International Journal of Agricultural Economics
2025, Vol. 10, No. 4, pp. 190-204
https://doi.org/10.11648/j.ijae.20251004.15

Research Article

Influence of Agricultural Input Subsidy on Potato Yield Among Smallholder Farmers in Marakwet West Sub-county, Elgeyo Marakwet County (Kenya)

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Abstract

Agricultural input subsidy interventions are designed to make essential inputs, mainly fertilizers and seeds, more affordable and accessible to smallholder farmers, thereby enhancing agricultural productivity and household food security. However, there is currently limited empirical information on the extent to which such subsidies influence smallholder potato production in Kenya. This study aimed to evaluate the effect of fertilizer and seed subsidies on potato yields in Marakwet West Sub-County, Elgeyo Marakwet County, Kenya. A sample of 372 smallholder farmers was selected using stratified random sampling, and data was collected through a structured questionnaire. The Cobb-Douglas production function was applied to analyze the relationship between subsidized inputs and Potato productivity. Findings showed that 58% of the respondents received 537 kg of subsidized fertilizers, while 83.1% received 2,453 kg of subsidized potato seeds during the production season. Farmers who accessed both fertilizer and seed subsidies achieved significantly ($P < 0.05$) higher yields than those who did not benefit from subsidies or received only one input. Regression analysis indicated that the quantity of subsidized fertilizers ($\beta = 0.679$) and seeds ($\beta = 0.481$) had a strong positive influence on potato yields ($R^2 = 0.714$; $P < 0.01$). The study concludes that providing both fertilizer and seed subsidies substantially improves potato yields for smallholder farmers. It is therefore recommended that the relevant stakeholders continue to enhance farmers' access to these subsidies and prioritize research on developing high-yielding, drought-and disease-resistant potato varieties to further increase production and ensure sustainable food security.

Keywords

Agricultural Subsidy, Potato Yields, Small-holder Farmers, Sustainability

1. Introduction

Government agricultural input subsidy interventions aim to incentivize agricultural production by reducing the price of key inputs like fertilizers, herbicides, machinery, fuel, and seeds to prices below prevailing market rates [1, 2]. By lowering the costs of these inputs, subsidies enable farmers to purchase them in the right quantities while freeing up income to invest in other production essentials that drive agricultural productivity [3, 4]. The use of agricultural subsidies in crop

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Received: 19 June 2025; **Accepted:** 3 July 2025; **Published:** 24 July 2025

production can lead to positive outcomes such as increased yields and overall production.

In Sub-Saharan Africa (SSA), agricultural input subsidies were largely state-led during the 1960s and 1970s but declined in the 1990s due to structural adjustment programs [5, 6]. A resurgence in the early 2000s saw the adoption of Input Subsidy Programs (ISPs) across SSA as a strategy to support smallholder farmers [7-9]. By 2023, twenty-two countries in SSA had active subsidy programs, but the overall use of subsidized inputs remains low compared to global standards [1, 10, 11].

In Kenya, fertilizer and seed subsidies were introduced in the 1960s, phased out in the 1990s, and revived through programs like the National Accelerated Agricultural Input Access Programme (NAAIAP) in 2007 and the 'Kilimo Plus' initiative [12-14]. These interventions increased fertilizer use by 80% between 1999/2000 and 2021/22, benefiting millions of farmers.

However, influence of subsidy on potato remains understudied within subsidy policy debates. Despite being Kenya's second most important food crop after maize, potato farming has received little direct subsidy support compared to cereals like maize [15]. Many farmers divert maize subsidies to potatoes, but a dedicated input scheme for potatoes is lacking.

Potato cultivation is concentrated in high-altitude areas, with major zones including Mt. Kenya slopes (Embu, Nyandarua, Meru, Kirinyaga), the Mau Escarpment (Mau Narok, Molo), and the Rift Valley (Nandi, Uasin Gishu, Trans-Nzoia, Elgeyo-Marakwet) [15]. Despite favorable conditions, national average yields remain low at 8–10 tons per hectare, far below the potential 50–60 tons under optimal practices [16-21].

In Marakwet West, agricultural input subsidies mainly target maize, coffee, avocado, and livestock, while potato farming remains largely excluded. Yet, Potatoes have become increasingly important to household incomes and regional food security. Local farmers face high input costs and limited access to quality seeds and fertilizers, constraining yields.

Therefore, this study aimed to evaluate the influence of agricultural input subsidies on potato yields among smallholder farmers in Marakwet West Sub-County, Kenya.

2. Methodology

2.1. Study Area

This study was undertaken in Marakwet West Sub-county which is one of the sub-counties in the Elgeyo Marakwet County of the Rift Valley. The county has a population of 454,480 (KNBS, 2019) and three agro ecological zones; the valley, mid highland and highland. Marakwet West has a total population of 137,513 within 29,523 households (KNBS, 2019). Marakwet West Sub-county has a total of six wards: Kapsowar, Lelan, Sengwer, Cherang'any/Chebororwa, Moiben/Kuserwo and Arror. Potato is grown in all the wards except Arror, which is located in the Kerio Valley basin. The temperatures range from a minimum of 14°C to a maximum of 24°C. Meanwhile rainfall range from 400 mm to 1400 mm per year (Ministry of Agriculture and Livestock, 2023).

2.2. Research Design

This study adopted explanatory research design and this is because it establishes cause-and-effect relationships between different study variables. In the study, the cause was the agricultural input subsidies whereas the effect were three aspects; potato production, income and adoption of agricultural technology. The correlation that is one of the method of analysis in explanatory research design was used in the analysis of cause-effect relationship between two or more quantitative variables [22]. The suitability of the design is that the current study was establishing how inputs factors through subsidies influence yields, profitability and adoption.

2.3. Target Population

The target population was smallholder potato farmers who benefited from the subsidy programme in Marakwet West Sub-county. The number of smallholder potato farmers who benefited from the subsidy programme Marakwet West Sub-county during the study was 5,499 (Elgeyo-Marakwet Agriculture Annual Report, 2023). The potato farmer's population distribution per ward is as shown in Table 1.

Table 1. *Population of smallholder potato farmers per ward in Marakwet West Sub-County in 2023.*

Ward	Target population
Cherang'any/Chebororwa	850
Moiben/Kuserwo	1400
Kapsowar	760
Lelan	1545
Sengwer	944
Total	5,499

Source: Elgeyo-Marakwet Agriculture Annual Report (2023).
*Arror ward was removed because there was no potato production in the area.

2.4. Sample Size

The sample size of the study was calculated by using the Slovins formula [23] with a 95% confidence level as:

$$n = \frac{N}{1 + Ne^2} = \frac{5499}{1 + 5499 * 0.05^2} = 372.87 \approx 372$$

Where: n = Sample size required

N = Number of people in the population

e = Allowable error (5%) 0.05 for population 1,000 to 10,000

Therefore, the sample size for this study was 372 potato farmers.

2.5. Sampling Procedure

The sampling procedure employed in this study was proportional stratified random sampling, which is achieved by division of the population into distinct subgroups based on populations [24]. The five wards in Marakwet West selected under the study were; Sengwer, Moiben/Kuserwo, Lelan, Kapsowar, and Cherang`any/Chebororwa these served the strata. After this, the total number of smallholder potato farmers in each of the five wards was determined using the ward agricultural office data and proportion of smallholder potato farmers in each ward calculated in relative to the total number of smallholder potato farmers across all five wards as indicated in table 2 from the desired total sample size of 372 respondents for the study. A random sample proportional to the population was drawn from each stratum to ensure representation from each ward. Within each stratum, simple random sampling was employed. This technique ensured that each individual in the population had an equal chance of being selected [25].

The use of stratified random sampling in this study was to allow for a representative sample that captures the diversity and characteristics of smallholder potato farmers across the different wards.

Table 2*. Population, proportion and sample size of smallholder potato farmers per ward in Marakwet West Sub-County in 2023.*

Ward	Population	Proportion	Sample size
Cherang'any/Chebororwa	850	15.5	58
Moiben/Kuserwo	1400	25.5	95
Kapsowar	760	13.8	51
Lelan	1545	28.1	105
Sengwer	944	17.2	64
Total	5,499	100	372

Source: Author's tabulation (2023)

2.6. Data Type, Sources and Instruments

The data collected for this study was primary data. Primary data was collected directly from the 372 Potato farmers through structured questionnaires in the five wards of Marakwet West Sub-County. This data collected provided specific information about the subsidy inputs, potato farm production, and profitability and technology adoption.

For this study, the data collection instruments were; questionnaire, interview guide and observation checklist. The questionnaire was used to gather information from potato farmers regarding their subsidy inputs, farm production, profitability and technology adoption. The interview guide was utilized to conduct in-depth interviews with key stakeholders, such as extension service providers, to explore their perspectives on the logistic of subsidies. Additionally, an observation checklist was employed during on-site visits to document the status of Potatoes production among farmers.

2.6.1. Validity of Instruments

To establish validity, multiple measures were implemented. Firstly, content validity was ensured through expert opinions (Jones, 2019). Content validity was done through discussion with ministry of agriculture officials from Marakwet County. Suggestions were incorporated in the final instruments. Additionally, criterion validity was established by comparing the instrument results with established measures or indicators.

2.6.2. Reliability of the Instruments

Reliability was measured using Cronbach's Coefficient [26] Score for Cronbach's Alpha was obtained during piloting, where a sample of 37 **(**10% of the sample population) of Potato smallholder farmers in Keiyo North Sub-County, Kapchemutwa ward were provided with test questionnaires. Cronbach's alpha coefficient of 0.7 and above was acceptable to validate the study.

2.7. Data Collection Procedures

Before data collection, the researcher applied for research permit from the National Commission for Science Technology and Innovation (NACOSTI), a legally mandated body for research in Kenya. The researcher sought approval from County Government of Elgeyo-Marakwet in the Ministry of Agriculture, Livestock and Fisheries to conduct interviews. Data collection took place from March to June 2024.

2.8. Definition, Measurement of Variables and Expected Signs

Table 3 shows the variables used in this study and their measurements. The positive sign (+) was used to show probable increase when inputs are applied negative sign (-) means was supposed to depict that when the variable increase, output decreases.

Table 3. Descriptions and Measurement of Variables.

Variables	Description	Units	Expected sign
Dependent Variables			
Potato production (output)	Continuous	Kgs	+
Independent Variables (Agricultural subsidies)			
Access to subsidized Fertilizers	Categorical	Has access to subsidized fertilizers: 1=Yes; 2=No	+/-
Access to subsidized seeds	Categorical	Has access to subsidized seeds: 1=Yes; 2=No	+/-
Quantity of subsidized fertilizers	Continuous	50-kg bags	+
Quantity of subsidized seeds	Continuous	50-kg bags	+
Ease of acquiring subsidized fertilizers	Categorical	It is easy to access subsidized fertilizers: 1. Strongly Disagree, 2. Disagree 3 Not sure, 4. Agree 5. Strongly Agree	+
Ease of acquiring subsidized seeds	Categorical	It is easy to access subsidized seeds: 1. Strongly Disagree, 2. Disagree 3 Not sure, 4. Agree 5. Strongly Agree	+

Source: Author (2024)

2.9. Data Analysis and Presentation

Filled questionnaires were screened; coded and entered in IBM Statistical Packages for Social Sciences (SPSS) version 26.0. The collected data was analyzed using appropriate statistical methods to address the research objectives. The analysis involved both descriptive and inferential statistics. Descriptive statistics was used to summarize the characteristics of the variables. Frequency distributions (%) were used for categorical variables. The following are the models that were used to analyze the research objectives.

2.9.1. Cobbs Douglass-Multiple Regression Model

Linearized Cobbs-Douglass production function followed by Multiple linear regression was used to test the strength and direction of the relationship between a single dependent variable measured in this study and three independent variables. The coefficient of each factor showed their relative contribution to the overall prediction of the dependent variables as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_n X_n ... + \varepsilon_i \tag{1}$$

Where Y is the dependent variable, and X_1… X_n are the *n* independent variables.

The relationship between production and input factors is usually modeled using Cobbs-Douglass production function in the form: $Q=AK^{\alpha}L^{\beta}$. Where Q = output, A is a constant, K and L are combinations of inputs/factors used to produce Q. To linearize the relationship, it takes the for $Ln(Y)= Ln[(f(X_i)]$. To evaluate the first objective on the influence of agricultural input subsidy on Potato yield among smallholder potato farmers. The Cobb Douglass double log equation was equation used was:

$$Ln(Y) = Lm\left(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} ... + \varepsilon_i\right) \tag{2}$$

Where
$Ln(Y)$ is yield of Potato
$Ln(X_1)$ = Received fertilizer subsidies
$Ln(X_2)$ = Frequency of receiving fertilizer subsidies
$Ln(X_3)$ = Price of fertilizer subsidies
$Ln(X_4)$ = Types of subsidized fertilizers
$Ln(X_5)$ = Quantity of subsidized fertilizers received
$Ln(X_6)$ = Received seed subsidies
$Ln(X_7)$ = Frequency of seeds subsidies
$Ln(X_8)$ = Price of seeds subsidies
$Ln(X_9)$ = Types of subsidized seeds
$Ln(X_{10})$ = Quantity of subsidized potato received
$Ln(X_{11})$ = Received fertilizer and seed subsidies

2.9.2. Multiple Regression Model

To evaluate the second objective on the influence of agricultural input subsidy on Potato production among smallholder potato farmers. The equation used was:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} ... + \varepsilon_i \quad (3)$$

Where
Y is Profitability of Potato
X_1 = Received fertilizer subsidies
X_2 = Frequency of receiving fertilizer subsidies
X_3 = Price of fertilizer subsidies
X_4 = Types of subsidized fertilizers
X_5 = Quantity of subsidized fertilizers received
X_6 = Received seed subsidies
X_7 = Frequency of seeds subsidies
X_8 = Price of seeds subsidies
X_9 = Types of subsidized seeds
X_{10} = Quantity of subsidized potato received
X_{11} = Received fertilizer and seed subsidies

Diagnostic tests was conducted on the regression results obtained from the analytical approach, specifically the SPSS output. These tests aim to assess the assumptions underlying the chosen analytical model, which in this study is multiple linear regression using ordinary least squares. Multicollinearity, which refers to the correlation between independent variables, was assessed using the Variance Inflation Factor (VIF) in SPSS. The VIF measures the extent to which the variance of an estimated regression coefficient is inflated due to multicollinearity. A VIF of 1 indicates no correlation, while values between 1 and 5 suggest moderate correlation that does not require corrective measures. VIFs greater than 5 indicate severe multicollinearity, which can lead to unreliable coefficient estimates and questionable p-values (Snee and Marquardt, 1984).

2.10. Ethical Considerations

The main ethical consideration emphasized in the study were those that ensure subject protection during research [27, 28]. Ethical considerations to protect respondents' rights, dignity, and welfare and included: confidentiality, objectivity, openness, and intellectual property rights. The researcher maintained confidentiality through ensuring anonymity of participants' details. The researcher also ensured objectivity by delinking the study from personal interest and group prejudice. The researcher maintained openness by: promoting the study progress through publication and data sharing. The researcher respected the respondents by avoiding gender-based discrimination, as well as biasness through religion. All intellectual property including copyrights was respected and plagiarism avoided.

3. Results and Discussion

3.1. Questionnaire Response Rate and Reliability

A total of 372 of questionnaires were distributed to the smallholder potato farmers, out of which 326 were returned and used in the current analysis. This resulted in a response rate of 87.6%. This response rate was considered good, since an overall response rate of 60-100% adequately validates such studies in the past [29].

The overall reliability of the questionnaire during this study was 0.87. A reliability value above 0.6 is adequate to accept the research instrument's internal consistency [30, 31]. Therefore the high reliability value above 0.6 showed that the questionnaires were good for analysis.

3.2. Socio-economic Status of Smallholder Potato Farmers

This section provides the results of the socio-economic profiles of the smallholder Potato farmers including age, household size, gender, level of education, and occupation.

A summary statistics showing the mean age and household size is shown in Table 4.

Table 4. Socio-demographic characteristics of the small-holder potato farmers.

	Mean	Std. Dev.	Min.	Max.
Age	36.5	10.3	21	63
Household size	4.76	1.87	1	9

Source: Author's computation Survey Data (2024)

The results indicate that the mean age of smallholder potato farmers in Marakwet West Sub-county was 36.5 ± 10.3 years, suggesting that most farmers were middle-aged and within the economically active population [32]. This finding aligns with similar studies in Kenya [33-37], where the average age of smallholder potato farmers ranges between 36 and 39 years (e.g., Gilgil, Mauche Ward, Bomet County). Comparable age profiles have also been reported in neighboring African countries (e.g., Nigeria, DR Congo, Rwanda, Ethiopia; and Zimbabwe [38-45]). The average household size was 4.76 ± 1.87 members, which is consistent with the national rural household average of about 5 members in Kenya and similar potato farming households in Nyandarua, Bomet, and Baringo Counties [35-37]. This suggests that family labor is likely an important resource for smallholder potato farming in the area.

The result on Table 4 on household size indicates that there were 4.76 ± 1.87 members in each family, where the minimum number was 1 and maximum of 9 members. The current result largely concurs with the provincial and national average family size of 5 members in Kenya [46]. The current study also compares well with household size of potato farmers across various region in Kenya, such as 5.39 ± 5.14 members in Bomet County [19], 5.3 ± 0.7 members in Nyandarua [20], and 4.69 members in Mumberes, Baringo County [47]. The mean number of 4.78 members in each household compares well with household sizes in other countries in Africa such as 5.0 members in Nyanga District Zimbabwe [44] and Musanze Rwanda [45].

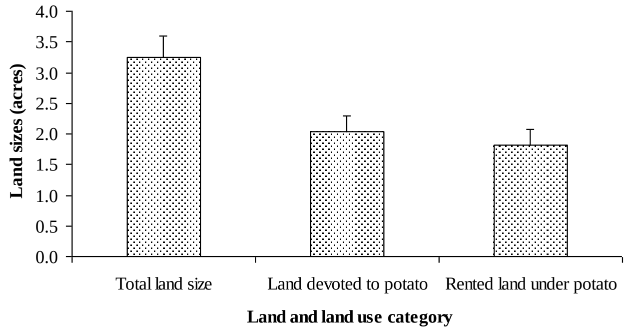
Results of the gender, level of education and main economic activities in the household of the smallholder Potato farmers in Marakwet West Sub-county is shown in Table 5.

Table 5. *Gender, level of education and position in the household of the small-holder Potato farmers in Marakwet West Sub-county.*

Attribute	Frequency	%
Gender		
Male	208	63.8
Female	118	36.2
Total	326	100
Level of education		
Primary	144	44.2
Secondary	120	36.8
Tertiary	54	16.6
University	8	2.5
Total	326	100
Main economic activities		
Crop farming	240	73.6
Keeping cattle	262	80.4
Trading activities	134	41.1
Formal employment	88	27
Total	724/326*	-

*Number is over 326 due to overlapping activities
Source: Author's computation Survey Data (2024)

The findings show that 63.8% of household heads were male and 36.2% were female, which is typical for smallholder farming systems in Kenya and aligns with regional studies indicating male dominance in decision-making and land ownership. Comparable gender distributions have been reported in other potato producing regions within Kenya and Sub-Saharan Africa. In terms of education, most farmers had attained only primary (44.2%) or secondary (36.8%) education, with a small proportion (16.6%) having tertiary education and just 2.5% having university education. This limited level of formal education may influence awareness and adoption of improved farming practices and access to subsidy programs. Regarding economic activities, potato and crop farming (80.4% and 73.6% respectively) were the main livelihoods, with many households also involved in livestock keeping, small-scale trading (41.1%), and some formal employment (27%). This pattern suggests that potato farming is a primary source of income, supported by mixed farming and petty trade to diversify household income.



Source: Author's computation Survey Data (2024)

Figure 1. *Attributes of land sizes among respondents.*

Land size devoted to potato farming was 2.04 ± 0.7 ha (62.9 ± 12.6%). These are consistent with 2.3 ± 0.6 acres of land used for farming Potatoes in Molo Sub-county [35], 2.3 acres for potato in Bomet County [36], 1.8 ± 0.8 acres in Nyandarua North [48]. The current 2.0 acres dedicated to potato farming are similar to 1.9 acres for potato farming in Guinea [49]. However, the current 2.0 acres differ from those found in other African countries such as 1.0 acres or less dedicated to potato farming in South Kivu Province, DRC [39], 0.52 acres put aside for potato farming in the Arid Oromia District of Ethiopia [42], and 1.5 acres dedicated to potato farming in Musanze, Rwanda [45].

A total of 1.8 acres (56.5%) was hired by the smallholder farmers for potato farming. Hiring or renting of land for potato production is common in Kenya and the current land size hired for potato farming are consistent with other studies such as 23% of farmers hiring land for potatoes farming in Western Kenya [50].

3.3. Descriptive Statistics Results for Fertilizer Subsidies

Results showing smallholder farmers access to fertilizers and the frequency is shown in Table 6.

Table 6. *Frequency of receiving subsidized fertilizers per year among the small-holder farmers.*

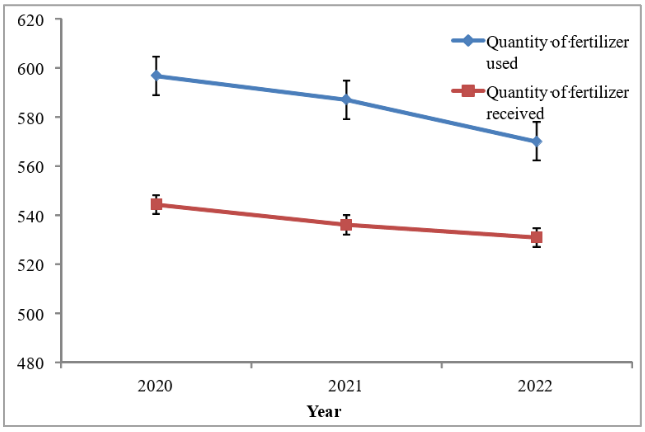
Attribute	Frequency	%
Received fertilizers		
Yes	189	58
No	137	42
Total	326	100
Frequency of receiving subsidized fertilizers		
None	137	42
Once	159	48.8
Twice	30	9.2
Total	326	100

Source: Author's computation Survey Data (2024)

According to the results in Table 6, majority of the smallholder farmers (58.0%) received fertilizer subsidies while 42% did not received any subsidized fertilizers. The current result suggests access to subsidized fertilizers by the farmers. The current study concurs with another study in Trans Nzoia where 51% of farmers accessed subsidized fertilizers [51]. In a survey of fertilizers use in Kenya in 2016 [52], the imported fertilizers benefited 400,000 to 650,000 farmers and majority of the fertilizers were supplied in the North Rift region where the bulk of agricultural activities in Kenya is based. Such supply increases the chance of the most farmers benefiting from the subsidies. The current results also agree with several studies in Kenya where higher number of farmers reported receiving fertilizers subsidies such as a survey conducted in Kenya between 2018 and 2023 [53-55], which reported that the government subsidy programme targeted 55% of farmers in the North Rift Region and indeed confirm that 56% of the smallholder farmers received fertilizer subsidies. The current 58% access to subsidized fertilizer is higher than the Kenya national average of 40% small scale farmer access to subsidized fertilizers based on a survey between 2018 and 2023 as well as higher than 15.6% subsidized fertilizer access among small scale farmers in the North Rift region in 2016.

The results of the frequency of receiving subsidized fertilizers indicated that 48.8% of the smallholder farmers received subsidized fertilizers once, while 9.2% received subsidized fertilizers twice. Considering that there are two planting season every year in the study area, these results indicate that majority of the farmers did not receive the subsidized fertilizers whenever they were about to plant Potatoes but the subsidy was provided once every year prior to major planting season. This concurs with another study in the neighboring Trans-Nzoia County, where most of the fertilizers subsidies were provided once. In a survey conducted in Kenya in 2016 [52], the importation of fertilizers was done by 18 companies but the distribution targeted the major planting season in the year when there is long rainy season. Most of the fertilizer subsidy programmes targeted maize farmers (45%) compared to Potato farmers (3%) and therefore it is not surprising that most of the subsidized fertilizers were received once which coincided with the onset of maize planting season.

The quantity of fertilizer (kgs) used and received by smallholder farmers in 2020, 2021 and 2022 planting seasons is shown in Figure 2.

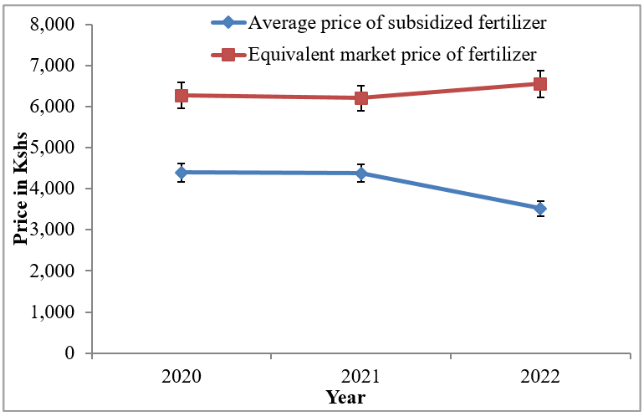


Source: Author's computation Survey Data (2024)

Figure 2. *Quantities of fertilizer (kgs) used and received by smallholder farmers in 2020, 2021 and 2022 planting seasons.*

The results in Figure 2 indicate that over the three years period, farmers used an average of 584.8 kg bags of fertilizers (about 11 to 12 50-kg-bags), but received 537 kg (about 10-11 50-kg-bags) of subsidized fertilizers per household. The ratio of subsidized fertilizer received/subsidized fertilized used translate to 91% availability of subsidized fertilizer. While fertilizer demand in Kenya in 2020/21 was 600,000 to 800,000 metric tons, the amount of imported fertilizers over the same period was 820,000 metric tons [56], which means most of the fertilizers demanded by the farmers were supplied. In 2023, Elgeyo-Marakwet County received 125,000 bags of subsidized fertilizers (NCPB 2023) and through County Government initiative, further subsidized the fertilizers which availed most subsidized fertilizers to most farmers in the region. The recommended fertilizer use is 500 kg/ha for planting and top dressing, which implies that if potato was the only crop being planted by farmers, the current fertilizer quantities were adequate. However, the fertilizers used including the subsidized fertilizers were also used in other crops such as maize and may be limiting in potato farming.

The average and equivalent market prices of subsidized and retail market fertilizers in 2020, 2021 and 2022 planting seasons is shown in Figure 3.



Source: Author's computation Survey Data (2024)

Figure 3. *The average and equivalent market prices of subsidized and retail market fertilizers in 2020, 2021 and 2022 planting seasons.*

The average price of subsidized fertilizer received fluctuated between the years ranging from an average of Kshs 4,395 ± 176 in 2020, Kshs 4,380 ± 183 in 2021 and reducing to Kshs 3,520 ± 145 in 2022. The price of subsidized fertilizers made them to be 36% cheaper than fertilizers sold in retail market. The current price of subsidized 50-kg bag of fertilizer was higher than the prices reported among farmers in Kirinyaga County of Kshs 2,500 [57]. However, the price of 50-kg bags of fertilizer in the open market was stable ranging between Kshs 6,273 ± 142 in 2020, 6,273 ± 241 in 2021 and Kshs 6,556 ± 233 in 2022. The current market price of 50-kg bag of fertilizer was higher than Kshs 5,500 reported in Kirinyaga County.

The type of subsidized fertilizers received by the small holder farmers is provided in Table 7.

Table 7. *Attributes of the subsidized fertilizers among the small holder farmers.*

Attributes	Frequency	Percent
NPK	178	94.2
Urea	3	1.6
Both NPK and urea	8	4.2
Total	189	100

Source: Author's computation Survey Data (2024)

The result in Table 7 indicate that majority of the farmers (94.2) received NPK fertilizers, followed by both NPK and Urea (4.2%). According to a survey conducted in Kenya in in 2021/22, the fertilizers imported in Kenya were 34% DAP, 32% NPK and 18% CAN [58, 59]. In another survey conducted in 2023 [54], it was shown that imported fertilizers in Kenya were DAP (60,000 bags), NPK (54,000 bags) and Urea (51000 bags). These fertilizer import statistics indicate that there is higher demand for DAP and NPK fertilizers. However, most of the DAP are heavily used in maize farming leaving NPK available for what farmers describe as 'lesser crops' like potatoes. NPK fertilizer also has the major nutrient components required for uptake by plants. However, the current study differed with another study conducted in North-Western Kenya among potato farmers [55], where the authors found that most farmers (64%) used diammonium phosphate (DAP; 18-46-0) at planting during both rainy seasons, 32% used NPK, 21% using CAN and 8% using urea (20%).

3.4. Descriptive Statistics Results for Seed Subsidies

The results showing receipt and frequency of receiving subsidized Potato seeds among the smallholder potato farmers is presented in Table 8.

Table 8. *Frequency of receiving subsidized seeds among the small holder farmers.*

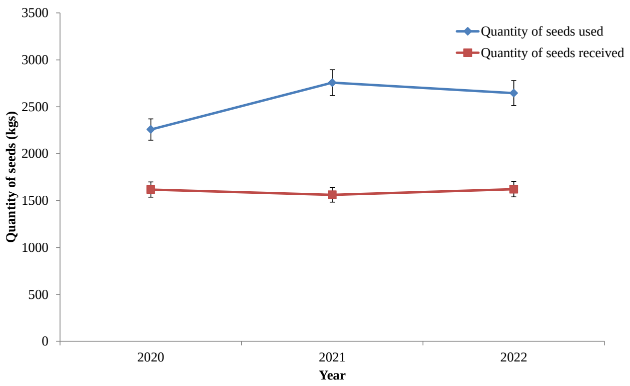
Attribute	Frequency	Percent
Received subsidized seeds		
Yes	271	83.1
No	55	16.9
Total	326	100
Frequency of receiving subsidized seeds		
None	55	16.9
Once	204	62.6
Twice	67	20.6
Total	326	100

Source: Author's computation Survey Data (2024)

According to the results in Table 8, majority of the smallholder farmers (83.1%) received subsidized Potato seed and a paltry 16.9% did not. The current result suggests that most of the farmers in the study area received subsidized Potato seeds. The current results compare well with a study conducted in Lelan Ward (Marakwet West Sub-county), where 70% of the farmers indicted that they planted subsidized Potato seeds [56]. Most of these potato seeds were obtained from several dealers who liaised with the county Government of Elgeyo Marakwet to supply seeds and most of these dealers sell subsidized Potato seeds. Result of the current study also concurs with another study in Trans Nzoia where 51% of farmers accessed subsidized fertilizers [58]. The high access to subsidized seeds is associated with the cooperation between the county government of Elgeyo Marakwet and seed suppliers to help the farmers access subsidized seeds. The current study also concurs with another study in the Gicumbi District in Rwanda [40], where farmers attested that they received subsidized Potato seeds.

Majority of the respondents (62.6%) received seed subsidy once, followed by those who received seed subsidy twice (20.6%). The seeds are supplied to farmers during planting seasons which coincide with the long rainy season when the demand for the seeds are high and therefore most farmers are likely to get the subsidized seeds during the planting season. In the county and region, most of the Potato farming occur twice a year similar to another study among smallholder potato farmers in Molo Sub-county [35]. However, during the short rainy season, not many seed suppliers sell the subsidized seeds because of uncertainty of the harvest from the short rainy season. In another study conducted in the neighboring Trans Nzoia County, 84% of the farmers planted Potato twice each year, during long rainy season, most of the farmers (63%) received the subsidized Potato seeds [51] while during short rainy season only 34% received subsidized Potato seeds.

Results of the quantities of seeds (kgs) used and received by small-holder Potato farmers in 2020, 2021 and 2022 planting seasons are provided in Figure 4.



Source: Author’s computation Survey Data (2024)

Figure 4. *Quantities of seeds (kgs) demand, received and used by small-holder farmers in 2020, 2021 and 2022 planting seasons.*

The results in Figure 4 indicate that over the three years period, farmers used an average of 2453 kgs (51 50-kg-bags of seeds) but received 1600 kg (36 50-kg-bags). The current results indicate that farmers received 72% of the demanded subsidized Potato seeds. In another study conducted in the neighboring Trans Nzoia County, 70% of the farmers indicted that they received between 60 to 70% of their Potato seed in form of subsidized seeds [51]. Meanwhile in Nyandarua, a study on the use of subsidized inputs by farmers indicated that farmers received up to 54% of their seeds through subsidized programmes.

The price of subsidized Potato seeds in 2020, 2021 and 2022 planting seasons are shown in Table 9.

Table 9. *Average price of subsidized and retail market Potato seeds in the 2020, 2021 and 2022 planting seasons.*

Year	Average price of seed received	Equivalent market price of fertilizer
2020	3,097 ± 514	4,554 ± 177
2021	3,112 ± 354	4,780 ± 277
2022	3,184 ± 234	4,333 ± 182
Average	3,131 ± 385	4,556 ± 224

Source: Author’s computation Survey Data (2024)

The average price of subsidized potato seeds averaged of Kshs 3131 over three years being 3,097 in 2020, Kshs 3,112 in 2021 and Kshs 3,184 in 2022. Meanwhile the price of 50-kg bags of seeds in the open market was on average Kshs 4556, and ranged from Kshs 4,554 in 2020, 4,980 in 2021 and Kshs 4,333 in 2022. The current results indicate that subsidized Potato was sold at 68% of the retail price (32% cheaper) of Potato in the region. The government subsidy programme was aimed at ensuring that fertilizers are sold at Kshs 2500, however, even with the subsidy programme it seems that some of the dealers are still selling the subsidized seeds way above the recommended Kshs 2500 price per bag.

The main type of subsidized Potato seed purchased by the small-holder farmers in the study area is shown in Table 10.

Table 10. *Types of subsidized potato seed subsidies among the small holder farmers.*

Attribute	Frequency	%
Certified seeds	251	77
Apical cuttings	34	10.4
Local variety	41	12.6
Total	326	100

Source: Author’s computation Survey Data (2024)

The results shows that certified potato seeds was obtained by most farmers (77%), followed by local variety (12.6%) and least was genetically modified (10.4%). This could be possible because these seeds are provided to farmers by the County Department of Agriculture in Marakwet West Sub-county. The current study also compares with the study in Lelan where farmers accessed certified seeds.

The types of subsidized potato seed is shown in Table 11.

Table 11. Types of subsidized potato seed among the small holder farmers.

Potato variety grown	Frequency	%
Shangi	292	89.6
Tigoni	17	5.2
Alka	17	5.2
Total	326	100

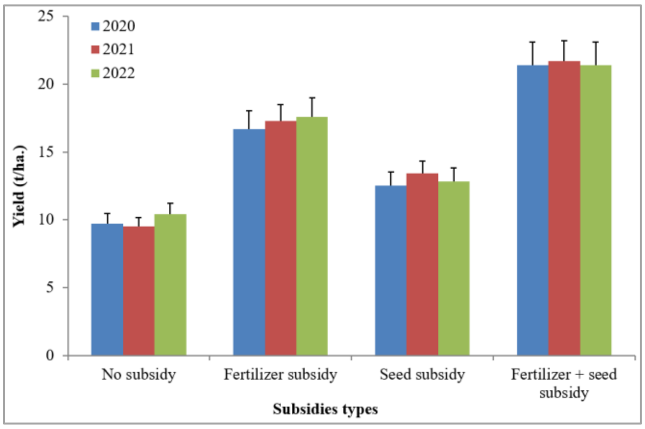
Source: Author's computation Survey Data (2024)

The results of the study indicate that majority (89.6%) of the farmers planted Shangi variety, followed by Tigoni (5.2) and Alka (5.2%). The current results are in agreement with another study in Molo Sub-County, Kenya [35], where majority (96.7%) of the respondents use Shangi. In another study conducted in Lelan Marakwet West, 100% of respondents obtained Shangi [55].

3.5. Descriptive Statistics Results for Potato Production

The yield of potatoes (kgs) from fertilizer subsidies, seed subsidies and fertilizer + seeds subsidies among small-holder farmers in 2020, 2021and 2022 is shown in Figure 5.

The current study indicate that the potato yield 9.8 t/hectare was achieved without subsidies, 17.1 t/ha with fertilizer subsidies, 12.9 t/ha with seed subsidies and finally 21.8 t/ha with fertilizer and seed subsidies. The current results compare with another study in Kenya [43, 58, 59], where the yield was 19.12 t/ha. Potato yield in Uasin Gishu was 2609 kg/ha (21 50-kg bag) [60]. The current production levels of potato is lower than 126.8 of 50-bags in Western Hararghe Zone, Ethiopia [61], 68.2 50-kg-bags in arid area of in the Arid Oromia District of Ethiopia [42] and 143.5 of 50-bags in Wolaita zone, southern Ethiopia [61]. In another study conducted in southern Ethiopia, [62] reported an average yields of 16.6 t ha^{-1}.



Source: Author's computation Survey Data (2024)

Figure 5. Yield parameters from fertilizer subsidies, seed subsidies and fertilizer + seeds subsidies among small-holder farmers in 2020, 2021and 2022.

3.6. Estimates of the Influence of Agricultural Input Subsidy on Potato Production

The study's first objective sought to determine the influence of agricultural input subsidy on Potato production in Marakwet West Sub-County, Kenya. The estimated results on the effects of agricultural input subsidies on potato production are shown in Table 12. As shown in table of the result, the value of R-Square indicates the goodness of fit of the linear regression. R-square and Adjusted R Square values are 0.733 and 0.714 respectively which means that 71.4% of the total variation in the dependent variable (potato production) was attributed to the subsidies while the remaining 28.6% lies within the error term in the regression model for this study.

ANOVA test was conducted to test the significance of the relationship between the independent variables (input subsidies) and dependent variable (Potato production) by predicting the power of the model with that of an intercept-only model [63]. The results established from the ANOVA test in Table 12 shows that the *P*-value is <0.01. This indicates a statistical significant relationship between potato production and input subsidies.

Table 12. Multiple Linear Regression Model showing the relationship between potato production (t/ha.) and subsidies.

Regression Statistics	
Model summary	
Multiple R	0.856
R Square	0.733

Adjusted R Square	0.714				
Observations	326				
Standard Error	0.9581				
ANOVA	SS	df	MS	F	*P*-value
Regression	367.466	10	36.747	15.633	<0.01
Residual	134.009	315	2.351		
Total	501.474	325			
	Unstandardized Coefficients		Standardized Coefficients	t Stat	*P*-value
	Beta	Std. Error	Beta		
(Constant)	2.798	0.899		3.111	0.002
Received subsidized fertilizer	0.956	0.182	0.320	5.246	0.000**
Quantity of subsidized fertilizers	0.679	0.301	0.205	1.769	0.000**
Received subsidized seeds	0.853	0.281	0.268	4.461	0.000**
Quantity of subsidized seeds	0.481	0.201	0.191	2.425	0.000**
Type of subsidized seeds	0.180	0.108	0.076	1.661	0.099
Received subsidized fertilizers and seed	1.315	0.751	0.345	4.415	0.000**

* = significant at 1% level and **=significant at 5%
Source: Author's Computation from Survey Data (2024)

The regression results clearly demonstrate that specific attributes of agricultural input subsidies significantly influence potato production in Marakwet West Sub-County. Notably, the receipt and quantity of both fertilizer and seed subsidies had positive and significant effects at the 1% level. This implies that beyond simply providing subsidies, the actual volume of subsidized inputs received by farmers is a key driver of production increases.

Practically, the positive coefficient for quantity of subsidized fertilizers (β = 0.679) suggests that for each additional unit (e.g., a 50 kg bag) of subsidized fertilizer received, there is an associated increase of approximately 0.679 tons per hectare in potato production, holding other factors constant. This finding has clear policy relevance: subsidy schemes should emphasize not only access but also sufficient quantities per household, ideally calibrated to farm size. Extension officers and subsidy program managers should therefore assess the typical acreage under Potato cultivation per household and ensure that fertilizer packages align with agronomic recommendations for optimal yield response.

Similarly, the significant effect of subsidized seed quantity (β = 0.481) indicates that increasing the amount of quality seed provided per farmer could boost yields by about 0.481 tons per hectare per additional unit. This reinforces the need for government and county input support programs to bundle adequate quantities of certified seed together with fertilizer support, rather than distributing them in isolation or in small, fragmented packages.

Conversely, some variables such as the frequency of receiving subsidies or the price paid for subsidized inputs were statistically insignificant. For example, the number of times a farmer received a fertilizer or seed subsidy did not significantly affect production outcomes. This suggests that repeated, smaller disbursements spread over time may not be as impactful as single, adequately-sized disbursements that match cropping calendars and recommended input rates. Policymakers should therefore consider refining the design of subsidy schemes to focus more on adequacy and timing of input delivery rather than merely frequency of access.

The combined effect of receiving both fertilizers and seeds together (β = 1.315) further highlights the synergistic benefit of an integrated subsidy package. Farmers who accessed both inputs simultaneously experienced the highest gains, implying that coordinated input support is more effective than piecemeal approaches. Therefore, policy frameworks should prioritize integrated subsidy models that deliver fertilizer and seed inputs in a timely, complementary manner to fully exploit yield potentials.

Overall, these findings reinforce the policy argument that well-targeted, adequately-sized, and integrated input subsidy programs can contribute significantly to improving potato productivity among smallholder farmers in Marakwet West and similar agro-ecological contexts.

4. Conclusions

This study established that a majority of smallholder farmers (58%) in Marakwet West Sub-County benefited from fertilizer subsidies, while 42% did not receive any subsidized inputs. Most recipients accessed subsidized fertilizers only once (48.8%), with a smaller proportion benefiting twice (9.2%). On average, farmers used about 585 kg of fertilizer but received about 537 kg through subsidies, at an average subsidized price of Kshs 4,395 per 50-kg bag. The vast majority (94.2%) received NPK fertilizers. Regarding seeds, 83.1% of farmers received subsidized Potato seeds, mainly once (62.6%) or twice (20.6%). On average, each farmer used 2,453 kg of seed, with 1,600 kg obtained through subsidies. The average price for subsidized potato seed was Kshs 3,131 per 50-kg bag, compared to Kshs 4,556 in the open market. Most farmers (77%) used certified seed, predominantly planting the Shangi variety (89.6%).

The regression results confirmed that agricultural input subsidies significantly improved Potato yields ($R^2 = 0.714$, $p < 0.01$). Specifically, receipt and quantity of subsidized fertilizers and seeds all showed strong positive effects on yields. Overall, the study concludes that fertilizer and certified seed subsidies enhanced potato yields, increased profitability, and promoted the adoption of improved agricultural practices among smallholder farmers in the study area.

5. Recommendations

1) Improve Access and Targeting: The government and development partners should strengthen strategies for rolling out and targeting agricultural input subsidies to reach more smallholder farmers, with a focus on clear enrolment criteria and transparent distribution channels.
2) Integrate Potatoes in Formal Subsidy Programs: Potatoes should be formally included in national subsidy frameworks alongside other staple crops to ensure sustained input support for Potato farmers in regions like Marakwet West.
3) Time Distribution Strategically: Input distribution should be aligned with the agricultural calendar to ensure that fertilizers and seeds reach farmers well ahead of planting seasons, improving timely land preparation and planting.
4) Enhance Monitoring and Equity: Establish robust monitoring, evaluation, and feedback mechanisms to ensure that subsidies reach the intended beneficiaries, reduce leakages, and address inequalities in subsidy access.
5) Invest in Research and Seed Development: The government should also invest in research to develop and promote high-yielding, drought- and disease-resistant potato varieties suitable for local conditions, to further boost productivity and resilience.

Abbreviations

NPK	Nitrogen, Phosphorus, and Potassium (Compound Fertilizer)
Kshs	Kenya Shillings
NGO	Non-Governmental Organization
R^2	Coefficient of Determination
β	Standardized Regression Coefficient
FAO	Food and Agriculture Organization
MoALD	Ministry of Agriculture, Livestock and Fisheries Development
GDP	Gross Domestic Product
SSA	Sub-Saharan Africa
SHF	Smallholder Farmer
M&E	Monitoring and Evaluation

Acknowledgments

The authors thank the farmers from Marakwet West Sub-county for volunteering to respond to the questionnaires.

Author Contributions

Ben Kibor: Conceptualization, Investigation, Formal Analysis, Writing – original draft, Writing – review & editing

Linnet Gohole: Conceptualization, Writing – original draft, Data curation, Methodology, Investigation, Supervision, Writing – review & editing

Chemwok Philip: Supervision, Data curation, Methodology, Investigation Writing – original draft, Writing – review & editing

Funding

This work is not supported by any external funding.

Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Biography

Ben Kibor is currently pursuing a Master of Science in Agricultural Education and Extension at the University of Eldoret (Kenya), having successfully completed BSc in Agricultural Extension from the Egerton University in 2014. Recognized for his exceptional contributions, Mr. Kibor worked for 13 years as an extension officer in State Department/Ministry of Agriculture Livestock and Fisheries from 2010 to date. Currently he works at the Elgeyo-Marakwet County as the County Project Coordinator for Food Systems Resilience Project. He is a dedicated agricultural professional with a strong background in Agricultural Extension and Education. This background, has equipped him with the skills to effectively communicate, disseminate, and implement sustainable farming practices among rural communities. Moreover, he has a passion for improving the livelihoods of smallholder farmers through participatory approaches, capacity building, and community-based agricultural development. His strengths lie in training delivery, farmer empowerment, and mobilization of local resources to support agricultural transformation.

Linet Gohole Prof. Linet Gohole is a dedicated lecturer and researcher in Resource Conservation with a specialization in Agricultural Entomology at the University of Eldoret, Kenya. With a strong academic background in entomology and sustainable agriculture, Prof. Gohole focuses on integrated pest management, biodiversity conservation, and ecological approaches to crop protection. He/she has contributed significantly to research on beneficial insect biodiversity, pest dynamics in agro-ecosystems, and the role of indigenous knowledge in sustainable pest control. She is actively involved in training students and farmers on environmentally friendly pest management strategies and has published in reputable peer-reviewed journals. Passionate about sustainable agriculture and climate-smart practices, Prof. Gohole collaborates with national and international stakeholders to promote resilience in smallholder farming systems. At the University of Eldoret, she also mentors postgraduate students and participates in curriculum development aimed at addressing current challenges in agricultural production and natural resource conservation.

Philip Chemwok Dr. Philip Chemwok is a Lecturer in the School of Agriculture and Natural Resources at Moi University in Eldoret, Kenya. Dr. Philip Chemwok is a dedicated academic and researcher at Moi University's School of Agriculture and Natural Resources in Eldoret, Kenya. With a strong foundation in agricultural sciences, he focuses on enhancing sustainable farming practices and natural resource management. Dr. Chemwok is actively involved in teaching, mentoring students, and conducting research that addresses the challenges faced by smallholder farmers in Kenya. His work emphasizes the integration of scientific knowledge with practical applications to improve agricultural productivity and environmental conservation. Through collaboration with local communities and stakeholders, Dr. Chemwok contributes to the development of innovative solutions aimed at achieving food security and sustainable development. His commitment to excellence in education and research has made him a valuable asset to Moi University and the broader agricultural sector in Kenya.

Research Field

Ben Kibor: Agricultural Extension and Education, Financial Management, Data Analytics, Procurement, Agriculture Production Technology, Environmental and Social safeguards.

Linet Gohole: Production Ecology, Agricultural, Resource Conservation (Agricultural Entomology), Extensions and Education, Data Analytics, Procurement, Financial Management, Accounting, Agriculture Production Technology.

Philip Chemwok: Agricultural Extensions and Education, Financial Management, Data Analytics, Procurement, Environmental Conservation, Human Resource Development, Agriculture Production Technology.