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EFFECT OF COMMERCIALIZATION ON INPUT USE AMONG SMALLHOLDER PRE-COOKING BEAN AGRIPRENUERS IN KENYA

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ABSTRACT: *Agricultural commercialization is a strategy that has been adopted to enhance input use among smallholder farmers in order to increase productivity. This paper determines the effect of commercialization on input use among smallholder pre-cooking bean agriprenuers in Kimilili Sub-County, Kenya. Cross-sectional data were collected from 413 smallholder pre-cooking bean farmers through an interview using a semi-structured questionnaire. Double-Hurdle model was used for analysis. Findings revealed that receiving a subsidy and owning livestock reduced the probability of buying chemical fertilizer at 1% and 5% significance levels, respectively. However, owning a farm store increased the buying probability at 1% significance level. Education, land size, intercropping, and owning a transport facility increased values of chemical fertilizer bought. However, receiving a subsidy reduced the value bought at 1% significance level. Commercialization specifically through input subsidy has a significant negative effect on input use. The study recommends a swift from direct price support to market-enabling strategies like road network and storage facility improvements.*

KEYWORDS: Chemical fertilizer, Commercialization, Double Hurdle, Effect, Pre-cooking bean.

INTRODUCTION

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Agricultural commercialization that is increased interaction by farm households with input and output markets has been promoted among smallholder farmers to improve their welfare. Commercialization is assumed to ease access to agricultural inputs by making them available in markets (Assefa *et al*., 2024). It has both positive and negative effects on input use. Commercialization can lead to increased input use as farmers strive to produce more crops and livestock for sale. It can also lead to more efficient input use as farmers adopt new technologies and management practices to reduce costs and improve profits. Kimani *et al*. (2021) found that farmers who engaged in commercial farming used more fertilizer and pesticides than farmers who were engaged in subsistence farming. The adoption of high-yielding crop varieties led to increased input use (Ogada *et al*., 2022). Similar findings have been reported by Adepoju *et al*. (2021), who found that agricultural commercialization in Nigeria led to increased input use and productivity of smallholder farmers. Additionally, Chinsinga and Kachule (2020) found that agricultural commercialization in Malawi led to increased input use.

Similarly, Teklewold *et al.* (2022) found that agricultural commercialization in Ethiopia led to increased input use. Commercialization can lead to more efficient input use. For example, Karanja *et al*. (2020) found that the introduction of integrated pest management led to a reduction in pesticide use without sacrificing crop yields. Another study by Mutiso *et al*. (2023) found that the development of slow-release fertilizers led to a reduction in fertilizer use without sacrificing crop yields. Past studies have documented how input use affected market participation paying no attention to the possible effect of commercialization on input use. Participation by farmers in the input market plays a vital role of exposing them to a variety of recommended input brands that they can choose from. This affects the amount of inputs that the farmers use in the crop production process. This study determined the effect of pre-cooking bean commercialization on input use. The research question of this paper is how does pre-cooking bean commercialization affect input use among smallholder agriprenuers in Kimilili Sub-County, Kenya? The next sections of the paper give theoretical underpinning, methodology, followed by results, discussions, implications to research and practice, conclusion, future research and finally references.

THEORETICAL UNDERPINNING

This paper is grounded on an agricultural farm household theoretical model, specifically the Non-Separable Model (Singh *et al*., 1986). The model is used because it better reflects reality in developing countries like Kenya, particularly for semi-subsistence smallholder farmers. It posits that, market failures and transaction costs exist, production and consumption decisions are interdependent and input use is also determined by household preferences, endowments like family labor, and wealth. Under this model farmers are producers and at the same time consumers of their products. They produce products using inputs produced on the farm and sourced from the input markets. Their participation in the market is expressed as:

$$PS = f(MS, TC, HC, IF) \quad (1)$$

Where: PS is the proportion of sales (commercialization), MS is the marketed surplus, TC is the transaction costs, HC is Household characteristics, and IF institutional factors.

METHODOLOGY

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Research design

This study used a survey research design. Surveys are used for descriptive, explanatory and exploratory research. This study is exploratory. Therefore, the survey research design was the most suitable design to answer the research question of this paper.

Study area

The study was conducted in Kimilili Sub-County, Bungoma County, Kenya. The study area was selected since it was one of the Sub-Counties in Bungoma County where governments and Non-governmental organizations encouraged smallholder farmers to commercialize their farm activities. Pre-cooking bean commercialization was promoted in the Sub-County for several reasons: to reduce high levels of protein and micronutrient deficiencies as the bean is rich in iron, zinc and other micronutrients; to increase productivity because it is high yielding; to improve farmers' income since the bean has a relatively higher market price, demand and is preferred by processors. Kimilili Sub-County's geographical coordinates are 0° 45' 0" North, 34° 43' 0" East. The Sub-County covers an area of 181.20 Km^2 divided into two divisions; Kimilili 94.00 Km^2 and Kamukuywa 87.20 Km^2 each having two wards. Kimilili division has Kibingei 51.90 Km^2 and Kimilili 42.10 Km^2 wards, while Kamukuywa has Maeni 41.00 Km^2 and Kamukuywa 46.20 Km^2 wards (GOK, 2023). The map of the study area is shown in Figure 1.

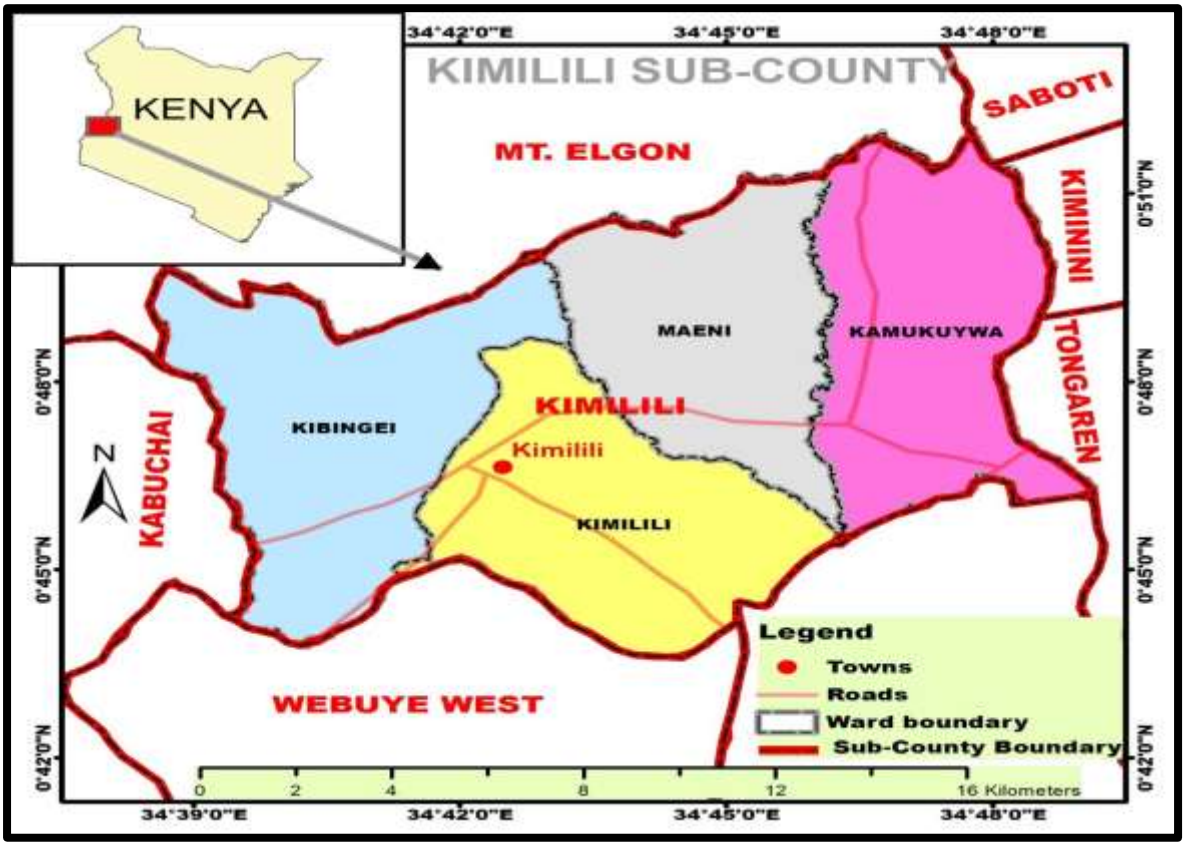

Figure 1: Map of the study area.
Source: *World Resource Centre (2022).*

Sampling procedure

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The target population of this study was smallholder pre-cooking bean agriprenuers in Kimilili Sub-County, Kenya. A multistage sampling procedure was used to obtain the required sample. In the first stage, Kimilili Sub-County was purposively selected because it is among the Sub-Counties of Bungoma County where pre-cooking bean production and commercialization had been promoted. In the second stage, all four County assembly wards were considered. Based on information about pre-cooking bean production quantities from the ward Ministry of Agriculture offices, Kibingei Sub-Location was selected from Kibingei ward; .Kimilili rural Sub-location from Kimilili ward; Sikhendu Sub-Location from Maeni ward and Nabikoto Sub-Location from Kamukuywa ward were selected. A simple random sampling technique was used to select the respondents from each Sub-location proportionate to their smallholder precooking bean farmers' population sizes.

Sample Size determination

The required sample size was determined using proportionate to the number of households sampling methodology adapted from Anderson *et al*. (2007):

$$n = \frac{pqZ^2}{E^2} \tag{2}$$

Where; n= Desired sample size; Z= confidence level (α=0.05); p= proportion of the target population containing the major interest q; q= 1-p; E= allowable error. Since the proportion of the population was not known, p=0.5, q=1-0.5=0.5, Z=1.96 and E=0.05 (Fisher *et al*., 1991).

The sample size, was calculated as;

$$n = \frac{(0.5)(0.5)(1.96^2)}{(0.05)^2} = 384$$

Smallholder precooking bean agriprenuers (3)

The number of pre-cooking bean agriprenuers who were interviewed was 415. However, two questionnaires were incomplete so data from them were not considered for analysis bringing the sample size to 413.

Data Collection methods and sources

A semi-structured questionnaire was the tool used for data collection. A pilot survey was carried out in Webuye West Sub-County to assess the validity and reliability of the data collection tool before using it. Primary data was collected from smallholder pre-cooking bean agripreneurs through face-to-face interviews. The data collected from the questionnaire were managed using STATA Version 2017 software.

Analytical Framework

The research question for this paper was: how does pre-cooking bean commercialization affect input use among smallholder agriprenuers in Kimilili Sub-County, Kenya? A Double Hurdle Model (DHM) developed by Cragg (1971) was used for analysis. The model was appropriate because the dependent variables were two: participation in the input market, which was binar,y andthe value of input (chemical fertilizer) purchased for use in pre-cooking bean production, which was continuous. Double Hurdle models the farm households' decision on input

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commercialization and value of variable inputs purchased as a two-tier decision. In the first tier, farm households decided whether or not to participate in the pre-cooking bean inputs market as buyers. Conditional on that decision being positive, they decided on the quantity of variable inputs (chemical fertilizer) to buy for use in pre-cooking bean production in the second tier (Burke, 2009). The first tier was a binary decision, expressed as:

$$d_i^* = \alpha x_i + \mu_i; \quad \mu_i \sim N(0,1) \text{ and } d_i = \begin{cases} 1 if\ d_i^* > 0 \\ 0 otherwise \end{cases} \tag{4}$$

Where the subscript *i* =the respondent of the *i*th farm household. d_i^* = a latent variable for d_i .When $d_i = 1$, the respondent bought chemical fertilizer to use in pre-cooking bean production, while $d_i = 0$ indicated no chemical fertilizers were purchased. The decision on the value of chemical fertilizers bought for use in precooking bean production is expressed as:

$$Y_i^* = \beta Z_i + V_i; \quad v_i \sim N(0, \sigma^2) \text{ and } Y_i = \begin{cases} Y_i^* if\ Y_i^* > 0 and\ d_i = 1 \\ 0 otherwise \end{cases} \tag{5}$$

Where Y_i^* = a latent variable for Y_i which represents the observed value of chemical fertilizers used by the household *i*. In equations 4 and 5, χ_i and Z_i = vectors of explanatory variables, which contain the same variables. α and β = vectors of parameters to be estimated, while μ_i and V_i = random error terms. The variables that were used in this analysis are presented in Table 1.

Table 1: Variables used to determine the effect of pre-cooking bean commercialization on inputs use

Variable	Variable description and measurement	Expected sign
Dependent variables		
Input comm	Buying of variable inputs-Binary(1=Yes, 0=No)	
Variable input value	Value of variable inputs bought -Continuous(Number)	
Independent variables		
schooling years	Years spent in formal schooling -continuous(Number)	+/-
In the Land size	Log of land size -continuous(Number)	+/-
Land ownership	Land ownership type-Binary(1=Titled,0=No Title)	+/-
Intercropping	Intercropping in main season -Binary(1=Yes,0=No)	+/-
Subsidy received	Whether the agriprenuer got input subsidy - Binary(1=Yes,0=No)	+/-
TLU	Tropical Livestock Units owned -continuous(Number)	+/-
Transport facility	Ownership of transport facility -Binary(Y1=es,0=No)	+/-

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Farm store	Farm store ownership -Binary(1=Yes,0=No)	+/-

RESULTS

Descriptive results for continuous variables

Table 2: Mean of schooling years, log of land size, and livestock units owned by non-commercialized and commercialized agriprenuers.

Variable	Non-Commercialized	Commercialized	Combined	t-value
Schooling years	8.6335	9.9459	9.3390	-3.8769***
	(3.5425)	(3.3305)	(3.4880)	
Log of land size	0.6760	0.8900	0.7910	-5.4750***
	(0.3535)	(0.4291)	(0.4096)	
Livestock Units owned	1.1318	1.5136	1.3370	-2.4883**
	(1.2521)	(1.7739)	(1.5644)	

Note: ** and *** represent significance at 5% and 1% levels, respectively. Figures in parentheses are standard deviations

Descriptive results for categorical variables

Table 3: Percentage differences in categorical variables used for non-commercialized and commercialized agriprenuers

Variable	Description	Non-commercialized n=211	Commercialized n=202	χ^2 Value
Land ownership type	With title	41.90	58.10	4.75**
	Without title	54.22	45.78	
Intercropping	No	71.43	28.57	2.40
	Yes	50.38	49.62	
Received subsidy	No	43.30	56.70	3.08*
	Yes	53.48	46.52	
Own transport facility	No	59.39	40.61	10.39***
	Yes	43.52	56.48	
Own farm store	No	52.55	47.45	3.27*
	Yes	37.50	62.50	

Econometric model results

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Table 4: Double hurdle model results for the effect of pre-cooking bean commercialization on input use

Variable	Input commercialization		Effect on variable input purchased	
	Coefficient	**SE**	**Coefficient**	**S.E**
Years spent in formal schooling	0.0894	0.0655	0.0522***	0.0137
Log of land size	1.2118	0.7660	1.0285***	0.1257
Land ownership type	0.6566	0.9609	-0.1249	0.1070
Intercropped	1.6423	1.6514	1.8150***	0.4291
Subsidy received	-3.8856***	0.3395	-0.3916***	0.1054
Tropical Livestock Units owned	-0.2052**	0.1036	0.0377	0.0481
Ownership of a transport facility	0.5173	1.6262	0.1797**	0.0801
Ownership of a farm store	4.3638***	0.7020	0.0433	0.2469
sigma Constant	0.8883***	0.0337	0.8883***	0.0337
Number of observations				413
Wald chi2				(8) =306.45
Probability chi2				0.0000

Note: ** and *** represent significance at 5% and 1% level, respectively. S.E represents standard errors. The standard errors have been calculated using the bootstrap method.

DISCUSSION

The first column in Table 4 presents the independent variables used in the study analysis. The second and third columns presents the input commercialization (participation in pre-cooking bean input market) decision coefficients and their corresponding standard errors, respectively. The fourth column shows the effect of input commercialization on value of variable input (chemical fertilizers) purchased for use in pre-cooking bean production coefficients with their standard errors in the fifth column. The dependent variables were commercialization (participation in the input market as a buyer of chemical fertilizers), which was binary (whether the agriprenuer participated in the pre-cooking inputs market as a buyer or not 1 if yes and 0 otherwise). If yes value of variable inputs bought for use in pre-cooking bean production which is continuous.

In the second column (pre-cooking bean input commercialization), coefficients of three variables; subsidy received, tropical livestock units owned and ownership of farm store ownership were statistically significant. Subsidy received by the pre-cooking bean agriprenuers significantly reduced their likelihood of participation in the input market as buyers of chemical fertilizers at 1% significance level. This result was not expected. The sellers were expected to have many buyers since the prices of the inputs were reduced. The subsidy was from the Kenyan national government specifically on inorganic fertilizers. The recorded outcome could be attributed to the available fertilizers brands for planting and top dressing being from a few manufacturing companies most of them not preferred by the agriprenuers. Furthermore, the agriprenuers were not allowed to choose from the few options but instead they were to take

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what had been offered to them. The precooking bean agriprenuers who received the subsidized chemical fertilizers could not source for the same inputs from the input markets again at an almost double price. This finding corroborates what Ricome *et al*. (2024) reported when studying the effect of government fertilizer subsidy on input use and income in Senegal. Receipt of subsidized fertilizer resulted in a decrease in commercial fertilizer use. This was attributed to subsidized fertilizer substituting for commercial fertilizer. After analysing the effect of fertilizer subsidy on input commercialization, in Kenya, Mather and Jayne (2018) confirmed this result. It was attributed to fertilizer subsidies limiting the development of commercial fertilizer markets. Similarly, input subsidy discourages private investment by farmers in the input market (Akber *et al*., 2022). Contrary to this finding when evaluating the impact of agricultural input subsidy policy on market participation and income distribution in Malawi, a significant positive relationship between input subsidy and commercialization was documented (Camara &Savard, 2023).

Regarding tropical livestock units owned, a significant negative relationship was reported between input commercialization and livestock units owned at 5% significance level. This implies that agriprenuers who owned livestock units were unlikely to buy chemical fertilizers for use in pre-cooking bean production. This result was not expected. Crop farmers who own livestock are seen to have diversified their income sources; they could get money from sale of livestock products, sale of livestock or both. The many sources of income could be used to buy agricultural inputs like chemical fertilizers. The negative relationship documented in this study could be attributed to livestock units producing manure used as organic fertilizer on pre-cooking bean plots. Manure or organic fertilizer is a perfect substitute for inorganic or chemical fertilizer. More livestock units mean more use of organic fertilizer, reducing the likelihood of those owning livestock buying the same from input markets. Commercial inputs were substituted by those from the farm (on-farm) thus reducing the participation in the input market as buyers of chemical fertilizers. This finding is in agreement with that documented by Asfaw *et al*. (2022) when studying date commercialization in Ethiopia. Similarly, Kifle *et al*. (2024) found a significant negative relationship between potato commercialization and livestock excluding oxen and equines at 5 % significance level. Contrary to this outcome, Assefa *et al*. (2024) while studying *Teff* commercialization found a significant positive effect of tropical livestock units owned on commercialization at 5 % significance level. This was attributed farmers who owned livestock units having extra income from the sale of livestock products or the livestock units to buy farm inputs.

Ownership of a farm store significantly increased the likelihood of participating in the input market as buyers of chemical fertilizers at 1% significance level. This finding was expected. Owning a farm store allows the agriprenuer to buy pre-cooking bean inputs at a convenient time probably when they have money and keep them until the time of use. The agriprenuers who own farm stores could be purchasing their inputs when the input prices are low and keep them in the store to be used at the time they are needed. Farmers owning farm stores were likely to participate in the output market as sellers. They could use the stores as market outlets where buyers come and buy directly from sellers (Abate *et al*., 2024).

The fourth column presents the effect of commercialization on the value of chemical fertilizers bought for use in pre-cooking bean production. Years spent in formal education had a significant positive effect on the value of chemical fertilizers bought for use in pre-cooking bean production at 1% significance level. This result was expected. Pre-cooking bean

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agriprenuers who spent more years in formal schooling purchased large quantities of chemical fertilizers to use in pre-cooking bean production. Probably, formal schooling imparted knowledge to participants on the importance of using the required quantities of input that led to the realized result. Formal education improves the farm household head's understanding on how to get the amount of inputs they need for production. Furthermore, formal education exposes participants to networks that can help them acquire the inputs like chemical fertilizers they need. This finding corroborates those documented earlier on smallholder farmers' commercialization (Andaregie *et al*., 2021; Asfaw *et al*., 2022; Megerssa *et al*., 2020).

Log of land size had a statistically significant positive effect on value of chemical fertilizers purchased for use in pre-cooking bean production at 1% significance level. This finding was anticipated. Land size presented as the log of land size increase leads to an increase in the quantity of chemical fertilizers purchased for use in pre-cooking bean production. Pre-cooking bean agriprenuers who have large land size require large quantities of variable inputs like fertilizers that are got from their farms and complemented by the input market. A similar finding was reported by Hailu and Fana, (2023), when studying input commercialization in Ethiopia, they found that land size had a significant positive effect on the level of input commercialization. Moreover, a positive relationship between land size and commercialization was reported among smallholder potato and date farmers in Ethiopia (Asfaw *et al*., 2022; Kifle *et al*., 2024). However, contrary to this finding, Konja and Mabe (2023), while studying groundnut commercialization in Ghana, reported a significant negative relationship between commercialization and land size. This result was attributed to large farm size owners getting most of the inputs from other farm enterprises, therefore reducing what they bought from the input markets.

Intercropping pre-cooking bean with maize had a significant positive effect on the value of chemical fertilizers purchased for use in pre-cooking bean production at a 1% significance level. This result was anticipated. Pre-cooking bean and maize require similar chemical fertilizers although in different ratios, if they are planted on the same plot, they will require more of the inputs. Probably, pre-cooking bean agriprenuers who intercropped the bean were aware of the crops inputs requirements that is why they bought chemical fertilizers in quantities that were sufficient for both crops. This finding corroborates that reported by Ahmad *et al*.(2025), which when analysing the effect of intercropping maize with soybean on productivity and Phosphorus use efficiency found that intercropping led to the use of more phosphorus fertilizer. Similarly, intercropping cereals with legumes was reported to consume more units of chemical fertilizers (Tzemi *et al*., 2025). However, contrary to this finding, intercropping led to a reduction in the amount of external inputs used in integrated pest management on fall armyworm (Rao *et al*., 2025).

The subsidy received had a significant negative effect on the value of chemical fertilizers bought for use in pre-cooking bean production at 1% significance level. This outcome was not expected. Subsidy on agricultural inputs is like chemical fertilizers meant to encourage smallholder farmers who are the most financially constrained to buy and use more inputs. It is usually a strategy of many developing countries' governments to enhance productivity among smallholder farmers who are the majority. However, probable reasons for the observed negative effect would be the provision of few brand options, not giving the farmers freedom to choose what they want from the available few alternatives, as well as restricting the quantity of subsidised fertilizer that each smallholder agriprenuer could buy. Furthermore, most of the

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brands that were available were from manufacturing companies least preferred by the agriprenuers so they did not buy them. For those agriprenuers who bought the chemical fertilizers, they only used what they got irrespective of whether it was appropriate or not. This finding is in agreement with those documented earlier on the effect of input subsidy on the quantity of input used (Akber *et al*., 2022; Mather & Jayne, 2018; Ricome *et al*., 2024). However, input subsidies have been reported to encourage smallholder farmers to buy and use high quantities of variable inputs like certified seed and inorganic fertilizers (Camara &Savard, 2023).

Ownership of transport facility had a significant positive effect on the value of chemical fertilizers bought for use in pre-cooking bean production at 10% significance level. Agriprenuers who owned transport facility purchased a high quantity of chemical fertilizers for use in pre-cooking bean production. This result was anticipated. This outcome could be attributed to agriprenuers owning their own transport facilities facing low transport cost thus purchased large quantities of chemical fertilizers without worrying about how they would be moved to their farms. Ownership of a means of transport by smallholder rural farmers makes it convenient to them to buy large quantities of inputs. Furthermore, agriprenuers who have their own transport means could be offering transport services to other farmers at a fee as a source of extra income that is used to buy more of the inputs they require. Ownership of transport means had been reported to have a significant positive relationship with the amount of inputs sourced from the market for use on their farms (Belete & Nigatu, 2023; Konja &Mabe, 2023; Tafesse *et al*., 2023).

IMPLICATION TO RESEARCH AND PRACTICE

A significant negative effect of an input subsidy on input commercialization and input use carries profound implications for both research and agricultural development practice. This outcome is referred to as the “crowding-out effect”, where the public provision of a subsidized good displaces the private commercial market. The negative effect implies that the subsidy is primarily undermining the long-term sustainability of the input delivery system. This calls for re-evaluating and restructuring subsidies by shifting from direct price support to market-enabling strategies. Furthermore, implementing output market support policies that raise the profitability of farming like improving road networks, storage facilities, and market information would increase the farmers ‘willingness to pay the full price for inputs, thereby “crowding in” commercial input use. Subsidy programs should be designed with clear exit strategies and rigorous targeting towards the poorest and most remote farmers facing genuine credit and access constraints, where the private sector is genuinely absent. Additionally, subsidies could be gradually phased out as commercial markets become more established, providing certainty to private investors. Focusing on private sector development by: allocating public funds to public goods that lower private transaction costs like roads, rural electrification, and market information systems could help. The government could address the credit constraint on the supply side by facilitating access to working capital for importers and wholesalers, which can lead to lower retail prices for farmers, effectively achieving the goal of affordability without direct subsidy.

CONCLUSION

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Pre-cooking bean commercialization had a significant negative effect on input use. Specifically, the subsidy received on inputs and tropical livestock units owned reduced the likelihood of smallholder pre-cooking bean agriprenuers buying chemical fertilizers in Kimilili Sub-County, Kenya. However, ownership of a farm store increased the likelihood of participating in the market as buyers of inputs (chemical fertilizers). Regarding the value of chemical fertilizers bought, agriprenuers who spent more years in formal schooling, intercropped maize with beans, owned larger sizes of land and a transport facility, purchased more chemical fertilizers for use in pre-cooking bean production. Contrary to this agriprenuers who received subsidy on inputs bought less value chemical fertilizers.

FUTURE RESEARCH

Future research could consider a comprehensive analysis using an integrated approach that combines neoclassical and diffusion theoretical frameworks. Regression models based on production functions could be useful to establish the economic rationale and quantify the direct effect of commercialization on the level of input use. The diffusion framework could be used to identify the structural and behavioural factors like credit access, market distance, information and risk aversion that explain the likelihood of participation as well as act as moderating variables in the core economic model. The combined framework allows for understanding the effect of commercialization on input use as well as why and for whom this effect is strongest (the underlying mechanisms).

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The dataset used in this study is available from the corresponding author upon reasonable request.

Ethical approval

Data collection began following clearance from the National Commission for Science, Technology and Innovation (NACOSTI) (License No: NACOSTI/P/25/414853)

Informed consent

Informed consent was obtained from the respondents verbally

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