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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.

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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

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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.

1. INTRODUCTION

Food and Agriculture Organization [FAO], [1] reported that Potatoes are a valuable and nutritious staple crop contributing to global food security and GDP growth. It is estimated to be the third most critical food crop globally after rice and wheat in terms of human consumption. There are over 4,000 edible varieties of potatoes, primarily found in the Andes of South America. More than a billion people globally eat potatoes. Potatoes' qualities, such as easy storage, high nutritional value, and high yield, make them a suitable crop in the processed food industry. It is an essential food security element for millions across South America, Africa, and Asia, including Central Asia. Based on the data from FAOSTAT, potato production in China was reported to be 75,657,850 metric tons in 2019, which increased to 78,236,596 metric tons in 2020. This makes China the current world's largest producer of potatoes. Fresh and chilled potatoes are the two major classifications in the global potato market.

Fresh potatoes are used daily, while chilled potatoes are exported or imported and used in the food processing industry. Harahagazwe et al. [2] noted that 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 [3].

According to Okello et al. [4], the primary threat to potato smallholder farmers and the potato sector in Kenya is using low-quality seed potatoes that are highly contaminated with seed-borne diseases and pests. The scarcity and inadequacy of certified seed potatoes cause the phenomenon. Most smallholder potato farmers do not use certified seed potatoes for various reasons, including a lack of knowledge about their potential value, high prices, and a lack of seed dealers. Additionally, a significant majority are not able to access certified seed multipliers.

Mariita [5] highlighted that informal seed systems are disproportionately impacted by a lack of quality control in seed potatoes; because of this, many tubers have a low phytosanitary status. These seeds are saved on farms or exchanged between farmers. They account for over 95% of potato farmers' seed consumption [6]. Kenya Plant Health Inspectorate Service (KEPHIS) is the certifying body for seeds in Kenya. Seed certification aims to provide farmers with high-quality seed that is true to identity, pure and 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.

2. LITERATURE REVIEW

2.1 Access to Certified Seed Multipliers by Smallholder Farmers

Globally, a seed is considered an essential input since farmers must invest about 25-50% of the total cost to maximize 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 [7]. Alzaidi et al. [8], 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 Blekking et al. [9], 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% recently, 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 [10]. Diro et al. [11] identified quality seeds as an integral part of modern agricultural technologies 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 to increase quality seed supply to smallholder potato farmers in Kenya. For example, CIP has introduced apical cutting technology that accelerates multiplication, producing more seed potatoes 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 [12].

Despite the increasing crop demand in Kenya, there is an inadequate supply of certified seed potatoes. 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 and seeds from local markets [13]. 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 partnered with other private organizations and companies, such as CIP and Kisima Farm, in seed production and multiplication. According to the CIP report [14], the Kenyan formal seed system involves the production and distribution of certified seed; Kenya Agricultural and Research Organization (KALRO), in partnership with International Potato Centre (CIP), develops, maintains potato varieties, and supplies foundation seed. Kenya Plant Health Inspectorate Services (KEPHIS) offers seed inspection services. At the same time, Agricultural Development Corporation (ADC), and a few farmers and private institutions multiply 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 [15].

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

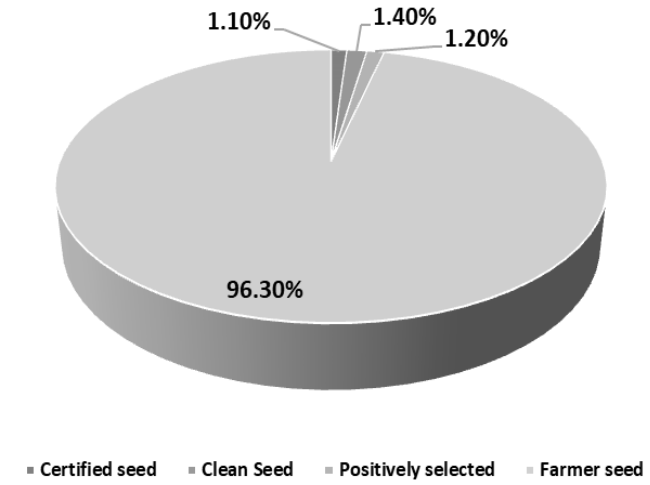

Fig. 1. The proportion of seed potato types planted in Kenya
Source: Kaguongo et al. (15)

3. MATERIALS AND METHODS

3.1 Study Location

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: Wanjohi, Kipipiri, Geta, and Githioro. The Sub-County has a total population of 113,938. 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. 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.

3.2 Sampling Procedure and Sample Size

Smallholder potato farmers were selected to participate in the study. A proportionate random 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 [16], was used to compute 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,
N = the population within the study area,
C= Coefficient of Variation,
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 [16] 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.

3.3 Instrumentation

A closed-ended researcher-administered survey was used to collect data to answer the study objectives to develop a structured questionnaire. The questionnaire was appropriate for this study given the quantitative nature of the study and ease of data collection and analysis. Section A of the questionnaire covered general information about the smallholder farmer, while section B had access to certified seed multipliers. The questionnaire was researcher administered.

3.4 Validity

The validity is the ability of the instrument to measure what it is purposed to measure [17]. It manifests as content and face validity. The research tool was reviewed by the different research experts from Egerton University and my research advisors to check for the instrument's accuracy. Remarks from the experts were used to improve the instrument. The review process ensured the survey items were aligned with the study objectives and well formatted to ensure content and face validity.

3.5 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 [17]. 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.

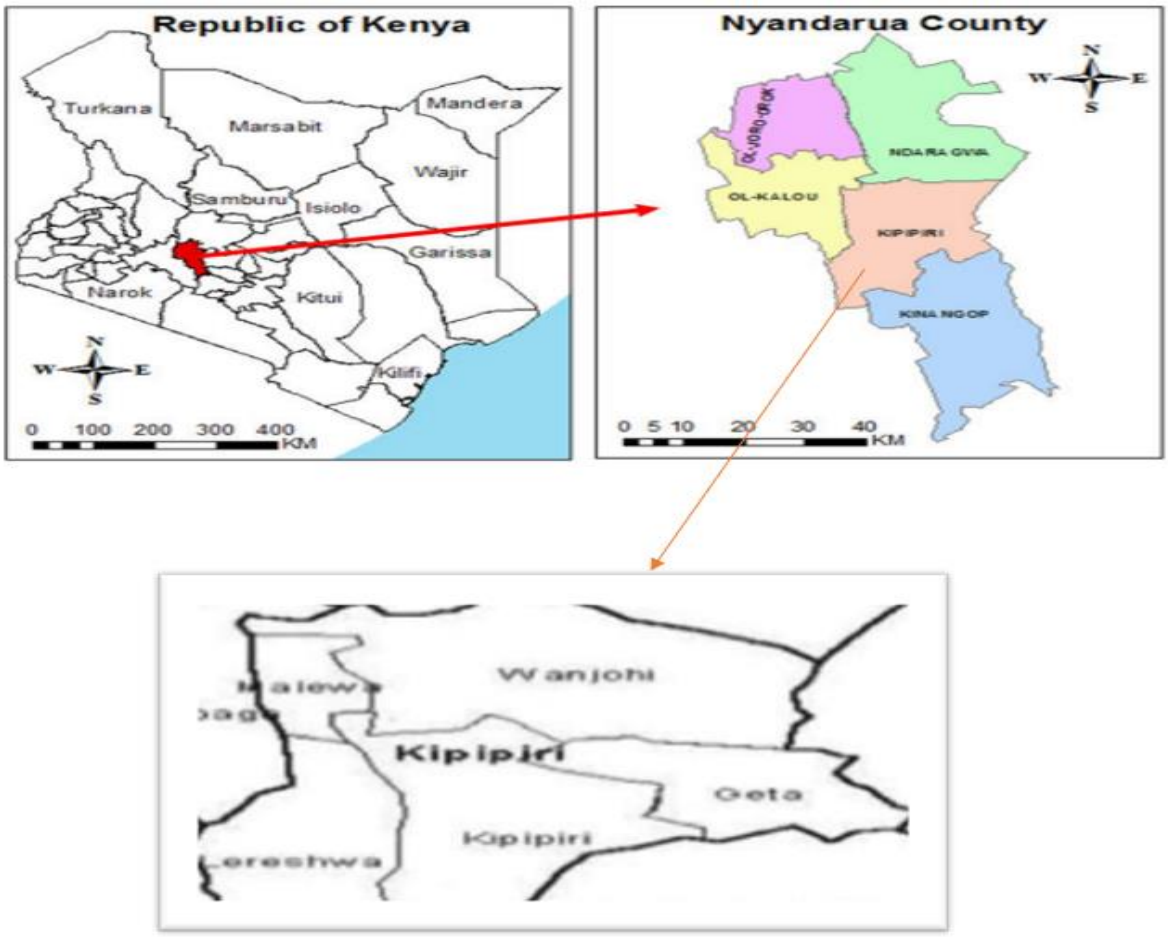

Fig. 2. Kipipiri Sub-County, Kenya

Table 1. Accessible population and sample size distribution

Population unit	Accessible population	Proportion (%)	Sample size
Wanjohi ward	800	32	34
Kipipiri ward	650	26	28
Githioro ward	600	24	25
Geta Eastward	450	24	19
Total	2500	100	106

Source: MoALFI, (2021)

The reliability coefficient was estimated using Cronbach's Alpha at .05 alpha level set a *priori*. The scale of α = 0.756. The questionnaire was considered reliable after attaining Cronbach's Alpha value of 0.756. The alpha coefficient above the threshold (α = 0.70) is acceptable reliability [18].

3.6 Data Analysis

The data collected were coded and cleaned then analyzed using Statistical Package for Social Sciences (SPSS) Version 25 to enhance analysis. Percentage, frequency, and binary logistic models were employed to analyze the data meaningfully.

4. RESULTS AND DISCUSSION

The study intended to describe the level of access to certified seed multipliers, sources of potato seeds, challenges farmers face in accessing CSPs, and the influence that access to certified seed multipliers has on the use of CSPs. The results obtained from this study were analyzed and discussed as follows.

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

The objective was as:

> *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*

4.2 Access to Certified Seed 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 2.

Table 2. Access to certified seed multipliers among smallholder potato farmers

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

Source: Own computation of survey data, (2022)

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. This claim is supported by Ali et al. [19] and Ullah et al. [20], who found that agricultural productivity and sustenance of the agriculture sector depend on farmers' adoption and use of improved technologies, such as certified seeds.

4.3 Challenges Faced by Farmers in Accessing Certified Seed Potato Multipliers

Descriptive statistics were used to analyze the smallholder potato farmers' challenges in accessing certified seed multipliers, and the results are summarized in Table 3.

When asked, out of the 64% of the smallholder farmers with no access to certified seed multipliers, 39% indicated that high costs of certified seeds were 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. At the same time, 16% of the farmers claimed that they were not interested in other sources of seeds. There were 14% no seed-certified multipliers in their area, and 8% indicated long booking procedures for the seeds. The findings agree with Elahi et al. [21], 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. As a result, there was a significant gap increase between potential and actual crop productivity [20]. According to Ogundeji et al. [22], most farmers in developing countries are unable to adopt technologies since they lack financial investments.

4.4 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 4.

Results show that out of the 64 smallholder potato farmers who did not access certified seed.

Table 3. 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
Lengthy procedures for booking seeds	5	8
High costs of certified seed	25	39
Not interested	10	16
Total	64	100.0

Source: Own computation of survey data, (2022)

Table 4. Sources of seed potatoes 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

Source: Own computation of survey data, (2022)

multipliers, the majority relied on farmer stores (70%), followed by farmers who sourced from their neighbours (24%) and only 6% source their seeds from local seed marketers. This indicates that most farmers use seeds from their farmer stores. This may imply that such categories of farmers may not adequately use CSPs because seeds from their stores are not certified and therefore, the re-use lowers potato productivity in the area. The study agrees with Poku and Gupta [23], who argued that the clean and commercial seed sector supplies a small per cent of the total seed demand in Ghana. Further, about 80% of seeds used in the West African country are sourced from the informal sector, majorly 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 [24], who found that 60% of smallholder farmers had access to and used certified seeds.

4.5 Test of Hypothesis H_{O2}

The objective 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 certified seed multipliers as independent variables relating to the use of CSPs was statistically significant.

Table 5 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 without access to certified seed multipliers. This could be because access to certified seed multipliers gives farmers an upper hand in purchasing and using Sub-County CSPs. It may also imply that farmers are made aware of the available channels used to obtain CSPs and the necessary methods and practices involved in cultivation afterwards. The finding coincides with Wagle's [25], who observed that access to innovative agricultural centres, such as seed multipliers, positively affected the use and uptake of technologies in modern farming, such as the use of CSPs. Further, ease of access to agro-services locations, innovative agricultural techniques, and input providers such as seed dealers was found to be essential for farmers in improving agriculture productivity.

Table 5. Institutional variable in the binary logistic regression equation

Institutional variables		B	S.E.	Wald	df	P-value	Exp(B)
Step 1[a]							
	Access to certified seed multipliers	0.777	0.611	1.619	1	0.203	2.176
	Constant	0.423	0.301	1.970	1	0.160	1.526

a. Variable(s) entered on step 1: Access to Certified Seeds multipliers using CSPs

5. CONCLUSION

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.

6. RECOMMENDATIONS

The following recommendations were made:

(i) Policymakers should prioritize policies that support seed multiplication and research centres, extension providers, and financial facilities.
(ii) The National Government and development partners should invest more in seed multiplication and breeding, mainly in the County's Agricultural training centres and at the farmer level.

CONSENT AND ETHICAL APPROVAL

This research study ensures numerous ethical considerations, which included presenting a research permit to the Kipipiri Sub-County Department of Agriculture, Livestock and Fisheries, Crops unit. Self-introduction to the farmers and an explanation of the real purpose of the study was done. The study also respected the confidentiality, anonymity, dignity, norms, and culture of the farmers. Full consent was obtained from respondents before the data collection process.

COMPETING INTERESTS

The authors have declared that no competing interests exist.

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