INFLUENCE OF ACCESS TO INSTITUTIONAL FACTORS ON THE USE OF CERTIFIED SEED POTATOES AMONG SMALLHOLDER POTATO FARMERS IN KIPIPIRI SUB-COUNTY, KENYA

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EGERTON UNIVERSITY

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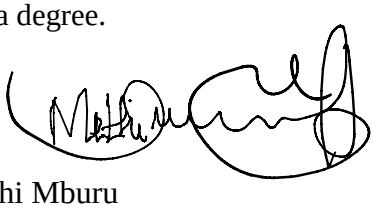
DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented in this University or any other for the award of a degree.

Signature  Date 13/06/ 2024

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Recommendation

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DEDICATION

This thesis is dedicated to the potato smallholder farmers of Kipipiri Sub-County and my beloved family.

ACKNOWLEDGMENTS

First, I wish to thank the Almighty God for His grace and good health without which successful completion of my studies would not be possible. I highly acknowledge the Mastercard Foundation through the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) for the scholarship that enabled me to further my studies. I am indebted to my supervisors, Dr. Millicent Oyugi and Professor Paul Makenzi, for their invaluable input to my work and continuous guidance throughout my research journey till the completion of my studies. Lastly, my heartfelt gratitude to the Department of Agricultural Education and Extension of Egerton University lecturers for their immense support and guidance throughout the study period.

ABSTRACT

Extension services delivery remains a key driver in farmers' uptake and use of improved farming technologies and innovations. Availability and access to certified seed multipliers increase the chances of smallholder potato farmers' uptake and use of certified seed technologies and practices. Furthermore, access to credit services increases farmers' financial capability to purchase and use certified seed potatoes. This is common in rural areas, which subsistence smallholder farmers predominantly occupy. Empirical evidence suggests that certified seed potatoes are critical in boosting potato yield, increasing income, and improving nutrition and food security at the household level. Nevertheless, smallholder potato farmers in Kipipiri Sub-County have recorded low potato yields in the recent past. Most of these farmers have limited access to certified seed potatoes. They, therefore, reuse their own saved seeds. Without access to certified seed potatoes, smallholder potato farmers are more likely to use seeds from their own stores, which are of poor quality or infested with pests and diseases. Reusing poor-quality seed potatoes decreases farm yields. Consequently, smallholder potato farmers may be compelled to focus on cultivating potatoes for subsistence, potentially jeopardizing the development of the small-farm sector in the long run. This study sought to determine the influence of access to institutional factors on the use of Certified Seed Potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya. The study's target population was 48000 smallholder farmers, while the accessible population consisted of 2500 actively engaged in potato production in the Sub-County. One hundred and six (106) smallholder potato farmers participated in this study. Semi-structured questionnaires with established reliability and validity were used to collect data from the respondents. Data analysis was done using SPSS version 25 to run descriptive and inferential statistics. Binary logistic regression was used to establish the relationship between access to institutional factors and the use of CSPs for the rejection or acceptance of the null hypotheses at a 5% level of significance. It was found that access to extension services was significantly associated with the use of CSPs. Further, access to certified seed multipliers and credit were found to be significantly related to the use of CSPs among smallholder potato farmers in Kipipiri Sub County, Kenya. This study recommends implementing seed multiplication policies, supporting research and training centers, facilitating credit among farmers, and supporting young people to venture into the seed multiplication business.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADC	Agricultural Development Corporation
AFC	Agricultural Finance Corporation
AGRA	Alliance for Green Revolution in Africa
ASDS	Agricultural Sector Development Strategy
AVCD	Accelerated Value Chain Development
CIDP	County Integrated Development Plan
CIP	International Potato Center
CSPs	Certified Seed Potatoes
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GoK	Government of Kenya
KALRO	Kenya Agriculture and Livestock Research Organization
KEPHIS	Kenya Plant Health Inspectorate Services
KSH	Kenya Shilling
MoA	Ministry of Agriculture
NACOSTI	National Commission for Science, Technology, and Innovation
NGOs	Non-Governmental Organizations
SHF	Smallholder Farmer
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
TTM	Trans-Theoretical Model
USD	United States Dollar

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Potatoes are a valuable and nutritious staple crop contributing to global food security and GDP growth. However, in the recent past, the food insecurity rate has increased, reaching an estimated 25.9% of the world's population in 2020, with smallholder households more likely to face severe food insecurity (Food and Agriculture Organization [FAO], 2020). Asia, particularly China, is estimated to produce half of the world's potatoes, followed by Europe, which produces about a third. Africa produces approximately 7% of the world's potato crop, primarily in Egypt and South Africa (Mburu *et al.,* 2020).

Potato production in Sub-Saharan Africa (SSA) was estimated to be 11.6 million tonnes in 2016, implying that millions of smallholder farmers cultivated it as a food security and cash crop (Musita et al., 2020). Agriculture is critical for economic development in developing countries. Agricultural development is unmatched in terms of job creation and poverty reduction. As a result of economic progress, a decline in agricultural contributions to employment creation and Gross Domestic Product (GDP) is unavoidable (Osabohien *et al.,* 2019). The majority of Sub-Saharan Africans (SSA) live in rural areas where agriculture is their primary source of income. The region faces significant challenges, such as rapid population growth and food insecurity, necessitating the development of a more capable and productive agriculture sector. However, productivity in SSA is low due to insufficient agricultural inputs such as fertilizers and seeds, as well as a lack of knowledge (Mulugeta *et al.,* 2020).

According to Harahagazwe *et al.* (2018), if potato farmers in SSA had access to high-quality seeds, the annual production of 10.8 million metric tons in 2018 would increase by 140% by 2021. Potato production in the highlands of East and Central Africa has enormous potential despite significant yield declines over the last two decades (FAO, 2020).

Potatoes are the second most important crop in Kenya, after maize, and are grown by smallholder farmers as both a food and a cash crop. Farmer organizations such as seed cooperatives are forming to capitalize on the collective bargaining benefits of the crop's volatile market. The cooperatives alleviate farmers' burdens, thereby encouraging investment in the potato sector despite the crop's marketing difficulties (Kangogo *et al.,* 2020). Due to

inefficient distribution systems, the use of improved seeds has remained low. The International Potato Center (CIP) introduced rooted apical cutting technology to increase the availability of high-quality seed potatoes in Kenya. Scientists from CIP and the Vietnamese Research Center for Experimental Biology developed and tested the technology (CIP, 2018).

Okello *et al.* (2017) state that the primary threat to potato smallholder farmers and the potato sector in Kenya is the use of low-quality seed potatoes that are highly contaminated with seed-borne diseases and pests. The phenomenon is caused by the scarcity and inadequacy of certified seed potatoes. Most smallholder potato farmers do not use certified seed potatoes for a variety of reasons, including a lack of knowledge about their potential value, high prices, and a lack of seed dealers. According to Mariita (2016), informal seed systems are disproportionately impacted by a lack of quality control in seed potatoes, as a result of which, many tubers have a low phytosanitary status. These seeds are saved on farms or exchanged between farmers. They account for more than 95% of potato farmers' seed consumption (kaguongo *et al.,* 2014).

Kenya Plant Health Inspectorate Service (KEPHIS) is the certifying body for seeds in Kenya. Seed certification provides farmers with high-quality seed that is true to identity, pure, germination-capable, and free of certain pests and diseases. Seed quality is critical in crop production because it ensures high yields and profitability and reduces the likelihood of crop failure (NCBA, 2019).

AGRA (2018) annual report noted that individual farmers have limited access to critical services and inputs due to their inability to advocate for collective needs. As a result, rural producer organizations, such as smallholder seed cooperatives, secure markets for their members and improve their livelihoods. The World Bank Group (2017) identified critical institutions for agriculture's capacity to contribute to the improvement of productivity in subsistence-oriented traditional farming, the majority of which are smallholder farmers. These institutions strengthen input distribution by increasing access to certified seed sources, extension services, capacity building through education and training, and increasing smallholder farmers' access to credit facilities (FAO, 2020).

Baglan *et al.* (2020) identified several factors that contribute to smallholder farmers' reluctance to use uncertified seeds. These include infertility caused by prolonged use, storage difficulties such as warehouse pests and diseases, and high pesticide costs for seed maintenance. However, adoption and usage remain low. There is limited evidence regarding the influence of institutional factors on smallholder potato farmers' use of certified seeds. As a result, a dearth

of empirical evidence may significantly impede the formulation of policies capable of addressing current variability in the potato seed sector and productivity.

Potato production improvements have the potential to boost farm incomes. However, smallholder potato farmers in the Kipipiri Sub-County have fallen short of realizing that potential. The low level of production has been exacerbated by low-quality, disease-infested seeds. As a result, any attempt to increase the use of certified seed potatoes by SHF potato farmers gives them an advantage (CIP, 2019).

Although technological input studies have been conducted, the majority of them focus on the promotion of improved crop varieties to increase rural productivity and household income. Mathenge *et al.* (2014) discovered that using high-yielding seed varieties of selected cereals increased yields, resulting in an increase in household income and poverty reduction in Asia and Latin America. As a result, farmers who use indigenous seeds face greater challenges in terms of food security and poverty than farmers who use improved seeds. Shiferaw *et al.* (2015) argued in support of this statement that introducing new agricultural technology can benefit both poor subsistence farmers and more educated farmers by providing critical information and awareness to boost productivity. The aforementioned studies omit information about the seeds' origins and certification process. Additionally, the studies do not demonstrate how access to specific institutions affects the use of certified seeds. As a result, this study is conceptualized in opposition to this justification.

1.2 Statement of the Problem

Extension services delivery remains a key driver in farmers' uptake and use of improved farming technologies and innovations. Availability and access to certified seed multipliers increase the chances of smallholder potato farmers' uptake and use of certified seed technologies and practices. Furthermore, access to credit services increases farmers' financial capability to purchase and use certified seed potatoes (CSPs). This is more particularly in rural areas, which are predominantly occupied by subsistence smallholder farmers. Empirical evidence suggests that certified seed potatoes (CSPs) are critical in boosting potato yield, increasing income, and improving nutrition and food security at the household level. Nevertheless, smallholder potato farmers in Kipipiri Sub-County have recorded low potato yield in the recent past. Most of these farmers have limited access to certified seed potatoes. They, therefore, reuse their own saved seeds. Without access to certified seed potatoes, smallholder potato farmers are more likely to use seeds from their own stores, which are of

poor quality or infested with pests and diseases. Reusing poor-quality seed potatoes decreases farm yields. Consequently, smallholder potato farmers may be compelled to focus on cultivating potatoes for subsistence, potentially jeopardizing the development of the small-farm sector in the long run.

1.3 Purpose of the Study

This study sought to establish the influence of access to institutional factors on the use of certified seed potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya.

1.4 Objectives of the Study

The objectives of this study were to

i. Determine the influence of access to extension services on the use of certified seed potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya.
ii. Determine the influence of access to certified seed multipliers on the use of certified seed potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya.
iii. Determine the influence of access to credit services on the use of certified seed potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya.

1.5 Research Hypotheses

The null hypotheses of the study were as follows:

$H0_1$: Access to extension services has no statistically significant influence on the use of certified seed potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya.

$H0_2$: Access to certified seed multipliers has no statistically significant influence on the use of certified seed potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya.

$H0_3$: Access to credit services has no statistically significant influence on the use of certified seed potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya.

1.6 Significance of the study

The study is significant because its findings may help the SHFs in Kipipiri Sub-County understand the value of using CSPs. Consequently, improving the use of CSPs in potato production by better understanding the relationship between the institutional factors and the use of CSPs. The knowledge may translate to significant potato yields and subsequent farming income. The results, if adopted by policymakers, may help formulate agricultural policies by

providing them with essential areas of strategic intervention. Other researchers could also use the results from this study as a source of knowledge for reference.

1.7 The Scope of the Study

This study was conducted in Nyandarua County's Kipipiri Sub-County. It examined the effect of institutional factors on smallholder potato growers' use of certified seed potatoes in Kipipiri Sub-County. Specifically, the study focused on the effect of access to extension services, certified seed multipliers, and credit on SHF's usage of CSPs. Access to extension services comprises the frequency with which smallholder potato farmers in the Sub-County attend extension services, both private and public, and training programs. Farmers who utilize certified seed potatoes from a KEPHIS-approved source have access to certified seed multipliers. Smallholder farmers who obtain credit facilities such as agricultural loans define access to credit. The use of CSPs will be measured by the percentage of farmers using CSPs.

1.8 Assumptions of the Study

In this study, the researcher made the following assumptions:

i. The respondents would be honest in their responses.
ii. Farmers in the study area re-use seed potatoes from their farm-stores which may be of low quality.

1.9 Limitations of the Study

The following were the limitations of this study:

i. Some respondents were not willing to give their responses openly. Therefore, respondents were assured of the confidentiality of their information and hence consented.
ii. Language barrier: Most smallholder farmers in the study area did not understand English, which was used in structuring the questionnaire; therefore, the researcher translated to them and helped them fill out the questionnaire. This helped capture correct responses from the respondents.

1.10 Definitions of Terms

Access: Ability to derive benefits from things (Ribot & Peluso, 2003). In this study, it's operationalized as the ability of smallholder potato farmers to obtain and make use of extension services, certified seed multipliers and credit facilities.

Certified Seed Potato: According to the National Potato Council of Kenya master plan (2014), a Certified seed potato is a seed of a prescribed standard of quality, produced under a controlled multiplication scheme, either from basic seed or from a previous generation of certified seed. It is obtained from multiplying basic seeds under the stringent supervision of KEPHIS. In this study it refers to seed potatoes which are free from pests and disease-causing micro-organisms, normally sourced from KEPHIS accredited dealers.

Credit services: According to Sekyi *et al.* (2019), credit refers to loans issued to assist in a production activity and are expected to be paid later. In this study, credit is operationalized as all services that ensure smallholder potato farmers access loans to finance agricultural production, especially in securing agricultural inputs.

Extension services: An informal educational process directed toward the rural population. This process offers advice and information to help them solve their problems. Extension provides information such as the availability of credit and farm input hence assisting farmers in making decisions and generally enabling them to take action (Abed *et al.,* 2020).In the context of this study, it refers to training and advisory services accessed by smallholder potato farmers, guiding them on the importance and use of certified seed potatoes in potato production. This will be measured by the frequency and number of training programs attended by target farmers.

Influence: The capacity to affect the character, development, or behaviour of someone or something or the effect itself (Stevenson, 2010). In this study, influence refers to any effect on the institutional factors that can cause farmers to use certified seed potatoes.

Institutional Factors: These are institutional arrangements and conditions, norms and rules which are either formal or informal, that define rights of access to goods and certain services, as well as access to the management of a given space or to its natural resources (Raleting & Obi, 2015). In this study, operationally defined as access to extension services, access certified seed multipliers and access to credit services.

Smallholder farmers: A farmer owns or cultivates a small piece of land on which they grow subsistence crops and one or two cash crops, relying almost exclusively on family labour. In Kenya, smallholdings are classified as being

below five hectares; the average is two hectares for ware potato farmers. They produce crops mainly for family consumption and income (Dixon, *et al*., 2003). For the purpose of this study, smallholder farmers refer to those who produce potatoes on an area of land less than five hectares, either owned or hired.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews selected relevant literature on significant topics that supported the study. It starts by reviewing the literature on potato production overview in Kenya, potato production in Nyandarua County, concepts of certified seed potatoes, seed potato production in Kenya, the role of extension services, and the importance of credit services to smallholder farmers. The chapter ends by giving the study's theoretical and conceptual frameworks.

2.2.1 Potatoes Production Overview

Potatoes are globally significant, ranking as the third most cultivated crop after rice and wheat (CIP,2023). In 2021, a total of 18132,694 hectares of potatoes were planted with an average yield of 21 tons per hectare, reaching an annual production of 376 million tons, with China as the top producer, accounting for 94 million tons of this output (FAO, 2021). Significantly, one billion people consume potatoes, and an enormous segment of the global population, particularly farmers and entrepreneurs, relies on potato production for their livelihoods (CIP, 2023).

According to Muthoni and Shimelis (2023), potatoes are considered a strategic staple crop in Africa, providing both food and income security. The crop is cultivated under various conditions and farming systems throughout the continent, with commercial farms in Egypt and South Africa relying on irrigation, while smallholder farmers in the tropical highlands of Eastern and Central Africa grow potatoes under rainfed, intensive, and low-production input systems. In Sub-Saharan Africa, the majority of potatoes are produced in Eastern Africa, accounting for 71% of the total production, while Southern and West Africa contribute 21% and 8%, respectively.

Despite this, the yield per hectare in the region remains low, ranging from 6 to 10 tons per hectare, which falls far below the attainable yields of 25-35 tons per hectare. The primary causes of the low yields include the scarcity of high-quality seed potatoes, inadequate adoption of available improved varieties, and a lack of good agricultural practices. Unfortunately, over 95% of seed potatoes are acquired from informal seed systems (Gildemacher *et al.*,2023). Efforts to improve potato production in Africa should prioritize the adoption of improved varieties, the promotion of good agricultural practices, and the establishment of formal seed

systems to ensure the availability of high-quality seed potatoes. By addressing these issues, African countries can increase potato yields, improve food and income security, and contribute to regional economic growth (Obedi, 2023).

In Kenya, potato (*Solanum tuberosum L*) is the second most vital crop after maize. It plays an important role in national food and nutritional security, hence emerging as one of the promising enterprises that will play a significant role in the realization of the set objectives of Kenya Vision 2030 under the economic pillar (Nyandarua County Paper, 2020). According to the Government of Kenya National potato strategy paper (2017), Potatoes are mainly grown in the Kenyan high-altitude areas of 1,500-3,000 m above sea level; over 70% of potato production is grown above 2,100 m above sea level, where Kenya's main staple food crop, maize, has no comparative advantage. These areas are: the slopes of Mt. Kenya, mainly Meru, Embu and Kirinyaga; parts of Laikipia, Nyeri, Muranga, Kiambu and Nyandarua Counties. Also grown in the highlands of Mau Narok and Molo. The increasing demand for the crop has led to the expansion of potato production to non-traditional potato-growing areas such as Naivasha and Tana River. The availability of new heat-tolerant varieties and modern irrigation technologies has made it possible. The altitude of these zones makes potatoes grow faster than maize and produce more energy and protein per ha per day (Janssens *et al.,* 2013).

Potato is grown by about 800,000 farmers cultivating about 161,000 hectares per season with an annual production of about 3 million tonnes in two growing seasons, while across the whole value chain, about 2.5 million people receive income from potatoes. The annual potato crop is valued at KSh. 50 billion (USD 500 million) at farm gate prices (Muthoni *et al.,* 2017). Nyandarua County contributes 33% of ware potatoes produced in Kenya with a net worth of over Ksh 7.0 billion. The potato value chain contributes to the income generation of 13,1697 farming households. However, smallholder farmers in the County produce an average yield of 3-4 tonnes per acre per season. The yield is below the potential 10 tonnes per hectare, which can be realized using certified seed potatoes (Nyandarua County Intergrated Development Plan, 2020).

2.2.2 Potatoes Production in Nyandarua County

Potato is the leading crop in Nyandarua County, covering over 37,000 hectares annually. There are about 70,000 smallholder potato farmers who, on average, produce 550,000 tonnes of potatoes worth Kshs 10 – 12 billion annually. Low availability and use of certified seed potatoes has been identified as a significant challenge in the potato sub-sector in the County.

Other challenges in the sector include a lack of a structured potato market and poor agronomic practices. Geographically, the County is surrounded by the Aberdare Ranges, therefore characterized by rich and fertile soils and good ecological conditions; subsequently, crop production is favourable all year round (Nyandarua County Integrated Development Plan, 2020).

Nyandarua potato strategy paper (2017) noted that by 2017, Nyandarua County contributed about 33% of the total potato produced in Kenya. However, the crop, which is second to dairy in the county, faces numerous challenges along its value chain, resulting in low average yields of about 8 to 10 tonnes/Ha, which is way below the achievable levels of 20- 40Tonnes/Ha. The County Integrated Development Plan (2018-2022), in accordance with Vision 2030 and the Big 4 Agenda, identifies potatoes as an important crop and lays down strategic interventions to grow the sector further. The County has also developed a county potato strategy to coordinate potato subsector activities and guide interventions.

2.3 Concepts of Certified Seed Potatoes

Adiyoga (2021) noted that, globally, a seed is considered an essential input since farmers have to invest about 25-50% of the total cost in maximizing crop yield. The seed highly determines yield realization; therefore, regardless of how a smallholder farmer uses other productive inputs such as fertilizer, land, and labour, the efficiency of other production inputs will still depend on the seed. Alzaidi *et al.* (2020) suggested that in Sub-Saharan Africa, organizations and institutions should work together to serve farmers by making agricultural inputs and supplies such as seeds available. Consequently, disseminating agricultural information to smallholder farmers. According to Waldman *et al.* (2020), institutions dealing with agricultural policy and research view seeds, specifically improved varieties, as an essential constituent of improving production and food security.

Kenya leads in certified seed production in Africa; however, it only meets approximately 2% of effective seed demand, which has slowly increased from 0.6% in the recent past, with other SSA countries lagging further behind on seed supply. Current seed systems rely on producing mini-tubers from tissue culture plants in the greenhouse, followed by three to four seasons of multiplication in the field to produce certified seed (Parker, 2018).

Diro *et al.* (2021) identified the use of quality seeds as an integral part of modern agricultural technologies that is critical for improving agricultural productivity, especially in developing countries where new agricultural technologies remain limited and traditional farming practices

pre-dominate farmers' farms and plots. Different actors in the potato value chain are in an effort to increase quality seed supply to smallholder potato farmers in Kenya. For example, CIP has introduced apical cutting technology, a technology that accelerates the multiplication process, producing more seed potatoes more quickly and cheaply than other methods. It is estimated that farmers and seed multipliers can earn 40% more from apical cuttings than from mini-tubers (CIP, 2018).

2.4 Seed Potatoes Production in Kenya

In Kenya, there is an inadequate supply of certified seed potatoes despite the increasing demand for the crop. It is approximated that only 1% of the potato area is planted with certified seed. Farmers, therefore, depend on informal seed sources such as farmer-saved seeds as well as seeds from local markets (Wiersema *et al.*, 2017). Kenya Agricultural and Livestock Research Organization (KALRO) is the body double mandated with research and commercial production of seed potatoes. However, due to the increased demand for high-quality seed, it has therefore partnered with other private organizations and companies, such as CIP and Kisima farm, in seed production and multiplication (CIP, 2019).

According to the CIP report (2019), the Kenyan formal seed system involves the production and distribution of certified seed; the Kenya Agricultural and Research Organization (KALRO), in partnership with the International Potato Centre (CIP), develops, maintains potato varieties, and supplies foundation seed. Kenya Plant Health Inspectorate Services (KEPHIS) offers seed inspection services, while the Agricultural Development Corporation (ADC) and a few farmers and private institutions carry out the multiplication of basic seeds to produce certified seeds. The Government provides policy and regulatory framework, while extension services are provided explicitly by the Ministry of Agriculture (MoA) and other partners like KALRO and NGOs (Kaguongo *et al.*, 2014).

The primary seed producers in Kenya are ADC-Molo, Agrico East Africa Nairobi, Gen-Biotech Ltd, Grace Rono Kisima Farm, and Suera farm, with common varieties produced, are; Manitou, Tolu Shangi, Tigoni, Unica, Kenya Karibu, Annet, Sherekea, Kenya Mavuno, Dutch Robijn, Wanjiku, Chulu, Nyota (GoK, 2019). Farmers' saved seeds account for 96.3%, clean seeds for 1.4%, and positively selected seeds for 1.2%. Only 1.1% of certified seeds are planted in Kenya. Figure 1 shows the proportion of seed potato types planted in Kenya.

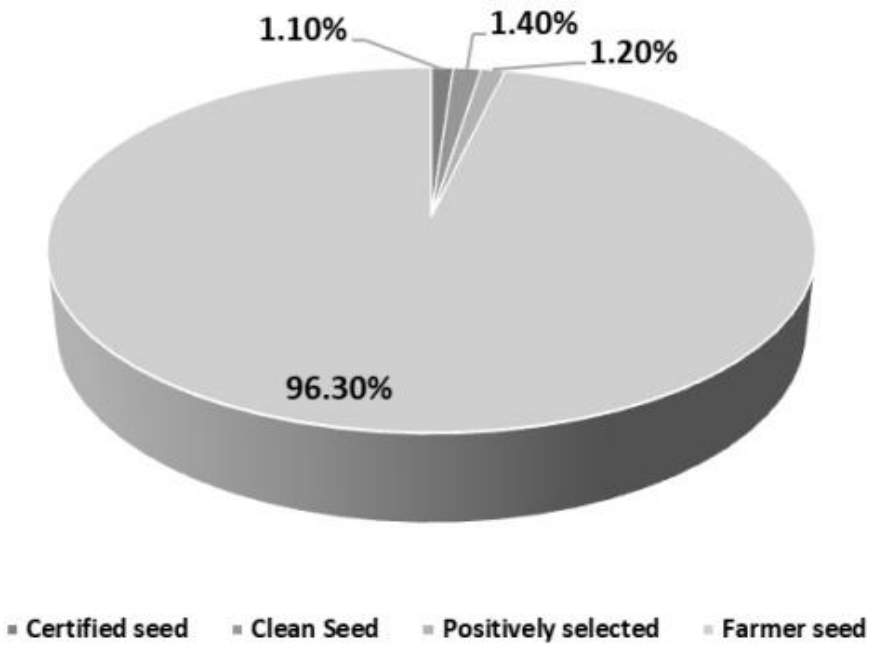


Figure 1. *The proportion of seed potato types planted in Kenya*
Source: *Kaguongo et al. (2014)*

2.5 Access to Extension Services by Smallholder Farmers

Antwi-Agyei and Stringer (2021) and Kassem *et al.* (2021) highlighted that agricultural extension services were globally introduced as an institutional input for revolutionizing agriculture and stimulating rural development. It also links farmers with research agencies and other agricultural value chains, such as input providers. A high-quality agricultural extension service is one that is useful, well-managed, and accountable to farmers. It also meets the needs of farmers in different agro-ecological environments through regular contact between farmers and extension providers (Cook *et al.,* 2021).

As noted by Ragasa and Masunda (2018), in many African countries, extension agents are an essential source of information for farmers and play a key role in convincing farmers to adopt agricultural modernizations. Agricultural extension and advisory services help promote rural development and support the revolution of modern farming (Alotaibi *et al.,* 2021). Kalogiannidis *et al*. (2024), conducted a study indicating that agricultural extension delivery channels, including workshops and training, exert a positive impact on farm productivity. Moreover, government demonstration farms and media-based agricultural programs were found to influence farm productivity significantly. Consequently, workshops and training in agriculture could substantially enhance farm output. Through extension services, farmers can

solve farming-related problems as well as make better farming decisions by the provision of timely information.

Extension workers facilitate farmers' networking with various partners in the value chain (Baiyegunhi *et al.,* 2019; Lamm *et al.,* 2021).According to Ampaire *et al.* (2020), identified agricultural extension services, input suppliers, and credit facilities as vital institutions that bring smallholder farmers together, forming farmer organizations for a common gain. Maertens *et al.* (2020)**,** noted that, through agricultural extension services, farmers overcome information constraints, consequently encouraging the adoption of improved agricultural technologies, thereby increasing yields and incomes. The success of agricultural extension depends on the model of extension employed. Primary models include systems of training and visits, demonstration plots, farmer field days, and field schools. Farmers are made aware and informed about enhancements to the production process, including the optimal use of inputs (Abed *et al.,* 2020).

Namyenya *et al.* (2021) identified accountability as a major challenge in agricultural extension service delivery in the public extension system. Weak upward accountability arises due to the limited voice of the beneficiaries, such as a lack of farmer complaint channels and a lack of robust supervisory mechanisms, therefore making it difficult for the supervisors to monitor and evaluate the performance of large numbers of remotely located field officers and public bureaucracies were also noted. However, an increase in the capacity and incentives of the supervisors to adequately monitor field activities and improve the farmers' ability to demand better services would minimize the challenge (Anang *et al.,* 2020).

In Kenya, the transfer of new technology and innovation from research to farmers is mainly carried out by public agricultural extension services and hardly by private extension providers. Characterized by insufficient funds for extension and rearrangement of public extension services, there has been a drop in the transfer of agricultural information and technologies as well as widening gaps between the extension staff to farmer ratio, thereby causing constraints in the delivery of extension services(Khalid *et al.*, 2021).

According to Jane *et al.* (2021), skilled extension staff are mandated to develop useful extension programs that identify difficult problems and then design appropriate combinations of remedies. These provide the required information, including results of on-farm trials that demonstrate feasibility, and are essential for the timely transfer of technologies to farmers who are the end-users. It is therefore accepted that a well-designed and functioning extension

system is vital for disseminating information and promoting the adoption of new farming technologies among farmers who otherwise may lack the knowledge of and opportunities to obtain new technologies on their own (Montfaucon, 2020).

A study on access and the role of extension services (Alotaibi *et al.,* 2021) revealed that farmers participated in the extension services offered at a low level. Nonetheless, they had access to high-quality extension services. Furthermore, farmers' satisfaction was significantly influenced by their participation in extension services. The study failed to demonstrate the impact of access to extension on farm input use. As a result, this study will examine the impact of access to extension services on farmers' use of CSPs.

2.6 Access to Credit Services by Smallholder Famers

According to Mamuye (2021), access to credit is considered one of the key elements in realizing the transformation plan and also is an important economic driver necessary for the achievement of higher growth in the agricultural sector world-wide. Subsequently, efforts to improve farmers' access to agricultural credit would translate to higher adoption and use of improved farm inputs and modern farming technologies. Through access to agricultural credit, farmers are assured of accessing all other production resources, which are important in the improvement of agricultural production. Ultimately, there is substantial progress in rural welfare and farmers' income (Kofarmata & Danlami, 2021).

Varangis *et al*. (2021).) highlighted that rural smallholder farmers, particularly female farmers, face significantly limited access to affordable financial services and products as loans, compared to their male counterparts. This constrained access, adversely affects female farmers and their households, substantially impeding their advancement and prosperity. Female farmers frequently encounter constraints in obtaining formal savings and credit, curtailing their capacity to cope with unforeseen exigencies and to invest in seasonal inputs, durable goods, and productive assets. Additionally, Montfaucon (2020), noted that smallholder farmers in developing countries often need credit for working capital at the beginning of the growing season to procure inputs such as seeds and to invest in equipment such as tractors and human labour. Despite this being the case, access to financial services for smallholder farmers remains a challenge. Increased access to credit helps smallholder farmers overcome short-run liquidity problems and possibly increase the adoption of more efficient and effective agricultural technologies (Wabwire, 2020).

According to Dossou *et al.* (2020), credits have the beneficial effect of increasing farm productivity and the cash flows of farmers' households; however, in Africa, formal financial services are controlled by banks, most of which are foreign, with the industry being highly concentrated in urban cities. Lack of banking infrastructure characterizes rural areas. Financing constraints in the agricultural sector limit the productive capacity of poor smallholder farmers, consequently impending agriculture modernization and technological uptake by the farmers (Chandio *et al.*, 2020).

According to Wabwire (2021), essential changes in Kenyan agriculture have profoundly affected agricultural financial services. In the past, financing of agriculture in Kenya was mainly done through the Agricultural Finance Corporation (AFC), a financial institution expressly set up to enable farmers to acquire credit. Nevertheless, the AFC was not serving the credit needs of smallholder farmers since the loans went to large farms averaging 19 acres (Chenaa *et al.*, 2018). Risks and uncertainties related to rain-fed agriculture made most agricultural financiers reluctant to serve the agricultural sector. However, this financial need and gap have been covered by self-finance and cooperatives, hence smallholder farmers. Kibaara and Nyoro (2007) noted that the initiation of innovative banking models through commercial banks such as Equity banks had seen a higher proportion of the rural population, whose majority are smallholder farmers, previously unreached, being reached by financial services.

Studies on access to credit services by smallholder farmers have been conducted previously; an example is a recent study conducted in Siaya County, Kenya, by Odhiambo and Upadhyaya (2021), who found that the level of flexibility of loans offered to farmers is low. Further shows that refinancing and lines of credit are more likely to improve access to credit when farmers are more educated and wealthier, respectively. The age of a farmer, the type of lender, the type of loan, education and household wealth are the main determinants of access to credit. The study did not, however, show the relationship between credit and the use of agricultural farm inputs. In Kipipiri Sub-County, no study has been done to show the influence access to credit has on the use of CSPs. Therefore, this study attempts to fill this knowledge gap.

2.7 Theoretical Framework

The study adopted the Trans-Theoretical Model (TTM) of behaviour change, also known as the stages of change theory by Prochaska and Diclemente (1984), an integrative theory of

therapy that assesses an individual's readiness to act on new, healthier behaviour and provides strategies, or processes of change to guide the individual. The model is composed of constructs such as stages of change, processes of change, levels of change, self-efficacy, and decisional balance (Moeini *et al.*, 2010).

Figure 2 shows the stages of change in the Trans-Theoretical model.

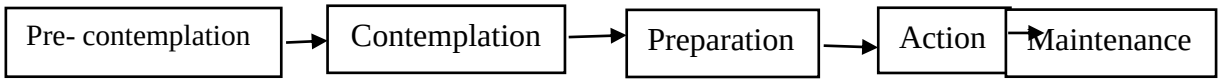


Figure 2: *Stages of change in the Trans-Theoretical model*

Stages of Change in the Model

Pre-contemplation: In this stage, the Smallholder farmers are unwilling to act, unaware that their behaviour is problematic. Contemplation: in this stage, the farmers are beginning to know that their behaviour is problematic and, therefore, begin to look for a solution. Preparation: At this level, smallholder farmers now intend to act in the immediate future and may begin taking small steps toward behaviour change. Action: in this stage, farmers have made specific overt modifications to modify their problem behaviour or acquire new behaviours. Maintenance: In this stage, farmers have been able to sustain an action for at least six months and are working to prevent reversion. Termination: Individuals have zero temptation, and they are sure they will not return to their old habits as a way of coping (Moeini *et al.*, 2010).

Other theories would also suit this study. An example of this is Rogers' theory of diffusion of Innovations (Rogers, 2003), which explains how, why, and at what rate new ideas and technology spread. Therefore, it would help explain how smallholder farmers use certified seed potatoes in a social system. According to the theory, four main elements tend to influence the spread of a new idea: the innovation itself, communication channels, time, and a social system. However, the researcher found the Trans-Theoretical Model (TTM) of behavior change as the most appropriate. This is because the theory reveals how usage and uptake of learning behaviour, such as smallholder farmers' use of certified seed potatoes, can be enhanced. The model also provides a gradual measure of farmers' decision-making concerning the use of certified seed potatoes.

2.8 Conceptual Framework

The conceptual framework summarized the relationship between the independent, moderating, and dependent variables of the study. The independent variables were SHF'S access to extension services, access to certified seed multipliers, and access to credit services. Access to extension services was measured by establishing the frequency, number of trainings attended and the percentage of SHFs who had access to extension services in the study area. Access to certified seed multipliers was measured by determining the percentage of smallholder potato farmers who acquired seeds from certified seed multipliers. Access to credit services was measured by establishing the percentage of smallholder potato farmers who had access to agricultural loans from credit facilities in the Sub-County. The moderating variables of the study consisted of SHF's education level, gender, and age. The moderating variables were controlled by ensuring that the sampled respondents were homogeneous with respect to the independent variables. The dependent variable of the study was smallholder potato farmers' use of CSPs. To measure this dependent variable, Smallholder potato farmers' use or no use of CSPs was determined. Additionally, the percentage of SHFs using CSPs in Kipipiri Sub-County was established.

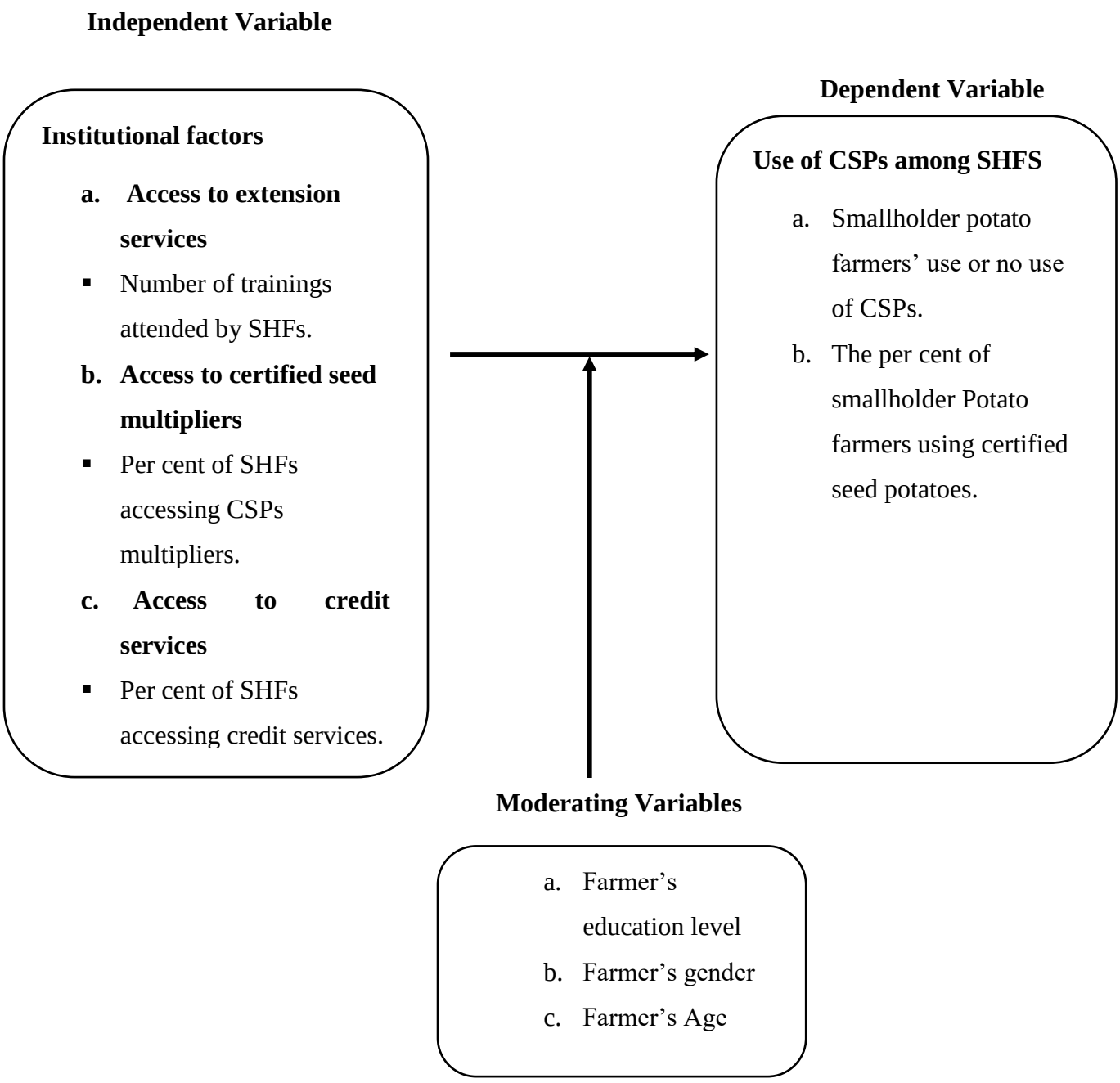


Figure 3. *Institutional factors influencing smallholder potato farmer' use of certified seed potatoes in Kipipiri Sub-County, Kenya.*

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the methodology that was used to obtain the objectives of the study. It presents the research design, the location of the study, the population of the study, sampling procedures, sample size, instrumentation, data collection, and data analysis.

3.2 Research Design

The study adopted a cross-sectional survey design. The design was appropriate since it allows the data collection at a single point in time (Sada & Maldonado, 2013)The researcher used a cross-sectional survey to collect data on smallholder potato farmers' use of certified seed potatoes.

3.3 Location of the Study

The study was conducted in Kipipiri Sub-County, Nyandarua County, Kenya. Kipipiri Sub-County is in the central region. The Sub-County covers 543.7 km2 with four administrative wards, namely, Wanjohi, Kipipiri, Geta, and Githioro. The Sub-County has a total population of 113,938 (CIDP, 2018). Agricultural activity is extensively carried out in the Sub-County, with potatoes being the leading crop. It is grown both for subsistence and commercial use. Other crops grown in the area are maize, cabbages, peas, and carrots. The farmers in the region also practice livestock production, mainly dairy farming. The study area falls under the high-rainfall agro-ecological zone, characterized by a cool and temperate climate with reliable rainfall which is generally well distributed throughout the year, with two rainy seasons: long rains from March to May with a maximum rainfall of 1,600 mm and short rains from September to December with a maximum rainfall of 700 mm (ASDS, 2020). Appendix B provides the map of the study area.

3.4 Target Population

The study targeted smallholder potato farmers in Kipipiri Sub-County. According to MoALFI (2020), there are 48000 smallholder farmers actively engaged in potato production in Kipipiri Sub-County. These formed the target population. The accessible population consisted of 2500 smallholder potato farmers who grow potatoes in Wanjohi (800), Kipipiri (650), Githioro (600), and Geta (450) wards of Kipipiri Sub-County. Other actors such as agricultural extension providers, certified seed multipliers, and credit agencies (agricultural loan

providers) were studied under institutional factors in terms of farmers' access to their services, and therefore the study findings may help them improve their services to target farmers.

3.5 Sampling Procedure and Sample Size

The smallholder potato farmers were selected to participate in the study. Stratified proportionate sampling method was used to determine the number of smallholder potato farmers to be studied in each ward. A simple random sampling technique was used to obtain participants from the proportionate sample drawn from each ward. The following formula, as stated by Nassiuma (2000), was used to come up with an appropriate sample size for the study.

$$n = \frac{\boldsymbol{NC^2}}{\boldsymbol{C^2+(N-1)e^2}}$$

Where:

n = the required sample size,

$\boldsymbol{N}$ = the population within the study area,

$\boldsymbol{C}$ = Coefficient of Variation,

$\boldsymbol{e}$ = Standard error.

$$n = \frac{2500x(0.21)^2}{(0.21)^2 + (2500-1)x(0.02)^2} = 106$$

The sample was obtained using the coefficient of variation of 21%, a standard error of 2%. The population within the study area of 2500 smallholder potato farmers in Wanjohi, Kipipiri, Githioro and Geta wards. This meets Nassiuma's (2000) contention that in most surveys, a coefficient of variation occurs within the range of 21%≤C≤30% and that standard error occurs within the range of 2%≤e≤5%. Therefore, the stated coefficient of variation and standard error were preferred for this study. The lower limit for the coefficient of variation and standard error were selected to ensure low variability in the sample and minimize the degree of error.

The study expected 95% confidence (5% sampling error) to obtain a sample size of 106 smallholder potato farmers. The study obtained the sample size for each ward proportionate to the population within the study area. Table 1 shows the sampling procedure to ensure that there was no bias in distributing the sample size in the study area.

Table 1

Distribution of Sample Size of Smallholder Potato Farmers per Ward

Wards	Population	Proportion Percentage	Sample size
Wanjohi	800	32	34
Kipipiri	650	26	28
Githioro	600	24	25
Geta	450	18	19
Total	**2500**	**100**	**106**

Source: *MoALF, (2020)*

3.6 Instrumentation

This study used a semi-structured questionnaire to collect data from the sampled smallholder potato farmers in the four wards of Kipipiri Sub-County. The questionnaire was administered in person by the researcher. A semi-structured questionnaire was chosen since it enabled the respondents to interact directly with the researcher. Additionally, it was easy to administer and analyze the data that it yielded. The questionnaire was developed based on the proposed study objectives. Section A of the instrument collected general information about the respondents. Section B collected information on access to extension services, section C collected information on access to certified seed multipliers, and section D collected information on the access to credit on smallholder farmers' use of CSPs.

3.6.1 Validity

Validity is the ability of the instrument to measure what it is meant to measure (Mugenda & Mugenda, 2003). It manifests as content and face validity. Face validation of the instrument ensured that its contents appeared relevant to the study objectives. The research tool was reviewed by different research experts from Egerton University to check for the instrument's accuracy. Remarks from the experts were used to improve the instrument.

3.6.2 Reliability

Reliability measures the degree to which a research instrument yields consistent results of data over repeated trials. The major reason to test reliability is to ascertain the internal consistency of the instrument items (Mugenda & Mugenda, 2003; Nunnally, 1978). A pilot test was conducted in Olkalou Sub-County, which has similar agricultural conditions. Smallholder potato farmers from the Sub-County have similar characteristics to those in Kipipiri Sub-County. The respondents for piloting were thirty randomly selected smallholder potato

farmers selected in the Sub-County. The reliability coefficient was estimated using the Cronbach Alpha Scale of 0.756α. The questionnaire was considered reliable after attaining the alpha coefficient above the threshold (0.70α) for acceptable reliability (McMillian &Schumacher, 2004).

3.7 Data Collection Procedures

An introductory letter was obtained from the Board of Post-Graduate Studies at Egerton University, and I applied for a research permit from the National Commission for Science, Technology, and Innovation (NACOSTI). The researcher used the permit to approach the Nyandarua County Director of Agriculture and later the Kipipiri Sub-County agricultural officers, seeking permission to access the study area and population for data collection. The researcher got the lists of smallholder potato farmers from the agricultural extension officers in Kipipiri Sub-County. The semi-structured questionnaire was administered in person to the sampled smallholder potato farmers during the data collection exercise.

3.8 Data Analysis

The data was coded and entered into the statistical Packages for Social Sciences (SPSS) version 25 Statistics. Logistic regression analysis was used to create inferences on the influence of access to selected institutional factors on the use of certified seed potatoes. Logistic regression is a technique used when the dependent variable is categorical or nominal. It determines the impact of multiple independent variables presented simultaneously to predict the membership of one or other of the two dependent variable categories. The analysis model is appropriate for this study since the use of certified seed potatoes fits into a dichotomous choice; whether a respondent uses or does not use certified seed potatoes. It should be noted that the use of logistic distributions has an advantage over other models in the analysis of dichotomous outcome variables; binary logistic models do not rest on the assumption of linearity between dependent and independent variables and do not assume homoscedasticity (Suvedi *et al*., 2017). All tests of significance were computed at α = 0.05 significance level. The logistic regression analysis model was as indicated below:

$$\ln\left(\frac{Pi}{1-Pi}\right) = ß_0 + ß_1X_1 + ß_2X_2 + ß_3X_3 + \varepsilon.$$

Where: Pi is the probability that Yi takes the value 1 and then (1 − Pi) is the probability that Yi is 0

Yi= Use of CSPs (Dependent variables)

$ß_0$ = intercept, $ß_1$, $ß_2$, and $ß_3$ = coefficient of determination

$X_n = X_1+X_2+X_3$ (Independent variables); X_1= access to extension services; X_2 = access certified seed multipliers; X_3 = access to credit services; and ε = random error term.

The *Chi*-square ($\chi 2$) omnibus test of unstandardized beta coefficients was used to determine the overall fitness of the model. Cox & Snell R Square and Nagelkerke R Square were used to show the prediction of the independent variables. The odds ratio (*OR*) represents the predicted probabilities of the occurrence of the dependent variable in question (Pituch & Stevens, 2015).

Table 2

Summary of Data Analysis

Hypotheses	Independent variables	Dependent variables	Statistical Analysis	Measurement of the Dependent variable
$H0_1$: Access to extension services has no statistically significant influence on the use of certified seed potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya	Access to extension services	SHF' use of CSPs	Logistic regression Descriptive statistics	Categorical, Measured as 1=Use of CSPs 2=No use of CSPs
$H0_2$: Access to certified seed multipliers has no statistically significant influence on the use of certified seed potatoes among smallholder potato farmers in	Access to certified seed multipliers	SHF' use of CSPs	Logistic regression Descriptive statistics	Categorical, Measured as 1=Use of CSPs 2=No use of CSPs

Kipipiri Sub-County, Kenya				
$H0_3$: Access to credit services has no statistically significant influence on the use of certified seed potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya	Access to credit services	SHF' use of CSPs	Logistic regression Descriptive statistics	Categorical, Measured as 1=Use of CSPs 2=No use of CSPs

3.9 Ethical Considerations

Ethical issues were observed. The researcher presented the research permit to Kipipiri Sub-County Agricultural Offers to seek data collection permission. The respondents were informed about the purpose and the procedures of the study. Afterwards, the respondents were asked to sign a consent to participate in the study before the data collection began. The dignity and cultural values of the respondents were highly observed and respected, respectively. Confidentiality and privacy were observed at the highest level possible. Furthermore, the findings of the study would be shared with the relevant authorities and the participants after data analysis and presentation.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents and discusses the results of the study based on the formulated objectives and hypotheses as presented in chapter one. The study examined the influence of access to institutional factors on the use of Certified Seed Potatoes (CSPs) among smallholder potato farmers in Kipipiri Sub-County, Kenya. The data were collected from the smallholder potato farmers from the four wards (Wanjohi, Kipipiri, Geta, and Githioro) within Kipipiri Sub-County, Kenya. Both descriptive and inferential statistics were used in the analysis of the data. The results were presented in the form of figures and tables and further discussed in relation to other studies. This chapter is divided into four sections, as follows: general information about smallholder potato farmers in Kipipiri Sub-County, the influence of access to extension services, access to certified seed multipliers and access to credit on the use of certified seed potatoes. To test the null hypotheses, this study examined whether access to extension services, access to certified seed multipliers and access to credit had a statistically significant influence on the use of CSPs among smallholder potato farmers in the study area.

4.2. General Information on the Smallholder Potato Farmers

In this section, the study considered three major variables: farmers' gender, age, and education level. The descriptive statistics were summarized as frequencies and percentages.

4.2.1 Gender of Smallholder Potato Farmers

Figure 4, showing information on the gender of smallholder potato farmers, reveals that smallholder potato farmers who participated in the study were mainly females.

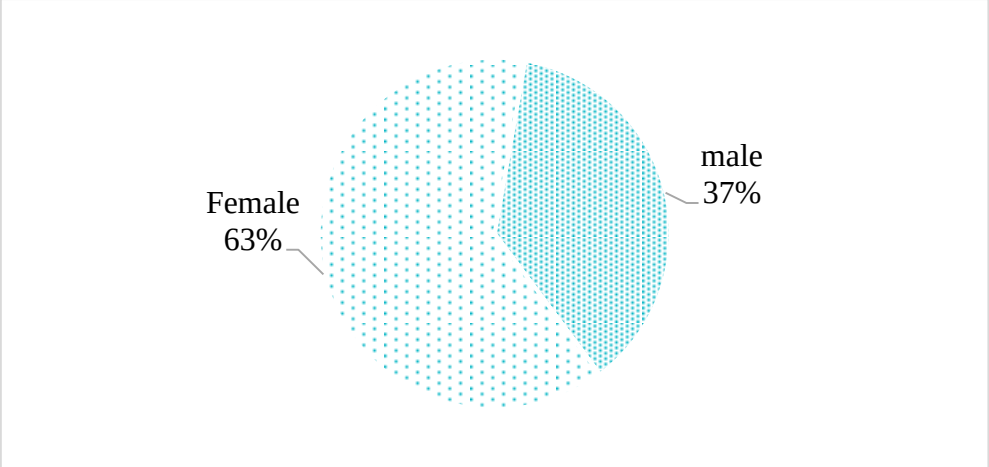


Figure 4. *Gender of smallholder potato farmers*

Descriptive statistics show that 37% of the respondents were males, while 63% were females. This indicates that most of the smallholder potato farmers are females. This could be because female farmers have been found to be involved in different agricultural activities such as planting, weeding, harvesting and marketing more than their male counterparts (Gebre *et al*., 2021). The findings agree with Diiro *et al*. (2018), who argued that women participate more in agricultural production activities than their male peers. However, they are faced with major production constraints such as land ownership and access to quality farm inputs. This has impeded rural agricultural productivity (Menon *et al*.,2023). This assertion is similar to other studies that revealed 83% of female household members engaged in agricultural production in arid regions of Kenya. The current results could be an indicator that potato production in Kipipiri is predominantly practiced by female farmers (Chimoita *et al*., 2017). On the contrary, the findings disagree with Agholor *et al.* (2013), who revealed that the age group between 21 years to 100 years of farmers was dominated by males. Subsequently, more males were found to participate in the whole agricultural sector as compared to their female counterparts.

4.2.2 Age of Smallholder Potato Farmers

Figure 5 shows the percentage proportions of smallholder potato farmers by age group. Over 50% of smallholder farmers fall in the 38 - 47 (25.5%) and 48 -57 (31.1%) age categories.

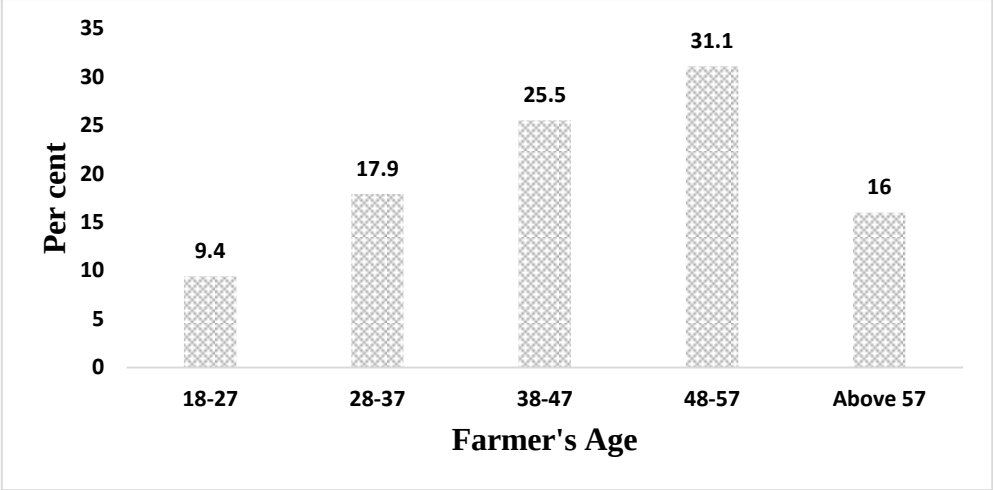


Figure 5. *Smallholder Potato Farmer's Age*

The results indicate that over 73% of smallholder potato farmers were above 37 years. Only 27% of the smallholder potato farmers were youths (18-37 years). This implies that in Kipipiri Sub-County the majority of the young people do not embrace agricultural activities since a majority do not own land and have low access to financial support services. This confines options available for them to engage in agriculture. This finding agrees with Ngongo (2014), who found that young people could participate in potato production; however, the majority of them do not participate due to a lack of financial resources and land. Further, Twumasi *et al.* (2019), argued that despite youths' participation in agriculture being a key driver of alleviating poverty and food insecurity in a developing country, Kenya not being an exception; the majority of youths (70%) decides not to engage in farming. The study also disclosed lack of access to credit, education level, and high input prices led to low youth engagement in agriculture. The results agree with Kassem *et al*. (2020), who found that most of the farmers and agricultural participants fall in the age range of 41 -60 years, which implies that youths are less active in agricultural activities.

4.2.3 Education Level of the Respondents

Figure 6 presents information on smallholder potato farmers' education level. The responses were segmented into five levels: No formal education, primary, secondary, and tertiary education. The study indicated that 75.5% of smallholder potato farmers had attained primary (32.1%) and secondary (43.4%) school levels.

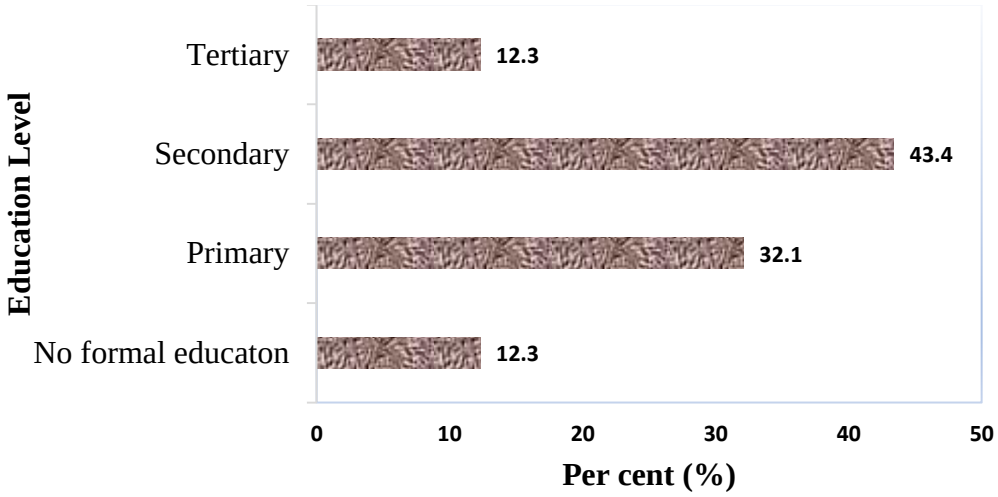


Figure 6. *Education level of smallholder potato farmers*

Results show that the majority (43.4%) of the smallholder potato farmers had attained secondary education, followed by primary education (32.1%), tertiary education (12.3%) and no formal education (12.3%). This may indicate that many smallholder potato farmers engaged in agricultural production were the farmers who attained secondary education in the study area. This contradicts the findings of Lindsjö *et al*. (2020), who found that most respondents with primary education had high chances of participating in agriculture. Tertiary education level smallholder farmers are few. This could be attributed to a majority going for white color jobs instead of farming which is perceived as a practice for the illiterate. This may further explain why there is low use of certified seed potatoes in the Sub-County. Additionally, Udimal *et al*. (2017) found that farmers with high education levels were inclined to get information on advanced agricultural technologies, including the use of farm inputs, and therefore in a position to adopt than their counterparts.

4.3 Access to Extension Services and Use of Certified Seed Potatoes

The first objective was as follows:

To determine the influence of access to extension services on the use of certified seed potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya

4.3.1 Access to Extension Services among Smallholder Farmers

Descriptive statistics were used to analyze smallholder potato farmers' access to extension, and the results are summarized in Table 3.

Table 3

Access to Extension Services among Smallholder Potato Farmers

Access to extension services	Smallholder potato farmers	
	Frequency	Percentage
No	22	21
Yes	84	79
Total	106	100.0

The study shows that 79% of the smallholder potato farmers had access to extension services, while 21% did not. Mwololo *et al*. (2019) highlighted the significance of extension services to farmers, noting that the services promote crop technologies such as the use of CSPs among smallholder farmers. He, however, argued that despite farmers accessing multiple sources of extension services, no significant effect on the use of agricultural technologies was reported among the crop farmers.

4.3.2 Frequency of Accessing Extension Services among Smallholder Farmers

Descriptive statistics were used to analyze smallholder potato farmers' frequency in accessing extension services, and results are summarized in Table 4.

Table 2

Frequency of Accessing Extension Services among Smallholder Potato Farmers

Frequency	Smallholder potato farmers	
	Frequency	Percentage
Always	30	36
Rarely	54	64
Total	84	100.0

Although 79% of the respondents had access to extension services, the findings show that 64% of the respondents rarely accessed the services, while 36% frequently (at least once per month) received the services. The findings are supported by Baloch and Thapa (2018), who carried out a study in the Panjgur district of Pakistan and recorded that despite most farmers (78%) having access to extension services, they could only meet an extension worker once per year. Aphunu and Otoikhian (2021) contradict the finding in their argument that the majority (61.7%) of the farmers have contact with extension agents monthly.16% of them are being contacted a fortnight, while 22% reported being visited once every two months.

4.3.3 Sources of Extension Services among Smallholder Potato Farmers

The farmers who had access to extension services had their preferred sources, which are summarized in Table 5.

Table 5

Sources of Extension Services among Smallholder Potato Farmers

Sources of extension service	Smallholder Potato farmers	
	Frequency	%
Government Extension providers	26	31
NGOs/Private Extension agencies	34	40
Other farmers	10	12
Media (Magazine, TV/Radio)	5	6
Research stations	0	0
Online Sources (Facebook, blogs, farmer forums, web pages)	9	11
Total	84	100.0

Results show that out of the 84 (79%) smallholder potato farmers who had access to extension services, the majority relied on NGOs/Private Extension agencies (40%), followed by Government Extension providers (31%).12% of the respondents accessed extension services through other farmers. Online sources of extension services (Facebook, blogs, farmer forums, web pages) were used by 11% of the respondents. Only 6% of the respondents accessed extension services from media, i.e. magazines, and TV/radio, and 0% received extension services via research stations. The findings agree with Muyanga and Jayne (2008), who noted an increase in the use of private and NGO extension sources among smallholder farmers as compared to other extension delivery sources. Further added that, despite the government extension agencies reaching many farmers, they were found to diminish their access because they are constrained by bureaucracy and inadequate funds. To complement the private and government extension sources, other studies (Tata *et al.*, 2018 & Marwa *et al.,* 2020) have advocated the need to use online platforms via information and technology enhancement.

4.3.4 Challenges Faced by Farmers in Accessing Extension Services

Table 6 Presents challenges faced by the farmers in accessing extension services.

Table 6

Challenges Faced by Farmers in Accessing Extension Services

Challenges on accessing extension services	Smallholder potato farmers	
	Frequency	%
Lack of information about the existence of extension services	2	9
Extension offices are located very far away	3	14
The location of my farm is remote and not easily accessible	2	9
Very few extension officers are available	7	32
Not interested	8	36
Total	22	100.0

When examined, out of the 22 respondents with no access to extension services, 36% noted that they were not interested in extension services. 32% indicated that a few extension officers were available, hence unable to access their services, while 14% claimed that extension officers are located very far away, hence finding it difficult to reach them for extension training and consultations. 9% of the respondents revealed a lack of information about the existence of extension services and farmer's farm being remotely located as the reasons they didn't receive extension services. The results agree with Siddiqui and Mirani (2012) and Benjamin (2013), who noted that farmers face the challenge of accessing extension services since some may not be interested in the services for not meeting their specific needs and unavailability of extension staff, thus terming it as inadequate. Additionally, World Bank (2010) and Ghosh (2012) highlighted an insufficient number of extension officers and workers and a lack of information on their services. Further, poor transportation facilities and infrastructure were also highlighted as existing challenges that would hinder farmers from accessing extension services.

4.3.5 Attendance of CSPs Training among Smallholder Farmers

Descriptive statistics were used to analyze smallholder potato farmers' attendance at CSP training, and the results are summarized in Table 7.

Table 7

Attendance of CSPs Trainings among Smallholder Potato Farmers

Attendance of CSPs Training	Smallholder potato farmers	
	Frequency	Percentage
Attend	22	26
Not attended	62	74
Total	84	100.0

Although 84 respondents had access to extension services, the findings show that 74% of them, did not attend training on CSPs, while 26% attended training on the use of CSPs. Ragasa (2020) supports the findings by remarking that only 20 per cent of farmers participated and interacted with extension providers in a study conducted in Malawi. Consequently, limited coverage of extension staff in the provision of agricultural information, as well as low attendance of farmers in their training, was recorded.

Test of Hypothesis H_{O1}

Objective one was translated into the following hypothesis:

H_{01}: Access to extension services has no statistically significant influence on the use of CSPs among smallholder potato farmers in Kipipiri Sub-County, Kenya.

Binary logistic regression was used in testing the hypothesis, and the analysis of extension services as independent variables relating to the use of CSPs was statistically significant.

From Table 8, it was observed that the relationship between extension services and use of CSPs was statistically significant at a 5% level of significance ($\chi 2 = 10.219$, $df = 4$, $p < 0.05$).

Table 8

Omnibus Tests of Model Coefficients for Extension Services

		Chi-square	df	P-value
Step 1	Step	10.219	4	0.037
	Block	10.219	4	0.037
	Model	10.219	4	0.037

This signifies that a relationship existed between extension services and the use of CSPs. The null hypothesis is therefore rejected. This inference is consistent with findings from previous studies (Aryal *et al.*, 2018; Tran *et al.*, 2020) where institutional factors such as extension services were relevant for agricultural technologies such as the use of CSPs.

Table 9

Extension Services' Model Summary

Step	-2 Log likelihood	Cox & Snell R^2	*Nagelkerke* R^2
1	124.741[a]	0.082	0.121

It was also noted that between 12.1% (Cox & Snell R Square) and 8.2% (Nagelkerke R Square) of the variance in the use of CSPs is explained by the extension services (Table 9).

Table 10

Institutional Variables in the Binary Logistic Regression Equation

Institutional variables		B	S.E.	Wald	df	P-value	Exp(B)
Step 1[a]	Access to Extension services	1.072	0.504	4.524	1	0.033	2.922
	Access to certified seed multipliers	0.777	0.611	1.619	1	0.203	2.176
	Access to Credit	1.042	0.520	4.008	1	0.045	0.353
	Constant	0.423	0.301	1.970	1	0.160	1.526

a. Variable(s) entered on step 1: Access to credit, Access to Certified Seeds multipliers, and access to credit on use of CSPs.

Access to Extension Services

There is a positive relationship between access to extension services and the use of CSPs. This is statistically significant at a 5% level of significance (Wald $\chi 2 = 4.524$, df = 1, $p < 0.05$).

Results show that smallholder farmers with access to extension services had 2.922 more chances of using CSPs than those with no access to extension services. This could be because access to extension services empowers the farmers with knowledge and creates awareness of the need to use CSPs. In support of this assertion, Nasereldin *et al.* (2023) argued that the decision to use CSPs is positively associated with the variable of formal agricultural training. At 5%, the training coefficient was found to be positive and significant. This indicates that agricultural extension services increase smallholder farmers' chances of using CSPs.

4.4 Access to Certified Seed Potato Multipliers and Use of Certified Seed Potatoes

The second objective was as follows:

To determine the influence of access to certified seed multipliers on the use of certified seed potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya.

4.4.1 Access to Certified Seed Potato Multipliers among Smallholder Farmers

Descriptive statistics were used to analyze smallholder potato farmers' access to certified seed multipliers, and the results are summarized in Table 11.

Table 11

Access to Certified Seed Potato Multipliers Among Smallholder Potato Farmers

Access to credit	Smallholder potato farmers	
	Frequency	Percentage
No	64	60
Yes	42	40
Total	106	100.0

The study shows that 40% of the smallholder potato farmers had access to certified seed multipliers, while 60% did not. This may imply low use of CSPs among the majority of potato smallholder farmers in the Sub-County since they are not able to access certified seed sources. Ali *et al.* (2015) and Ullah *et al.* (2020) support this claim, finding that agricultural productivity and the sustenance of the agriculture sector depend on farmers' adoption and use of improved technologies, such as certified seeds.

4.4.2 Challenges Faced by Farmers in Accessing Certified Seed Potato Multipliers

Table 12 Presents challenges faced by the farmers in accessing certified seed potato multipliers. When asked, out of the 64% of the smallholder farmers with no access to certified

seed multipliers, 39% indicated that the high cost of certified seeds was the major encounter that spurned them away from getting seeds from certified dealers, and 23% claimed they were not aware of the existence of these facilities in the area. While 16% of the farmers claimed that they were not interested in other sources of seeds. 14% had no certified seed multipliers in their area, and 8% indicated long booking procedures of booking the seeds. The findings agree with Elahi *et al*. (2018), who found that farmers lack basic production resources such as land and finances to purchase inputs, which are expensive to smallholder farmers; thus, they are unable to improve input systems such as the use of clean planting materials and agricultural technologies. This was found to increase a major gap between potential and actual crop productivity (Ullah *et al.,* 2020). According to Ogundeji *et al*. (2018), farmers in developing countries are unable to adopt technologies since they lack financial investments.

Table 12

Challenges Faced by Farmers in Accessing Certified Seed Potato Multipliers

Challenges in accessing certified seed multipliers	Smallholder potato farmers	
	Frequency	%
Lack of knowledge of their existence	15	23
No certified seed multiplier in my area	9	14
Long procedures for booking seeds	5	8
High-certified seed costs	25	39
Not interested	10	16
Total	64	100.0

4.4.3 Sources of Seed Potatoes among Smallholder Potato Farmers

The farmers who had no access to certified seed multipliers had their preferred sources, and these are summarized in Table 13. Results show that out of the 64 smallholder potato farmers who did not access certified seed multipliers, the majority relied on farmer stores (70%), followed by those farmers who sourced from their neighbours (24%) and only 6% sourced their seeds from local seed marketers. This indicates that the majority of the farmers use seeds from their own farmer stores. This may imply that CSPs may not be adequately used by such categories of farmers because seeds from their stores are not certified, and therefore, the reuse lowers potato productivity in the area. The study agrees with Poku and Gupta (2018), who argued that, in Ghana, the clean and commercial seed sector supplies a small percent of the total seed demand. Further, about 80% of seeds used in the West African country are sourced from the informal sector, mainly farmer-saved seeds from farmers' stores and purchased in

local seed markets. A contradiction is, however, observed between this study and the findings by Freeman and Qin (2020), who found that 60% of smallholder farmers had access to and used certified seeds.

Table 13

Sources Credit Among Smallholder Potato Farmers

Sources of seed potato	Smallholder Potato farmers	
	Frequency	%
Farmer stores	45	70
Neighbour	15	24
Local marketers	4	6
Others	0	0
Total	64	100.0

4.4.4 Qualities of Seed Potatoes Sourced from Certified Seed Multipliers by Smallholder Potato Farmers

Table 14 shows rankings of various seed qualities for which smallholder potato farmers accessed through certified seed multipliers. Among the qualities of seed potatoes sourced from certified seed multipliers, large and many tubers development/high yields ranked high (76%), and this was followed by high germination percentage (64%), early maturity (62%) and resistance to crop pests (35%). An average of 70% of the farmers reported resistance to perennial weeds. Consequently, resistance to drought and resistance to potato diseases were ranked lowest, with over 82% and 60%, respectively.

Table 14

Qualities of Seed Potatoes Sourced from Certified Seed Multipliers

Various Qualities	Percentage		
	Low	Average	High
High germination percentage	18	18	64
Large and many tubers development/High yields	10	14	76
Resistant to drought	82	18	0
Resistant to crop pests	42	23	35
Resistant to perennial weeds	30	70	0
Resistance to potato diseases (viral/bacterial/Fungal	60	40	0
Early Maturity	16	22	62

Test of Hypothesis H_{O2}

Objective two was translated into the following hypothesis:

H_{02}: Access to certified seed multipliers has no statistically significant influence on the use of CSPs among smallholder potato farmers in Kipipiri Sub-County, Kenya.

Binary logistic regression was used in testing the hypothesis, and the analysis of access to certified seed multipliers as an independent variable relating to the use of CSPs was statistically significant.

From Table 15, it was observed that the relationship between access to certified seed multipliers and the use of CSPs was statistically significant at a 5% level of significance ($\chi 2 = 10.219$, $df = 4$, $p < 0.05$). This signifies that a relationship existed between access to certified seed multipliers and the use of CSPs. The null hypothesis is therefore rejected. This inference is consistent with findings from previous studies where institutional factors such as access to certified seed multipliers were relevant for agricultural technologies such as the use of CSPs (Aryal *et al.*, 2018; Tran *et al.*, 2020).

Table 15

Omnibus Tests of Model Coefficients for Access to Certified Seed Multipliers

		Chi-square	df	P-value
Step 1	Step	10.219	4	0.037
	Block	10.219	4	0.037
	Model	10.219	4	0.037

It was also noted that between 12.1% (Cox & Snell R Square) and 8.2% (Nagelkerke R Square) of the variance in the use of CSPs is explained by the extension services (Table 16).

Table 16

Extension Services 'Access to Certified Seed Multipliers Model Summary

Step	-2 Log likelihood	Cox & Snell R^2	*Nagelkerke* R^2
1	124.741[a]	0.082	0.121

Access to certified seed multipliers

Table 17 shows a positive relationship between access to certified seed multipliers and the use of CSPs. This is statistically significant at a 5% level of significance (Wald $\chi 2 = 4.308$, $df = 1$, $p < 0.05$). Results show that smallholder farmers with access to extension services had 2.176 more chances of using CSPs than those with no access to certified seed multipliers. This could be because access to certified seed multipliers gives farmers an upper hand in purchasing and using CSPs in the Sub-County. It may also imply that farmers are made aware of the available channels used in obtaining CSPs and the necessary methods and practices involved in cultivation thereafter. The finding coincides with Wagle (2023), who observed that access to innovative agricultural centers, such as seed multipliers, was found to have a positive association with the use and uptake of technologies in modern farming, such as the use of CSPs. Further, ease of access to the locations of agro-services, innovative agricultural techniques, and input providers such as seed dealers was found to be essential for farmers in the improvement of agriculture productivity.

Table 17

Institutional Variables in the Binary Logistic Regression Equation

Institutional variables		B	S.E.	Wald	df	P-value	Exp(B)
Step 1[a]	Access to Extension services	1.072	0.504	4.524	1	0.033	2.922
	Access to certified seed multipliers	1.077	0.511	4.308	1	0.039	2.176
	Access to Credit	1.042	0.520	4.008	1	0.045	0.353
	Constant	0.423	0.301	1.970	1	0.160	1.526

b. Variable(s) entered on step 1: Access to credit, Access to Certified Seeds multipliers, and access to credit on use of CSPs.

4.5 Access to Credit and Use of Certified Seed Potatoes

The third objective was as:

To determine the influence of access to credit on the use of certified seed potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya.

4.5.1 Access to Credit among Smallholder Farmers

Descriptive statistics were used to analyze smallholder potato farmers' access to credit, and the results are summarized in Table 18. The study shows that 27% of the smallholder potato farmers had access to credit, while 73% did not. This may imply low use of certified seed potatoes since these seeds are costly to access and buy. This is because access to credit facilitates farmers to access CSPs from the right and recommended sources. This claim is supported by Lakhan *et al*. (2020), who found that access to credit facilitated farmers to adopt technologies such as the use of CSPs. Similarly, on average, agricultural credit was found to improve a farmer's performance by increasing technical efficiency by 3.8% and reducing the technological gap by providing opportunities for the adoption of better farm inputs such as certified seeds (Abdallah, 2016).

Table 18

Access to Credit Among Smallholder Potato Farmers

Access to credit	Smallholder potato farmers	
	Frequency	Percentage
No	77	73
Yes	29	27
Total	106	100.0

4.5.2 Challenges Faced by Farmers in Accessing Credit

Table 19 Presents challenges faced by the farmers in accessing credit.

When asked, out of the 73% of the smallholder farmers with no access to credit, 39% indicated that high-interest rate was the major challenge that shun them away from seeking credit, and 35% claimed it requires long credit application procedures, which they are unable to meet. While 13% lacked the collateral required to access credit, 8% were not aware, and 5% indicated they had no need for the availability of credit, respectively. The finding agrees with Ogundeji *et al*. (2018), who noted that in Lesotho, a high interest rate (15%-30%) was the main nightmare that hindered farmers from accessing credit. Additionally, other studies (Abbas & Yuansheng, 2018; Chandio & Jiang, 2018) argued that interest rate lending procedure, time lag and distance to the formal credit sources were limitations hindering farmers from accessing credit. Sindh *et al*. (2017), however, contradict the findings by highlighting that factors such as lending procedures, high-interest rates and time lag did not limit farmers from accessing credit from formal sources in Pakistan.

Table 19

Challenges Faced by Farmers in Accessing Credit

Challenges in accessing credit	Smallholder potato farmers	
	Frequency	%
No need	4	5
Not aware of the availability of credit	6	8
Lack of enough collateral to secure a facility	10	13
High interests in the credit	30	39
Long credit application procedures	27	35
Total	77	100.0

4.5.3 Sources of Credit among Smallholder Potato Farmers

The farmers who had access to credit had their preferred sources and these are summarized in Table 20. Results show that out of the 29 smallholder potato farmers who accessed credit, the majority relied on informal sources [Neighbor/Family] (35.0%), followed by community groups (24%), Shwari/Mobile money/M-Pesa (14%), microfinance institutions (10%) & SACCOs (10%) and formal Bank (7%). This indicates that the majority of the farmers access credit from informal sources more than formal sources due to high-interest rates. This may imply that CSPs may not be adequately used by such categories of farmers because informal sources of credit are not always sufficient to meet all the costs associated with purchasing certified seed potatoes. This result is in line with Iftikhar *et al*. (2017) who found that farmers accessed credit from both informal and formal sources, though the majority accessed from informal sources. Also, a contradiction is observed between this study and the findings by FAO (2019), who found most farmers have access to credit from saving groups.

Table 20

Sources Credit among Smallholder Potato Farmers

Sources of credit	Smallholder Potato farmers	
	Frequency	%
Formal bank	2	7
SACCOs	3	10
Informal Sources (Neighbor/Family)	10	35
Microfinance institution	3	10
Community Group	7	24
M-Shwari/Mobile money/M-Pesa	4	14
Total	29	100.0

4.5.4 Purpose of Credit Accessed by the Smallholder Potato Farmers

Table 21 shows rankings of various purposes for which smallholder potato farmers accessed credit. Among the purposes for which the farmers accessed credit, buying agrochemicals ranked high (81%), and this was followed by crop protection (62%), soil management (59%) and buying certified seeds (30%). An average of 82% of the farmers reported that they accessed credit for reasons other than using CPC practices. Similarly, an average of 67% and 55% accessed credit for the adoption of soil management and proper harvesting, respectively.

Consequently, seed storage facilities ranked lowest, with over 83% of the farmers accessing credit for its use at a low rate.

Table 21

Purpose of Credit Accessed by The Farmers

Various purposes	Percentage		
	Low	Average	High
For buying certified seeds	45	25	30
For buying agro-chemicals	13	6	81
Seed storage facilities	83	17	0
Soil management	12	29	59
Water management	33	67	0
Proper Harvesting	45	55	0
Crop protection	20	18	62
Others	11	82	7

Hypothesis Three

$H0_3$: *Access to credit had no statistically significant influence on the use of CSPs among smallholder potato farmers in Kipipiri Sub-County, Kenya*.

Access to Credit

There is a positive relationship between access to credit and the use of CSPs. This is statistically significant at a 5% level of significance (Wald $\chi 2 = 4.008$, df = 1, $p < 0.05$). Results show that smallholder farmers with access to credit had 1.353 more chances of using CSPs than those with no access to credit. This could be because access to credit empowers the farmers with finances to buy certified seeds as well as carry out the necessary management practices for the effective productivity of CSPs. The results agree with Kinyangi (2014) and Nderitu *et al.* (2019), who noted that there exists a positive and significant effect between access to credit and the use of technologies among smallholder farmers in the North Sub-County of Kakamega, Kenya. Additionally, Mulwa *et al.* (2017) found a positive and significant relationship between access to credit and adaptation strategies such as the use of CSPs. The reason raised by the study is access to credit is required to fund the uptake of agricultural innovations and the use of different agricultural technologies. Contrastingly, Aryal

et al. (2018) reported an insignificant relationship between access to credit and the use of agricultural technologies.

Table 22

Institutional Variables in the Binary Logistic Regression Equation

Institutional variables		B	S.E.	Wald	df	P-value	Exp(B)
Step 1[a]	Access to Extension services	1.072	0.504	4.524	1	0.033	2.922
	Access to certified seed multipliers	1.077	0.511	4.308	1	0.039	2.176
	Access to Credit	1.042	0.520	4.008	1	0.045	0.353
	Constant	0.423	0.301	1.970	1	0.160	1.526

a. Variable(s) entered on step 1: Access to credit, Access to Certified Seeds multipliers, and access to credit on use of CSPs.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter provides a summary, conclusions, and recommendations of the study, and suggestions for future research.

5.2 Summary of the Study

The use of CSPs has the potential to increase potato yields and subsequent smallholder farmers' income. However, its low use presents a menace to the world's increasing food demand. The influence of access to institutional factors on the use of CSPs had not been studied in Kipipiri Sub-County, Kenya. Therefore, this study sought to establish the influence of access to institutional factors on the use of certified seed potatoes among smallholder potato farmers in Kipipiri Sub-County, Kenya. A cross-sectional research design was used to collect data. Data analysis was done using descriptive statistics. A binary logistic regression model was used to test the hypotheses with the aid of SPSS version 25. The study found that smallholder farmers in Kipipiri Sub-County have experienced critical challenges producing potatoes due to the low use of certified seed potatoes. The institutional factors, access to extension services, access to certified seed multipliers, and access to credit, had a statistically significant relationship with the use of CSPs in potato production.

i. General Information on the Smallholder Potato Farmers

The study revealed that 37% of the respondents were males, while 63% were females. This indicates that most of the smallholder potato farmers are females. 73% of farmers were above 37 years old, while only 27% of the smallholder potato farmers were young people (18-37 years). On the education level, a majority (43.4%), of the respondents had attained secondary education, followed by primary education (32.1%), tertiary education (12.3%) and no formal education (12.3%).

ii. Access to extension services and Use of Certified Seed Potatoes

From the study, 85% of the smallholder potato farmers had access to extension services, while 21% did not. However, 54% of the respondents rarely access the services, while 30% frequently (at least once per month) receive the services. It was also found that out of the 65 smallholder potato farmers who had access to extension services, the majority relied on NGOs/Private extension agencies (46%), followed by Government extension providers

(29%).12% of the respondents accessed extension services through other farmers. Online sources of extension services (Facebook, blogs, farmer forums, webpages) were only used by 8% of the respondents. Only 5% of the respondents accessed extension services from media, i.e. magazines, and TV/radio, and 0% received extension services via research stations. Further, out of the 22 respondents with no access to extension services, 36% noted that they were not interested in extension services. 32% indicated that a few extension officers were available, hence unable to access their services, while 14% claimed that extension officers are located very far away, hence finding it difficult to reach them for extension training and consultations. 9% of the respondents revealed a lack of information about the existence of extension services and the farmer's farm being remotely located as the reasons they didn't receive extension services. Although 85% of the respondents had access to extension services, the findings show that 74% did not attend training on CSPs, while 26% indicated that they attended training on the use of CSPs. Additionally, a positive relationship between access to extension services and the use of CSPs was observed. This is statistically significant at a 5% level of significance (Wald $\chi2 = 4.524$, df = 1, $p < 0.05$). Results show that smallholder farmers with access to extension services had 2.922 more chances of using CSPs than those with no access to extension services.

iii. Access to Certified Seed Potato Multipliers and Use of Certified Seed Potatoes

The study indicated that 40% of the smallholder potato farmers had access to certified seed multipliers, while 60% did not. Out of the 64% of the smallholder farmers with no access to certified seed multipliers, 39% high costs of certified seeds were the major barrier hindering them from accessing certified seeds, and 23% claimed they were not aware of the existence of these facilities in the area. 16% claimed that they were not interested. While 14% highlighted no certified seed multipliers in their area, and 8% indicated long booking procedures of booking the seeds. The majority relied on farmer stores (70%), followed by those farmers who sourced from their neighbours (24%), and only 6% sourced their seeds from local seed marketers. Among the qualities of seed potatoes sourced from certified seed multipliers, large and many tubers development/high yields ranked high (76%), and this was followed by high germination percentage (64%), early maturity (62%) and resistance to crop pests (35%). An average of 70% of the farmers reported resistance to perennial weeds. Consequently, resistance to drought and resistance to potato diseases were ranked lowest, with over 82% and 60%, respectively. A positive relationship between access to certified seed multipliers and the use of CSPs was noted. This is statistically significant at a 5% level of significance (Wald $\chi2 =$

4.308, df = 1, p < 0.05). Results show that smallholder farmers with access to extension services had 2.176 more chances of using CSPs than those with no access to certified seed multipliers. This could be because access to certified seed multipliers gives farmers an upper hand in purchasing and using CSPs in the Sub-County. It may also imply that farmers are made aware of the available channels used in obtaining CSPs and the necessary methods and practices involved in cultivation thereafter.

iv. Access to Credit and Use of Certified Seed Potatoes

From the study, 27% of the smallholder potato farmers had access to credit, while 73% did not. Out of the 73% of the smallholder farmers with no access to credit, 39% indicated that high-interest rate was the major challenge that shunned them away from seeking credit, and 35% claimed it requires long credit application procedures, which they are unable to meet. While 13% lacked the collateral required to access credit, 8% were not aware, and 5% indicated they had no need for the availability of credit, respectively. majority of farmers relied on informal sources [Neighbor/Family] (35.0%), followed by community groups (24%), Shwari/Mobile money/M-Pesa (14%), microfinance institutions (10%) & SACCOs (10%) and formal Bank (7%). A positive relationship between access to credit and the use of CSPs was found to exist. This is statistically significant at a 5% level of significance (Wald $\chi 2$ = 4.008, df = 1, p < 0.05). Results show that smallholder farmers with access to credit had 1.353 more chances of using CSPs than those with no access to credit. This could be because access to credit empowers the farmers with finances to buy certified seeds as well as carry out the necessary management practices for the effective productivity of CSP.

5.3 Conclusions

The main conclusions of this study are as follows:

i. From the results, there was a significant relationship between access to extension services and the use of CSPs. 85 per cent of the respondents were found to have access to extension services, while 21 % had no access. However, on the frequency, majority of the respondents (64%) rarely accessed the services and 36% reported to access the extension services always.
ii. There was a significant relationship between access to certified seed multipliers and the use of CSPs. Only 40 % of smallholder farmers had access to certified seed multipliers, while the majority (60%) did not consequently opt to use other sources, mainly farmer stores.

iii. The outcome of the binary logistic regression analysis of the credit and the use of CSPs was statistically significant. Only 27% of the respondents had access to credit, whereas 73 % of the smallholder farmers did not access credit.

5.4 Recommendations

Based on the findings of this study, the following recommendations were made:

(i) Policymakers should prioritize policies that support seed multiplication and research centers, extension providers and credit facilities.

(ii) The County Department of Agriculture Livestock and Fisheries invests more in seed multiplication and breeding, especially in the County Agricultural training centers.

(iii) The County Government and financial providers should provide an enabling environment for farmers to access credit easily.

(iv) The County Government should create an enabling environment for young people to invest in seed multiplication as a business. This would help bridge the seed demand gap as well as create employment for young people who view farming as a practice for the elderly.

5.5 Suggestions for Further Research Studies

The following suggestion for further research was arrived at based on the results of this study:

(i) A research study should be conducted to determine the role of the private sector and NGOs in training and providing CSP services in different potato-producing areas in Kenya and beyond.

REFERENCE

Abdallah, A. H. (2016). Agricultural credit and technical efficiency in Ghana: is there a nexus? *Agricultural Finance Review, 76*(2), 309-324.

Abed, R., Sseguya, H., Flock, J., Mruma, S., & Mwango, H. (2020). An evolving agricultural extension model for lasting impact: How willing are Tanzanian farmers to pay for extension services? *Sustainability (Switzerland), 12*(20), 1–13. https://doi.org/10.3390/su12208473

Adiyoga, W. (2021). *Seed Systems in the Four Shallot Producing Areas of Java: A Focus Group Discussion. 01003, pp.* 1–11.

Agholor, I. A., Monde, N., Obi, A., & Sunday, O. A. (2013). Quality of extension services: A case study of farmers in Amathole. *Journal of Agricultural Science, 5*(2), 204.

AGRA (2018) *Africa Agriculture Status Report: Catalyzing Government Capacity to Drive Agricultural Transformation (6).* Nairobi, Kenya

Ali, A., Rahut, D. B., Behera, B., & Imtiaz, M. (2015). Farmers' access to certified wheat seed and its effect on poverty reduction in Pakistan. *Journal of Crop Improvement*, *29*(2), 247-265.

Alotaibi, B. A., Yoder, E., & Kassem, H. S. (2021). Extension Agents' Perceptions of the Role of Extension Services in Organic Agriculture: A Case Study from Saudi Arabia. *Sustainability* 2021, 13, 4880.

Alzaidi, A. A., Baig, M. B., Kassem, H. S., & Zia, M. A. (2020). The role of cooperative association in providing the agricultural services in the governorate of Unaizah-Kingdom of Saudi Arabia. *Journal of Agricultural Sciences–Sri Lanka, 15(2).*

Ampaire, E. L., Katungi, E. M., Tegbaru, A., & Buruchara, R. (2020). Gender differences in agri-marketing farmer organizations in Uganda and Malawi: Implications for R4D delivery mechanisms. *African Journal of Agricultural Research, 16*(6), 916-93.

Anang, B. T., Bäckman, S., & Sipiläinen, T. (2020). Adoption and income effects of agricultural extension in northern Ghana. *Scientific African*, *7*, e00219. https://doi.org/10.1016/j.sciaf.2019.e00219

Antwi-Agyei, P., & Stringer, L. C. (2021). Improving the effectiveness of agricultural extension services in supporting farmers to adapt to climate change: Insights from northeastern Ghana. *Climate Risk Management*, *32*, 100304

Aphunu, A., & Otoikhian, C. S. (2021). Farmers' perception of the effectiveness of extension agents of Delta State Agricultural Development Programme (DADP). *African Journal of General Agriculture*, *4*(3).

Aryal, J. P., Jat, M. L., Sapkota, T. B., Khatri-Chhetri, A., Kassie, M., Rahut, D. B., & Maharjan, S. (2018). Adoption of multiple climate-smart agricultural practices in the Gangetic plains of Bihar, India. *International Journal of Climate Change Strategies and Management*, IJCCSM-02-2017-0025. https://doi.org/10.1108/IJCCSM-02-2017-0025.

Aryal, J. P., Rahut, D. B., Maharjan, S., & Erenstein, O. (2018). Factors affecting the adoption of multiple climate-smart agricultural practices in the Indo-Gangetic Plains of India. In *Natural Resources Forum* (Vol. 42, No. 3, pp. 141-158). Oxford, UK: Blackwell Publishing Ltd.

Baglan, M., Zhou, X., Mwalupaso, G. E., & Xianhui, G. (2020). Adoption of certified seed and its effect on technical efficiency: Insights from Northern Kazakhstan. *Journal of Agricultural Science*, *12*(3), 175. https://doi.org/10.5539/jas.v12n3p175.

Baiyegunhi, L. J. S., Majokweni, Z. P., & Ferrer, S. R. D. (2019). Impact of outsourced agricultural extension program on smallholder farmers' net farm income in Msinga, KwaZulu-Natal, South Africa. *Technology in Society*, *57*, 1-7.

Baloch, M. A., & Thapa, G. B. (2018). The effect of agricultural extension services: Date farmers' case in Balochistan, Pakistan. *Journal of the Saudi Society of Agricultural sciences*, *17*(3), 282-289. https://doi.org/10.1016/j.jssas.2016.05.007

Agbarevo, M. N. B., & Benjamin, N. (2013). Farmers' perception of effectiveness of agricultural extension delivery in cross-river state, Nigeria. *IOSR Journal of Agriculture and Veterinary Science*, *2*(6), 1-7

Waldman, K. B., Todd, P. M., Omar, S., Blekking, J. P., Giroux, S. A., Attari, S. Z., ... & Evans, T. P. (2020). Agricultural decision making and climate uncertainty in developing countries. *Environmental Research Letters*, *15*(11), 113004

Chandio, A. A., Jiang, Y., Rehman, A., Twumasi, M. A., Pathan, A. G., & Mohsin, M. (2020). Determinants of demand for credit by smallholder farmers': a farm level analysis based on survey in Sindh, Pakistan. *Journal of Asian Business and Economic Studies*, *28*(3), 225-240. https://doi.org/10.1108/jabes-01-2020-0004

Chandio AA, Jiang Y (2018). Determinants of Credit Constraints: Evidence from Sindh, Pakistan. *Emerging Markets Finance and Trade*,*54*(15),3401-3410. https://doi.org/10.1080/1540496X.2018.1481743.

Chimoita, E. L., Onyango, C. M., Kimenju, J. W., & Gweyi-Onyango, J. P. (2017). Agricultural extension approaches influencing uptake of improved sorghum technologies in Embu County, Kenya. *Universal Journal of Agricultural Research*, *5*(1), 45-51.

Cook, B. R., Satizábal, P., & Curnow, J. (2021). Humanising agricultural extension: A review. *World Development, 140,* 105337. https://doi.org/10.1016/j.worlddev.2020.105337.

Diiro, G. M., Seymour, G., Kassie, M., Muricho, G., & Muriithi, B. W. (2018). Women's empowerment in agriculture and agricultural productivity: Evidence from rural maize farmer households in western Kenya. *PloS one, 13*(5), e0197995.

Diro, S., Tesfaye, A., Erko, B., & Girma, T. (2021). The role of improved coffee variety use on the adoption of key agricultural technologies in the coffee-based farming system of Ethiopia. *4464(1),* 7–18. https://doi.org/10.36349/easjebm.2021.v04i01.002.

Dossou, S. A. R., Aoudji, A. K. N., Houessou, A. M., & Kaki, R. S. (2020). Microfinance services for smallholder farmers: An assessment from rice farmers' expectations in Central Benin. *Agricultural and Food Economics*, *8*(1), 1–15. https://doi.org/10.1186/s40100-020-00165-1.

Elahi, E., Abid, M., Zhang, L., Ul Haq, S., & Sahito, J. G. M. (2018). Agricultural advisory and financial services; farm level access, outreach and impact in a mixed cropping district of Punjab, Pakistan. *Land use policy*, 71, 249-260.
https://doi.org/10.1016/j.landusepol.2017.12.006

FAO (2021). Global potato statistic: Latest FAO data published. https://www.potatonewstoday.com/2023/01/21/global-potato-statistics-latest-fao-datapublished/

FAO. (2020). Tracking progress on food and agriculture-related SDG indicators 2020. 76. http://www.fao.org/sdg-progress-report/en/

FAO, IFAD, UNICEF, WFP, & WHO. (2018). Food security and nutrition in the world the state of building climate resilience for food security and nutrition. www.fao.org/publications

Fonda, J. A., Mary, A. O., Kevin, O. O., Jonathan, M. M., Jacob, A., Betty, M. N., Nancy, N., & Gilbert, V. S. (2021). Aquaculture extension service in Kenya: Farmers and extension officers perspectives. *Journal of Agricultural Extension and Rural Development*, *13*(1), 14–22. https://doi.org/10.5897/jaerd2020.1203.

Freeman, K., & Qin, H. (2020). The role of information and interaction processes in the adoption of agriculture inputs in Uganda. *Agronomy*, *10*(2), 202.

Gebre, G. G., Isoda, H., Rahut, D. B., Amekawa, Y., & Nomura, H. (2021). Gender differences in agricultural productivity: Evidence from maize farm households in southern Ethiopia. *GeoJournal*, *86*(2), 843-864.

Ghosh, S. (2012). Innovations in public sector-led agricultural extension.

Gildemacher, P., & ter Steeg, E. M. S. (2023). Potential impact of hybrid true potato seed in Sub-Saharan Africa. *In Impact of hybrid potato (pp. 75-94)*. Wageningen Academic.

GoK. (2019). Promoting Co-operative Societies for Industrialization.

Harahagazwe, D., Condori, B., Barreda, C., Bararyenya, A., Byarugaba, A. A., Kude, D. A., Lung'Aho, C., Martinho, C., Mbiri, D., Nasona, B., Ochieng, B., Onditi, J., Randrianaivoarivony, J. M., Tankou, C. M., Worku, A., Schulte-Geldermann, E., Mares, V., Mendiburu, F. De, & Quiroz, R. Q. (2018). How big is the potato (Solanum tuberosum L.) yield gap in Sub-Saharan Africa and why? A participatory approach. *Open Agriculture*, *3*(1), 180–189. https://doi.org/10.1515/opag-2018-0019.

Hartmann, K., & Martin, M. J. (2021). Cooperative Extension in Indigenous communities: characteristic of successful programs. *Journal of Agricultural Education*, *62(3).*

Integrated Development Plan (2018). Republic Of Kenya County Government of Nyandarua: The socio-economic transformative agenda for Nyandarua County Integrated. 2018–2022.

International Potato Center (2018). CIP Annual Report 2018. Towards food system transformation. Lima, Peru. International Potato Center. 36 p. *Report 2018*. https://doi.org/10.4160/02566311/2018

International Potato Center (2019). *Discovery to impact*.

International Potato Center (2019). CIP Annual Report 2019. Discovery to Impact: Science-based solutions for global challenges. Lima, Peru. International Potato Center. 37 p. https://doi.org/10.4160/02566311/2019

International Potato Center. 2023. CIP Annual Report 2022. Catalyzing Change: Food Systems for Resilience, Prosperity, and Health. Lima, Peru. International Potato Center. 40 p. https://doi.org/10.4160/02566311/2022

Janssens, S. R. M., Wiersema, S. G., Goos, H., & Wiersma, W. (2013). The value chain for seed and ware potatoes in Kenya; Opportunities for development. *Lei Wageningen UR*, *1*(1), 57.

Kaguongo, W., Maingi, G., Barker, I., Nganga, N., & Guenthner, J. (2014). The value of seed potatoes from four systems in Kenya. *American Journal of Potato Research*, *91*(1), 109–118. https://doi.org/10.1007/s12230-013-9342-z

Kalogiannidis, S., & Syndoukas, D. (2024). The impact of agricultural extension services on farm output: A worldwide viewpoint., *Research on World Agricultural Economy, 5(1)* 96-114

Kangogo, D., Dentoni, D., & Bijman, J. (2020). Determinants of farm resilience to climate change: The role of farmer entrepreneurship and value chain collaborations. *Sustainability*, *12*(3), 868. https://doi.org/10.3390/su12030868

Kassem, H. S., Alotaibi, B. A., Muddassir, M., & Herab, A. (2021). Factors influencing farmers' satisfaction with the quality of agricultural extension services. *Evaluation and Program Planning, 85*(101912), 1-10. https://doi.org/10.1016/j.evalprogplan.2021.101912

Kassem, H. S., Shabana, R. M., Ghoneim, Y. A., & Alotaibi, B. M. (2020). Farmers' perception of the quality of mobile-based extension services in Egypt: A comparison between public and private provision. *Information Development, 36*(2), 161-180. https://doi.org/10.1177/0266666919832649

Khalid, I. O., Onyekachi, F., Mbabazi, R., & Maredia, K. (2021). Agricultural Extension Services & Seed Systems for Agricultural Technology Transfer in Nigeria List of Abbreviations. 1–14.

Kinyangi AA (2014). *Factors influencing the adoption of agricultural technology among smallholder farmers in Kakamega north subcounty, Kenya* (Doctoral dissertation, University of Nairobi).

Kofarmata, Y. I., & Danlami, A. H. (2021). A micro-level analysis of the intensity of agricultural finance supply in Nigeria: empirical evidence. *SN Business & Economics*, *1*(1), 1–17. https://doi.org/10.1007/s43546-020-00011

Kreuze, J. F., Souza-Dias, J. A. C., Jeevalatha, A., Figueira, A. R., Valkonen, J. P. T., & Jones, R. A. C. (2020). Viral Diseases in Potato. *In The Potato Crop.* https://doi.org/10.1007/978-3-030-28683-5_11

Lakhan, G. R., Channa, S. A., Magsi, H., Koondher, M. A., Wang, J., & Channa, N. A. (2020). Credit constraints and rural farmers' welfare in an agrarian economy. *Heliyon, 6(10),* 05252.

Lamm, K. W., Masambuka-Kanchewa, F., Lamm, A. J., Davis, K., Nahdy, S., & Oyugi, M. A. (2021). A case study analysis of extension service provision in Malawi. *African Journal of Agricultural Research, 17(11),* 1386–1392. https://doi.org/10.5897/AJAR2021.15781

Maertens, A., Michelson, H., & Nourani, V. (2020). How do farmers learn from extension

services? Evidence from Malawi. *American Journal of Agricultural Economics*, *103*(2), 569–595. https://doi.org/10.1111/ajae.12135

Mamuye, W. (2021). Determinants of smallholder farmers participation in formal credit and challenges faced by institutions: The case of Mojana Wodera District, Amhara Region, Ethiopia. *International Journal of Finance and Banking Research*, *7*(1), 9-20. https://doi.org/10.11648/j.ijfbr.20210701.12

Mariita, M. O., Nyangeri, J., & Makatiani, J. K. (2016). Assessing the incidences of late blight disease on Irish potato varieties in Kisii County, Kenya. *Annual Research & Review in Biology, 1-8.*

Twumasi, M. A., Jiang, Y., & Acheampong, M. O. (2019). Determinants of agriculture participation among tertiary institution youths in Ghana. *Journal of Agricultural Extension and Rural Development*, *11*(3), 56-66.

Marwa, M. E., Mburu, J., Elizaphan, R., Oburu, J., Mwai, O., & Kahumbu, S. (2020). Impact of ICT based extension services on dairy production and household welfare: The case of iCow service in Kenya. *J. Agric. Sci*, *12*(3), 1-12.

Mathenge, M. K., Smale, M., & Olwande, J. (2014). The impacts of hybrid maize seed on the welfare of farming households in Kenya. *Food policy*, 44, 262-271.

Menon, N., Rodgers, Y. V. D. M., & Tanjeem, N. (2023). The Agricultural Marketplace and Women's Work. Available at SSRN 4316602.

Mburu, H., Cortada, L., Haukeland, S., Ronno, W., Nyongesa, M., Kinyua, Z., Bargul, J. L., & Coyne, D. (2020). Potato cyst nematodes: A New threat to potato production in East Africa. *Frontiers in Plant Science*, *11*(May), 1–13. https://doi.org/10.3389/fpls.2020.00670

Moeini et al, H. M. M. (2010). Effect of education based on trans-theoretical model on promoting physical activity and increasing physical work capacity. *Iranian Journal of Military Medicine Fall*, *12*(3), 123–130. http://militarymedj.ir/article-1-731-en.pdf

Montfaucon, A. F. (2020). Increasing agricultural income and access to financial services through mobile technology in Africa: Evidence from Malawi. *The palgrave handbook of agricultural and rural development in Africa (Pp. 247-262). Palgrave Macmillan, Cham.*, *3*(10), 163–176. https://doi.org/10.31149/ijie.v3i10.710.

Mugenda, O. M., & Mugenda, M. A. (2003). *Research Methods: Quantitative and Qualitative Approaches*. African Centre of Technology Studies press (ACTS).

Mulugeta, T., Muhinyuza, J. B., Gouws-Meyer, R., Matsaunyane, L., Andreasson, E., & Alexandersson, E. (2020). Botanicals and plant strengtheners for potato and tomato

cultivation in Africa. *Journal of Integrative Agriculture*, *19*(2), 406–427. https://doi.org/10.1016/S2095-3119(19)62703-6.

Mulwa, C., Marenya, P., Rahut, D. B., & Kassie, M. (2017). Response to climate risks among smallholder farmers in Malawi: A multivariate probit assessment of the role of information, household demographics, and farm characteristics. *Climate Risk Management, 16*, 208–221. https://doi.org/10.1016/j.crm.2017.01.002.

Musita, C. N., Okoth, M. W., Abong', G. O., & Omayio, D. G. (2020). Glycoalkaloids in commercial potato varieties traded in Nairobi, Kenya. *F1000Research, 9,* 423. https://doi.org/10.12688/f1000research.23783.2

Muthoni, J., Nyamongo, D. O. N., & Mbiyu, M. (2017). Climatic change, its likely impact on potato (*Solanum tuberosum* L.) production in Kenya and plausible coping measures. *International Journal of Horticulture*, January. https://doi.org/10.5376/ijh.2017.07.0014

Muthoni, J., & Shimelis, H. (2023). An overview of potato production in Africa. *Potato production worldwide, 435-456.*

Muyanga, M., & Jayne, T. S. (2008). Private agricultural extension system in Kenya: Practice and policy lessons. *Journal of agricultural education and extension, 14(2*), 111-124.

Mwololo, H. M., Nzuma, J. M., Ritho, C. N., & Aseta, A. (2019). Is the type of agricultural extension services a determinant of farm diversity? Evidence from Kenya. *Development Studies Research, 6(1*), 40-46.

Nassiuma, D. K. (2000). *Survey sampling: Theory and methods.* Egerton University press.

Namyenya, A., Daum, T., Rwamigisa, P. B., & Birner, R. (2022). E-diary: a digital tool for strengthening accountability in agricultural extension. *Information Technology for Development, 28(2*), 319-345. https://doi.org/10.1080/02681102.2021.1875186

Nasereldin, Y. A., Chandio, A. A., Osewe, M., Abdullah, M., & Ji, Y. (2023). The credit accessibility and adoption of new agricultural inputs nexus: Assessing the role of financial institutions in Sudan. *Sustainability, 15*(2), 1297.

NCBA plc. (2019). Ncba group annual report and financial statements 2019 1.

Nderitu EM, Kamuru SM, & Matofari JW (2019). Influence of institutional factors on adoption of improved cassava processing technologies among small scale farmers in Migori County, Kenya. The authentic knowledge: *African Journal of Pure and Applied Science Research 1*(1):26-32.

Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.

Ngongo RN (2014). *Factors Influencing the adoption of modern agricultural technologies by small scale farmers: The case of Thika East Sub-County, Kenya P 119.*

Obedi, N. I. (2023). Production of Potato Quality Seeds in Mountainous Region of Central Africa. *In Advances in Root Vegetables Research. IntechOpen*

Odhiambo, F.O. and Upadhyaya, R. (2021). Flexible loans and access to agricultural credit for smallholder farmers in Kenya. *Agricultural Finance Review, 81(3),* 328-359. https://doi.org/10.1108/AFR-05-2020-0072.

Ogundeji AA, Donkor E, Motsoari C, Onakuse S (2018). Impact of access to credit on farm income: Policy implications for rural agricultural development in Lesotho. *Agrekon 57*(2):152-166. https://hdl.handle.net/10520/EJC-103929370a

Okello, J. J., Zhou, Y., Kwikiriza, N., Ogutu, S., Barker, I., Schulte-Geldermann, E., ... & Ahmed, J. T. (2017). Productivity and food security effects of using of certified seed potato: the case of Kenya's potato farmers. *Agriculture & Food Security*, *6*, 1-9.

Osabohien, R., Matthew, O., Gershon, O., Ogunbiyi, T., & Nwosu, E. (2019). Agriculture development, employment generation and poverty reduction in West Africa. *The Open Agriculture Journal, 13(1).*

Parker, M. (2018). Accelerated value chain development (AVCD) program Root crops component Apical rooted cuttings to enhance seed potato production *Seed production in Kenya. 1–2.*

Pituch, K. A., & Stevens, J. P. (2015). *Applied multivariate statistics for the social sciences: Analyses with SAS and IBM's SPSS*. Routledge.

Poku, A. G., Birner, R., & Gupta, S. (2018). Why do maize farmers in Ghana have a limited choice of improved seed varieties? An assessment of the governance challenges in seed supply. *Food Security*, *10*, 27-46.

Ragasa, C. (2020). Effectiveness of the lead farmer approach in agricultural extension service provision: Nationally representative panel data analysis in Malawi. *Land Use Policy*, *99*, 104966.

Ragasa, C., & Mazunda, J. (2018). The impact of agricultural extension services in the context of a heavily subsidized input system: The case of Malawi. *World Development*, *105*, 25-47.

Raleting, P. M., & Obi, A. (2015). An Analysis of institutional factors influencing vegetable production amongst small-scale farmers in six vegetable projects of the Nkonkobe Local Municipality. *Journal of Agricultural Science, 7(6).* https://doi.org/10.5539/jas.v7n6p184.

Rogers, E. M. (2003). Diffusion of innovations (5th Ed). New York, NY: *Free Press*

Sada, A. N., & Maldonado, A. R. (2013). *Research Methods in Education. Sixth Edition - by*

Louis Cohen, Lawrence Manion and Keith Morrison (Review). February 2021. https://doi.org/10.1111/j.1467-8527.2007.00388.

Siddiqui, A. A., & Mirani, Z. (2012). Farmer's perception of agricultural extension regarding diffusion of agricultural technology. *Pakistan Journal of Agriculture: Agricultural Engineering Veterinary Sciences (Pakistan).*

Shiferaw, B., Kebede, T., Kassie, M., & Fisher, M. (2015). Market imperfections, access to information and technology adoption in Uganda: Challenges of overcoming multiple constraints. *Agricultural economics, 46(4)*, 475-488.

Sindh AA, Jiang Y (2017). Full article: Determinants of credit constraints: Evidence from Sindh, Pakistan: *Cogent Economics and Finance* 5.1 (2017).

Suvedi, M., Ghimire, R., & Kaplowitz, M. (2017). Farmers' participation in extension programs and technology adoption in rural Nepal: a logistic regression analysis. *Journal of Agricultural Education and Extension, 23*(4), 351–371. https://doi.org/10.1080/1389224X.2017.1323653.

Tata, J. S., & Mcnamara, P. E. (2018). Impact of ICT on agricultural extension services delivery: Evidence from the Catholic Relief Services SMART skills and Farmbook project in Kenya. *The Journal of Agricultural Education and Extension, 24(1)*, 89–110.

The Government of Kenya. (2017). Agricultural Sector Development Strategy *2016-2020, Government of Kenya (GoK)*. 1–120. http://www.ascu.go.ke/DOCS/ASDS Final.pdf.

Tran, N. L. D., Rañola, R. F., Ole Sander, B., Reiner, W., Nguyen, D. T., & Nong, N. K. N. (2020).Determinants of adoption of climate-smart agriculture technologies in rice production in Vietnam. *International Journal of Climate Change Strategies and Management*, *12*(2), 238–256. https://doi.org/10.1108/IJCCSM-01-2019-0003

Udimal TB, Jincai Z, Mensah OS, Caesar AE (2017). Factors influencing the agricultural technology adoption: The case of improved rice varieties (Nerica) in the Northern Region, Ghana. *Journal of Economics and Sustainable Development 8*(8):137- 148.

Ullah, A., Arshad, M., Kächele, H., Zeb, A., Mahmood, N., & Müller, K. (2020). Socio-economic analysis of farmers facing asymmetric information in inputs markets: Evidence from the rainfed zone of Pakistan. *Technology in Society*, *63*, 101405. https://doi.org/10.1016/j.techsoc.2020.101405

Ullah, A., Mahmood, N., Zeb, A., & Kächele, H. (2020). Factors determining farmers' access to and sources of credit: evidence from the rain-fed zone of Pakistan. *Agriculture*, *10*(12), 586.

Varangis, P., Buchenau, J., Ono, T., Sberro-Kessler, R., & Okumura, A. (2021). *Women in Agriculture Using Digital Financial Services* (No. 35471). The World Bank Group. http://hdl.handle.net/10986/35471

Wabwire, J. M. (2020). Editon Consortium Journal of Business and Management Studies (ECJBMS) Demographic Factors Influencing the Adoption of Mobile Phones in the Utilization of Formal Financial Services by Smallholder Farmers in Kenya Editon Consortium.. *Journal of Business 2*, 81–92.

Wabwire, J. M. (2021). Socio-Economic Factors and Utilization of Formal Financial Services among smallholder Farmers in Kenya. *Science Publishing Group 3*(1), 177–188. https://doi.org/10.51317/ecjeds.v3i1.196.

Wagle, S. P. (2023). Farmers' access to agricultural development services in the eastern hills of Nepal: A Case of the Milke-Tinjure watershed region. *In Nature, Society, and Marginality: Case Studies from Nepal, Southeast Asia and other regions* (pp. 197-208). Cham: Springer International Publishing.

World Bank Group. (2017). Gaining momentum in peruvian agriculture : Opportunities to increase productivity and enhance competitiveness. *Report Produced Under the Peru Agricultural Opportunities (ASA) World Bank Group*.

World Bank (2010). *Extension and advisory systems: Procedures for assessing, transforming, and evaluating extension systems*, Washington, D.C.

Appendix A: Questionnaire For Smallholder Potato Farmers

I am John Mburu, an MSc in Agricultural Extension Student at Egerton University, Kenya. Department of Agricultural Education and Extension. I am conducting my research in Kipipiri Sub-County. The purpose of this study is to establish the influence of access to institutional factors on the use of Certified Seed Potatoes (CSPs) among smallholder potato farmers in Kipipiri Sub-County, Nyandarua County. As a respondent, you are kindly requested to participate in answering this questionnaire. The information obtained here will be used for academic purposes and making recommendations on the use of CSPs. The information will be treated with the utmost confidentiality. Thank you.

Sub-County_____ Ward_____

SECTION A: **General information about the Smallholder Farmers**.

Answer all the questions by filling in the blank spaces provided or put a tick ( ) where necessary.

1. Gender of respondent

[ ] Male

[ ] Female

2. Respondent's age range

18-27 years [ ] 28-37 years [ ] 38–47 years [ ] 48-57 Years [ ]

Above 57 years []

3. Highest level of education

None [] Primary [ ] Secondary [ ] Tertiary [ ]

SECTION B: **Access to extension services on SHF's use of CSPs**.

Tick (√) the appropriate answers to the following questions.

4. Do you receive extension services?
Yes [ ] No [ ]

5. If yes in question 4 above, how often do you normally receive extension services
Always [ ] Rarely [ ]

6. If yes in question 4, which one is the major source of extension services do you use? Select all that apply:

Government Extension providers [ ]

NGOs/Private Extension agencies [ ]

Other farmers [ ]

Media (Magazine, TV/Radio) [ ]

Research stations [ ]

Online Sources (Facebook, blogs, farmer forums, webpages) [ ]

Others, (please specify) …….

7. If no in 4 above what are the likely reasons why you have never accessed extension services?

Lack of information about the existence of extension services [ ]

Extension offices are located very far away [ ]

The location of my farm is remote and not easily accessible [ ]

Very few extension officers are available [ ]

Not interested [ ]

Others, please specify.....

8. Have you attended any training on the use of Certified Seed Potatoes (CSPs)?

Yes [ ] No [ ]

9. If yes in question 8, indicate the methods of training. Select all that apply:

Farm training and visit [ ] Famer Field school [ ]

Group discussion [ ] Field trips [ ]

Agricultural conferences [ ] Media (Magazine, TV/Radio) [ ]

Demonstration Farms [ ] Farmer to Famer Learning [ ]

Others, please specify.....

10. To what score is the extent of the extension training method effective? (Use a scale of 1-5, where; 1-very low, 2-low, 3-average, 4-high, 5-very high)

	Very low	low	average	high	Very high
i. Farm training and visit					
ii. Famer Field School					
iii. Group discussion					
iv. Demonstration Farms					
v. Field trips					
vi. Agricultural conferences					
vii. Farmer to Famer Learning					
viii. Media (Magazine, TV/Radio)					

11. If yes in 8 above, how often do you attend the training on the use of CSPs?

Once per week [ ] Once in a month [ ]

Once in three months [ ] Once in six months [ ]

Once per year [ ]

Twice per year [ ]

12. If yes in 8, which of the following CSPs Practices do you receive training on?

Healthy seed selection [ ] Disease management [ ] sourcing of certified seeds directly from certified sources [ ] record keeping [ ], field hygiene [ ] Crop protection [ ] harvest-handling [ ],

Others please specify…….

13. If yes in 8, do you apply the information obtained from training in your farm activities?

Yes [ ] No [ ]

14. If yes in 8, how often do you use the information from the training?

Always [ ] Not at all [ ] Rarely [ ]

15. Which CSPs training practice do you apply in potato production? Select all that apply:

Healthy seed selection [ ] Disease management [ ] sourcing of certified seeds [ ] record keeping [ ], field hygiene [ ] Crop protection [ ] harvest-handling [ ],

Others please specify……

Section C: Access to certified seed potato multipliers

16. Do you source seed potatoes from a certified seed multiplier/dealer?

A. Yes [ ] b. [ ]

17. If no in 16 above why?

Lack of knowledge of their existence [ ] no certified seed multiplier in my area [ ] long procedures of booking seeds [ ] High certified seed costs [ ] Not interested [ ] others specify……

18. If no in 16 above where do you source your seed potatoes?

Farmer stores [ ] Neighbor [ ] local marketers [ ] others specify ……

19. If yes in the above 16, what specific seed type do you get from the certified multipliers?

Shangi [ ] Unica [ ] Dutch Robjin [ ]

Tigoni [ ] Kenya mpya [ ] others please specify ……

20**.** Rank the notable seed qualities of seeds sourced from certified seed Multipliers **(**1-very low; 2-low; 3-Average; 4-High; 5-Very high)

	Very low	low	Average	high	Very high
i. High germination percentage					
ii. Large and many tuber development/High yields					
iii. Resistant to drought					
iv. Resistant to crop pests					
v. Resistant to perennial weeds					
vi. Resistance to potato diseases (viral/bacterial/Fungal					
vii. Early Maturity					

Section D: Access to credit on SHF's use of CSPs

21. Do you normally acquire credit?

Yes [ ] No [ ]

22. If No in question 21 above, why?

No need [ ] Not aware of the availability of credit [ ]

Lack of enough collateral to secure a facility [ ] High interests on the credit [ ]

Long credit application procedures [ ]

Other, please specify…….

23. If Yes in question 21 above, what is the source of your credit? (Tick as many as applies)

Formal bank [ ] Microfinance institution [ ]

SACCO [ ] Community group [ ]

Informal Sources (e.g. Neighbour / Family) [ ] Mobile Money Banking (Mpesa/Airtel money/KCB Mpesa/) [ ]

Other, please specify……

24. If yes in 21, how would you score the purpose of acquiring credit? (Provide a Likert scale sort f: 1-very low; 2-low; 3-Average; 4-High; 5-Very high)

For buying certified seeds [ ] for buying agrochemicals [ ]

Seeds storage facilities [ ] Soil management [ ]

Water management [ ] Harvesting [ ]

Crop protection [ ]

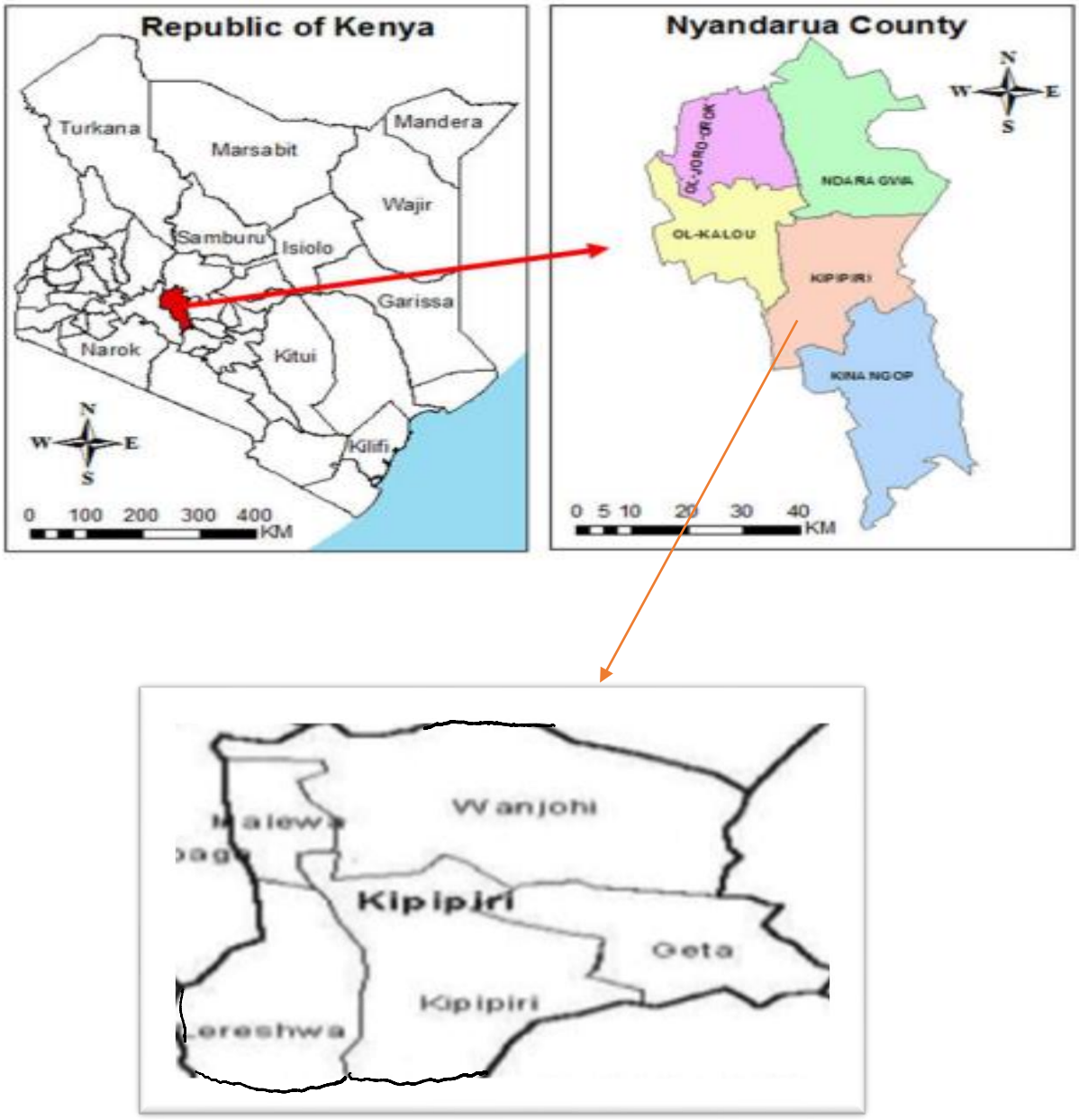
Others, please specify……

25. If yes in 21, the amount received

Less than (≤) KES 10,000 [ ] KES 10,001- KES 35,000 [ ]

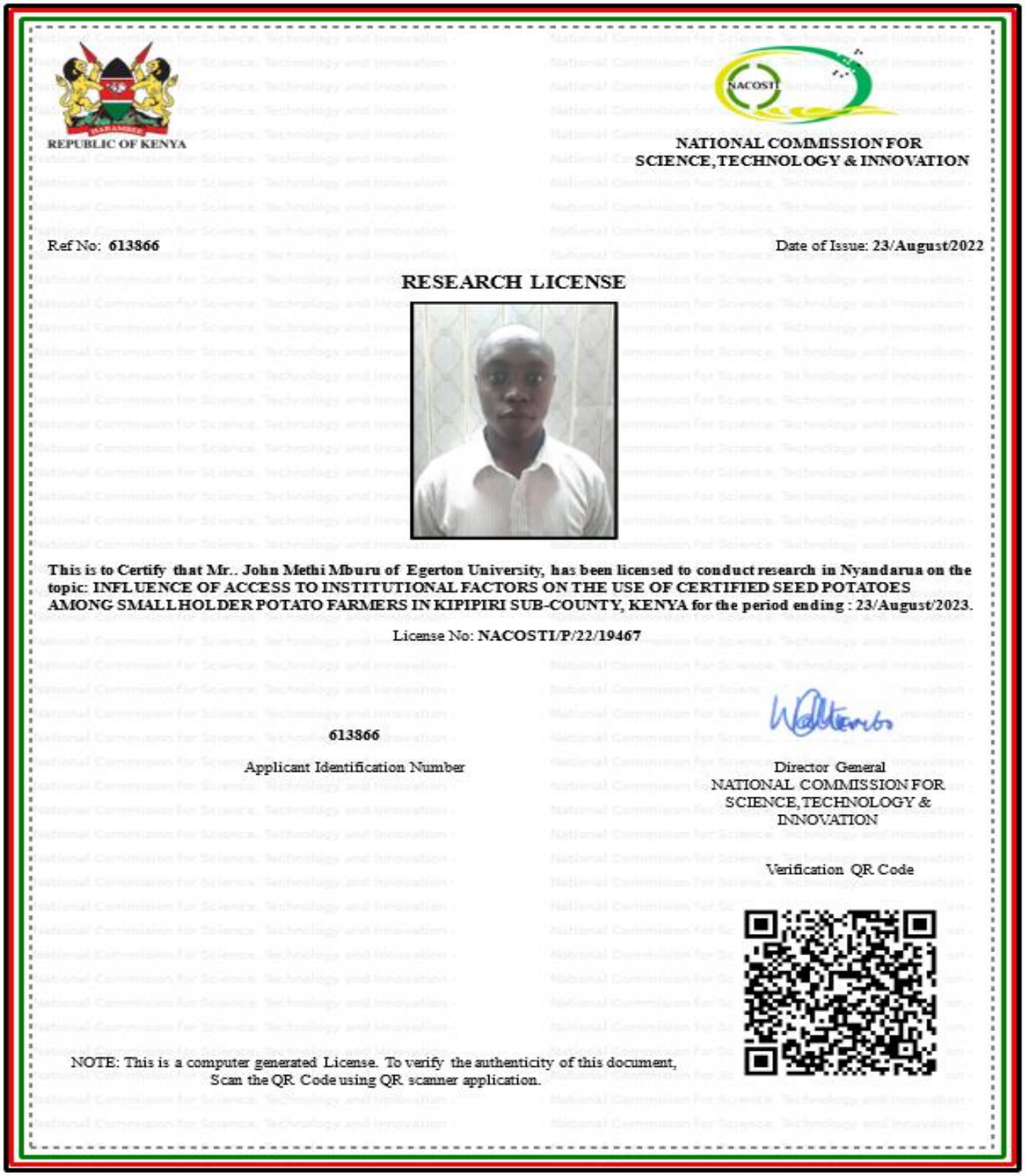
KES 35,001- KES 60,000 [ ] Above (>) KES 60,000 [ ]

Appendix B: Map of The Study Area, Kipipiri Sub County



Map of Kipipiri Sub-County

Appendix C: Research License



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Appendix D: Abstract's Page of the First Publication

Asian Journal of Agricultural Extension, Economics & Sociology

Volume 41, Issue 4, Page 169-177, 2023; Article no.AJAEES.97064
ISSN: 2320-7027

Influence of Access to Extension Services on Smallholder Farmers' Use of Certified Seed Potatoes (CSPs) in Kipipiri Sub-County, Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. Author JMM conducted the literature review, designed the study, collected data, analyzed the data and prepared the first draft of the manuscript. Authors MAO and PMM helped with literature review, data collection and analysis, edited the manuscript and supervised the study process. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Extension services delivery remains a key driver in farmers' uptake and use of improved farming technologies in rural areas which are predominantly occupied by poor farmers. The use of certified seed potatoes (CSPs) increases yield and potato productivity. Most smallholder farmers lack knowledge of how to use CSPs while others are not even aware of their existence. This has given farmers an opportunity to use and re-use their own seeds saved from their local storage facilities. The paper sought to determine whether access to extension services influenced smallholder farmers' use of CSPs in Kipipiri Sub-County, Kenya. A structured, researcher-administered, questionnaire was used in collecting data from one hundred and six smallholder potato farmers randomly selected from the area. Descriptive statistics and a binary logistic model were used for statistical analysis. The findings indicated that there was a significant relationship between access to extension services and the use of CSPs. 85 per cent of the respondents were found to have access to extension services while 21 % had no access. Additionally, on the frequency, the majority of the respondents (64%) rarely accessed the services and 36% reported accessing the extension services always. These findings suggest that extension services are a major component that drives farmers' use of CSPs in the study area. Therefore, for farmers to benefit fully, extension agents need to increase their service delivery to smallholder potato farmers. County governments also need to improve the existing farmer training centers to assist farmers to acquire knowledge on the use of CSPs. This would increase potato productivity in the area.

Keywords: Extension services; CSPs; smallholder farmer; productivity.

Appendix E: Abstract's Page of the Second Publication

Asian Journal of Agricultural Extension, Economics & Sociology

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ISSN: 2320-7027

Determining if Access to Certified Seed Multipliers Influence Smallholder Farmers' Use of Certified Seed Potatoes (CSPs) in Kipipiri Sub-County, Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. Author JMM conducted the literature review, designed the study, collected data, analyzed the data, and prepared the first draft of the manuscript. Authors MAO and PMM helped with data analysis, edited the manuscript, and supervised the study process. All authors read and approved the final manuscript.

Article Information

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Original Research Article

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ABSTRACT

Empirical evidence suggests that certified seed potatoes (CSPs) are critical in boosting potato yield, increasing income, and improving nutrition and food security at the household level. Availability and access to certified seed multipliers increase the chances of smallholder potato farmers' (SHF) uptake and use of certified seed technologies and practices. Most farmers cannot access certified seeds from these multipliers, forcing them to use and reuse the seeds saved from their local storage facilities. The paper sought to determine whether access to certified seed multipliers influenced potato smallholder farmers' use of CSPs in Kipipiri Sub-County, Kenya. A closed-ended, researcher-administered survey was used in collecting data from 106 SHFs selected from the area. Descriptives and binary logistic statistics were used to answer the study objectives. The findings indicated a significant relationship between access to certified seed multipliers and the use of CSPs. From the study, only 40 % of smallholder farmers had access to certified seed multipliers, while the majority (60%) did not. This trend would be why the respondents opted to use other sources of seeds from farmer stores. Additionally, the high cost of certified seeds and lack of awareness of existing certified seed sources/multipliers were recorded as the significant barriers hindering farmers from accessing certified seed potatoes in the study area.

Keywords: Certified seed multipliers; CSPs; smallholder farmer; yield.