kilometres away from households (see Table 4.1), suggesting that farmers or extension agents had to cover considerable distances to access or provide extension services, respectively. This is consistent with the observation that 71 percent of the households were at least five kilometres away from the nearest extension office as shown in Table 4.1.

Table 4.1: Access to extension to extension by radial distance from block office

RADIUS FROM THE NEAREST EXTENSION OFFICE	NO. HOUSEHOLDS	PERCENT
Within two kilometres	1,157	18.21
Above two kilmetres but less five kilometres	701	11.04
Five kilometres and above	4,494	70.75
Total	6,352	100

Source: RALS Data (2015)

Only 18 percent of the households were within a radius of two kilometres away from an extension block. These results suggest difficulties for farmers to access extension services due to longer distances between their farms and extension officers. Moreover, the results indicated that feeder roads where the nearest road infrastructure to households. A feeder road was approximately one kilometre away on average, showcasing a comparatively closer proximity than tarmacs which were located 25 kilometres away from households. The reliance on feeder roads suggests potential transport difficulties for farmers in seeking extension services during particularly in rainy seasons when most feeder roads become impassable.

The Boma office, another public facility was the furthest from a household with an average distance of 40 kilometres as shown in

Table *4.2*. Furthermore, output and input markets where distant from households suggesting challenges in household access to markets. Certain households in remote districts were even farther located from extension offices, markets, tarmac and boma offices with average distances of 40, 80, 95 and 114 kilometres. Given the substantial distances from crucial public facilities necessary for accessing services, the study suggested that households may encounter obstacles in achieving socioeconomic development through sustainable agriculture (The World Bank, 2016).

Table ***4.2*** below summarizes the distances from the nearest public facility for reference.

Table 4.2: Descriptive statistics of distances in kilometres to a nearest public facility

Variable	*Min*	*Mean*	*Std. Dev.*	*Max*
Kilometres to nearest boma	<1	39.70	29.75	114
Kilometres to nearest tarmac	<1	25.33	27.78	95
Kilometres to nearest market	<1	23.68	24.02	80
Kilometres to nearest feeder road	<1	1.14	1.81	5
Kilometres to nearest block office	<1	14.22	14.09	44

Source: RALS Data (2015)

4.2 Effect of access to extension services on crop diversity

The Crop Diversity Index (CDI) was employed to assess the level of crop diversity within households. CDI measured the extent to which the household diversified their crop production by growing different crops (see the list of crops in Appendix D). The values CDI ranged from 0 to 1 with zero indicating low crop diversity and 1 high crop diversity. The study revealed a mean CDI of 0.395, indicating a low level of crop diversity among the sampled households. Notably, 14% of the households exhibited a crop diversity index of 0, signifying cultivation of a single crop, while 6% had a CDI ranging from 0.7 to 0.839, denoting highest crop diversity. Mporokoso district had the highest crop diversity index with a mean CDI of 0.63 as shown in **Error! Reference source not found.**.

Beta regression analysis revealed that the proximity to an extension office did not influence the crop diversity index, suggesting no relationship between access to extension services and crop diversity. This implied that a farmer in close proximity to an extension office exhibited the same level of crop diversity as a farmer located farther away. The lack of a significant effect of proximity to extension offices could be due to the ineffectiveness of the extension system due to the huge numbers of farmers that extension officers serve (Sebaggala and Matovu, 2020). In Zambia, an extension agent serves at least 2000 farmers as opposed to the recommended 400 farmers. Furthermore, the ineffectiveness is worsened by the longer distances between the extension offices and farming households. Table 4.3 below summarises the results obtained from a beta regression involving crop diversity.

Table 4.3: Results of the Beta Regression for the effect of distance to an extension block office on crop diversity

VARIABLE	ESTIMATE	STD. ERROR	Z VALUE	PR(>|Z|)	
Intercept	-0.0035	0.0305	-0.1150	0.9083	
Age	-0.0007	0.0003	-2.2550	0.0241	*
Gender	-0.0098	0.0117	-0.8370	0.4027	
Household size	-0.0049	0.0017	-2.8390	0.0045	**
Kilometres to nearest tarmac	0.0010	0.0002	5.5220	0.0000	***
Kilometres to nearest market	0.0002	0.0002	1.1010	0.2709	
Kilometres to nearest block office	0.0002	0.0004	0.4670	0.6406	
Size of land (hectares)	0.0058	0.0015	3.7750	0.0002	***
Farm group membership	-0.0579	0.0098	-5.9270	0.0000	***
Education level	-0.0368	0.0103	-3.5650	0.0004	***

phi coefficients (phi model with identity link):

	Estimate	Std. Error	Z value	Pr(>|z|)	
(phi)	37.059	3.368	11.01	<2e-16	***

Exceedance parameter (extended-support xbetax model):

	Estimate	Std. Error	Z value	Pr(>|z|)	
Log(nu)	0.2216	0.0705	3.143	0.0017	**

Exceedance parameter nu: 1.2481
Type of estimator: ml (maximum likelihood)
Log-likelihood: -1398 on 12 df
Number of iterations in bfgs optimization: 46

Source: RALS Data (2015)

Similarly, the outcomes of the beta regression indicated that proximity to a market did not impact crop diversity, implying that farmers both near and far from markets had an equivalent level of crop diversity. The lack of a stronger effect of proximity to markets on crop diversity may be attributed to the influence of government programmes like the traditional Farmer Input Support Programme (FISP) and Food Reserve Agency (FRA). These programmes, primarily focused on subsidizing maize-related activities, have been identified as not supporting to crop diversity. Furthermore, the observation that proximity to a market does not affect crop diversity may stem from rural markets' failure to adequately meet farmers' needs, including the provision of farming inputs and output markets, as argued by Fungo et al. (2017). However, distance to a tarmac showed a strong positive relationship with household crop diversity increasing by 0.001 for each kilometre away from the tarmac. Increasing crop diversity is known to be a strategy used by households far from all-weather transport facilities, such as tarmacs, to ensure food and nutrition security, especially since access to food markets may be a challenge.

Similarly, land size exhibited a positive correlation with crop diversity, with an additional hectare translating to an increased crop diversity index of 0.006. The larger land size enabled farmers to allocate their land to a variety of crops, thereby fostering crop diversity. This positive influence of land size on crop diversity aligns with the findings of Li et al. (2021), reinforcing the significance of adequate agricultural land in promoting crop diversity. Intriguingly, membership in a farmer group, such as a cooperative, exhibited a counterintuitive trend by reducing crop diversity by 0.06. This unexpected finding may be attributed to the fact that most farmer groups were formed to access farm inputs through programmes like the Farmer Input Support Programme (FISP) or to sell products to the Food Reserve Agency (FRA). However, these programmes are biased toward maize, incentivizing farmers to engage in monocropping. Furthermore, the negative impact of farmer group membership on crop diversity could be explained by arguments posited by certain studies, suggesting that group membership may not be sufficient, as favouritism and unequal treatment based on interpersonal relationships might undermine the equitable distribution of resources within the group.

Possessing an education qualification better than primary education reduced crop diversity. Households with a household head who had any level of secondary education or better had a crop diversity index 0.04 higher than those households with heads having primary education or lower. This is consistent with the observation by Kankwamba et al. (2013), who contended that increased levels of education result in less crop diversity as more educated farmers tend to specialize in crop production. Also, the age of the household head had a negative effect on crop diversity, with each additional year in the age of the household head resulting in reduced crop diversity by 0.001. This is a similar observation to that made by Lawin and Tamini (2017), who justified the results as being due to increased education, access to information, and a willingness to take risks, such as trying new crops among young farmers. The study also observed a negative influence of household size on crop diversity suggesting increasing household size by one person reduced crop diversity by 0.005. This could be due to financial challenges associated with larger households which would reduce investment in different crops.

4.3 Effect of farmers' access to extension on crop yield

In the third objective, the study focused on investigating the impact of farmers' access to extension services on crop production, quantified as the natural log of the total crop quantity (in kilograms) harvested. On average, a farmer harvested 2.8 tonnes of crops during the farming season under review (2014/5). Itezhi-Tezhi district had the highest average quantity produced with a farmer producing about 4.5 tones as shown in **Error! Reference source not found.**. While some farmers consumed their produce, others sold a portion of their produce, with average sales per farmer being ZMW 8300. Farmers from Chingola district sold the most with a mean sale of ZMW 21700, whereas Mufulira farmers made an average of ZMW 4300 from crop sales. However, the data indicated low productivity among farmers. For instance, maize farmers, on average, produced 0.92 tonnes per hectare, falling below their potential of 10 tonnes per hectare achieved by commercial farmers and research stations.

The Cobb-Douglas function (Table 4.4) revealed no significant effect of access to extension services (measured by the distance covered to reach the nearest extension office) on the total crop quantity produced. This suggested that farmers, whether near or far from an extension office, yielded similar quantities of crops. These findings aligned with the observations of Sebaggala and Matovu (2020), who argued that inefficient extension services in Uganda had a non-significant effect on crop productivity. Zambia's poor extension agent-to-farmer ratio, as reported by the Ministry of Agriculture, has usually been attributed to inefficient extension services, leading to no significant impact on crop production, as observed in this study. Equally, the study noted no significant relationships between distances to the nearest tarmac and market and the quantity of crops produced by farmers. According to Fungo et al. (2017), markets in rural areas may not adequately meet the needs of farmers hence farmers utilise both distance and local markets, ultimately resulting in no effect on crop production.

Table 4.4: Results of the cobb-douglas model of the effect of farmers' access to extension on quantity of crop produced

VARIABLES	COEF.	P-VALUE	[95% CONF INTERVAL]		SIG
Age	-1.5603	0.4842	-5.9320	2.8114	
Gender	-353.7783	0.0000	-514.4983	-193.0582	***
Household size	78.8910	0.0000	55.7426	102.0394	***
Kilometres to nearest tarmac	-0.2800	0.8256	-2.7705	2.2106	
Kilometres to nearest market	1.0729	0.4791	-1.8988	4.0446	
Kilometres to nearest block office	0.5398	0.8258	-4.2663	5.3458	
Size of land (hectares)	314.2232	0.0000	293.4022	335.0443	***
Farm group membership	-1132.9386	0.0000	-1262.3366	-1003.5407	***
Education level	301.3039	0.0000	162.3470	440.2608	***
Constant	3068.5599	0.0000	2651.8820	3485.2378	***
Mean dependent var	2794.3540	SD dependent var	2873.7869		
R-squared	0.2400	Number of obs	6352.0000		
F-test	222.4714	Prob > F	0.0000		
Akaike Crit. (AIC)	117469.2033	Bayesian crit. (BIC)	117536.7685		

Source: RALS Data (2015)

The study revealed that male-headed households experienced lower agricultural production compared to female-headed households. Female-headed households produced 354 kilogramme of total crop production more than their male-headed counterparts. Additionally, the size of the household positively impacted crop production, with each additional member contributing to a 79 kilogramme increase. This observation was attributed to the availability of increased family labour in larger households compared to smaller ones.

Education also emerged as a significant factor influencing crop production. Farmers who had any education qualification better than primary produced 301 kg of crop more than their counterparts who had primary education. Education enhances access to information, aids decision-making, and promotes the adoption of technology in farming leading to increased crop production. Additionally, the size of cultivated land positively correlated with crop production, associated with economies of scale. Farmers cultivating larger areas experienced higher crop production, aligning with the concept of efficiency and scale in agricultural operations.

Surprisingly, membership in farmer groups, such as cooperatives, exhibited a negative impact on agricultural production. Group members produced one tone less than their counterparts who did not belong to any farmer group. This unexpected result may be attributed to challenges faced by these groups, such as governance issues, favouritism among members, and the lack of a clear establishment purpose as most of the farmer groups were established for purposes of receiving farming inputs under the Farmer Input Support Programme (FISP) rather than sharing knowledge.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Summary of results

Access to extension services has emerged as an important element of agricultural development, serving as a vital link between agricultural innovators and end-users. This connection plays a pivotal role in bridging the gap between the technical language of laboratories and the practical understanding of farmers. By simplifying complex information, extension services contribute to enhancing farmers' knowledge and facilitating the adoption of innovative practices. This study aimed to explore the correlation between farmers' distance to extension services and crop diversity and production.

The study revealed that, on average, farmers covered a significant distance of 14 kilometres to reach an extension office, indicating poor access, particularly in remote districts. While feeder roads were relatively closer to households (approximately one kilometre on average), critical infrastructures such as tarmacs, markets, and boma offices were located at distances of 25, 24, and 40 kilometres, respectively. This implied substantial challenges for farmers in accessing both input and output markets. However, the study did not find a significant effect of distance to extension services on either crop diversity or crop production quantities. This could be due to the ineffectiveness of the extension system in Zambia plagued with very low extension agent-to-farmer ratio. Therefore, the study rejected the hypotheses that distance to extension services affected crop production and diversity. The study also observed no significant impact of distance to markets on crop diversity which suggested that local markets did not adequately meet the needs of the farmers. Nonetheless, the study observed a strong effect of distance to tarmacs on crop diversity indicating that households far away from tarmacs found it challenging to reach food markets where they could buy various nutritious foods. Such households relied on crop diversity to ensure food and nutrition security hence higher crop diversity.

However, the study observed no significant effect of distance markets and tarmacs on crop production. This suggested that farmers close tarmacs and markets harvested the same quantity of crops as the farmers who were farther away. The study also identified several factors significantly influencing both crop diversity and production, including household size, education, cultivated hectares, gender, age and farmer group membership.

5.2 Conclusion

In conclusion, while difficulties to access extension services was evident, its direct impact on crop diversity and production was not significant. The study suggests policy interventions such as employing more extension staff to increase the extension agent to farmer ratio. Furthermore, the government should consider implementing the e-voucher system and redefine the role of FRA to enhance crop diversity and production. Additionally, addressing challenges within farmer groups could potentially improve their contribution to agricultural development. In summary, the study draws the following conclusions from its findings:

A. The study observed difficulties to access extension services in Zambia, primarily due to extensive distances covered by farmers to reach extension offices or by extension agents to reach farmers. This challenge is particularly pronounced in remote districts, where the distances are notably extensive.

B. The study reveals that distances to extension services and markets do not significantly affect crop diversity and quantity of crop harvested while access to tarmacs does affect crop diversity. Crop diversity and quantity harvested was also found to be influenced by socioeconomic and demographic factors suggesting their crucial role in crop production.

5.3 Recommendations

Based on the above conclusions, the study makes the following recommendations:

A. Policy should address gaps affecting the efficiency of the extension services such as the longer distances between farmers and extension services. One of the solutions could be to employ more extension officers to reduce the distances travelled by farmers, thus improving the effectiveness of the extension service.

B. As government build tarmacs and markets closer to households, households in remote areas should be supported to increase crop production and diversity to ensure food security since tarmacs and markets are distant.

C. Cooperatives and other farmer groups should be supported to engage in other economic activities as opposed to focussing on receiving FISP inputs only.

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APPENDIX

Appendix A: Average distances to the nearest extension office by district

SN	DISTRICT	MEAN	MAX
1	Chadiza	9.42	30
2	Chama	13.20	44
3	Chibomb	17.42	44
4	Chienge	11.78	44
5	Chililabombwe	7.15	16
6	Chilubi	23.90	44
7	Chingola	18.13	44
8	Chinsali	24.58	44
9	Chipata	6.91	44
10	Choma	15.88	44
11	Chongwe	11.83	44
12	Gwembe	20.98	44
13	Isoka	17.57	44
14	Itezhi-tezhi	16.56	40
15	Kabompo	15.67	44
16	Kafue	13.29	44
17	Kalabo	19.23	44
18	Kalomo	16.44	44
19	Kalulushi	7.79	17
20	Kaoma	15.70	44
21	Kapiri-Mposhi	25.83	44
22	Kaputa	13.64	44
23	Kasama	13.01	44
24	Kasempa	8.05	44
25	Katete	12.29	44
26	Kawambwa	9.13	44
27	Kazungula	14.82	44
28	Luangwa	3.53	13
29	Luanshya	13.14	27
30	Lufwanyama	26.06	44
31	Lukulu	16.17	44
32	Lundazi	14.21	44
33	Luwingu	16.12	44
34	Mambwe	12.04	44
35	Mansa	11.12	44
36	Masaiti	10.26	44
37	Mazabuka	17.12	44
38	Mbala	15.94	44
39	Milenge	11.66	44
40	Mkushi	19.05	44
41	Mongu	17.30	44
42	Monze	11.06	44
43	Mpika	27.73	44
44	Mpongwe	8.77	35
45	Mporokoso	17.89	44
46	Mpulungu	11.32	44
47	Mufulira	8.42	20
48	Mufumbwe	11.89	44
49	Mumbwa	13.08	44
50	Mungwi	21.16	44
51	Mwense	11.65	44
52	Mwinilunga	27.01	44
53	Nakonde	15.63	44
54	Namwala	9.86	44
55	Nchelenge	9.29	44
56	Nyimba	10.22	44
57	Petauke	11.89	44
58	Samfya	9.57	44
59	Senanga	25.69	44
60	Serenje	24.35	44
61	Sesheke	12.96	44
62	Shang'ombo	13.26	35
63	Siavonga	17.46	44
64	Sinazongwe	7.64	44
65	Solwezi	17.79	44
66	Zambezi	6.56	40

Source: RALS Data (2015)

Appendix B: Average quantities of crop produced by the district

SN	DISTRICT	MEAN	SN	DISTRICT	MEAN
1	Chadiza	3645.96	34	Mambwe	1617.25
2	Chama	1284.73	35	Mansa	2413.33
3	Chibomb	4021.24	36	Masaiti	2656.98
4	Chienge	2293.69	37	Mazabuka	3119.48
5	Chililabombwe	2089.28	38	Mbala	3440.79
6	Chilubi	3347.15	39	Milenge	2448.29
7	Chingola	2649.84	40	Mkushi	4031.94
8	Chinsali	2434.83	41	Mongu	2004.24
9	Chipata	2918.61	42	Monze	3184.38
10	Choma	4582.30	43	Mpika	2870.18
11	Chongwe	3139.49	44	Mpongwe	4293.17
12	Gwembe	1721.93	45	Mporokoso	1879.14
13	Isoka	2723.68	46	Mpulungu	3220.55
14	Itezhi-tezhi	4671.30	47	Mufulira	2780.42
15	Kabompo	2649.96	48	Mufumbwe	2429.95
16	Kafue	2975.47	49	Mumbwa	4344.74
17	Kalabo	1885.81	50	Mungwi	3033.08
18	Kalomo	3969.46	51	Mwense	1505.32
19	Kalulushi	1286.91	52	Mwinilunga	2717.62
20	Kaoma	2459.58	53	Nakonde	2933.39
21	Kapiri-Mposhi	4355.93	54	Namwala	3562.54
22	Kaputa	2076.89	55	Nchelenge	2299.38
23	Kasama	2132.73	56	Nyimba	3394.14
24	Kasempa	3486.72	57	Petauke	3169.61
25	Katete	2748.38	58	Samfya	2076.17
26	Kawambwa	2357.41	59	Senanga	1128.01
27	Kazungula	2880.87	60	Serenje	3380.89
28	Luangwa	1392.42	61	Sesheke	1250.30
29	Luanshya	3180.85	62	Shang'ombo	1260.84
30	Lufwanyama	2927.41	63	Siavonga	1127.55
31	Lukulu	814.24	64	Sinazongwe	1935.89
32	Lundazi	2706.86	65	Solwezi	1792.10
33	Luwingu	3110.12	66	Zambezi	2227.77

Source: RALS Data (2015)

Appendix C: Average crop diversity index by district

SN	DISTRICT	MEAN	SN	DISTRICT	MEAN
1	Chadiza	0.45	34	Mambwe	0.44
2	Chama	0.54	35	Mansa	0.46
3	Chibomb	0.26	36	Masaiti	0.26
4	Chienge	0.45	37	Mazabuka	0.24
5	Chililabombwe	0.25	38	Mbala	0.55
6	Chilubi	0.30	39	Milenge	0.45
7	Chingola	0.23	40	Mkushi	0.37
8	Chinsali	0.48	41	Mongu	0.30
9	Chipata	0.47	42	Monze	0.32
10	Choma	0.23	43	Mpika	0.43
11	Chongwe	0.21	44	Mpongwe	0.29
12	Gwembe	0.26	45	Mporokoso	0.62
13	Isoka	0.49	46	Mpulungu	0.41
14	Itezhi-tezhi	0.18	47	Mufulira	0.39
15	Kabompo	0.41	48	Mufumbwe	0.33
16	Kafue	0.14	49	Mumbwa	0.35
17	Kalabo	0.49	50	Mungwi	0.51
18	Kalomo	0.24	51	Mwense	0.44
19	Kalulushi	0.22	52	Mwinilunga	0.54
20	Kaoma	0.42	53	Nakonde	0.50
21	Kapiri-Mposhi	0.40	54	Namwala	0.28
22	Kaputa	0.46	55	Nchelenge	0.34
23	Kasama	0.52	56	Nyimba	0.40
24	Kasempa	0.25	57	Petauke	0.38
25	Katete	0.44	58	Samfya	0.38
26	Kawambwa	0.39	59	Senanga	0.36
27	Kazungula	0.34	60	Serenje	0.52
28	Luangwa	0.22	61	Sesheke	0.41
29	Luanshya	0.39	62	Shang'ombo	0.25
30	Lufwanyama	0.21	63	Siavonga	0.35
31	Lukulu	0.34	64	Sinazongwe	0.17
32	Lundazi	0.53	65	Solwezi	0.42
33	Luwingu	0.48	66	Zambezi	0.46

Source: RALS Data (2015)

Appendix D: List of crops grown by sampled

SN	CROP
1	Maize
2	Sorghum
3	Rice
4	Millet
5	Sunflower
6	Groundnuts
7	Soya beans
8	Seed cotton
9	Irish potato
10	Virginia tobacco
11	Burley tobacco
12	Mixed beans
13	Bambara nuts
14	Cowpeas
15	Velvet beans
16	Sweet potato-white
17	Cassava
18	Paprika
19	Sweet potato-orange
20	Popcorn
21	Sugarcane
22	Pigeon peas
23	Sesame seeds
24	Black Sun hemp
25	Red Sun hemp

APPENDIX E: SPEARMAN'S RANK CORRELATION COEFFICIENTS

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Kilometres to nearest market	1.00											
(2) Kilometres to nearest tarmac	0.39	1.00										
(3) Asset value kwacha ('000)	-0.10	-0.16	1.00									
(4) Size of land (hectares)	0.05	0.05	0.36	1.00								
(5) Kilometres to nearest block office	0.38	0.28	-0.09	0.02	1.00							
(6) Household size	0.02	-0.02	0.30	0.29	-0.03	1.00						
(7) Farm group membership	0.03	0.06	-0.31	-0.27	0.07	-0.18	1.00					
(8) Number of info sources	-0.12	-0.08	0.19	0.21	-0.09	0.10	-0.23	1.00				
(9) gender	-0.02	-0.03	-0.22	-0.22	-0.02	-0.21	0.09	-0.08	1.00			
(10) age	-0.04	-0.08	0.06	0.09	-0.03	0.07	-0.07	0.04	0.15	1.00		
(11) District road density	0.06	0.08	-0.12	0.00	0.03	-0.03	-0.03	-0.15	0.01	-0.04	1.00	
(12) Education level	-0.09	-0.10	0.25	0.10	-0.09	0.08	-0.11	0.06	-0.16	-0.14	-0.02	1.00
Spearman rho = -0.018												

Source: RALS data, 2015