PERFORMANCE OF THE SINGLE SPINE SYSTEM IN UGANDA, A CASE OF SMALL HOLDER CROP FARMERS IN BUHWEJU DISTRICT

Patience Nimushaba

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A DISSERTATION SUBMITTED TO THE FACULTY OF SCIENCE AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURE AND RURAL DEVELOPMENT OF UGANDA CHRISTIAN UNIVERSITY

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ABSTRACT

This study was conducted to assess the performance of the single spine system in Uganda, a case of smallholder crop farmers in Buhweju District". Despite, Uganda's reformation of her agricultural extension system to a single spine system, access to extension system has declined considerably over the years. Therefore, the study sought to establish the availability and accessibility of agricultural extension services to smallholder crop farmers. The study also intended to determine the adoption levels of agricultural technologies and how it could have been be affected by availability and accessibility of agricultural extension services. The study employed a cross sectional survey design and a sample of 393 crop farming households was selected using multistage sampling. The study employed key Informant Interviews and structured interview guides to collect data. Quantitative data was analysed using STATA version 16 to get descriptive and inferential statistics. The findings revealed that whereas extension services are readily available, it is not known to most crop farming households. As such, there is minimal level of accessibility. The Chi-square and Tobit regression model results reveled that, farmers' socioeconomic characteristics such as household income, labour, group belonging, credit access positively influence the availability and accessibility of extension services which in turn affects adoption levels of agricultural extension services. Therefore, policy makers should encourage collective action among farmers, improve access to credit, provide enough funding to extension service and convince farmers on the importance of agricultural extension services. Farmers need to seek opportunities for continuous learning and skill development.

DECLARATION

I Nimushaba Patience, hereby declare that this dissertation entitled **"PERFORMANCE OF THE SINGLE SPINE SYSTEM IN UGANDA, A CASE OF SMALL HOLDER CROP FARMERS IN BUHWEJU DISTRICT"** is my original work, it is not plagiarized and has not been submitted to any other institution for any award.

Signature:

Name: Nimushaba Patience

Research Student

Date: **16th March, 2024**

APPROVAL

This Research Dissertation titled **"PERFORMANCE OF THE SINGLE SPINE SYSTEM IN UGANDA, A CASE OF SMALL HOLDER CROP FARMERS IN BUHWEJU DISTRICT''"** has been submitted with my approval as the academic supervisor.

Signature: 

Name: Jeremy Waiswa (PhD)

Date: 19th March 2024

DEDICATION

I affectionately dedicate this research to my husband Muhwezi Abert, and my children;

Ahwera Pearl, Akampwera Pagiel, Aryampwera Padre and Ampwerire Palvin

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LIST OF ACRONYMS AND ABBREVIATIONS

ACODE: Advocates Coalition for Development and Environment

AEGS: Agriculture Extension Guidelines and Standards

AES: Agriculture Extension Services

AEOs: Agriculture Extension Officers

CAADP: Comprehensive Africa Agriculture Development Programme

Civil Society Organisations

DAES: Directorate of Agricultural Extension Services

FY: Financial Year

GDP: Gross Domestic Product

GOU: Government of Uganda

ITO: International Trade Organisation

MAAIF: Ministry of Agriculture Animal Industry and Fisheries

MDAs: Ministries, Departments and Agencies

MFPED: Ministry of Finance, Planning and Economic Development)

NAADS: National Agricultural Advisory Services

NAEP: National Agricultural Extension Policy

NAES: National Agricultural Extension Strategy

NGOs: Non-Governmental Organisations

OWC: Operation Wealth Creation

SSA: sub-Saharan Africa

SSAES: Single Spine Agricultural Extension System

UBOS: Uganda Bureau of statistics

USAID: United States Agency for International Development

CHAPTER ONE

GENERAL INTRODUCTION

1.1 Background of the Study

Globally, the role of agricultural extension in the transformation of the agriculture sector has been widely recognized. An ineffective agricultural extension system is probably the single most important factor limiting agriculture productivity (AfranaaKwapong & Nkonya 2015). A strong extension system enhances adoption of good practices through increasing farmers' access to knowledge /information and advice to new agricultural technologies and production practices (Barungi et al., 2016). Thus, contributing to improved agricultural productivity, food and nutritional security, increased household incomes (Ragasa & Mazunda, 2018). Sebaggala & Matovu (2020), further note that, a well-built, structured and functioning agricultural extension system is a prerequisite for increased agriculture productivity, as it guarantees the provision of timely, appropriate and quality extension services which increase farmers' knowledge, information and adoption of technology

Relatedly, agricultural extension systems globally have been changing due to technological development and emergency of new challenges that include; increasing world population (Blum & Cofini, 2020; FAO, 2019), reduction in the availability of water, increasing soil degradation and many others. These have necessitated immediate attention to increase agricultural production but sustainably. (FAO, 2014), hence change in the focus of extension service systems. However, Blum & Cofini (2020)

and Namyenya *et al*. (2022) revealed that, most developing countries have failed to establish effective agricultural extension systems.

In addition to the above, Uganda's Agricultural Extension System has been reformed several times so as to enhance agriculture production more especially crop production because more than half of Uganda's population especially rural households depend on growing and selling crops as their major source of food and income (Barungi *et al.*, 2017). Uganda has a high crop production potential because of low temperatures, bi-modal rainfall and fertile soils, which makes it favorable to a wide range of crops including; coffee sugarcanes, tea, plantain, beans, cassava, millet and many others. However, commercialization of the crop sector in Uganda is challenged by farmers' limited use of manures and fertilizer, low quality seeds, poor post-harvest handling, over dependency on rain fed crop production and many others which inhibit high quality and quality production (International Trade Organisation (ITO), 2022). This needs an effective agricultural extension system. However, despite the many reforms in agricultural extension, most farmers especially the small scale farmers have remained unreached (ACODE, 2020), inhibiting agricultural production and productivity.

In June 2014, Uganda changed its Agricultural extension system from the National Agricultural Advisory Services (NAADS) to the current system called "Single Spine system" (MFPED, 2019) to improve the provision of agricultural extension services. This led to the transfer the extension function from the National Agricultural Advisory Services (NAADS) to the mainstream Ministry of Agriculture Animal Industry and Fisheries (MAAIF), the creation of a Directorate of Agricultural Extension Services (DAES) and integration of the NAADS program into the local government production departments (MAAIF, 2016). According to Mushemeza (2023), the single spine system was conceptualized as a well-coordinated, harmonized, gender responsive, market oriented, decentralized, public sector-led pluralistic extension system. Its aim was to eliminate parallel institutional arrangements that emerged during the NAADS program implementation and building institutional capacity. This would result into different government departments and agencies and private prayers working together in a regulated manner in the provision of extension services to Ugandans that would lead to adoption of appropriate technologies by smallholder farmers. Hence move them from subsistence to commercial farming.

In addition to the above, according to MAAIF (2017), the provision of extension of agricultural extension services under the single spine pluralistic extension system consists of Directorate of Agricultural Extension Services (DAES), a decentralized local government public structure, technical directorates and agencies; and the non-state actors all providing extension services to farmers and other value chain actors in Uganda. The non-state actors are organizations or and institutions that are not government owned and managed. These include; Non-governmental organizations, private

companies and farmer organizations. At the national level, the Directorate of Agricultural Extension Services (DAES) is the agency assigned with extension services in Uganda and it is under the Ministry of Agriculture Animal Industry and Fisheries (MAAIF). The DAES was also given authority for leadership, management and coordination of both the public and private extension service providers and works with the technical directorates responsible for animal resources, crop resources, fisheries resources and Commodity Agencies. For example; Uganda Coffee Development Authority, Cotton Development Authority, and Dairy Development Authority. The technical directorates and agencies are mandated with bringing out technical information to the DAES. Which is then organized professionally for dissemination to extension service providers, farmers and other value chain actors.

In addition to the above, MAAIF (2017) and MAAIF (2016), further guided that, under the single spine extension system, the technical directorates and agencies were also mandated with the role of developing commodity-specific value chains. They are supposed to detail the types of extension services needed along the specific value chains; and work with DAES to ensure that farmers and other value chain actors along the specific value chains get relevant extension services. Finally, at the local government levels, government agricultural extension functions are carried out by staff stationed at the district and sub county levels. However, government agencies and directories also come in to give specific agricultural extension services to specific value chain actors according to the needs identified with in a district. On the side of non-state actors, different institutions, organizations and individuals are also accepted to

provide extension services under government guidelines and regulations. These may vary from district to district.

The provision of extension services under the single spine system was seen as a pillar of adoption of appropriate technologies that would help smallholder farmers' progress from subsistence to commercial agricultural using available and accessible agricultural extension services (MAAIF, 2017). However, it is not clear whether, this current extension service system has enhanced the provision of extension services. This can be evidenced by the availability and accessibility of the services. King (2019) observes that, availability of extension services deals with the existence of adequate extension services in terms of types of services required by the farmers and their quantity. Accessibility of extension services refers to reaching out and getting the services. This includes; physical, social, administrative and financial accessibility.

Related to the above, Boushey (2016) revealed that, it is when the right technologies are adopted, that the provision of extension service system is believed to have achieved its aim. Adoption in this aspect refers to an action accompanied by the purpose to use the new practices for as long as such new practices present an advantage over other alternative practices (Parston, 2015). This means that, for farmers to desire to use any practice that practice must prove to be worthwhile.

In 2016, the government of Uganda promised to have all the districts and sub-counties across the country fully staffed by 2020 in addition to giving them motorcycles. Also, the required funds were budgeted for and implementation guidelines were issued to the district and sub-county staff with a conditionality that 30% of releases were for

district level activities, and 70% for sub-county activities to enhance the provision of extension services by making agricultural extension services available, accessible for enhanced adoption of appropriate technologies leading to the transformation of the sector from subsistence to commercialized agriculture (MFPED, 2019). However, after six years, some of the challenges that extension service faced previously have remained (Mushemeza, 2023). Also, Tukahirwa *et.al*, (2020), noted that COVID-19 impacts on agriculture are still disturbing farmers requiring immediate attention from extension service. Also given the level of poverty among the smallholder farmers, one wonders if the single spine system is meeting its objectives hence the need for the study to assess the performance of the single spine agricultural extension system in Uganda, A case of smallholder crop farmers in Buhweju. Focus was placed on availability and accessibility of extension services under the single spine, adoption levels of agricultural technologies and how the available and accessible agricultural extension services affect adoption of appropriate agricultural technologies.

1.2 Statement of the Problem

Despite Uganda's reformation of her agricultural extension system in 2014 to improve the provision of agricultural extension services, access to these services in the country has declined considerably from 23.8% in 2016 (Kutesa *et al.*, 2018) to 21% in 2017 (UBOS, 2018), 12% in 2018 (UBOS, 2020), and 5% in 2019 (UBOS, 2021). Noteworthy is that, access to agricultural extension services wanes as you descend to remote areas across the country (Barungi, 2020). Consequently, this has led to very low agricultural productivity growth of 1.3% to 2.6%, which is far below the 6% per annum target of the

Maputo 2003 Comprehensive Africa Agriculture Development Programme (CAADP) (Sebaggala & Matovu, 2020). UBOS (2021) predicts a progressive decline in agricultural productivity if nothing is done to avert the situation. Despite this trend of events, most studies focusing on single spine system in Uganda, have dwelt on structures, methods, appropriateness and the performance of managers (Namyenya *et al.*, 2021), with limited or no assessment of the performance of single spine system in regard to delivery of extension services to farmers and facilitating adoption of appropriate technologies in Uganda creating a knowledge gap. As such, this study was purposed to assess the performance of the single spine system in Uganda: a case of Buhweju district. Focus here was placed on the availability, accessibility, usability of AES, adoption level of agricultural technologies and how those available and accessible agricultural extension services have affected the adoption of appropriate agricultural technologies.

1.3 Objectives of the Study

The main objective of the study was to assess the effectiveness of agricultural extension services provision to smallholder crop farmers in Buhweju district, Uganda. The specific objectives were;

1) To assess the availability and accessibility of agricultural extension services by smallholder crop farmers under the single spine system in Buhweju District.
2) To determine the adoption levels of agricultural extension technologies among smallholder crop farmers under the single spine system in Buhweju District.

3) To examine the effect of availability and accessibility extension services on adoption levels of agricultural extension practices among smallholder crop farmers under the single spine system in Buhweju District.

1.4 Research Questions

The study was guided by the following research questions:

1) What extension services are available to and accessible agricultural extension services by smallholder crop farmers under the single spine system in Buhweju district?
2) What is the adoption level of agricultural extension technologies among smallholder crop farmers under the single spine system in Buhweju district?
3) What is the effect of availability and accessibility of extension services on adoption levels of agricultural extension technologies among smallholder crop farmers under the single spine system in Buhweju district?

1.5 Scope of the study

The study was conducted in Buhweju District in the months of August, September and October, 2023 in the purposively selected sub counties of Bihanga, Karungu and Nyakashaka. Informed by Uganda Bureau of Statistics, (2017), Buhweju District is located in South Western Uganda, Ankore sub-region bordering Ibanda Distict in the North, Mbarara District in the East, Sheema District in the South East, Bushenyi District in the South and Rubirizi District in the West. It is at an elevation of 1,800m and approximately 310 Km by road South West of Kampala and has a total population of 120,720 people who belong to 24,912 households. Buhweju district was selected

because it is the district with the highest percentage of people living in rural areas and also with the highest percentage of population involved in agriculture in general and crop production in particular. There was also an information gap regarding the performance of extension service in this area which should be the focus of everyone.

The study examined the performance of single spine system in Uganda through a case of smallholder crop farmers in Buhweju District. This content scope was basically guided by the purpose of this study. This study only focused on agricultural extension services provided with in the year 2022. Uganda had a mission of transforming the agricultural sector from subsistence to commercial agriculture, which is competitive, profitable and sustainable by 2020. Access to quality agricultural extension and advisory services was thought to be the key route to mission (MAAIF, 2017). However, in 2020, Covid 19 come and destabilized the system some months to its estimated time of achievement of its aim and objectives (Tukahirwa *et. al*, 2020). Therefore, by 2022, it was hoped that the deliverables of the single spine system would be visible hence its performance.

1.6 Justification

A well-built and structured agricultural extension system is a fundamental requirement to increase farmers' adoption of good farming practices for increased productivity and sector development (Sebaggala & Matovu, 2020). Farmer's access to agricultural extension services in Uganda has declined with marked variations from 23.8% in 2016 (Kutesa et al., 2018) to 5% in 2019 (UBOS, 2021). This has resulted into poor farm productivity as a result of inadequate practical skills. However, Uganda had reformed her extension system to a single spine system to improve the provision of agricultural

extension services for increased farm productivity. Therefore, this study was necessary to assess the effectiveness of agricultural extension services provision to smallholder crop farmers in Buhweju district, Uganda met.

1.7 Significance of the study

The findings of the study will help MAAIF to know the progress of the single spine system as far as achieving the intended goal of promotion of application of appropriate information, knowledge, and technological innovations for commercialization of the sector is concerned.

Also the findings of this study will provide information to the Directorate of Agricultural Extension Services about the exact actors in the provision of agricultural extension and challenges they system faces so that solutions can be forged.

The study will provide the local government with information on what actually happens on ground in agricultural extension and what can be done to improve agriculture extension service for proper utilization by the farmers.

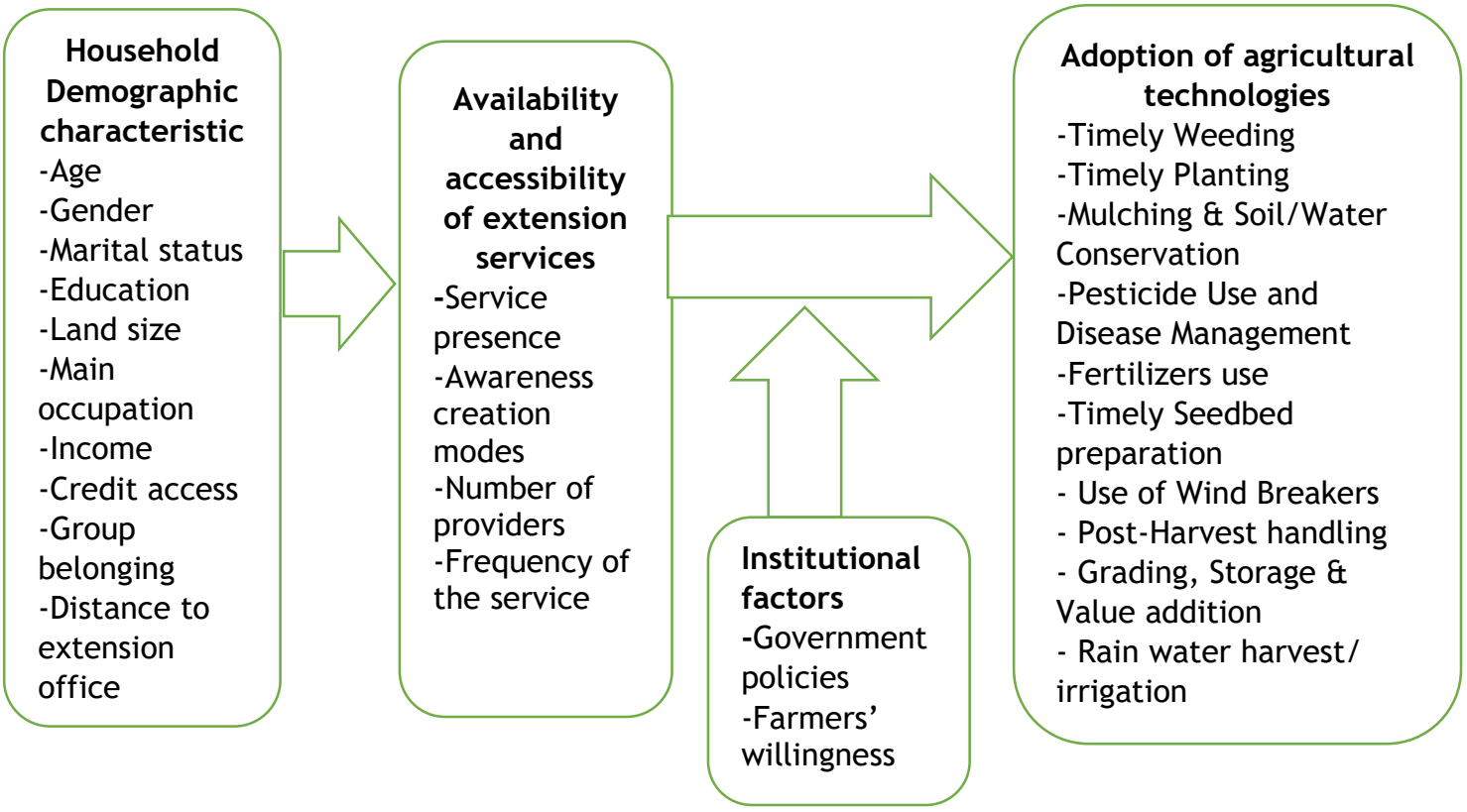
Finally, farmers will be helped to know the available and accessible extension services in their localities for proper access and benefit.

1.8 The conceptual framework

The conceptual framework is the diagrammatic relationship between the variables of the study. The study was conceptualized that social demographic characteristics of households, availability and accessibility of agricultural extension services as the

independent variable. On the other hand, adoption of agricultural extension technologies was conceptualized as the effect availability and accessibility of agricultural extension services by smallholder crop farming households with desirable social demographic characteristics. However, the study took into account institutional factors such that government policies and farmers' willingness to be intervening variables as shown in *figure 1*.

INDEPENDENT VARIABLE **DEPENDENT VARIABLE**



Source: Self conceptualized as guided by Knook et al., (2018)

Figure 1: conceptual framework

CHAPTER TWO

LITERATURE REVIEW

2.1 The nature of Agricultural extension services in sub-Saharan Africa

According to Nwafor *et al.;* (2021), agricultural extension service is a vehicle for *modernizing* agriculture in many sub-Saharan African (SSA) countries. It is aimed at transforming productivity while simultaneously meeting social and economic development objectives. However, Mutimba (2014) and Ugochukwu and Chinyelu (2020) reveled that, the structural setting and trend of AES in SSA is changing as a result of democracy, liberalization, decentralization, privatization and urbanization.

Evidence from many countries in SSA shows that agricultural extension services were considered a pro-poor public investment, necessary for rural development and economic growth, including large-scale poverty alleviation (Nwafor *et al.*; 2021). However, with time, in attempt to improve agricultural production, countries introduced innovative approaches to improve extension service (Mukembo & Edwards, 2015). This means that agricultural extension services are now a need of everyone involved in agriculture.

Several studies on agricultural extension services in SSA (Blitzer *et al.;* 2016; Davis & Frantzel, 2018; Norton & Alwang, 2020), have spotted that, currently, there are multiple players involved in the provision of agricultural extension services. These include the public and private providers that include; donor-funded actors, private companies and individuals, in put dealers, and many more. This means that most SSA countries have moved towards pluralistic agricultural extension systems which rely on

multiple players and funding mechanisms (Davis & Franzel, 2018). Norton & Alwang (2020) also noted that, there are changes in content and delivery models in most countries in Africa and these are clear signs of the changing nature of extension service. However, Debebe & Dagne (2018), observed that, although they are multiple providers, most farmers in SSA have no contact on regular basis with extension officers. Therefore, this study will find out the agricultural extension providers available and accessible to farmers and how far they have gone in AES delivery to smallholder farmers in Uganda particularly, Buhweju District.

Relatedly, research has revealed that, the government is the major provider of extension services across the countries in the region but in some instances, donors have supported national government in providing public AES through projects across different countries (Bitzer *et al.;* 2016). In addition, some countries in SSA, for example, South Africa, government is now transforming to cost-recovery by charging for the provision of extension services and in other countries, the public sector has been reformed to enhance extension service delivery (Abdu-Raheem & Worth, 2016). However, Nwafor *et al*. (2021), noted that government extension services have gaps in extension delivery, often failing to provide quality services to farmers. Empirical evidences on challenges of public extension service include; extension agents being incompetent (Davis & Terblanche, 2016), dominance of male extension officers (Msuya et al.; 2017), inadequate funds and other resources (Raidimi & Kabiti, 2017), as well as limited linkages between research and extension delivery (Amungwa, 2018). Therefore, this study will try to find out how far Ugandan government has gone in provision of extension services to farmers in Uganda.

In addition to the above, a review conducted by Ugochukwu and Chinyelu (2020) on extension services in SSA countries revealed that, the number of non-state extension providers is increasing in most countries in the region with different aims that include; meeting specific commodity value chains, promoting agribusiness, supporting commercial farmers among others. However, DLEC (2019), puzzled out that, most of these private extension providers deal with the rich and cash crop farmers leaving out the poor smallholder and over 60% of SSA's population are smallholder farmers (Goedde et al.; 2019). This means that most farmers do not benefit from the private sector although, the well to do farmers can in turn benefit some poor smallholder farmers as model farmers or through farmer field schools. Therefore, this study will find out from the farmers, the private providers available to them and if they have benefited from them.

The provision of extension services in some countries across the region has been simplified under the use of ICT and media (Aker, 2011; Deichmann *et al.;* 2016). For example, Farmers in Ghana are involved in development of the programmes with the help of experts in media, extension service and ICT. However, even with the use of modern digital methods, rural farmers may still find it difficult to access agricultural extension services. Therefore, this study will find out from crop farmers if they are using ICT to access extension services.

2. 2. The nature of agricultural extension services in Uganda

According to UBOS (2017) report, agriculture is still the major source of livelihoods for most Ugandans because 80% of Ugandan households were found to be engaged in

agricultural activities and 92% of those households were found to be living in rural areas and were smallholder farmers. However, despite this, the sector is faced with many challenges, that include; low agriculture production and productivity, climate change, limited use of fertilizers, lack of access to sustainable markets, lack of irrigation infrastructure, pests and diseases, poor postharvest handling, use of poor quality seeds among others (FEWSNet, 2021; Uganda country commercial guide, 2022). Hence limiting the productivity of the sector.

Agricultural extension service is the **"Heart and Soul"** of the Uganda's agriculture sector because it is the major source of knowledge and is considered one of the critical elements necessary for agricultural sector transformation (MAAIF, 2016). Sebaggala and Matovu (2020) further noted that, the provision of extension services is one of the avenues through which Uganda can effectively contribute to the growth of the agricultural sector and poverty reduction. However, Blum, Cofini, and Sulaiman, (2020), detected that, the performance of Uganda's agricultural extension systems has been always hindered by a series of challenges and constraints. Some of the challenges include; poor coordination and collaboration amongst actors, poor adoption of technologies and best practices; low extension coverage, ineffective methods and approaches, narrow extension content and inadequate funding among others. This means that, Uganda must try by all means to look for solutions to those identified problems for extension services to make an impact.

Relatedly, Uganda's agricultural extension system has been changed many times to make it appropriate since colonial times (Barungi *et al.*, 2016; MAAIF, 2016). However, despite the continuous reforms, research has revealed that, Uganda's agricultural

extension systems have proved to be mostly ineffective especially in reaching out to smallholder farmers (FAO, 2021). Also, Barungi, *et al.* (2016) divined that, the practical implementation of agricultural extension systems in Uganda has been inefficient and ineffective. AfranaaKwapong and Nkoya, (2015) also figured out that some categories of farmers, especially vulnerable groups like women, are not enabled to access and adopt improved farming practices. Therefore, Ugandan government should focus more on the implementation side of her agricultural extension systems.

According Barungi, *et al.* (2016) and Monk and Adrupio (2021), public extension service in Uganda started in 1898. Colonial masters imported cash crops and established research stations up to 1907. However, extension services were not very serious until 1920 to 1956, when administrative chiefs assisted by a few field officers and African instructors were brought in. Chiefs coerced farmers to practice good farming practices to produce raw materials for colonial masters and ensure food security. From 1956 to 1963 extension service was provided through progressive farmers. These were selected and given technical advice and support in form of credit and inputs. Other farmers learnt from the progressive farmers through demonstrations. This approach was effective in solving the challenge of high extension officer to farmer ratio however, many progressive farmers misused the support and could not help other farmers making the system ineffective.

In 1964, the extension methods approach was introduced where extension workers were trained professionals. This reform was very effective in promoting technology development and transfer (Monk and Adrupio, 2021). From 1972 up to 1980, was a dormant period due to political turmoil. This made 1981 to 1991 to be recovery period

and emphasis was put on restoration of infrastructure and major services. However, conflicts arose due to many parallel agricultural extension actors making the reform ineffective (Barungi, *et. Al*, 2016). This led to another reform of a unified that resulted into the creation of current MAAIF. However, this centralized unified extension system faced challenges of high AEO to farmer ratio, inadequate funding and centralised concentration of resources at the ministry headquarters among others, rendering it ineffective because it could not solve the farmers' challenges. Therefore, unified system was decentralised in the late 1990s in order to easily transfer extension services to local government for the benefit farmers. However, the decentralised Unified Agricultural Extension system also was faced with many challenges, which included; primarily budget constraints, high farmer to extension officer ratio, failure to respond to farmers needs among others (Monk and Adrupio, 2021). All these and many others rendered the reform completely ineffective and therefore, another reform had to be made in 2001.

In April 2001, the government of Uganda introduced NAADS to facilitate demand driven agricultural extension services. NAADS' major objective was to assist the poor smallholder farmers to be aware and adapt improved technology and management practices so as to increase farm production and productivity (Barungi *et al*, 2016) and it was planned to last for twenty five years (Monk & Adrupio, 2021)). NAADS enabled formation of village farmer groups and increased access to extension services in general (Barungi *et al.;* 2013). However, it was spotted that NAADS had not increased the use of improved technologies nor crop yield. Again, Turyahikayo & Kamagara (2016), revealed that, NAADS had several challenges that included; corruption, elite capture,

political influence and many others that rendered it ineffective. In addition, the previous unified agricultural extension system, public research institutions, education institutions, private providers and NGOs were working alongside NAADS creating confusion.

In order to streamline agriculture extension services and address the challenges of smallholder farmers, the government of Uganda reformed the agricultural extension system to a single spine system in June 2014 (MAAIF, 2016; MAAIF, 2017; MAAIF, 2019). This resulted into the transfer of agriculture extension function from the NAADS to the newly created Directorate of Agricultural Extension Services in the MAAIF. Under the same reform process, NAADS was given the role of input distribution and other complicated interventions. The reformed agricultural extension system was hoped to greatly improve agricultural production and productivity and progress of farmers from subsistence to commercial farming (MAAIF, 2016; MAAIF, 2019).

To give the single spine system a clear direction, MAAIF formulated the National Agricultural Extension Policy (NAEP) and National Agricultural Extension Strategy (NAES) which gave implementation plan, strategies and activities to be done and outputs to be generated. However, the actors, content, methods and approaches were not properly spelt out (MAAIF, 2016; MAAIF, 2019). This left the system hanging.

To respond to the above and also for proper implementation of the single spine system. The government of Uganda developed national agricultural extension guidelines and standards (AEGS) to be followed so that the different actors offer quality agricultural service to farmers and other value chain actors. The guidelines are the protocols that

all actors are supposed follow in undertaking their duties, while the standards are the set of clear and measurable public criteria that define the acceptable level of performance of monitoring and assessing extension services. The guidelines clearly spell out, the organizational structure (as shown in figure 2), guiding principles and roles of all the actors involved in extension service. They also state clearly how the numerous actors should to work together and how the government will regulate them for quality control in addition to how these actors can target the clients. Content, Farmer innovations and indigenous knowledge, approaches and methods, institution development, planning, monitoring, assessment and evaluation of agricultural extension services are also spelt out clearly (MAAIF, 2017). However, it is not clear whether these policies, regulations, guidelines and standards are followed and to which extent they are being adhered to hence the need for this study.

All these actions targeted establishment of an effective agricultural extension system that would increase agricultural production, productivity and profitability that would propel socio-economic transformation of smallholder farmers (MAAIF, 2019). However, a study conducted by FAO (2021), in northern Uganda, to find out if blended public-private extension provision increase farmer revenue, ascertained that, lack of coordination and collaboration among the providers is still hampering the provision of agricultural extension services. The actors in extension service delivery are still many, uncoordinated and operating on their own creating confusion and duplication. Also delivering of services by face-to-face methods is unsustainable amidst limited resources. Poor quality inputs especially seeds, inadequate water supply for production, slow flow of funds from the central government to districts as a result of poor budgeting

and accounting and many other challenges were also found to be challenging the single spine system. Therefore, this study found out if, similar challenges are being experienced so as to ascertain the performance of the system.

According to MAAIF (2017), for the single spine to achieve its intended objectives, officers at sub county level are expected to mobilize and register farmers into groups, do needs assessment, and plan appropriate trainings so as to help farmers and other value chain actors' benefit from agricultural extension services. They are also expected to train farmers in group formation and leadership skills, proper nutrition, planting of pest and disease resistant varieties and soil and water conservation for improved agricultural production and productivity. Demonstration of proper agronomic practices, proper post-harvest handling and marketing of produce was to be done by these government sub county extension workers. They are also expected to advise farmers on rain water harvesting, demonstrate simple irrigation technologies and conduct study tours for farmers (MAAIF, 2017). However, MFPED, (2019) revealed that, some of the planned state extension activities were not being achieved as a result of inadequate and inconsistent funding but did not indicate what was being done and what was not being done, Therefore, this study found out from farmers the exact activities being done on ground by the frontline workers in comparison to what was planned.

In relation to the above, in order to guide the activities of non-government actors, under the Single spine system, MAAIF set activities to be done by these private providers. These include; policy advocacy , mobilization of resources, supply of inputs, supporting postharvest handling, mobilizing farmers into groups, sensitizing and

training of farmers, supporting vulnerable groups, supporting capacity building in extension services in order to promote delivery of quality services (MAAIF, 2017; MAAIF, 2019). However, MFPED (2019) and ACODE (2020) noted that the activities of the non-state actors are unknown and therefore can be recognized creating gaps in service delivery. Therefore, this study discovered the exact activities done by the non-state actor if at all they exist.

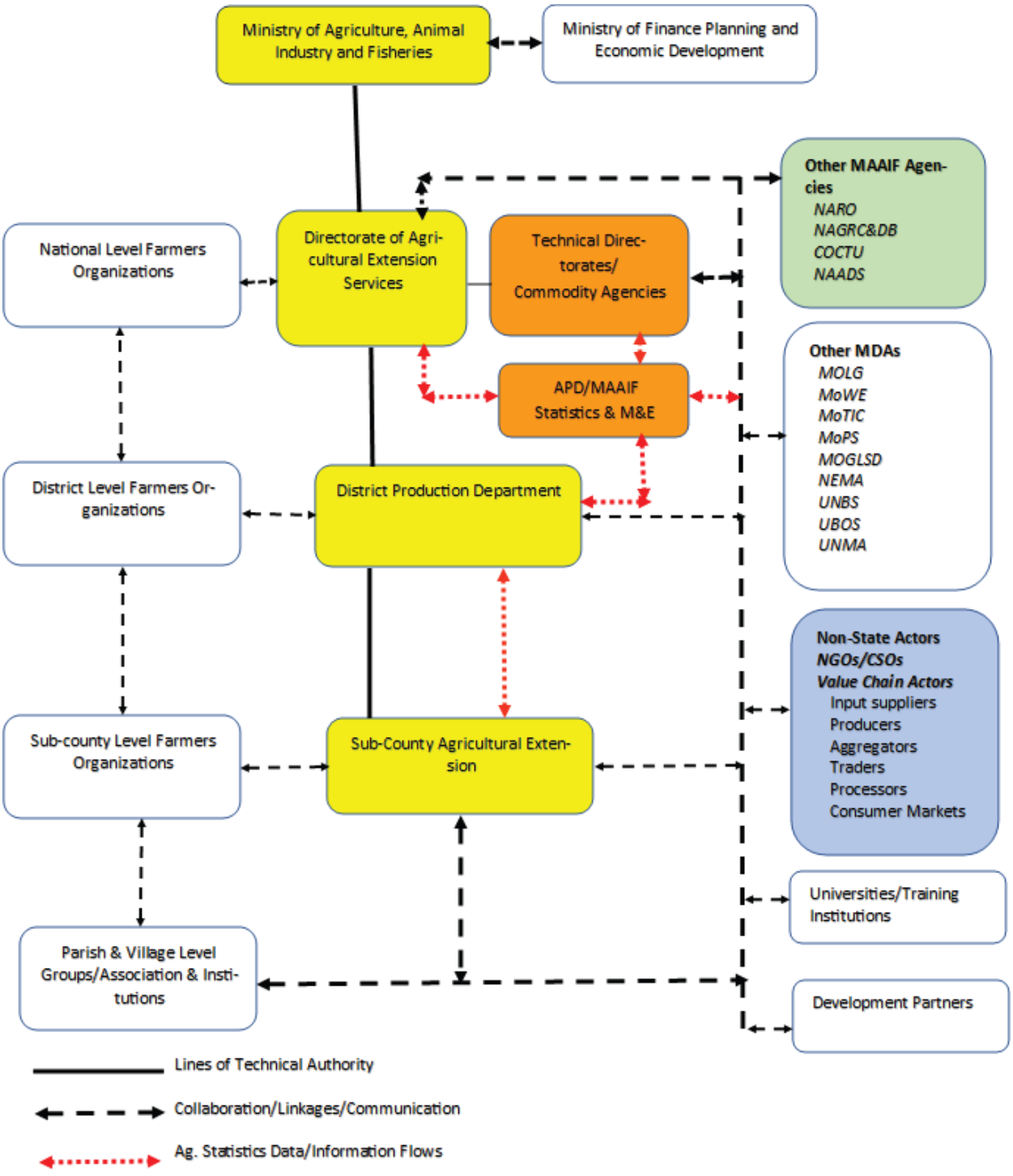


Figure 2: Organization structure of the national agriculture extension services

Source: MAAIF (2017)

2.3 Empirical studies on the need for agricultural extension services

Agricultural extension services are needed and exist throughout the world (Blum & Cofini, 2020) and their major function is to change farmers' behavior through extending new knowledge and technologies in non-formal settings in order to improve agriculture production and increase farmers' incomes (Leta *et al.;* 2017; Suvedi & Stoep, 2016). Thus helping farmers to improve their farming techniques and methods, increase production efficiency and income and lifting their standard of living (Agha et al.; 2018). Therefore agricultural extension services are necessary for life.

AfranaaKwapong & Nkonya (2015), observed that, agricultural extension services were first established with the major aim of achieving national food security through increased agricultural food production. However, FAO, (2019), ascertained that, today the focus of agricultural extension service has gone as far as improving farm efficiency and people's livelihoods. Suvedi & Stoep (2016), postulate and conclude that agricultural extension services are necessary to change farmers' practices through extending new knowledge and technologies. The new practices are usually focused on increasing or improving agricultural productivity.

Extension service serves as a link between agricultural research and farming communities by promoting the adoption of new practices (Agha *et al.;* 2018). Research has concluded that it is after adoption of the right practices that, extension service is credited for performing its duty. However, despite the efforts to promote adoption of the best agricultural practices through continuous reforms of extension service systems in Uganda, the adoption rate has always been very low (Pan et al.; 2018). So, it is

essential to understand the factors that influence the adoption practices. Therefore this study examined the factors that influence the adoption of practices advocated for by the single spine system.

Midamba, Kwesiga & Ouko (2023) detected that understanding the different factors affecting adoption and adoption levels of farmers is very vital in agriculture production. Mutyasira et al (2018) socioeconomic factors such as access to credit and off-farm income, household labor availability and livestock ownership increase the probability of adoption of agricultural practices. They further added that adoption levels can be increased by raising farmers' general awareness about the merits of the practices so that their perceptions and attitudes are drawn towards the new practice.

Furthermore, Priya, & Singh (2022) concluded that adoption levels depend many factors ranging from socio-economic, biophysical, institutional, financial, technical to psychological. However, Midamba, Kwesiga & Ouko (2023) noted that before adoption of an agricultural practice, the farmers need to be made aware of the practice through extension service. Then a farmer can evaluate it considering factors associated with the practice such as costs, relative advantage and others. Then, a farmer would then adopt the practice after being convinced that it is advantageous. Therefore, this study will add into the body of knowledge by explaining factors which affect adoption decisions and level of adoption of the single spine system practices.

2.4 Success of agricultural extension services

According to Birhanu Kalkidan & Alelign (2023), extension services have a positive and significant role on enhancing farm productivity. This is majorly through increasing

farmers' knowledge on application of agronomic practices such as pest and disease control and adoption of improved seed varieties as well as soil and water conservation technologies resulting increase in farm productivity. However, they revealed that for that to happen, it requires increased interaction and participation, adequate technical skills, proper use of services, strong linkages of research and extension and incentives among other. Therefore, governments need to improve the working conditions of extension workers.

Danso-Abbeam, Ehiakpor & Aidoo (2018), noted that extension services improve the welfare of farmers and other value chain actors through increasing incomes. However, for this to happen, governments should put more resources in the delivery of extension services to boost agricultural productivity, farm incomes and total household income. Also, farmers and other value chain actors should also be helped to access to agricultural credit and farmers should form farmer organizations. Therefore, this study found out if crop farmers have access to credit to enable them use agricultural extension services.

Farmers are diverse and even their needs and therefore, extension workers both government and private need to align their services to better serve the needs and respond in a more efficient and effective way to the demands of farmers (Bitzer, 2016). This requires collaboration between and among extension institutions, but also with all the actors involved in the delivery and support of AES (Blum & Cofini, 2020). However, extension providers in Uganda as a whole were found to work independently of each

other and in most instances, their activities unknown and unrecognized (MFPED, 2019). This has continuously hindered the success of extension service in Uganda.

In addition to the above, extension service to be considered a success, officers should provide demand-based knowledge in agronomic techniques and skills to improve production, income and quality of life of the population (Ijatuyi *et al.;* 2017). However, Sathish *et al.;* (2016) revealed that, that most public extension providers in many countries always provide low quality extension and untimely services according to farmers views hence reducing their demand. Devkota *et al*. (2016) noted that Agro-vets and farmers' cooperatives tend to offer quality services to farmers compared to the public. Hence, this study will find out from the farmers who provides quality extension services to them under the single spine system since there is no data on this variable.

According Babu *et al*. (2013), for the success of AES, agricultural technologies developed by research institutions must reach the farming communities. This necessitates linkages between research institutions, the private sector, extension workers and farmers. To achieve this, the government of Uganda promised to develop a sustainable mechanism for packaging and disseminating appropriate technologies to all categories of farmers and other beneficiaries in the agricultural sector using the single spine system (Blum & Cofini, 2020). However, it is not clear which technologies under the SSAES have so far been disseminated and utilized by the farmers. The study therefore seeks to establish the technologies that have been disseminated under the SSAES in the study area.

The main goal of extension services is for farmers to apply new knowledge, skills, and technologies. This includes learning how to operate new equipment, managing group projects, assessing technical advice economically, and improving farm management through record-keeping and resource allocation (Blum & Cofini, 2020; Srivetbodee & Igel, 2021). Therefore, it until the knowledge and skills are used, technologies adopted and farming practices adopted that extension is considered to be useful to the rural farmers and to the country in general. However, Hall (2019), noted that some farmers may not change their ways of farming even when they are taught the best ways to do it. Therefore, this study will also find out where farmers have reached in using knowledge, skills, inputs and adoption of technologies provided under the single spine extension system.

2.6 Conclusion and research gap

There is a vivid role for public, private, civil society organizations and all other extension service providers to work together in providing and receiving agricultural extension services to rural farm households within a broader agricultural innovation network. Uganda reformed its extension system to a single spine system to transform the sector from subsistence to commercialized agriculture using public led but pluralistic extension approach. However, it was not clear of who was actually involved in providing extension service, their distribution and the services they offer in the public led pluralistic setting hence the need to establish the availability of agricultural extension services. Also Midamba, Kwesiga & Ouko (2023), noted that, for farmers to access extension services, awareness must be created and it is not clear if farmers are

aware of the existing extension services so as to access them. Thus, this study also found out from smallholder crop farmers if they are aware of extension services within their reach.

In addition to the above, research has revealed that, for extension services to take route, farmers should have high access to extension services. However, UBOS (2021) spotted that access to agricultural extension in Uganda was declining with marked variations from 2016 to 2021. However, it was not clear if it was still declining or increasing and the factors to explain the trend. Therefore the need for the study.

Finally, studies have elucidated that, it is after adoption of the right practices that, extension service is credited for performing its duty. However, despite the efforts to promote adoption of the best agricultural practices through continuous reforms of extension service systems up to the single spine system. However, it was not clear, whether, this extension system has facilitated adoption of best practices, the level of adoption and the factors explaining the adoption levels.

CHAPTER THREE

METHODOLOGY

3.1 Research Design

This study employed a cross sectional survey research design. This involves studying the population at a particular point in time. In this study qualitative and quantitative approaches and techniques were used to collect and analyze data. According to Setia (2016), mixed methodology helps to eliminate errors that may arise from using a single method. It is also believed that the findings of the study become more credible because combining the two types of data helps to benefit from both the detailed, contextualized insights of qualitative data and the generalizable, externally valid insights of quantitative data.

The primary sources of information were interviews with farmers and key informants. The secondary sources of information were records kept by AEOs and the policy documents from government.

3.2 Area of Study

The research was conducted in Buhweju District. Informed by Uganda Bureau of Statistics, (2017), Buhweju District is located in South Western Uganda, Ankore sub-region (-0.45505 30.09690 -0.18557 30.51874) bordering Ibanda Distict in the North, Mbarara District in the East, Sheema District in the South East, Bushenyi Distict in the South and Rubirizi District in the West. The district has ten sub counties which are; Bihanga, Bitsya, Buhunga, Burere, Engaju, Karungu, Kyahenda, Nyakishana, Rubengye,

Rwengwe and three town councils which are Kashenyi-Kajani, Nsiika, Nyakashaka and Nyakaziba. It is approximately 310 Km by road South West of Kampala, has a total land area of 802 sq. km and it is an average elevation of 1,496 m above sea level. The district has a total population of 120,720 people who belong to 24,912 households. It also has a warm and overcast climate with temperature usually ranging from 59°F to 80°F throughout the year and temperature rarely falls below *57°F* or rises above 86°F. The district experiences mono-modal rainfall, with the wet season typically spanning from September to May and the dry season from May to September (www.weatherspark.com). Buhweju has been chosen due to a lack of information on agricultural extension effectiveness in existing literature, and UBOS (2017) highlights its significance, with 95.0% of households (23,661 out of 24,912) involved in agriculture, predominantly crop growing. Moreover, it has the highest rural population percentage (97.6%) and 89.5% of households depend on subsistence farming. Additionally, the education level is low, with 89.4% of individuals aged 15 and above having education below the ordinary levels. This means that the more effort should be put in this district as far as making AES available, accessible and usable so as to boost agricultural production particularly crop production in Uganda and in Buhweju Particularly which is now the major source of livelihood for almost all the people in the District.

3.3 Population and sampling techniques

The target population was farmers due to their role of receiving and implementing the extension services. The parent or primary population included all the crop farmers in Buhweju District and these are 23,414 crop farming households according to UBOS

(2017). The district production officer and the sub county agricultural officers were the key informants due to their key roles in providing extension services and supervising other actors.

To determine the sample size for this study, the formula provided by Yamane (1967), was used as follows:

$$n = \frac{N}{[1+N(e)^2]}$$

Where N= target population n = Sample size, e= degree of freedom/ Level of precision taking confidence level of 95% and margin of error of 5%. Therefore, from the formula, the study used a sample of 393 crop farming households drawn from 23,414 crop farming households in Buhweju district. The unit of analysis in this study was a household.

3.4. Sample selection

To select the sample of crop farming households, a multistage sampling procedure was used. In the first stage, Buhweju District was purposively selected because of being the district with the highest percentage of households involved in agricultural production in Uganda according to UBOS (2017). In the second stage, crop farmers were purposively because of being the majority compared to animal farmers. A total of 23,414 households out of 24,912 are engaged in crop growing making 94.0% of the total households compared to 16,810 (67.5%) households engaged livestock farming. Then, three sub counties were purposively selected basing on the intensity of agricultural production and from each sub county two parishes were purposively selected due to the intensity of agriculture production and from each parish two villages were randomly selected making a total of 12 villages. Finally systematic random sampling was used to select

393 households from the 12 villages. Here, crop farming households were listed and every fourth Household was selected. Each household was represented by one person preferably the household head or any adult found at home.

For the qualitative aspect, the study also used purposive sampling to select the District Production Officer (DPO) and the sub county AEOs. Purposive sampling was used to select the qualitative sample size members. These were selected because according to MAAIF (2017), agricultural extension services were decentralized to districts and sub counties. It's the districts that report to the directorate of agricultural extension services and the sub county agricultural extension officers are the frontline workers who engage with the farmers most.

3.5. Data Collection Methods and Instruments

The study utilized both primary and secondary data. Primary data was collected using face to face interviews conducted by well-trained enumerators using a well-designed household structured interview guide. Interviews were preferred because majority of the respondents were illiterate (UBOS, 2017) and therefore could not read and write. Secondary data was collected by reviewing other scholarly papers, reports and government publications.

The study employed Key Informant Interviews (KIIs) to collect qualitative data in the study area. The key informants were the district production and marketing officer and three sub county agricultural officers.

3.6 Quality Control

To make sure that credibility trustworthiness and rigour, are ensured, the researcher pretested the tools before using them. Data collected was kept on a computer with a password to avoid exposure to un authorized individuals. The researcher also endeavored to be honest and sincere so that trust worthiness was upheld. Also the researcher made ensure that enough data was collected for the study and all tools used were kept for future reference. Additionally as put out by (Baillie, 2015), some respondents and colleagues in research were used and allowed to cross-check the data collected and analysed to ensure quality and trustworthiness.

Closely observing the work of Creswell, (2014), a prior rapport was built between households and the researcher for a period of about two weeks to avoid reactivity effect. Tools were approved by the supervisors then piloted and tested to allow revision for data dependability. Also clearance was thought from the department and research ethical clearance was also thought from the research ethics committee of Uganda Christian University.

The researcher enhanced transferability by doing a thorough job of describing the research context and the assumptions that were central to the research problem. Also the researcher did a thick description of the data so as to transfer it well to similar settings.

To ensure conformability, the researcher made sure that the questions asked were clear and simple for participants to understand and comprehend. The researcher also made sure that respondents responded to questions in places with no interruption. Also respondents' views were captured as given.

Pre-testing of the research instruments was done to determine the reliability of the research instrument and that helped in re-designing of the instrument to improve the reliability and content validity of data. This was carried out on the population outside the respondents of the study. Face and content validity of the research instrument was tested by the research supervisor. Validity and reliability were determined to assess the credibility of the study. The reliability coefficient, often denoted as Cronbach's alpha (α), was calculated using a formula that considers the variance of the observed scores and the variance of the true scores, and it was 0.76 representing high reliability of the dataset. The scientific validity evidence is based on content, which can be gathered by having competent professionals who are familiar with the process of the survey to examine the items to judge whether they are appropriate for measuring what they are supposed to measure (Ary, Jacobs & Razavieh, 2002).

3.7 Data Analysis

Data was edited, cleaned and sorted. In handling the objectives one, STATA version 16 was used to obtain descriptive statistics such as means, percentages, Chi-square and t-tests. Qualitative data was were transcribed verbatim to avoid missing out most important information, then coded and analysed under different themes and categories that were of interest to the study objectives. Finally, direct quotations of individual responses that can explain the respondent's views and bring out their voices were identified and presented in the respondent's own words to give more insight into the issues under consideration.

For objective two, an adoption scale was developed and used using sigma scoring method and a Tobit regression model was used to determine the factors that affect adoption levels of agricultural technologies by crop farmers and for objective three. Farming households who were producing crops using recommended improved agronomic practices (improved seed, mineral fertilizer, spacing, post-harvest and storage management, harvesting method, application of herbicides and pesticides and weeding method) were considered as full adopters. Non-adopters were those were not using any of the technologies disseminated by government extension workers while partial adopters were those who used less than seven technologies disseminated. The farmers who fully adopted the technologies disseminated were scored 1; the ones who did not apply any of the elements of this technology were a scored 0. The rest of the farmers were scored between 0 and 1 in case a farmer had adopted only one or a few aspect of single spine extension technologies.

The model is explained as equation (1) as follows:

$$\boldsymbol{Y_{i^*} = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ij} + \varepsilon_i} \text{ ..... } \textbf{Equation (1)}$$

where Y_{i^*} is the latent variable representing the latent extent of adoption of the single spine agricultural extension technologies for household *i*, ßj are the coefficients to be estimated (*j* = 1, 2,..., *k*), x_{ij} are the explanatory variables, and ε_i is the random error term that is independently and normally distributed, with mean zero and constant variance $\delta^2(\varepsilon_i \epsilon N[0;\ \delta^2])$.

The observed variable Y_{i^*} represents the proportion of adoption of single spine extension services among farmers, which is expressed using the latent variable Y_{i^*} using equation (3) as follows:

$$Y_{i^*} = \begin{cases} 100 & if\ Y_{i^*} \geq 100 \\ Y_{i^*} & if\ 0 < Y_{i^*} < 100 \\ 0 & if\ Y_{i^*} \leq 0 \end{cases} \text{ ..... Equation (2)}$$

The Tobit regression coefficients are interpreted in the similar manner to Ordinary Least Squares (OLS) regression coefficients, except that the linear effect is on the latent variable, not the observed one.

$Yi^* = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \ldots\ldots\ldots\ldots + \beta n x n + \varepsilon_i$ ..... **equation (3)**

yi* is the dependent variable describing the farmers adoption levels of the improved SSAES technologies. Taking numeric values ranging from 1 to 0 where 1 for those adopting the whole package of technological practices as adopters, and 0 not applied any practice and the value between 1 to 0 for those applied any part of technological practices, x_i is a vector of variables explaining whether a farmer adopts single SSAES technologies and ε_i is the error term. The hypothesized list of variables includes gender of the household head, age of the household head, education of household head, and household's access to credit in the locality.

The Tobit regression equation is hypothesized with variables as follows:

Adoption or $Yi = \beta_0 + \beta_1 AGE + \beta_2 HSX + \beta_3 EDU + \beta_4$ HOUSEHOLDL $+ \beta_5 INC + \beta_6 SDP + \beta_7 FFS + \beta_8 HMS + \beta_9 HFS + \beta_{10} EXW + \beta_{11} FD + \beta_{12} HBF + \beta_{13} F2F + \beta_{14} IPS + \beta_{15} RH5 + \beta_{16} LF$ ..... **Eqn (4)**

Where;

B_0 = the intercept of the regression equation;

B_1- Ɓ16 = the parameter to be estimated;

AGE = Age group of the household head (measured by completed years of an individual);

HSX= Sex of the household head (1= Male, 0=female);

EDU= Education of the household head measure in years of schooling;

Household labour= Family labour (Number of individuals in the household who contribute their labour in the farming activities);

HMS= Marital status of the household head (1=marriage, 0= otherwise);

HFS= Household's farm size (measured in hectares);

EXW = Extension workers (1=Yes, No=0);

IPS= Input suppliers (1=Yes, No=0);

DP= demonstration plot (1=Yes, No=0);

FD=Field day (1=Yes, No=0);

F2F=Farmer to farmer (1=Yes, No=0);

INC= Household's income from other produce measured in Uganda shillings and

HBF= Household's membership in a farmer group (1=Yes, No=0)

3.8 Ethical considerations

The researcher submitted the data collection tools to the Research Ethics Committee (REC) for approval with the guidance of the supervisor. An introduction letter was then sought from the university and taken to relevant authorities in the area of study.

Obtaining informed consent shows respect for the participant's dignity and honesty (Laws & Mann, 2004). Informed consent was expressed verbally after the participants were informed about the purpose of the study. Consent was given voluntarily without

coercion and was renegotiable so that a respondent could withdraw at any stage of interaction.

The researcher ensured confidentiality of the information provided by participants. This was done by ensuring that there was awareness and sensitivity during the planning and data collection phases of research. The researcher assured that all respondents' information was kept private.

For this research, the respondents' identities were kept confidential since their names were not recorded during data collection but instead household IDs were used. Collected data was kept on a laptop with a password to avoid exposure to unauthorized persons.

Finally, all information got from studies and reports was cited and acknowledged to avoid plagiarism.

3.9 Limitations of the Study

The research study was limited in scope to Buhweju District leaving the rest of the districts where the SSAES is in operation and it was focused on only crop farmers leaving out other farmers who are also beneficiaries of the SSAES.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

4.1 Demographic Characteristics of crop farming households in Buhweju district

Households were asked some basic questions about their demographic and socio-economic characteristics. These questions included; the relationship of the respondent to household head, household head's gender, age, marital status, main occupation and highest school grade completed. Other questions asked were; household's experience in crop growing, location, size, number of productive children, number of household members engaged in other income generating activities besides farming, access to land for crop growing and land ownership. Also households were asked about main source of income, their access to credit, main loan sources and main purpose of seeking loans. Households who had not sought loans were also asked why they did not. Households were further asked if any their members belonged to any group dealing in production or marketing of crops and the main service they got from farmer groups and some of their responses are presented in the tables 4.1 and 4.2.

Table 4.1: Qualitative demographic household characteristics of crop farming households

		Percent (n=393)
Gender	Male	70.5
	Female	29.5
Occupation	Production of crops	91.1
	Production of livestock	1.0
	Salaried employment- government	3.3
	Salaried employment-private sector	1.5
	Casual laborer on-farm	3.1
Marital Status	Married	88.3
	Single	2.5
	Divorced	2.3

	Widowed	6.9
Highest Education level of the household head (Years)	Primary	56.8
	O' level	24
	A' level	11.9
	Bachelor degree	5.6
	Postgraduate	2.1

Source: Field data (2023)

Results presented in table 4.1 indicate that majority (70.5%) of the households are headed by males. This concurs with the findings of UBOS (2017) that, most households in Uganda are male headed.

As regards to the main occupation of the household head, the results in table 4.1 indicate that the main occupation of the biggest percentage (91.1%) of household heads is production of crops. This is in line with MAAIF (2017) which spotted that agriculture is still the heart and soul of Uganda as the main occupation of the household heat directly influences the main source of income of the family.

Results concerning the marital status of household heads indicate that majority (88.8%) of the household heads were married. This is supported by UBOS (2017) findings that most household heads in Uganda are married.

For the household heads' highest level of education, majority (56.8%) reported that they had stopped at primary level of education. This indicates that majority of the smallholder crop farmers in Buhweju district are less educated since they had stopped at the elementary level. This implies that they hardly have little knowledge about crop agriculture agronomic practices and tend to over rely on the traditional way of farming based on knowledge gained from parents and forefathers. This therefore justifies the relevance of agricultural extension services in Buhweju district.

As regards to household location, most of the households (72%) were rural, (19.1%) were urban while (8.9%) were peri-urban. This implies that most smallholder crop farmers in Buhweju district live in rural areas because crop farming requires adequate land for cultivation which is readily available in rural areas. This concurs with UBOS (2017), which spotted that the highest percentage of the population in Buhweju lives in rural areas.

Concerning access to credit, majority (55.5%) of the households reported having no access to credit. This concurs with the findings of Buyinza *et al* (2018), who spotted that, most people in Uganda have limited access to credit and this has continuously constrained the economic development of the country. Therefore, the government should support farmers to access credit at low interest rates and educate them how to use it for increased agriculture production and productivity.

Table 4.2: Quantitative demographic household characteristics of crop farming households

	N	Range	Min	Max	Mean	Std. Deviation
Age of the household head	393	75	15	90	44.4	14.92
Highest education level (years) of the household head	393	33	0	33	10.0	36.97
Farming experience of the household	393	54	1	55	25.4	30.90
Total number of household members	393	24	1	25	5.6	2.53
Unproductive children	393	10	0	10	1.8	1.80
Unproductive adults	393	8	0	8	0.6	1.28
Productive female adults	393	7	0	7	1.6	1.17
Productive male adults	393	8	0	8	1.4	1.05
Productive children	393	6	0	6	1.1	1.27
Male number engaged other activities	393	3	0	3	0.8	0.69
Female number engaged in other activities	393	4	0	4	0.6	0.79
Acreage planted (acres)	384	50	0	50	3.6	4.95
Amount of credit used yearly(Shillings)	393	4,000,000	0	4.000,000	282,608	377,712

Source: Field data (2023)

The quantitative results presented on table 4.2 indicate that all the smallholder farmers in Buhweju district are between the ages of 15-90 years where majority having been engaged in crop farming for 30-60 years with an average of 45 years (Mean=44.39±14.9 years). This indicates that most of the farmers are adults and mature people who seemingly have the required resources like land and capital to support crop production.

Most of the smallholder farmers had adequate experience in crop farming ranging from 8-40 years with an average of 24 years (Mean=24±16 years). This is quite a big experience in crop farming portraying adequate knowledge about crop farming and associated challenges.

The total number of household members' ranges from 1-25 members. However, majority of the households had total number of members ranging from 3-9 members with an average of 6 members (mean=5.6±2.5 members). This means that most households have a large number of members who can assist in crop farming by either directly involving them in cultivation and other agronomic practices or financing the activities to be undertaken by hired labour.

However, of the above household members, up to 4 members are often unproductive children (Mean=1.8 ±1.8 members) and up to 2 members are productive children (Mean = 1.1±1.3 members). Up to 2 members are unproductive adults (Mean = 1±1.3 members). Up to 3 members are either productive female adults (Mean = 1.6±1.2 members) or productive male adults (Mean = 1.43±1.1 members).

Up to 2 household members are males engaged in other activities other than crop farming (Mean = 0.8±0.69 members). One household member is a female engaged in other activities other than crop farming (Mean = 0.6±0.785 members).

Majority of the smallholder farmers have an acreage of less than 8.5 acres with an average of 4 acres (Mean = 3.55±4.95 members), reaping an annual income level of less than 660,000 Uganda Shillings with an average annual income level of 282,600 Uganda Shillings (Mean = 282600±377,700 Uganda Shillings).

4.2 Availability and accessibility of agricultural extension services under the single spine system

This section presents results on availability and accessibility of agricultural extension services.

4.2.1 Availability of agricultural extension services under the single spine system

In the first instance, a t-test was run for households that responded yes or no to availability of agricultural extension services with their continuous variables. The analysis aimed at determining the extent to which these variables are associated with the availability of extension services. The analysis of continuous variables for 393 farmers examined how age, farming experience, education, household labor, land size, income, and distance to extension offices influence the availability of extension services. The results are presented in table 4.3.

Table 4.3 Quantitative household demographic characteristics and availability of agricultural extension services

Continuous variables	Availability of extension services							
	(n=393)	No Mean(SD)	Yes Mean(SD)	Overall Mean(SD)	Median (Yes)	t-value	P-value	Sig
Age of household head (Years)	393	44(15)	45(14)	44.34(0.75)	42	-1.1	0.1	
Farming experience of the household(Years)	393	23(14)	22(13)	22(13)	20	0.3	0.392	
Education level of the household head (Years)	393	7(6)	9(4.)	8(5)	7	-3.1	0.001	***
Household labour (people)	393	4(2)	6(3)	4(3)	4	-3.3	0.000	***
Household Land size (acres)	391	2(2)	4(4)	3(3)	3	-6.0	0.000	***
Income of the household (UGX)	393	248980 (375892)	325711 (374855)	287443 (376857)	250,000	-2.0	0.021	***
Distance to extension office (Km)	393	5(6)	3(5)	3(5)	1.5	2.3	0.010	***

Source: Field data (2023)

Regarding age, household heads who said “Yes” to availability of agricultural extension services had a median of 42 years, with no significant difference between those with or said “No” to availability (t-value = -1.1, p = 0.1372), indicating that age does not play a crucial role in service availability. Similarly, farming experience, with a median of 20 years, showed no significant impact (t-value = 0.3, p = 0.3922), suggesting that experience does not affect whether farmers know the existence of agricultural extension services or not.

Education was a significant factor, with farmers “Yes” to availability of agricultural extension services having a higher median of 7 years of education compared to those “No” to availability of agricultural extension services. The t-value of -3.1 (p = 0.0010) demonstrates that more educated households are more likely to know the existence of agricultural extension services in their localities, supporting findings by Ragasa *et al*. (2016), who noted that higher education levels enhance farmers’ ability to seek agricultural knowledge hence . Household labor size also played a significant role, with households having a median of 4 people being more likely to know the existence of agricultural services within their localities (t-value = -3.3, p = 0.0006), likely due to their capacity to implement the practices recommended by extension workers.

Land size and income further influenced knowledge about agricultural extension service availability, with farmers who had larger landholdings (median = 3 acres) and higher incomes (median UGX 250,000) being significantly more likely to know the existence of extension services in their areas (t-values = -6.0, p = 0.0000 for land size, and -2.0, p = 0.0217 for income). Anderson and Feder (2017) also found that wealthier farmers tend

to know the existence of agricultural extension services, as they are better positioned to invest in modern agricultural practices which calls for more knowledge and skills. Lastly, farmers closer to extension offices (median distance = 2 km) had significantly better knowledge about their existence (t-value = 2.3, p = 0.0102), aligning with Birkhaeuser et al. (2018), who noted that proximity reduces travel costs and time hence improving increasing awareness.

Secondly, categorical variables were examined on how they influence availability of extension services and the results are presented in table 4.4. From table 4.4, data showed that among households who do not know the existence of extension services in their localities, 25% reported not having access to credit. This percentage suggests a substantial portion of these households face challenges in securing financial resources to support their farming operations. In contrast, among those who knew the existence of agricultural extension services, a significantly higher percentage of 74% reported having access to credit. This indicates a clear advantage of access to credit in agriculture. The chi-square value of 74 further confirms the strong relationship between credit access and extension services. The extremely low p-value less than 0.001, demonstrates that the association between these variables is statistically significant beyond reasonable doubt. In practical terms, this means that the likelihood of such a significant relationship occurring by random chance is highly improbable.

Table 4.4 Qualitative household demographic characteristics and availability of extension services

Variables	Availability of extension services				

		(n=393)						
		No % (freq.)	**Not sure % (freq.)**	**Yes % (freq.)**	**Overall % (freq.)**	**Chi square**	**P-value**	**Sig**
Credit Access (1=yes, 0=otherwise)		25(44)	1(1)	74(129)	44 (174)	75	0.0	***
Group belong (1=yes, 0=otherwise)		14(19)	1(1)	85(112)	34(132)	96	0.0	***
Gender of the household head	Male (1=yes, 0=otherwise)	42(117)	5(15)	52(145)	70(277)	3	0.2	
	Female (1=yes, 0=otherwise)	52 (60)	3(4)	45(52)	30(116)	3	0.2	
Marital status of the household head	Married (1=yes, 0=otherwise)	44(152)	4(15)	52(180)	88(347)	4	0.1	
	Single (1=yes, 0=otherwise)	50(5)	0(0)	50(5)	100(10)	1	0.8	
	Divorced/Separated (1=yes, 0=otherwise)	56(5)	22(2)	22(2)	100(9)	7	0.0	**
	Widowed (1=yes, 0=otherwise)	56(15)	7(2)	37(10)	7(27)	2	0.4	
Main Occupation of the household head	Crop Production (1=yes, 0=otherwise)	45(162)	4(15)	51(181)	50(197)	4	0.2	
	Livestock production (1=yes, 0=otherwise)	50(2)	0(0)	50(2)	1(4)	0	0.9	
	Employed salary (1=yes, 0=otherwise)	15(2)	23(3)	62(8)	3(13)	12	0.0	

Source: Field data (2023)

From table 4.2, the analysis shows that among the 'No' group households on the availability of extension services, 14% reported not to be belonging to any farmer group. This suggests that a significant portion of these farmers may be operating in relative isolation, potentially missing out on the benefits of collective action and shared

resources. In contrast, among those who said ‘Yes’ to availability of extension services, a significantly higher percentage of 85% reported belonging to a farmer group. The chi-square value of 96 confirms the robust relationship between group belonging and extension services. Importantly, the extremely low p-value less than 0.001, provides compelling evidence of the statistical significance of this association.

The analysis results of marital status, specifically looking at the category of "Divorced/Separated" (1=yes, 0=otherwise), provides interesting insights into how this aspect of personal life relates to the availability of extension services. In this case, the results shows that among farmers who are divorced or separated, 56% know the existence of extension services in their areas while 22% were unsure about the availability of extension services, and another 22% reported ‘No’ to availability of extension services. The chi-square value of 7 with a p-value less than 0.05 indicated a statistically significant relationship between marital status (specifically, being divorced or separated) and availability of extension services.

Households were also asked how information about available extension services is communicated to them to understand why some households know the existence of agricultural extension services and others do not know. Table 4.5 shows the results.

Table 4.5 Communication modes used to create awareness about the existence of agricultural extension services.

Availability mode	Percent (n=393)
Through local leaders	58.27
Through notices	9.67
Through outreach	2.04
Through phone calls	4.58
Through radios	22.65

Others	2.80
Total	100.00

Source: Field data (2023)

From table 4.5, the predominant method, reported by approximately 58.27% of the households is through local leaders. This observation underscores the pivotal role played by local leaders in bridging the gap between extension officers and rural communities. These leaders serve as intermediaries, facilitating the dissemination of valuable agricultural knowledge and resources within their communities.

In contrast, a smaller percentage, approximately 9.67%, rely on notices as a means of accessing extension services. Notices may encompass written communications or public announcements, serving as a formal channel for delivering information to farming households. Furthermore, about 4.58% of households receive extension services through direct phone calls, indicative of personalized interactions between farmers and extension officers.

Notably, radio broadcasts emerge as a significant mode of availability, with roughly 22.65% of households choosing this channel. This suggests that radio programs and broadcasts hold substantial appeal among farming communities, serving as an effective platform for disseminating and availing agricultural information and guidance. Lastly, a small portion of households, around 2.80%, utilize unspecified communication modes of awareness of agricultural extension services, reflecting potential unique or unconventional approaches that warrant further exploration.

4.2.2 Key partners and their roles in delivery of the agricultural extension services under the single spine system in Buhweju District

Interview responses from the DPO and the sub county officers at Buhweju district revealed how they are prepared to improve delivery of AES.

> "*We usually have annual work plans in place, we have 32 government officers in place, and provide training on E-extension although we have not started using it*". The DPO explained;
>
> "*We have contact persons in some villages to ease our work as sub county AEO. We always have Continuous Development courses facilitated by the district production department to refresh ourselves*". One sub-county officer explained.

Responses from KII also revealed that delivery of AES involves key partners including government providers such as the District production Department, sub county officers, NAADS and Operation Wealth Creation, Uganda Coffee development Authority (UCDA), Non-governmental Organizations as well as Private prayers. The government players mainly target smallholder farmers because commercial farmers and middle farmers can easily seek extension from other private providers even outside the district. However, NGOs and private providers have specific target groups of people; for example, all tea factories target only tea growers. Besides, most service providers always give priority to the poor, women, youth and even the disabled. In anything we do we make sure those groups of people are given priority. Almost all people in Buhweju live in villages so we do not have that ideal of urban and rural. We encourage our farmers to Join SACCOs so as to brow at reduced interest rates.

According to the DPO, the government providers available in Buhweju District are; the District Production Department (DPD), Sub County officers, NAADs/Operation Wealth Creation (OWC) and Uganda Coffee Development Authority (UCDA).

In his own words, the DPO of Buhweju District explained;

> "*The district production department has only two officers; the District Production and Marketing Officer (DPMO) and the District Commercial Officer (DCO). The department is responsible for making work plans to be followed, distribution of inputs, advising farmers on the proper use of inputs, planning for the agricultural sector within the National Policy Framework, providing support supervision of sub county officers, advising District Councils on matters related to the agricultural sector, monitoring all other actors involved in extension and evaluating performance of the agricultural programs and projects and coordinating all other actors in extension service*".
>
> "*There are thirty (30) sub county officers in the different sub counties and town councils. Each sub county and town council has at least two government officers. Each of sub counties has an officer specifically for crop production. Sub county officers are responsible for conducting needs assessment, advising farmers on proper agronomic practices, mobilizing farmers into groups, distribution of agricultural inputs, and demonstration of agronomic practices like planting and fertilizer application as well as agricultural data collection*".

The DPO further clarified the differences in roles of NAADS and OWC in delivery of AES. According to the DPO, NAADS procures inputs and then, OWC distributes those agricultural inputs using the already existing Sub county AEO.

Another key player in delivery of AES according to the DPO is Uganda Coffee development Authority (UCDA) whose main role is giving the DPD coffee seedlings to distribute to farmers, advising coffee farmers and other value chain actors on agronomic practices and post-harvest handling, demonstrating good agronomic practices to coffee farmers especially stumping, fertilizer application and soil and water conservation.

Non-governmental Organizations are also considered one of the key players in delivery of AES. According to the DPO, there are three NGOs that were in extension service in Buhweju District including Caritas-Uganda, SNV and International institute of Rural Reconstruction. According to the DPO, Caritas-Uganda aims at improving livelihoods and income of smallholder farmers in Buhweju District through advising farmers on proper agronomic practices and providing farmers with improved seedlings. In addition, SNV (Stiching Nederlandse Vrijwilliger) Netherlands Development Organization has professional trained six extension workers in Buhweju District. On the other hand, International institute of Rural Reconstruction (IIRR) has four trained AEO in the District, in the sub counties of Rwengwe, Karungu, Bihanga, Engaju and Burere. It trains and advises farmers on maize growing and gives out inputs like Fertilizer, seeds and pesticides.

Qualitative responses from the key informants also indicate that private prayers play a critical role in the provision of agricultural extension services and they are majorly in two groups of private actors; tea factories and agro input dealers. In his words, the key informant interviewed on 16th October, 2024 had this to say;

> "*We have two group of private actors in Buhweju and these are tea factories and agro input deals. There are four tea factories providing AES to tea farmers. Buhweju tea factory, Global tea factory, Tea Maria factory and Kashenyi Tea factory. Each of these factories have two professional AEO on ground to advise tea farmers. These officers have played a key role in demonstrating tea agronomic practices to farmers. These factories also give tea farmers in puts especially fertilizers at subsidized prices and even on credit and buys tea from farmers and middle men". They have cars that collect tea from tea collection centers that are near farmers' gardens. Besides tea factories, there are many agro input dealers in the different parts of the district who sell inputs like herbicides, pesticides, seeds and fertilizers. These advise farmers on the use of the inputs they sell. However,*

the quality of their services leaves a lot to be desired. Farmers easily ask for guidance from them because they are always available and accessible"

4.4 Accessibility of agricultural extension services under the single spine system

This section presents results on accessibility of agricultural extension services to smallholder crop farming households under the single spine system in Buhweju District. In order to determine the extent to which continuous variables are associated with accessibility, a t-test was used. This analysis of continuous variables for 393 farmers examined how age, farming experience, education, household labor, land size, income, and distance to extension offices influence the accessibility to agricultural extension services. The results are presented in table 4.6.

Table 4.6: Quantitative household demographic characteristics and accessibility of agricultural extension services

Continuous variables	Accessibility of Extension services					
	Yes Mean(SD)	No Mean(SD)	Overall Mean(SD)	Median (yes)	t-value	sig
Age of the household head (Years)	45(13)	44(15)	44(15)	42	0.7	
Farming experience of the household (Years)	22(12)	23(21)	23(13)	20	-0.7	
Education level of the household head (Years)	10(4)	7(6)	8(5)	10	3.8	***
Household labour (people)	5(3)	4(2)	4(3)	4	2.7	***
Household Land size (acres)	5(4)	3(3)	3(3)	3	5.7	***
Income of the household (UGX)	348831 (441093)	259145 (340425)	287443 (376857)	275,000	2.2	***
Distance to extension office (Km)	3(3)	5(7)	3(5)	2	-2.8	***

From table 4.6, education of the household head significantly influenced access to extension services, with farmers having a median of 10 years of education. A t-value of

3.8 (***) showed that more educated farmers are more likely to access services. This is consistent with Nambiro et al. (2017), who found that higher education levels enhance the likelihood of seeking agricultural extension support due to better understanding and application of agricultural innovations. Likewise, households with more labor (median of 4 people) were more likely to access services, a finding supported by Ragasa et al. (2016), who noted that larger households have a higher capacity to implement agricultural advice.

Land size also significantly influenced access, with farmers owning larger plots (median of 3 acres) more likely to access extension services. The t-value of 5.7 (***) highlights that larger landowners seek extension services to improve productivity, aligning with Anderson and Feder (2017), who emphasized that wealthier farmers often utilize more services due to their ability to benefit from economies of scale. Income played a similar role, with wealthier households (median income of UGX 275,000) being more likely to access services, consistent with Dinar et al. (2018), who found that income positively correlates with the adoption of extension recommendations.

Finally, distance to the extension office significantly affected access, with farmers living closer (median distance of 2 km) being more likely to utilize services. A t-value of -2.8 (***) indicates that proximity reduces the cost and effort of accessing services, a finding supported by Birkhaeuser et al. (2018), who observed that shorter distances increase service utilization. These findings highlight the need for policies that improve access for farmers in remote areas and those with lower education levels, smaller landholdings, and limited income.

Qualitative demographic characteristic were also examined on how they influence accessibility of agricultural extension services under the single spine system using a chi-square test and the results are presented in table 4.7.

Table 4.7 Qualitative household demographic characteristics and accessibility of agricultural extension services

Variables		Accessibility of extension services					
		Yes % (freq.)	No % (freq.)	Overall % (freq.)	Chi square	P-value	sig
Credit Access (1=yes, 0=otherwise)		60(104)	40(70)	44(174)	115.1	0.0	***
Group belong (1=yes, 0=otherwise)		73(96)	27(36)	34(132)	156.0	0.0	***
Gender	Male (1=yes, 0=otherwise)	32(88)	68(189)	70(270)	0.0	0.9	
Marital status	Married (1=yes, 0=otherwise)	33(115)	67(232)	88(347)	3.5	0.1	*
	Single (1=yes, 0=otherwise)	30(3)	70(7)	3(10)	0.0	0.9	
	Divorced/Separated (1=yes, 0=otherwise)	0(0)	100(9)	2(9)	4.2	0.0	**
Main Occupation	Crop Production (1=yes, 0=otherwise)	31(112)	69(246)	91(358)	0.1	0.7	
	Livestock production (1=yes, 0=otherwise)	50.(2)	50(2)	1(4)	0.6	0.4	
	Employed salary (1=yes, 0=otherwise)	46(6)	54(7)	3(13)	1.3	0.2	

Source: Field data (2023)

The chi square test on qualitative demographic characteristics indicates that, credit access highly influences access to agricultural extension services. This uncovers a substantial and highly significant association between access to extension services and access to credit (loan services). Specifically, a significantly higher percentage of farmers who have access to extension services also have access to credit, as evidenced by the 60% of respondents in the "Yes" category for accessibility and 44% in the overall sample, with a robust statistical significance with a p-value of 0.0 (***). This finding underscores the interconnected nature of credit and extension services in supporting agricultural activities and livelihoods. Farmers who benefit from extension services may

also be better positioned to utilize credit effectively for investments in their farms and agricultural ventures.

Table 4.7 results also indicate belonging to a group by a farmer unveiled a robust and highly significant association with accessibility to extension services. Notably, a significantly higher percentage of farmers who have access to extension services also belong to an agricultural group, as demonstrated by the 73% of respondents falling into the "Yes" category for accessibility, compared to the 34% overall, with a chi square value of 156 at $p<0.001$. This finding suggests that extension services play a pivotal role in encouraging or facilitating farmers' participation in agricultural groups or associations. These groups can provide valuable social networks, knowledge-sharing platforms, and economic support, contributing to farmers' overall well-being and agricultural development, as supported by findings from the Focus Group Discussions.

When farmers were interviewed on their marital status in relation to the accessibility of extension services, it indicated a marginally significant association as in table 4.7. Among married individuals, 33% have access to extension services, while 67% do not. In contrast, single individuals and those who are divorced or separated have lower percentages of accessibility, with 30% and 0%, respectively, among single individuals and 2% among those who are divorced or separated. The overall percentage of accessibility in the sample is 88%. While the p-value for this association is slightly above the conventional significance threshold (p-value > 0.05), at 0.1 (*), it suggests a potential trend that may warrant further investigation. This result indicates that marital status may have some influence on access to extension services, with married individuals showing a higher tendency towards access compared to their single or

divorced/separated counterparts.

4.2.3 Annual extension visits as reported by the interviewed households

Household who affirmed to have accessed agricultural extension services in 2022, were asked how often they did. The frequency of extension visits reported by the interviewed households are shown in figure 4.1.

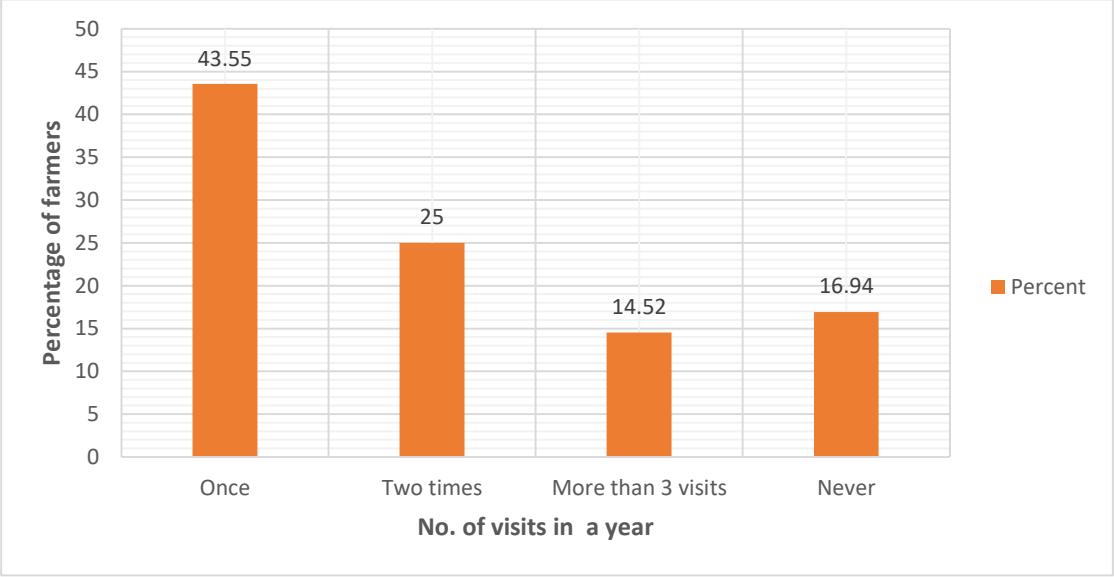


Figure 4.1: Frequency of extension visits as reported by farmers
Source: Field data (2023)

From figure 4.1, a significant portion of farmers in the sample have accessed extension services only once and some households reported never receiving extension visits. This finding highlights a gap in service delivery, as a substantial portion of farmers in the sample have not had any contact with extension services. These farmers may be missing out on valuable information and support that could enhance their agricultural practices and overall productivity. This underscores the need for improved outreach and engagement strategies to ensure that extension services effectively reach and benefit a wider segment of the farming community.

However, interviews with the key informants reveled some challenges that hinder accessibility of the available AES especially from the government. These include; high farmer to AEO ratio, inadequate government funding and farmers are not willing to pay for the services, uncoordinated planning of government agencies and departments involved in AES

In his own words, the DPO of Buhweju District further explained that;

"*We have only 5 motorcycles with 30 AEOs that means 25 out 30 AEOs do not have motorcycles to be used for transport. Allowances are very little for example AEO received a total of 600,000 for the first quarter of 2023/2024 and how much is given each quarter depends on how much is received from the central government. Also we have a problem of diversion of funds. For example the money that was meant for AES for the whole Buhweju District for the financial year 2022/2023 was diverted to rolling out the PDM meaning that as government, we were not accessible for the whole of that financial year. Late release of government funds which delays the provision of services. Some farmers are not willing to attend meetings organized by government AEOS and Buhweju is hard to reach all these limiting our accessibility*"

One sub county agricultural officer brought to my attention that, there inadequate needs assessment leading to wastage of resources. For example one key informant revealed to me that seedling of apples were rooting in the former Member parliament's compound without anyone to take them. In addition, key informants reported corruption at the District level as what is documented differs from the activities done on ground especially in providing inputs that what is always supplied to farmers is always different from what is in papers.

4.3 Adoption levels of agricultural technologies among smallholder crop farmers under the single spine system in Buhweju District

The adoption of agricultural technologies plays a significant role in enhancing agricultural productivity and improving the livelihoods of rural communities. Extension services provide farmers with access to critical knowledge, skills, and technologies necessary for modern farming practices. By facilitating the dissemination of information on improved crop varieties, soil management, pest control, and sustainable farming techniques, these services bridge the gap between research and practical farming.

4.3.1 Adoption index for 10 agricultural technologies under single spine system in Buhweju District

Ochugo (2012) identified five (5) methods for assessing the adoption of agricultural technologies, including: obtaining adoption index by the use of the sigma scoring method; calculating percentage of adopters; assigning numerical values to each stage of the adoption process; use of Likert scale and mean scores for disagregated levels of adoption. The sigma scoring method involves converting frequency counts to normal scores. The use of percentage involved asking household farmers to respond Yes (1) or No (0) to the single spine extension practice they have adopted. The adoption level was a summation of the numerical values of the yes responses.

The level of adoption (adoption index) of the single spine extension system services refers to the extent of application of package of extension practices recommended for a particular crop by the farmer. The level of adoption (adoption index) and their respective scores of extension practices across a sample of farmers were analysed in detail and the results are presented in table 4.8.

Table 4.8: Adoption index for 10 agricultural technologies under single spine system in Buhweju District

S/n	Single Spine Extension practices	No. of adopters	% of adopters (N=393)	Adoption Score
1	Mulching & Soil/Water Conservation	53	13.49	4.67
2	Timely Weeding	141	35.88	4.95
3	Timely Planting	87	22.14	4.87
4	Pesticide Use and Disease Management	65	16.54	4.73
5	Fertilizers use	24	6.11	2.67
6	Seedbed preparation	12	3.05	2.50
7	Use of Wind Breakers	6	1.53	1.53
8	Post-Harvest handling	3	0.76	0.98
9	Grading, Storage & Value addition	1	0.25	0.51
10	Rain water harvest/ irrigation	1	0.25	0.51
	Total Score = 26.78		**Mean Score =4.53**	

Source: Field data (2023)

The mean adoption score across all the technologies was calculated as 4.53, indicating a moderate level of adoption under the single spine extension system. Timely Weeding has the highest adoption score of 4.95, with 35.88% of respondents adopting this practice. Mulching & Soil/Water Conservation, Timely Planting, and Pesticide Use and Disease Management also show substantial adoption rates and scores.

The relationship between adoption score, Adoption index and the different factors (independent variables) were regressed to estimate the effect of the factors on adoption level.

In the adoption of agricultural extension services under the Single Spine framework, Feder et al. (1985) used an adoption index with score ranges of 0.5 to 5.0 to measure the extent of adoption of improved farming practices, categorizing the results into low, moderate, and high adoption levels. This was similar to the study and the approach was used. Empirical justification for this approach were drawn from reviewing similar studies in agriculture or technology adoption, which used comparable categorization

scales. For example, a low adoption range (0.51 - 2.00) typically indicated limited engagement where only a minority adopts the practice. A medium adoption range (2.01 - 3.50) reflected a moderate uptake, where a significant but incomplete portion of the population adopts the practice. Lastly, a high adoption range (3.51 - 4.95) signified widespread or full adoption, where the majority of the population actively engages with the practice. Hence the proposed categorization of the adoption index into Low, Medium, and High levels aligned with accepted methodologies and empirical findings on adoption measurement was effectively applied.

Table 4.9: Adoption levels of agricultural technologies among the smallholder crop farmers under the single spine system

	Freq.	Percent (n=393)
Low Adoption	36	9.2
Medium Adoption	346	88.5
High Adoption	9	2.3
Total	391	100.0

Source: Field data (2023)

Table 4.9 presented the adoption levels of agricultural technologies among smallholder farmers in the study area. The results showed that the majority of farmers, 88.5%, had medium adoption rate of these services. From this it was necessary to determine the factors that influence adoption of the single spine agricultural extension practices.

4.3.2 Factors that influence adoption of single spine agricultural extension practices among small holder crop farmers in Buhweju district

In order to determine the factors that influence adoption of single spine agricultural extension practices among small holder crop farmers in Buhweju district, the Tobit regression model was used.

Table 4.10 Factors that influence adoption of single spine agricultural extension practices among small holder crop farmers in Buhweju district

Adoption of single spine extension services	**Coef.**	**St.Err.**	**t-value**	**p-value**	**[95% Conf**	**Interval]**	**Sig**
Age of the household head captured in number of years	-.001	.001	-0.83	.41	-.003	.001	
Highest education of household head in years of schooling	0	.002	-0.09	.929	-.004	.004	
Farming experience of farmer in years	.001	.001	0.42	.674	-.002	.004	
Land access (*1=yes, 0=otherwise*)	.017	.151	0.11	.911	-.281	.314	
Total farm size (crop area planted in number of acres)	**.006**	**.003**	**1.91**	**.058**	**0**	**.012**	*
Household membership in a farmer group (*1=yes, 0=No*)	**.098**	**.031**	**3.19**	**.002**	**.037**	**.159**	***
Access to credit (*1=yes, 0=otherwise*)	-.043	.03	-1.46	.147	-.102	.015	
Household Income (*UGX*)	**-7.13e-08**	**2.77e-08**	**-2.58**	**.011**	**-1.26e-07**	**-1.67e-08**	**
Distance to nearest extension office (Km)	.001	.002	0.47	.637	-.003	.005	
Extension Availability (1=yes, 0=otherwise)	-.013	.015	-0.83	.41	-.043	.018	
Extension access (1=yes, 0=otherwise)	-.015	.033	-0.47	.642	-.08	.049	
Main Occupation Crop production (*1=yes, 0=otherwise*)	**-.085**	**.04**	**-2.15**	**.033**	**-.163**	**-.007**	**
Main Occupation Employed with Salary (*1=yes, 0=otherwise*)	**-.326**	**.115**	**-2.83**	**.005**	**-.553**	**-.099**	***
Household labour (*Number of family productive members*)	.001	.004	0.37	.716	-.006	.009	
Household head sex (*1=yes, 0=otherwise*)	.014	.026	0.55	.58	-.036	.065	
Household head Marital being married (*1=yes, 0=otherwise*)	.032	.042	0.75	.453	-.051	.114	
Extension workers as trainers for Extension (*1=yes, 0=otherwise*)	**.151**	**.026**	**5.72**	**0**	**.099**	**.203**	***
Communication mode to extension information access							
Through Media & digital platforms (*1=yes, 0=otherwise*)	.052	.03	1.73	.085	-.007	.111	*
Through Notices (*1=yes, 0=otherwise*)	.06	.032	1.91	.058	-.002	.123	*
Through Phone calls (*1=yes, 0=otherwise*)	-.102	.045	-2.25	.026	-.192	-.012	**
Constant	.159	.191	0.83	.408	-.219	.536	
var(e.Adoption)	.02	.002	.b	.b	.016	.025	

Mean dependent var	0.200	SD dependent var	0.157
Pseudo r-squared	-1.174	Number of obs	205
Chi-square	82.328	Prob > chi2	0.000

Akaike crit. (AIC)	-108.479	Bayesian crit. (BIC)	-35.373
*** p<.01, ** p<.05, * p<.1, Log likelihood = 76.239364, Prob > chi2 = 0.0000			

Source: Field data (2023)

The results of the Tobit regression analysis provided empirical estimates into the significance and direction of influence of various factors on farmers' adoption of agricultural technologies by smallholder crop farmers. The model results showed, the coefficient of 0.006 on total farm size, empirically indicating that there is a positive association between farm size and adoption of agricultural technologies, indicating that larger farm sizes may have a slight positive influence on the likelihood of farmers adopting a technology. However, it's important to note that the significance level, as indicated by the p-value of 0.058, is just below the conventional threshold of 0.05. This marginally significant result suggests that while there may be a trend towards larger farms being more likely to adopt many agricultural technologies, the evidence is not strong enough to draw a definitive conclusion.

Household Membership in a Farmer Group: The highly significant coefficient of 0.098 (p-value = 0.002) indicates that farmers who are members of farmer groups are significantly more likely to adopt more agricultural technologies. This underscores the importance of social networks and collective engagement in promoting the adoption of agricultural extension services. Farmer groups can serve as platforms for knowledge sharing, peer learning, and mutual support, making them effective channels for the dissemination of extension information.

Household Income: While the effect size is small, the statistically significant coefficient of -7.13e-08 (p-value = 0.011) suggests that higher income levels are associated with

lower adoption rates of agricultural technologies. This unexpected finding warrants further investigation to understand why higher-income households might be less inclined to adopt a few agricultural technologies. It may be related to perceptions of self-sufficiency or alternative sources of agricultural information and support.

Extension Workers as Trainers for Extension: The highly significant coefficient of 0.151 (p-value = 0.000) indicates that farmers who receive training from extension workers are significantly more likely to adopt more agricultural technologies. This finding underscores the pivotal role of extension workers as effective trainers and facilitators of agricultural knowledge transfer. Their capacity to deliver relevant and actionable information to farmers appears to have a substantial impact on adoption rates.

Communication Mode to Extension Information Access: The analysis reveals that different communication modes have varying effects on adoption. Access through media & digital platforms and through notices, with coefficients of 0.052 (p-value = 0.085) and 0.060 (p-value = 0.058) respectively, show marginally significant positive effects on adoption. This suggests that leveraging digital technologies and written communication materials can be effective in reaching and engaging farmers with extension services. Conversely, access through phone calls has a negative and significant impact (coefficient = -0.102, p-value = 0.026), which is somewhat surprising. This finding merits further exploration to understand the underlying reasons for the negative association between phone-based access and adoption.

Qualitative responses from interviews with key informants revealed that farmers who try to seek AES have adopted the practices but not all farmers are aware that the services exist. A key informant interviewed on 12th March, 2023 had this to say,

> "*….those who try to seek our services have adopted the practices although not all people are aware of our services…*"

According to key informants, the beneficiaries are supposed to be prepared for the AES. One key informant interviewed on 16th October, 2023 had this to say;

> "*Not every farmer is suitable for agricultural extension services. We admire demand driven agricultural extension for relevancy matters, proper utilization and sustainability. Therefore, farmers must first conduct needs identification. They must be prepared to receive our services and inputs. They must attend meetings and seminars and give us feedback on the services provided to help us in evaluation and future planning*".

However, from the above, it was necessary, to determine the factors that affect adoption of SSAES practices by farmers.

4.9. Effect of Availability and Accessibility of agricultural extension services on adoption levels of single spine practices

The ordered logit regression analysis for examining the effect of extension availability and accessibility of Agricultural Extension Services (AES) on the adoption was employed to a total of 393 observations. The model as a whole is statistically significant, as indicated by a Wald chi-squared value of 58.08 with a p-value of 0.0000, suggesting that the independent variables collectively explain a significant portion of the variation in the adoption index. However, the Pseudo R^2 value of 0.0072 suggests that the model explains only a small portion (0.72%) of the variation in the adoption index.

Table 4.11. The effect of availability and accessibility on adoption levels of agricultural technologies

Adoption level	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Extension Availability	.014	.025	0.56	0.047	-.035	.064	**
Extension accessibility	-.022	.031	-0.72	0.037	-.083	.038	***
Constant	1.583	.008	191.11	0	1.566	1.599	***

Mean dependent var	4.530	SD dependent var	0.901
Pseudo r-squared	0.007	Number of obs	393
Chi-square	58.082	Prob > chi2	0.000
Akaike crit. (AIC)	1407.355	Bayesian crit. (BIC)	1423.251

*** p<.01, ** p<.05, * p<.1

Extension service availability has a coefficient of 0.0141 with a p-value of 0.047, meaning it is statistically significant at the 5% level. This suggests that an increase in the availability of extension services is associated with a higher likelihood of being in a higher adoption category. However, the effect is relatively small, and the confidence interval ranges from -0.035 to 0.064, indicating a minor influence. Extension service access has a coefficient of 0.0221 with a p-value of 0.037, which is statistically significant at the 5% level. This positive coefficient indicates that improved access to extension services is associated with a higher likelihood of being in a higher adoption category. Like availability, the effect size is small.

CHAPTER FIVE

DISCUSSION OF RESULTS

5.1 Availability and accessibility of agricultural extension services to smallholder crop farmers under the single spine system in Buhweju District.

The study empirically sported that, education was positively and significantly (P<0.01) related to knowledge about availability of agricultural extension services. Increase in the number of years of schooling of the household head increases the household's ability to be aware of the different extension service providers in ones areas. This is in line with the findings by Midamba *et al.* (2022) who ascertained that, skills, knowledge and awareness farmers get as they advance school improve their reasoning ability and increases their which in turn increases their eagerness to look and get for information from many sources about the available agricultural extension actors in their localities.

The study findings also discovered a strong association between household labor size and availability of agricultural extension services. Households with a median of 4 people were more likely aware of the existence of agricultural extension services with in their sub counties compared to those with less members. This aligns with existing literature as previous studies have demonstrated more labor resources leads to more information, ideals and skills brought together (Doss *et al.;* 2018). This places households with a higher number of members at an advantage of getting information from many sources. Furthermore, household land size and income showed a statistically significant relationship with availability of agricultural extension services. Households with larger landholdings (median = 3 acres) and higher incomes (median UGX 250,000) were

significantly more likely to know the existence of agricultural extension services within their sub counties. This coincides with Anderson and Feder (2017) also found that wealthier farmers are better positioned to invest in modern agricultural practices and therefore may require more knowledge and skills making them to where the extension service providers are in their areas.

In addition to the above, households closer to sub county office (median distance = 1.5 km) had significantly knowledge on the existence of extension service providers with in their sub counties (t-value = 2.3383, p = 0.0102), aligning with Birkhaeuser *et al*. (2018), who noted that proximity reduces travel costs and time, improving awareness.

From table 4.4, it is evident that a higher proportion households who said “No” to availability of agricultural extension services in their areas, also had not access to credit for the whole of 2022 and the reverse is true. This concurs with the findings of Atsbeha & Gebre (2021) who discovered that, credit services facilitate farmers’ ability to join groups and groups facilitate their ability to access information from many sources about the available agricultural extension services.

The substantial difference in group membership between those who affirmed the availability of agricultural extension services and those who denied it underscores the importance of collective action in agriculture. Farmers who belong to farmer groups often benefit from knowledge sharing, collective decision-making, and resource pooling (Muyanga *et al*.; 2020). This finding aligns with studies emphasizing the positive impact of group participation on farmers' access to information.

The results on the relationship between marital status, particularly being divorced or separated, and the availability of extension services suggests potential disparities in awareness. Previous research has shown that marital status can influence farmers' decision-making within households (Doss *et al.;* 2018). Divorced or separated farmers especially women might have more freedom to move and look for information from different sources compared to those who are married.

Furthermore, results presented in Table 4.5 shed light on the various communication modes through which farming households are made aware of the existing services. The results align with existing literature on the importance of diverse communication modes in extension service and provide valuable insights into the preferences and patterns of information dissemination among farming communities. The prominence of local leaders underscores the influential role of community leaders in rural areas. Local leaders likely serve as trusted intermediaries who facilitate the flow of agricultural information and resources from providers to farmers. This finding resonates with studies emphasizing the significance of community-based approaches in extension service (Mukasa *et al*.; 2019).

The results from Table 4.6 shed light on the relationships between various socio-economic factors and the accessibility of extension services among farmers. These findings provide critical insights into the factors that influence farmers' ability to access extension services, which, in turn, can have significant implications for agricultural productivity and rural development.

The research results reveals a compelling association between education level and access to extension services. Farmers who have access to extension services tend to have a significantly higher mean education level (7.35 years) compared to those without access (8.04 years). The highly significant t-value (3.8359, $p<0.001$) underscores the role of education as a key determinant of accessibility to extension services. This result aligns with existing literature and is in line with the findings of Nagar et al who asserted that farmers who have studied a bit higher had significantly higher probability of accessing agricultural extension services than their counterparts because education increases awareness and understanding.

Relatedly, households with more labor (median of 4 people) were more likely to access extension services compared to their counterparts, a finding supported by Ragasa *et al*. (2016), who noted that larger households have a higher capacity to seek and implement agricultural advice. Land size also significantly influenced access, with farmers owning larger plots (median of 3 acres) more likely to access extension services. The t-value of 5.6524 (***) highlights that larger landowners seek extension services to improve productivity, aligning with Anderson and Feder (2017), who emphasized that wealthier farmers often seek and utilize more services due to their ability to benefit from economies of scale. Income played a similar role, with wealthier households (median income of UGX 275,000) being more likely to access services, consistent with Dinar et al. (2018), who found that more income may translate into heavy investment in agriculture and hence the need for more knowledge and skills.

Again, distance to the extension office was found to significantly affect access, with farmers living closer (median distance of 1.9 km) being more likely to utilize services.

A t-value of -2.8499 (***) indicates that proximity reduces the cost and effort of accessing services. This agrees with the findings of by Midamba *et al*. (2022) who concluded that farmers located near the extension centers have a higher probability of accessing extension services easily and timely compared to their counterparts because of reduced transport costs and increased awareness about the existence of these services.

The results from the chi-square tests reveal important associations between categorical variables and the accessibility of agricultural extension services among farming households. These associations provide insights into how various factors, such as credit access, group membership, and marital status, are linked to the ability of farming households to access extension services with implications for their agricultural practices and livelihoods.

The results from table 4.7 demonstrate a strong and highly significant association between access to credit and access to agricultural extension services. Significantly, a higher percentage of households who had access to credit also had access to agricultural extension services. This is so because credit enhances increased investment in agriculture and this require more understanding of agricultural practices that increase production. This underscores the importance of credit in enhancing agricultural production. This result aligns with previous research emphasizing the importance of credit access in enhancing accesses to credit. Atsbeha and Gebre (2021), also had spotted that farmers who have access to credit have a higher probability of accessing agricultural extension services compared to their counterparts.

The research results also underscores a substantial and highly significant association between group membership and accessibility to agricultural extension services. This finding suggests that belonging to a group facilitates access to agricultural extension services. These groups can provide valuable social networks, knowledge-sharing platforms, and economic support hence facilitating access to agricultural extension services. This result aligns with the findings of Midamba *et al*. (2022) who detected that belonging to an association is positively and significantly associated with access to agricultural extension services due to the peer farmers' trainings, information disseminations and sharing of ideas within the group.

The results also indicated a marginally significant association between marital status and the accessibility of agricultural extension services. Although, the p-value for this association was 0.063 (*). It suggests a potential trend that may warrant further investigation. While not statistically significant at the conventional threshold, this result indicates that marital status may have some influence on access to agricultural extension services with married individuals showing a higher tendency towards access compared to their single or divorced/separated counterparts.

5.2 Adoption levels of agricultural technologies among smallholder crop farmers under the single spine system

The study findings indicate a moderate level of adoption of agricultural technologies under the single spine agricultural extension services. Timely weeding has the highest adoption score, followed by mulching & soil/water conservation, timely planting, and pesticide use and disease management. This suggests that while some farmers are

engaging with and benefitting from agricultural extension services, there is still room for improvement in terms of widespread adoption of agricultural technologies. The implications of the findings are that, farmers have some level of awareness about agricultural extension services under the single spine system, and they have access to these services. However, the reach and coverage of agricultural extension services may be limited, causing some farmers to not fully engage with the available resources. Farmers who have adopted the practices find them to be valuable in improving their agricultural production and increasing productivity. However, there are still some farmers who may not see the immediate benefits or relevance of these services to their specific needs. The single spine system has made efforts to build the capacity of extension agents and equip them with the necessary knowledge and skills to support farmers effectively. This has led to a moderate level of adoption of agricultural technologies as farmers have some level of trust and confidence in the expertise of extension agents. Therefore, enhancing the availability and accessibility of agricultural extension services to reach more farmers, especially those in remote or marginalized areas, can help increase adoption rates. Likewise, providing more personalized and tailored extension services that address the specific needs and challenges of individual farmers can enhance the relevance and effectiveness of the services. Furthermore, implementing robust monitoring and evaluation mechanisms to track the impact and outcomes of extension services can help identify areas for improvement and optimize the delivery of services to farmers. Overall, while the level of agricultural technologies by crop farming households is moderate, there are opportunities to enhance this adoption through targeted interventions that address the barriers to engagement and

strengthen the impact of the single spine system on agricultural productivity and livelihoods.

In addition to the above, the tobit regression model results helped to identify factors influencing farmers' adoption of agricultural technologies and this drew valuable insights into the significance and direction of these factors. Each coefficient in the model provides empirical evidence of how different variables affect the likelihood of farmers adopting these technologies.

The coefficient of 0.006 on total farm size suggests a positive association between farm size and adoption of agricultural technologies. This implies that larger farm sizes may have a slight positive influence on the likelihood of farmers adopting these technologies. However, it's crucial to note that the p-value of 0.058 is just below the conventional threshold of 0.05, indicating marginal significance. This result suggests a trend but lacks strong evidence to draw a definitive conclusion. This concurs with the finding of Priya, & Singh (2022) that, larger farms might be more inclined to adopt more practices and technologies due to their potential for increased productivity.

The highly significant coefficient of 0.098 (p-value = 0.002) underscores the importance of farmer groups in promoting the adoption of AES. Farmers who are members of groups are significantly more likely to adopt better farming technologies spread under the single spine system. This finding aligns This result aligns with the findings of Midamba *et al.* (2022) who spotted that, belonging to an association is positively and significantly associated with increased access to agricultural extension services and hence increased

adoption level of better practices due to the peer farmers' trainings, information disseminations and sharing of ideas within the group.

Despite the small effect size, the statistically significant coefficient of -7.13e-08 (p-value = 0.011) suggests that higher income levels are associated with lower adoption rates of agricultural technologies. This finding is unexpected and warrants further investigation. It may be linked to perceptions of self-sufficiency among higher-income households or alternative sources of agricultural information and support. Understanding this phenomenon is crucial for tailoring agricultural extension services to diverse income groups.

The highly significant coefficient of 0.151 (p-value = 0.000) emphasizes the critical role of extension workers in promoting the adoption of agricultural technologies. Farmers who receive training from extension workers are significantly more likely to adopt technologies learnt. This highlights the capacity of extension workers to deliver relevant and actionable information to farmers, making them effective facilitators of agricultural knowledge transfer. This result aligns with the literature on the importance of extension workers in agricultural development (FAO, 2016)

The research results of communication modes reveals varying effects on adoption. Access through media & digital platforms and through notices, with coefficients of 0.052 (p-value = 0.085) and 0.060 (p-value = 0.058) respectively, shows marginally significant positive effects on adoption. This implies that leveraging digital technologies and written communication materials can effectively engage farmers with AES. Surprisingly, access through phone calls has a negative and significant impact (coefficient = -0.102,

p-value = 0.026), which requires further exploration to understand the underlying reasons for this negative association.

These findings provide valuable insights for policymakers and extension service providers, highlighting the need for tailored approaches that consider factors such as farm size, farmer group membership, income levels, the role of extension workers, and communication modes to enhance the adoption of the single spine practices for enhanced agricultural production and productivity.

5.3. Effect of availability and accessibility of extension services on adoption levels of agricultural technologies among smallholder crop farmers in Buhweju District.

The ordered logit regression results figured out that, extension availability and accessibility all play a statistically significant role in determining the adoption of agricultural technologies under single spine practices among smallholder crop farmers. However, although extension availability and access have positive effect, it is so small, indicating that while they contribute to moving individuals into higher adoption categories, their impact is limited, implying that there are so many factors affecting adoption levels of agricultural technologies among smallholder crop farmers. This concurs with the results of Priya, & Singh (2022) who spotted that, adoption levels depend on many factors ranging from socio-economic, biophysical, institutional, financial, technical to psychological.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study was conducted with the main objective of assessing the performance of the single spine system in Uganda, a case of smallholder crop farmers in Buhweju District. Data was collected from 393 farming households using a structured interview guide, analyzed, presented in chapter four and discussed in chapter five. Therefore, this is summary of key conclusions as per the set objectives.

From the study, all sub counties were found to have agricultural officers responsible for extension service, however, a high percentage of farmers do not know that they are available. These are available actor include; government actors such as the district productions department, sub county extension officers, NAADs and OWC. Also, NGOs such as SNV as well as private actors such as tea factories and agro-input dealers were also found into existence. Therefore the government should try to sensitise the farmers about the availability of these agricultural officers. Also agricultural officers should try to reach out farmers so that farmers can know that they are available. However, some households were not aware of their availability due to their social economic characteristics that include; education levels, household labour, household land size, household income, distance to extension service centres, access to credit and belonging to farmer groups.

From the findings, there is minimal level of accessibility of agricultural extension services among smallholder crop farmers under single spine system in Buhweju district.

While, this is mainly explained by farmers' socioeconomic factors such as education level, household labour dynamics, land size, income levels and distance from residence, it is also mainly influenced by availability of service providers including both government and public actors. Government actors such as the district productions department, sub county extension officers, NAADs, OWC and NGOs contribute significantly to accessibility of extension services. Likewise, availability of private actors such as tea factories and agro-input dealers in the community contribute significantly to accessibility of extension services.

The study highlight a moderate level of adoption of agricultural technologies by small holder crop farmers under the single spine system in Buhweju district. This was majorly explained by social economic factors. For example; households with larger farm sizes were found to have a higher likelihood of adopting more agricultural technologies compared to their counter parts. Also households with members of farmer groups belonging to farming groups were found significantly more likely to adopt appropriate technologies. On the other hand, higher income levels were associated with lower adoption rates of agricultural technologies. The study also emphasizes the critical role of extension workers in promoting the adoption of agricultural technologies. Farmers who receive training from extension workers were significantly more likely to adopt agricultural technologies. Further, communication modes reveals varying effects on adoption where access through media & digital platforms and through notices shows marginally significant positive effects on adoption. This implies that leveraging digital technologies and written communication materials can effectively engage farmers with extension services. Surprisingly, access through phone calls has a negative and

significant impact which requires further exploration to understand the underlying reasons for this negative association.

Finally, availability and accessibility of agricultural extension services have small but positive effect on the adoption of agricultural technologies. The positive sign implies that improved availability and accessibility is associated with higher adoption levels. However, the effect is small implying that there are other several factors that influence adoption levels of single spine practices apart from availability and accessibility of extension services.

6 .2 Recommendations

The local governments should prioritize mass sensitization of farmers to create awareness about the available agriculture extension services so that farmers can use the available services. Also farmers should be sensitized about the importance of agriculture extension services so that they can get interested to seek these services. This can be done using social media and local leaders.

Farmers should also be encouraged to join groups dealing in agricultural production and marketing as groups were seen to be major sources of information, knowledge, and advice. In addition, it is easy for an extension officer to meet farmers in groups compared to individuals given the high farmer to extension officer ratio.

The government should provide the sub county agricultural officers who are the frontline extension workers with adequate allowances to allow them do their work willingly. Also, they should be provided with motorcycles to ease their movement to villages.

There is a need for agricultural extension providers to do proper needs assessment such that desired and needed extension services are provided. This will attract farmers to seek for the services and use them to boost agricultural production and productivity.

The government should recognize the positive correlation between education levels and farmers' adoption of AES. Develop policies that support educational initiatives for farmers to enhance their capacity to understand and apply modern agricultural practices effectively.

The government should also support extension programs that leverage diverse communication channels, including digital platforms, written notices, direct phone calls, and radio broadcasts. Tailor communication methods to the preferences and needs of the target audience.

Farmers should consider joining farmer groups or associations to benefit from knowledge sharing, collective decision-making, and resource pooling. Active participation in these groups can enhance your access to extension services and support. Be open to receiving training from extension workers. Their guidance and expertise can significantly contribute to the adoption of improved farming practices and technologies.

Apart from enhancing availability and accessibility of extension services, the government and other non-state actors should improve the quality of extension services so as to attract the attention of the recipients as farmers may consider comparative advantage of the practice over the practices they have been practicing.

Further research should be conducted to understand why higher-income households may exhibit lower adoption rates of extension services. Explore the underlying reasons and potential solutions to bridge this gap.

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APPENDICES

Appendix 1: HOUSEHOLD INTERVIEW TOOL

Participant's informed Consent:

My name is ……,and am here on behalf of M/s Nimushaba Patience a student of Uganda Christian University pursuing a Master of Science in Agriculture and Rural Development. I am conducting a research about "Performance Of The single spine system; a case of smallholder farmers in Buhweju District." You have been selected to be one of my Households in this study. Here is a copy of my introduction letter from the University and the district production officer has received and endorsed it. You are free to participate or not participate in this study. The information provided will be treated with strict confidentiality and shall not be used for any other purpose except for academic purposes. The study will ensure your anonymity and confidentiality. Thank you very much for your cooperation. The interview will take between 30-40 minutes. Now I ask you; Are you willing to participate in this interview/study? Y/N. (If yes, I do the interview, if no, I thank the farmer and move to the next household)

SECTION 1: BACKGROUND INFORMATION OF HOUSEHOLDS

A. GENERAL INFORMATION AND SOCIAL ECONOMIC CHARACTERISTICS

HOUSEHOLDID_____ Date of Interview_____

A1	Sub-county name			**Name of Interviewer**	
A2	Parish name			**A12 (e).** Number of productive adult females participating in crop production	
A3	Village (LC I name)			**A12 (f)**. Number of productive children participating in crop production	
A4	Relationship of the respondent to Household Head **(see codes)**			**A12 (g).** No. of male household members engaged in other income generating activities	
A5	Gender of the household head	**1=Male; 2=Female**		**A12 (h).** No. of female household members engaged in other income generating activities	
A6	Age of the household head (years)			**A13.** Do you have access to land for crop production as a household? 1=Yes; 0= No 9= Not sure	
A7	Marital status of the respondent *(see codes)*			**A14.** If yes, what is its size in acres?	
A8	Main Occupation of respondent ***(see codes)***			A15. Did any member of this household belong to any group dealing in production or marketing of crops? 1=Yes; 0= No 9= Not sure	
A9	Highest school grade or class completed by the household head (should			**A16**. If yes, give one main service got from the farmer group ***(see codes)***	

	be in years of completed level or class)			
A10	Years of farming experience in the crop growing	1-Yes 0-No		**A17.** Did any member of this household access credit or loan last year 2022? 1=Yes 0=No
A11	Household location: (*1=Urban, 2=Peri-urban, 3=Rural*)			**A18.** If A17=1, What was the major loan source? ***(see codes)***
A12(a)	How many members does this household have?			**A19.** If A17=1, What was the main purpose for which the loan/credit was sought for? ***(see codes)***
A12(b)	No. of unproductive children *(less or equal to 18 years)* in the Household			**A20**. What is the Major source of income for this household? *1= Production and sale of crops 2=Production and sale of animals & animal products, 3=Sale of land, 4=Salary, 5=Remittances, 6=Hiring out casual labor (wages); 7=Transport Business e.g., bodaboda; 8=Sale of forest products, 9=Brewing, 10=Trading, 11=Fishing, 12=Other (specify)*
A12(c)	Number of unproductive adults in this household	1=Yes, 0=No		
A12(d)	Number of productive adult males participating in crop production			**A21.** On average, how much does this household earn per from this main income source? (In Uganda shillings?

A4.Relationship codes*: 1=Household head; 2=Spouse; 3=Son/daughter; 4=Parent; 5=Brother/sister; 6=Son/daughter in-law; 7= Grandchild; 8= Other relative; 9=Hired worker; 10= Other (specify)*

A7.Marital status codes*: 1=Married; 2=Single; 3=Divorced; 4=Widowed*

A8 Main Occupation codes*: 1= Production of crops; 2= Production of livestock; 3= salaried employment- government; 4= Salaried employment-private sector; 5=casual laborer on-farm; 6= Casual laborer off-farm; 7= Self-employed off-farm; 8=Herding; 9=Fishing; 10= Others (specify)*

A16 codes*: 1=credit 2=linkage to produce market 3=linkage to input suppliers 4= savings 5= extension services 6= Market information 7= Processing 8= storage 9= Transport 10= Irrigation/rain water harvest 11= Collective cultivation and production*

A18 Major loan source codes*: 1= Ka Box/VSLA 2= Farmer group 3= Relative 4= Friend 5= Commercial bank 6=Sacco 7=Employer 8=Commercial village fund 9= Money lender*

A19 Main loan purpose codes*: 1=Agriculture extension service 2=0ther agricultural investment 3=Non-agricultural investment 4=Consumption 5= Education 6=Medical/Health 7= Debt/loan settlement 8= Other household needs*

A22. Which crops did this household grow or have in the two seasons of 2022? ***(List all)***

A23.Answer these questions for the key crop enterprise dealt in by this household in last Year 2022.

A23 (A)	Main crop grown or had			**A23 (i).**Did you apply herbicides	1= Yes 0= No
A23 (b)	Cropping method (**see codes**			**A23 (j).** If yes, what was the source of herbicides used? **(See codes)**	
A23 (c)	Did you apply fertilizers?	1= Yes 0= No		**A23 (k).** Was the herbicide effective? **(See codes)**	
A23 (d)	If yes, what was the source of fertilizer used? **(See codes)**			**A23 (l).** Did you sell or market what was harvested?	1= Yes 0= No
A23 (e)	Was the fertilizer effective? **(See codes)**			**A23 (m).** Main mode of selling or marketing? **(See codes)**	
A23 (f)	Did you apply pesticides?	1= Yes 0= No		**A23 (n)** Main buyer **(See codes)**	
A23 (g)	If yes, what was the source of pesticide used? **(See codes)**			**A23 (o).** Main reason for selling to the main buyer. **(See codes)**	
A23 (h)	Was the pesticide effective? **(See codes)**				

A23 (b) codes: 1= Sole/pure stand 2= Mixed/Intercrop

A23 (d); A23 (g); A23 (j) codes: 1=own 2=Fellow farmer 3=Farmer group 4=NGOs 5= Government authorities 6= Politician or well-wisher 7= in put suppliers (shops).

A23 (e); A23 (h); A23 (k) codes: 1 Very effective 2= Effective 3=Less effective 4= Not effective

A23 (m). *1=collectively 2=Individually 3= Both collective & individual*

A23 (n) codes: *1=Consumer, 2=Trader, 3=FO 4=NGO 5=Institution 6=Exporter 7=Processor 8=Broker/middleman 9=Research institute 10=Other (specify)*

A23 (o) codes. *1=Only buyer available 2=Better prices 3=Nearest 4=Contractual arrangement 5=Poor quality 6=Convenience 7= Immediate need of cash 8=Other (specify)*

SECTIO

AVAILABILITY OF AGRICULTURAL EXTENSION SERVICES OFFERED UNDER THE SINGLE SPINE SYSTEM

B1. Are there agricultural extension providers in your farming area? (May be inspectors)

1=Yes 0=No 9= Not sure

B2. If yes, what exact agricultural extension service providers are in this area? (**Tick all that apply**)

1= Government extension agents 2=Private extension providers 3=Inputs dealers, 4=Traders, 5=Farmers' organizations 6=NGOs. 9. Others (specify)

B3. If yes, are there ones specific for crop production?

V 1. Yes 0. No. N/A. Not sure

B4. How is information about available extension services communicated to farmers and community members?

1. *Through local leaders*
2. *Through radios*
3. *Through notices*
4. *Through outreach*
5. *Through phone calls*
6. *Others (specify) ……*

B5. In your opinion, are the agricultural extension services available in this area adequate? ……

SECTION C

ACCESSIBILITY OF AGRICULTURAL EXTENSION SERVICES UNDER THE SINGLE SPINE SYSTEM

C1. Have you accessed any extension services in the past 12 months (last year 2022?)

1=Yes 2= No 3= Don't Know

C2. If yes, how many times did you get advice from the extension agents on crop production last year (2022)?

1= Once 2=Two times 3= Three visits and above 9= Never

C3. Did they advise you on the use of improved varieties and other common agricultural technologies?

1=Yes 2= No 3= Don't Know

C4. How do you compare access to information and technologies today as to NAADS times before the single spine was introduced?

1=Improved 2 = Same 3= Worsened 4= I don't know

C5. Are government agricultural extension offices within reasonable distance?

1=Yes 2=No 3 = Don't Know

C6. If yes, how many kilometers from your home?

(*indicate number of km)*

C7. Are there some procedural steps that must be completed before accessing government extension services?

1= Yes 2 = No 3 = Don't Know

C8. If yes what kind of procedures

1. *Registration*
2. *Belonging to a farmer group*
3. *Having a national ID*
4. *Having a mobile phone*

5. *Others specify……*

C9. Is there any cost associated with accessing government extension services?
1=Yes 2= No 3= Don't Know

C10. If yes what is such a cost
1. *Transport*
2. *Co-funding*
3. *Registration*
4. *Others (specify)……*

C11. Are there any common biases when extension officers are giving government extension services?
1= Yes 2 = No 3 = Don't Know

C12. If yes, what are such common biases based on in giving government extension services to farmers by extension officer in this community
1. *Age*
2. *Religion*
3. *Gender s*
4. *Political affiliation*
5. *Education Level*
6. *Others (specify) ……*

C13. How often do you seek agricultural extension services?
1 = Very often 2 = Often 3 = Rarely 4 = Not at all

C14. What could be the reasons for the answer in C13 above?
…… ……. …….

C16. What challenges do you face in accessing extension services?
…… …… ……

SECTION D

ADOPTION OF AGRICULTURAL TECHNOLOGIES UNDER THE SINGLE SPINE SYSTEM BY FARMERS

D.0 USE OF GOOD AGRIC. PRACTICES

D.1	D.2	D.3	D.4	D.5
Did any member of this household receive training in the following? *1=Yes; 2=No*	If yes, which extension service provider trained you? (main one) ***(see codes)***	If Yes to D1, did you apply the knowledge and or skills learnt? *1=Yes; 2=No*	If D.3=1, How often do you use the knowledge and our skills? ***(see codes)***	If D.3=2, give the main reason why you did not apply the knowledge and or skills learnt? ***(see codes)***
Soil fertility improvement				
Improved varieties				
Time, rate & application of Crop husbandry practices Eg planting early, weeding, application of fertilizers, herbicides, etc				
Pest management and control				
Soil and water conservation				
Post-harvest handling				
Farming as a business				
Mainstreaming Gender				
Energy Conservation				
Value Addition				
Collective marketing				
Modern and digital market access information				
Record keeping				
Financial literacy				
Water harvesting for production				

***D.2 Codes**: 1=Private Extension workers; 2= Government extension workers; 3=Fellow farmers; 4=Input dealers; 5=Traders; 6=Farmer Organization*
***D.4 Codes**: 1=Very often; 2=Often; 3=rarely; 4=Not at all*
***D.5 codes**: 1= limited access 2=Harmful to soil 3=Labour intensive 4=Expensive 5= Lack of enough skills 6= Didn't want 7 = Non needed*

D.6. Rate agricultural extension services in terms of quality
1=High quality; 2=Quality; 3=Low quality; 4=Uncertain

D.7. In your opinion which extension service packages do you wish the government should provide to you for your effective use?
…… …… ……

Thank you for your time!

APPENDIX 2: KEY INFORMANT INTERVIEW GUIDE

Participant's informed Consent:

I am M/s Nimushaba Patience a student of Uganda Christian University pursuing a Master of Science in Agriculture and Rural Development. I am conducting a research about "Performance of The single spine system; a case of Buhweju District." You have been selected to be one of my key informants in this study. Here is a copy of my introduction letter from the University and the district production officer has received and endorsed it. You are free to participate or not participate in this study. The information provided will be treated with strict confidentiality and shall not be used for any other purpose except for academic purposes. The study will ensure your anonymity and confidentiality. Thank you very much for your cooperation. The interview will take between 30-40 minutes. Now I ask you; Are you willing to participate in this interview/study? Yes/No.

Key Informant Interview guide questions

1. How would you describe the single spine extension system that you implement? (probe for the structural set)
2. What are the assumptions behind the project its implementation
3. What is the strategy being used by extension providers to support farmers? Probe for:

Availability

Accessibility

Usability

4. Comment on the relevancy and appropriateness of the single spine extension system design.
5. Explain how you ensure there is efficiency, effectiveness and sustainability of its operations and how they are enhanced?

6. Any government subsidies or affirmative schemes to support farmers? What support is given to build the capacities of small-holder farmers to increase adoption of the single spine extension system?
7. Who are the target beneficiaries? (key characteristics of the farmers targeted by extension system and the conditions they have to fulfil)
8. Who are the key partners and what roles do they play in delivery of the extension services? (probe for outstanding providers)
9. How are the issues of equity addressed during delivery of extension services? Probe for the poor, gender (women and youth), urban vs rural, and the cost of commercial borrowing being so high?
10. What are some of the regulatory and quality control mechanisms on extension service delivery and other services provided?
11. What are factors that have influenced the success and or failure of the single spine extension system (probe for the delayed disbursement of the funds)
12. What policies favour the program? (Probe for the effect of the COVID-19 pandemic, policy gaps, market, and farmers' capacity)
13. What are the obligations of the beneficiaries?
14. What has been the role of government and donor agencies in framing the design and implementation of the extension system?
15. Comment on the level of adoption of the extension services
16. What are the current achievements of single spine extension system?
17. What are some of the setbacks/shortcomings of the extension system being advocated for?
18. What types of extension services does your office/institution provide to small-medium farmers?
19. How have you been prepared to engage in the delivery of these services? (knowledge and skills, infrastructure including ICT, human resources)
20. What are most outstanding service provided to the farmers and explanations for that?
21. How should government and private sector agents modify their operations to provide better extension services to smallholder farmers?

APPENDIX 3: FACULTY RECOMMENDATION LETTER

UGANDA CHRISTIAN UNIVERSITY
A Centre of Excellence in the Heart of Africa

FACULTY OF AGRICULTURAL SCIENCES
DEPARTMENT OF NATURAL RESOURCE ECONOMICS & AGRIBUSINESS

01/03/2023

Ref: UCU/NREAM/002/2023

The Chairperson,

Research Ethical Committee,

Uganda Christian University

P. O. Box 4 Mukono.

Dear Sir/Madam,

Greetings in Christ!

RE: Recommendation Letter for Nimushaba Patience

This is to certify that the above-named person is a bonafide student in the Department of Natural Resource Economics and Agribusiness, pursuing a Master of Science in Agriculture and Rural Development.

The student has successfully defended her research proposal entitled: ***"Effectiveness of Agricultural Extension Services under the single Spine System in Uganda." A case of Buhweju District.***

Therefore, it is our humble prayer that she is given the necessary support from your office to enable her to start the data collection exercise. The department will highly appreciate your timely response and assistance to be accorded to our student.

Thank you so much!

Kind regards,

John Livingstone Mutyaba

HoD Natural Resource Economics & Agribusiness,

Faculty of Agricultural Science.

CC - file

APPENDIX 4: REC RECOMMENDATION LETTER

UGANDA CHRISTIAN UNIVERSITY

A Centre of Excellence in the Heart of Africa

31/03/2023

To: Patience Nimushaba

Uganda Christian University
0775436282

Type: Initial Review

Re: UCUREC-2023-480: Effectiveness of agricultural extension services under the single spine system; a case of Buhweju District., 1, 2023-03-01

I am pleased to inform you that the Uganda Christian University REC, through expedited review held on **30/03/2023** approved the above referenced study.
Approval of the research is for the period of **31/03/2023** to **31/03/2024.**

As Principal Investigator of the research, you are responsible for fulfilling the following requirements of approval:

1. All co-investigators must be kept informed of the status of the research.
2. Changes, amendments, and addenda to the protocol or the consent form must be submitted to the REC for re-review and approval **prior** to the activation of the changes.
3. Reports of unanticipated problems involving risks to participants or any new information which could change the risk benefit: ratio must be submitted to the REC.
4. Only approved consent forms are to be used in the enrollment of participants. All consent forms signed by participants and/or witnesses should be retained on file. The REC may conduct audits of all study records, and consent documentation may be part of such audits.
5. Continuing review application must be submitted to the REC **eight weeks** prior to the expiration date of **31/03/2024** in order to continue the study beyond the approved period. Failure to submit a continuing review application in a timely fashion may result in suspension or termination of the study.
6. The REC application number assigned to the research should be cited in any correspondence with the REC of record.
7. You are required to register the research protocol with the Uganda National Council for Science and Technology (UNCST) for final clearance to undertake the study in Uganda.

The following is the list of all documents approved in this application by Uganda Christian University REC:

No.	Document Title	Language	Version Number	Version Date
1	Prior Ethical Approval	ENGLISH	1	2023-03-01
2	Informed consent form for the recruitment of research participants	ENGLISH	1	2023-03-01
3	Data collection tools	ENGLISH	1	2023-03-01
4	Protocol	English	1	2023-03-01

Yours Sincerely

Prof. Peter Waiswa

For: Uganda Christian
University REC

APPENDIX 5: STATA INPUTS

Patience-do-file (2).do