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Determinants of utilization of banana value addition among small-scale agripreneurs in Kenya: A case of Kisii County

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There is an increased demand for banana fruit and its processed products among both rural and urban populations. Value addition has the potential to reduce postharvest losses, increase crop productivity, and enhance crop income. Despite the promotion of banana value addition by government and non-governmental organizations, its utilization remains low in Kisii county, Kenya. There is a lack of information on the determinants of the utilization of banana value addition. Previous studies on determinants of crop value addition have primarily focused on tomatoes, mangoes, tubers and root crops, with limited emphasis on banana fruit. This knowledge gap necessitated the current study. A multi-stage sampling procedure was employed to select 201 respondents. Data were collected using semi-structured questionnaires and analyzed using descriptive and inferential statistics, as well as Cragg's Double Hurdle model. The results revealed that banana value adders were involved in various activities such as flour milling (36%), slicing and drying (31%), cleaning, sorting and grading (26%), and crisps making (7%). In comparison to non-value adders, value adders were significantly younger, produced larger quantities of bananas, travelled longer distances to the market, received more training and extension visits, considered farming as their main occupation, owned smaller farm sizes, and the majority did not have access to credit. The decision to utilize banana value addition was significantly influenced by the total quantity of bananas produced, the type of roads, primary occupation, the number of training sessions and extension contacts, distance to the output market, group membership, and access to credit. The extent of value addition was influenced by extension contacts, type of roads, total quantity of bananas produced, and marital status (being married). The study recommends that socioeconomic and institutional factors influencing both the decision and extent of banana value addition should be considered when formulating and implementing policies aimed at promoting banana value addition.

Key words: Agripreneurs, banana, double hurdle, utilization, value addition.

INTRODUCTION

Bananas (*Musa* species) are among the major fruit crops in the global economy and are predominantly cultivated in more than 130 tropical and sub-tropical countries (Easwari and Maruthupandi, 2020; Lalitha et al., 2022).

They play a central role in providing food and nutritional security, as well as feed for livestock (Rono et al., 2020). As a food source, bananas are rich in minerals such as potassium, magnesium, sodium, phosphorus, and vitamins including vitamin C, B2, and B6, as well as fiber and energy (Gemechu et al., 2021; Lalitha et al., 2022). They are consumed when ripe, boiled, or in processed forms such as chips, dried fruit, bread, ice cream, smoothies, and juice, among others (Al-Dairi et al., 2023).

Globally, bananas have remained the second most consumed fruit and eighth most cultivated food crop (Jalawadi et al., 2021; Thangavelu et al., 2021). Currently, India, China, and Indonesia are the leading producers worldwide (Gebre et al., 2022). Global production has increased by about 150% in the last three decades, from 1985 to 2019 (FAO, 2020). Furthermore, this production is expected to rise due to an increase in population and changes in food consumption patterns (Sugianti et al., 2022). Africa produces 25% of the world's banana volume, covering an area of 4 million ha farmed by about 90% of smallholder producers (Nkwain et al., 2022). Major producers in Africa include Cameroon, Kenya, Cote d'Ivoire, Tanzania, and Uganda (Olumba and Onunka, 2020).

The crop is ranked as the fourth major starch food crop after maize, rice, and wheat in developing countries (Keba and Yilma, 2022; Masud et al., 2022). The sub-sector contributes to 17.8% of the aggregate value of fruits and vegetables and 34.5% of the total fruits in Kenya (Horticultural Crops Directorate (HCD), 2020). There are 390,000 farmers growing bananas, with 84% being smallholders owning less than 0.2 ha (Karienye et al., 2021). According to HCD (2020), Meru, Taita Taveta, Murang'a, Kirinyaga, Embu, Tharaka Nithi, Kisii, and Nyamira are the major producers of bananas in Kenya. In addition, in Kisii and Nyamira counties, green bananas are the most preferred types, while dessert types are commonly grown in central and eastern regions including Meru, Embu, and Kirinyaga (Omondi et al., 2020). One million metric tons are produced from about 80,000 ha of land translating to mean yields of 12.5 metric tons which is worth KES 40 to 45 billion (Karienye and Kamiri, 2020).

Despite the health and socio-economic benefits of bananas, the value chain is hindered by production and market related factors including low crop productivity, lack of access to better paying markets, low prices, decreasing prices, poor postharvest management, and inadequate farm incomes (Kumar and Achudhan, 2021; Natukwatsa, 2021). Banana agripreneurs sell their raw bananas at a low market price due to lack of access to postharvest handling attributed to inadequate access to credit, transportation problems and lack of banana cooperatives. Banana productivity is continuously declining due to conventional methods of banana production and poor agronomic practices (Tarekegn et al., 2020). There is primarily poor coordination of banana agripreneurs within the cooperatives which could link them to local markets (Zinabu et al., 2019). Also, due to changes in informal and formal channels of processors and markets, agripreneurs have no ability to sell their produce in staple food markets profitably (Wahome et al., 2021).

Banana fruit is climacteric, heavy and highly perishable in nature, therefore much of the produce get spoiled during excess supply because markets become flatted (Chabi et al., 2018). This is exacerbated by lack of storage facilities, improper handling, transport, marketing, and processing (Singh et al., 2018; Subbaiah et al., 2018). In such scenarios, prices of bananas become low and decreases inconsiderably giving middlemen a chance to dominate the market. Under such circumstances, it is important to process banana to storable products for instance banana powder, flour, chips, dried slices, jam, beverages, baby foods among others (Kikulwe et al., 2020). However, agripreneurs have inadequate technical knowledge on how to handle highly perishable produce in the fruit industry (Muigai et al., 2021).

As a result of these challenges, the Kenya Livestock and Research Organizations (KARLO) previously had issued improved banana varieties to farmers to improve productivity and boost the crop income (Mwangi and Kariuki, 2015). Furthermore, approaches including use of cold storage facilities, hexanal technologies and 1-methylcyclopropene were introduced at farm level to increase the shelf life of fruits by minimizing the losses (Al-Daire et al., 2023; Kahwai et al., 2021). However, banana productivity is still on the decline estimated at 4.5 to 10 tons/ha against the international levels of 40 to 50 tons/ha (Muthee et al., 2019). Moreover, post-harvest losses are still on alarming rate estimated at 30 to 40%.

Banana value addition could provide a solution to increase crop productivity, minimize post-harvest losses hence boost farm incomes (Natukwatsa, 2021; Kathuri et al., 2021). An extra value can be added to a product or a service. Value addition means adding an extra feature to an original product or transforming the original product to a different product. In this context, banana fruit was added value through cleaning, washing and grading, or transforming its original fruit to other products such as flour, dried chips, or crips. Transforming bananas into other products are profitable business opportunities that enhance profit margins of agripreneurs (Donkor et al., 2018). Banana is one of the crops that have been

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targeted by the Kenyan government in its developmental agenda to promote value addition to enhance sustainable agriculture and agro-industrialization because banana fruit provides raw materials for industries and creates employment opportunities for the youth in the rural populations. In addition, rural economy is characterised by poor infrastructure, high poverty levels and food insecurity (Obaga and Mwaura, 2018). Thus, integration of rural agripreneurs in value addition would spur rural socio-economic development through exploitation of rural agro-processing (Donkor et al., 2018).

Despite the known importance of value addition in the rural economy, both governments and non-governmental organizations have put in place interventions to promote the use of banana value addition. In spite of these efforts, the level of utilization of these value addition activities is still low. This is because, banana agriprenuers are still producing and marketing their raw fruits in the market with little or no attempt to make flour, dried chips, or crips (Marimo et al., 2020). Additionally, the influence of socio-economic and institutional factors on decision to participate in value addition and extent of participation is still not clear in the empirical literature. As the studies emphasizing on agripreneurs' decision and extent of utilization of banana value addition are limited, therefore the objective of this paper is to assess the determinants of utilization of banana value addition among small-scale agripreneurs in Kisii county. Thus, it is on this background that the study sought to fill these knowledge gaps among small-scale banana agripreneurs in Kisii county. Knowledge and information obtained from this study will enable policy makers to design policies and interventions aimed at promoting micro and small-scale banana agri-enterprise through value addition leading to increased production and consumption of banana and its value-added products for improved farm income and livelihoods.

LITERATURE REVIEW ON DETERMINANTS OF CROP VALUE ADDITION

Previous studies on determinants of crop value addition have focused on Irish potatoes, sweet potatoes, cassava and mangoes with little emphasis on banana fruit. Moreover, most studies have focused on factors influencing decision to adopt value addition with little or no attention on factors influencing the extent of adoption. For example, Orinda et al. (2017) used Heckman Two stage model to determine the factors influencing sweet potato and mango value addition in Kenya. The study stated that the decision of farmers to take up value addition was influenced by household size, total quantity produced, credit access, land size of the respondents, distance to the market, and group membership. While the extent of value addition was affected by the distance to the market, group membership, credit access and total quantity produced. Moreover, a study in Kenya by Musyoka et al. (2020) also used Heckman Two stage model to model the factors influencing decision and extent of adoption of mangoes. The study found that the factors which significantly influenced the decision of mango value addition included off-farm income, access to cold storage facilities, price of value-added products, group membership, extension contact, farmers' awareness, amount of credit, and hired labour. While training, farmers' awareness and access to cold storage facilities distance to market and livestock equivalence had a significant effect on the proportion of mangoes value added.

Okeke et al. (2023) used Double Hurdle to determine the decision to invest in cassava value addition and extent of investment in Nigeria. The study found that sex, marital status, age, and cooperative membership had a significant influence on investment decision while level of investment was significantly influenced by sex, marital status, and level of education, age, membership of cooperatives, return, and credit received. Jacob et al. (2023) used binary probit regression to examine the factors influencing the decision of cassava value addition in Nigeria. The study reported that the decision to add value to cassava was significantly affected by farm size, group membership, gender, farming experience, access to credit, and education level.

A study by Khoza et al. (2019) determined the factors that influenced agro-processing in South Africa. The findings of the study revealed that the decision to participate in agroprocessing was positively and significantly influenced by education level, access to trainings on agroprocessing, and land tenure while distance to the market and off farm income had a negative significant on decision to participate. On the other hand, household size, education level, farm size, access to training, grain and livestock producers, and age had a significant influence on level of processing. Osondu et al. (2023) used multiple regressions to examine the factors influencing decision of cassava value added technologies in Nigeria. The study reported that age, education level, marital status, extension contact processing cost annual income, group membership access to credit and quantity of cassava produced had a significant effect to value addition while the adoption process was constrained by the following, inadequate capital, lack of market, inadequate access to credit inadequate knowledge of technologies, high cost of equipment and scarcity of labour.

Maku et al. (2022) documented that access to good road network has a significant influence on participation in value addition. This is because agripreneurs easily transport their produce and products to the market hence enhancing trade of agricultural commodities. Access to credits increases the likelihood of participation in value addition since agripreneurs will be able to purchase the necessary value addition equipment and facilities.

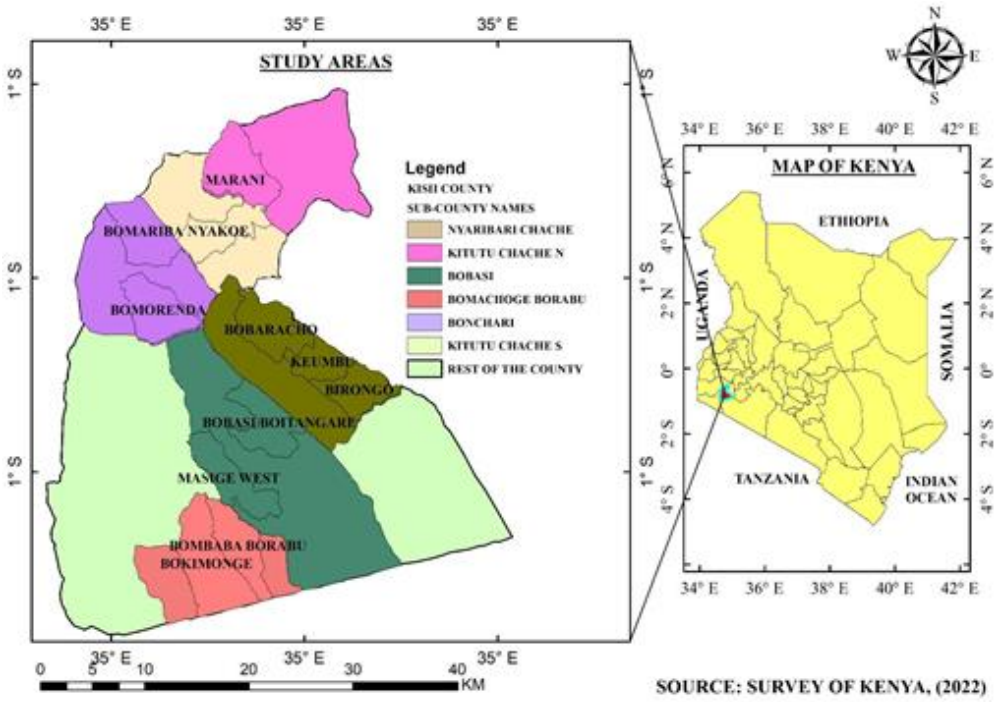

Figure 1. Location of the study area in Kisii County.

Agripreneurs who are organised in cooperative or group memberships have better access to markets as they have a high bargaining power. A study by Esheya (2023) reported that marital status increased the probability of farmers to add value to cassava. Extension contacts supply agripreneurs with information on banana production, technology adoption, marketing and management and reduce risks with new technologies. Agricultural trainings also offer agripreneurs with technical skills experience and knowledge on adoption of agricultural technologies.

Value addition, they give mixed results. Only two studies investigated the factors influencing the decision to adopt banana value addition. For instance, Muigai et al. (2021) in Kenya reported that access to credit and group membership influenced the decision to add value to banana fruit; while extension services, cropping systems, and gender of farmers by Natukwatsa (2021) in Uganda had a significant effect on decision to participate in banana value addition. There is no empirical information on determinants of banana value addition in Kenya. This study was therefore aimed at providing more evidence on factors influencing decision of participation in banana value addition and extent of participation using Cragg's Double Hurdle model. This model controls sample selection bias compared to Heckman Two stage model. Our study provides new evidence on policy related variables. This study aimed at informing the stakeholders including the ministry of agriculture, research institutions, and the private sector organizations on developing appropriate policies on banana value addition. The study will lead to minimized post-harvest losses, increased agripreneurs' incomes and food security; therefore attaining the global political goals of the United Nations through the use of value addition. Furthermore, information on value addition and any related field will be available through the findings and recommendations of this study, to future researchers who may have an interest to carry out research on the same.

METHODOLOGY

Study area

This study was carried out in Kisii county. The county is among the major banana producing areas in Kenya. It is located within the Western region of Kenya. It is found at latitude 0° 30' and 10° 0' South and longitude 34° 38'and 37° 61' East. The county receives bimodal rainfall. Long rains are experienced from March to June while short rains are received from September to November. The maximum and minimum temperatures ranging from 21 to 30°C and 15 to 20°C, respectively. Smallholder farmers in this region depend on agriculture which is mainly rainfed. Both dairy and crop farming does well in the area. The main crops grown in the area include: bananas, tea, coffee and sugarcane, maize, beans, sweet potatoes, cassava, among others. Figure 1 shows a map of the study area.

Sample size determination

To determine the sample size of this study, the Cochran's (1977) formula was applied as follows (Equation 1):

Table 1. Description of variables used in the first and second hurdles of the Cragg's Double hurdle model.

Variable	Description	Unit	Expected sign	
			First hurdle	Second hurdle
Dependent				
Utilization decision	1 if agripreneur utilized, 0 otherwise	Dummy		
Extent of utilization	kg of banana value-added	continuous		
Independent				
Age	Age of agripreneurs in years	Continuous	+/-	+
Gender	1 male 0 female	Dummy	+	+
Marial status	1 if married 0 Otherwise	Dummy	+	+
Education level	1 Non-formal; 2 primary levels; 3 secondary level; 4 tertiary level	Categorical	+	+
Household size	Number of family members	continuous	_	_
Farmsize	Acres of total farm size	Continuous	+	+
Banana acres	Land acreage under bananas	continuous	+	+
Credit access	1 if accessed credit, 0 otherwise	Dummy	+/-	+/-
Extension	Number of extension Visits received annually	Continuous	+	+
Training	Number of trainings received annually	continuous	+	+
Group	Membership to cooperative or group 1 Yes, 0 Otherwise	Dummy	+	+
Quantity	kg of bananas produced	Continuous	+	+
Experience	Years in banana arming	Continuous	_	+
Distance	Distance to output market in kilometres	Continuous	+	+
Occupation	Main Occupation 1 Farming 0 otherwise	Dummy	+	+
Type of road	Type of road accessed 1 tarmac 2 Murram 3 Earth	Categorical	+	+

$$n = \frac{z^2 pq}{e^2} \quad (1)$$

where n = sample size, p = is the proportion of small-scale banana agripreneurs that were engaged in value addition in the study area), (p=0.2), q = is the proportion in the target population estimated not to have characteristics being measured (q = (1-p) = 0.8), z = the standard value at a given confidence level (α = 0.05), e = the acceptable error (precision). The sample was determined as (Equation 2):

$$n = \frac{(1.96)^2(0.2)(0.8)}{(0.05)^2} = 246 \quad (2)$$

The derived sample size for the study was 246. However, during the survey, the actual sample that was collected and used for analysis was 201 respondents because the response rate was 82%.

Sampling procedure

This study adopted a mult-stage sampling procedure to select the respondents. In the first stage, Kisii county was purposively selected. It comprised a region that was introduced early with banana value-addition whereby small-scale agripreneurs were oriented and incubated on the same. The second stage was the purposive selection of five sub-counties with a high potential of banana production namely; Bonchari, Bobasi, Bomachoge Borabu, Kitutu Chache North, and Nyaribari Chache. Additionally, there have been several interventions introduced in these sub-counties geared towards promoting banana value addition. The third stage involved the purposive selection of ten wards whereby 61 banana value-adders and 140 non-value adders were selected using snowballing technique and simple random sampling respectively. The total respondents consisted of two hundred and one.

Data collection

Cross-section surveys were conducted in Kisii County which took place on 25th November and 10th December 2022. Primary data were collected through face-to-face interviews administered to the respondents by well-trained enumerators using semi-structured questionnaire. A pretest of the questionnaire was done prior to actual data collection to test its reliability and validity. Secondary data were obtained by reviewing the past literature that was relevant for the study. Then the data which were collected were coded and entered into SPSS (Version 25) and Stata (Version 17) software for analysis. Data was analysed by descriptive statistics such as mean, inferential statistics such as Chi square and t tests and Cragg Double Hurdle (DH) model.

The categorical and continuous variables that were used in the econometric analysis are shown in Table 1. They were obtained from literature review of previous studies (Adam et al., 2023; Bundi et al., 2020; Khoza et al., 2019; Korir et al., 2020; Maku et al., 2022; Mkandawire et al., 2018; Muigai et al., 2021; Musyoka et al., 2020; Natukwatsa, 2021; Okeke et al., 2022; Tijani, 2022). Before analysis, continuous variables were tested for multicollinearity problem using Variance Inflation Factor (VIF) (Table 2). The mean of VIF was 1.25 which was less than the recognized threshold value of 3 thus multicollinearity problem was not present. White test was also conducted to see the presence of heteroskedasticity. The test result indicated that the p-value was 0.1379 showing that there was no heteroskedasticity problem in the model (Table 3).

Table 2. Variance inflation factor test results for continuous explanatory variable.

Variable	VIF	1/VIF
Farm-Size in Acres	1.49	0.670004
Kg of banana harvested	1.46	0.686408
Number of trainings received by agripreneurs	1.30	0.7667753
Extension contacts received by agripreneurs	1.21	0.825155
Number of family members in households	1.06	0.945380
Age of agripreneurs head	1.05	0.950298
Distance from area of residence to nearest market	1.20	0.833053
Mean VIF	1.25	

Table 3. Heteroskedasticity test of explanatory variables using White test.

Source	Chi-square	df	p-value
Heteroskedasticity	138.44	156	0.1379
Skewness	19.12	17	0.0003
Kurtosis	2.71	1	0.0044
Total	160.27	174	0.0036

Empirical model specification

In this study, banana agripreneurs faced two hurdles in the participation of banana value addition. First hurdle was the decision to utilize banana value addition (1 Yes, 0 otherwise). The second hurdle was the extent of value addition measured as the quantity of banana fruit value added in kg. To determine the factors that influenced the decision of small-scale agripreneurs to participate in banana value addition and extent of participation, it was assumed that the two steps are independent. The binary probit model was used in the first stage to model the decision to participate and the truncated regression to model the extent of participation. Thus, Cragg's a double hurdle was applied following Alleluyanatha (2022). This study specified the Cragg's model as (Equations 3 and 4):

$d_i^* = Z_i\delta + \varepsilon_i \quad \varepsilon_i \sim N(0, \sigma_\varepsilon^2)$ Decision to utilize (3)

where $d_i = 1$ if $d_i^* > 0$, and = 0 otherwise

$y_i^* = X_i\beta + \mu_i \quad \mu_i \sim N(0, \sigma_\mu^2)$ Extent to utilize (4)

where $y_i = 1$ if $y_i^* > 0$, and = 0 Otherwise, by d_i^* is the latent variable showing agriprenuer's decision to utilize banana value addition and d_i is the observed value to utilize banana value addition = 1 if an agripreneur utilizes banana value addition and 0 if otherwise. y_i^* is the latent variable showing the extent of value-added banana and y_i is the observed responses on the quantity of banana value added. In addition, $y_i = 0$ for agripreneurs that did not utilize banana value addition and some positive values for agripreneurs that utilized banana value addition that is $d_i = 1$ if $y_i > 0$ and $d_i = 0$ if $y_i = 0$. δ and β are coefficients to be estimated. Z_i and X_i are the vector of factors that determined the decisions to utilize banana value addition and the quantity of bananas value-added respectively. ε_i and μ_i are the error terms that follows a normal distribution that is assumed to be independent (Cragg, 1971; Wooldridge, 2010).

The assumption holds that Equation 3 and 4 are independent and the joint likelihood function of the Cragg model is shown in Equation 5 (Cragg, 1971; Tambo and Abdoulaye, 2013).

$$f(d, y/X, Z)\{1 - \Phi(X_i\beta)\}^{1(d=0)} \left[\Phi(X_i\beta)(2\pi) - {}_{2\sigma}^{1} - 1exp\left\{\frac{-(y - z_i\delta)^2}{2\sigma^2}\right\}/\Phi\left(\frac{z_i\delta}{\sigma}\right)\right]^{1(d=1)} \quad (5)$$

where d is a binary variable = 1 if d is positive and 0 otherwise. Y is continuous variable for non-censored portion which is observed only when d = 1. The Cragg model indicates that if d > 0 and the value of y, given that y>0, may be influenced by δ and β. There is no restriction on X and Z showing that each decision can be explained by a different vector of independent variables according to Burke (2009). In addition, Tobit model is nested within Cragg's alternative for the reason that X = Z and $\beta = {}^{\delta}/_{\sigma}$. The Craggit model has been largely used in some studies which focused particularly on adoption of agricultural technologies and market participation (Gachuhi et al., 2021; Khoza et al., 2019; Kolapo et al., 2020; Okeke et al., 2022; Mohamed et al., 2022).

RESULTS AND DISCUSSION

Descriptive statistics

Figure 2 shows the various banana value addition activities practiced by agripreneurs in the study area. Of the total sample, 61 banana agripreneurs were value adders and 140 were non-value adders. Value addition activities practised include: flour milling (36%) slicing and drying (31%), sorting and grading (26%) and crisps

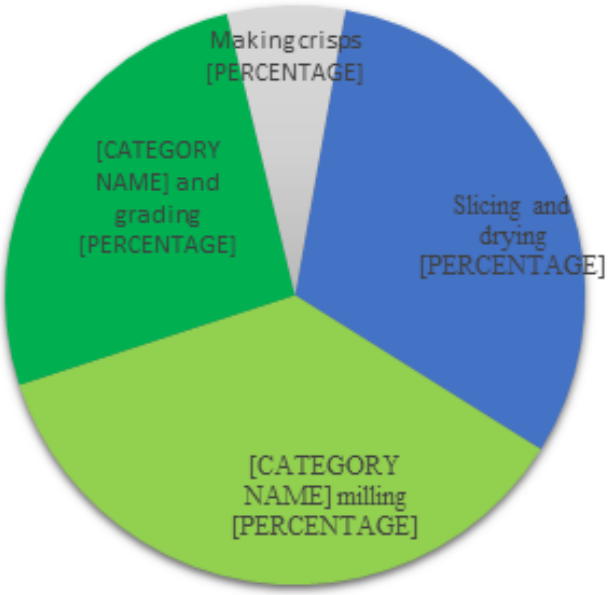

Figure 2. Banana value addition activities practiced in the study area.

making (7%). Results indicated that slicing and drying and flour milling were the most commonly practiced due to low input and technical support requirement. While sorting and grading, and crisps making were the least practiced because sorting and grading led to difficulties of transporting bananas to the market and crisps making was considered more advanced technique which required more inputs.

Socio-economic and institutional characteristics of small-scale banana agripreneurs

The characteristics of small-scale banana agripreneurs are shown in Tables 4 and 5. The results on categorical variables are discussed in Table 2. Regarding farming as the primary occupation of agripreneurs, 67.16% of all the respondents practiced farming as their main occupation while 32.84% relied on off-farm activities as their main source of income. In addition, 88.52% of value adders depend on farming crops and livestock as their main occupation for livelihood improvement, meaning these agripreneurs did not take part in off-farm activities and hence had no off-farm income compared to 57.86% of non-value adders. This enabled value adders to spend full time continuously taking part in value addition. There is a significant difference in primary occupation between the two groups at a 1% significance level.

About group membership, 89.05% of all agripreneurs were members of various agricultural groups; while 96.72% of agripreneurs who did not add value were members of the group compared to 84.71% of those who did not add value. This suggests that value adders were organized in the agripreneur groups than non-value adders. The difference was statistically significant at a 1% significant level. According to Orinda et al. (2017) group membership helps smallholder farmers to access the trainings and advice from various sources on agricultural technologies with ease.

The variable "type of roads" was broken down into earth, murram, and tarmac. Value adders accessed better roads compared to non-value adders. For instance, 78.69 accessed Murram roads compared to 62.14% of non-value adders who accessed earth roads to output markets. There was a significant mean difference on the type of road access to the market between the two groups at a 1% significant level. This finding is similar to a study which documented that improving rural road networks and infrastructure increases agricultural production as well as uptake of agricultural technologies (Maku et al., 2022).

Furthermore, characteristics of banana agripreneurs using continuous variables are shown in Table 5. Non-value adders had a mean age of 48.45 years while that of value adders was 45.05 years. And the difference was significant at 5%. This suggests that younger agripreneurs are risk-takers, more dynamic, and tend to try new ideas. This finding is similar to Kyomugisha et al. (2018) who reported that potato value adders were significantly younger than non-value adders in Uganda. This is in contrast to Ngeno et al. (2020) who found that older farmers have more experience and willingness to uptake agricultural innovations than younger farmers. The total land size owned by agripreneurs on average was 1.72

Table 4. Comparison of characteristics between banana value adders and non-value adders (categorical variables).

Variable	Overall (%)	Value adders (%)	Non-value adders (%)	Chi^2	P-value
Level of education of agripreneurs					
1=Non-formal education	10.95	11.48	10.71	1.27	0.74
2=Primary level	28.36	22.95	30.71		
3=Secondary level	40.80	44.26	39.29		
4=Tertiary level (college and university)	19.90	21.31	19.29		
Gender of agripreneurs					
1=Male	46.26	37.70	50.00	2.58	0.11
0= Female	53.73	63.30	50.00		
Marital status of agriprneurs					
1=Married	80.10	78.69	80.71	0.11	0.74
0=Otherwise	19.90	21.31	19.29	19.88	
Primary Occupation					
1=Farming only	67.16	88.52	57.86	18.12	0.00***
0=Otherwise	32.84	11.48	42.14		
Nature of the road					
1=Earth	46.27	9.84	62.86	116.80	0.00***
2=Tarmac	26.37	11.48	32.86		
3=Murram	27.36	78.69	5.00		
Group membership					
1=Yes	89.05	96.72	84.71	5.28	0.01***
0 =Otherwise	10.95				

***shows that value adders and non-value adders differ significantly at 1% respectively.

acres. However, the value adders owned significantly less land (1.55 acres) than non-value adders (1.80 acres). However, the land allocated to banana production did not differ significantly between value adders and non-value adders. Non-value adders have relatively large land sizes possibly because they have diversified their land with several crops and livestock production as an alternative source of income compared to value adders who may depend on bananas only as a source of income. This finding contradicts that of Musyoka et al. (2020).

Regarding production, 1,757.2 kg were harvested, on average. However, value adders harvested more (2,718.18 kg) compared to their counterparts, who harvested 1,339.35 kg. This finding supports Orinda et al. (2017) that farmers who added value to sweet potatoes and cassava respectively produced more output than smallholder farmers who did not participate in value addition.

Concerning the agricultural trainings received by agripreneurs annually, value adders received 3.23 trainings while non-value adders attended and 2.07 trainings and there was a significant difference in the number of agricultural value addition trainings received between treatment and control groups at 1% significant level. The significance of training among value adders is possible because value addition technologies are more complex and always need more labour hence requiring technical skills, experience, and knowledge. This finding is supported by Mkandawire et al. (2018) who deduced that trainings influence uptake of value addition positively and significantly. There was a significant difference in the number of contacts with extension service providers between non-value adders and value adders at a 1% significance level. On average, one agripreneur received 2 extension visits per year. However, value adders received a mean of 2.64 extension visits while non-value adders received an average of 1.72 contacts. Access to extension services facilitates the dissemination of new knowledge and information and consequently affects the decision to embrace agricultural technologies by small-scale agripreneurs (Osondu et al., 2023).

Banana agripreneurs who added live Kyomugisha et al. (2018) significantly further from output market than the

Table 5. Comparison of characteristics between banana value adders and non-value adders (Continuous variables).

Variable	Value adders (n=61)		Non-value adders (n=140)		Overall (n=201)	*t-value*	P-value
	Mean	Std.dev	Mean	Std.dev.	Mean		
Age of agripreneur (years)	45.05	11.57	49.93	13.78	48.45	2.42	0.02**
Household size (Number)	5.02	1.70	5.44	1.69	5.31	1.64	0.10
Farming experience(years)	20.79	9.88	22.54	9.74	22.00	1.17	0.25
Total land size (acres)	1.55	0.708	1.80	.784	1.720	2.14	0.03**
Area under banana (acres)	0.41	0.339	0.38	0.294	0.388	-1.00	0.43
Bananas harvested (Kgs)	2718.2	1565.9	1339.	1125.8	1421.4	-7.05	0.00***
Distance to output market	7.21	2.72	4.56	2.31	5.36	-7.08	0.00***
Extension visits (Number)	2.64	0.95	1.72	0.93	2.00	-6.40	0.00***
Trainings (Number)	3.23	1.12	1.56	1.37	2.07	-8.34	0.00***

** and *** show that value adders and non-value adders differ significantly at 5 and 1%, respectively. Std. dev = Standard deviation.

non-value adders. The mean distance in kilometres for value adders was 7.21 km whereas for non-value adders it was 4.56 km. There was a significant difference in kilometres covered by the output market between value adders and non-value adders at a 1% significant level. The distance to the market is used to determine whether an agripreneur can access the market hence the transaction cost. Far markets have better prices, therefore, value adders envisaged better prices in far distance markets for their products. The result is contrary to a study conducted in Uganda by Kyomugisha et al. (2018) that potato farmers who mainly added value were near the output market.

Determinants of utilization of banana value addition and extent of utilization of decision among small-scale agriprenuers

The Cragg's Double Hurdle model (DH), was used to simultaneously determine the factors affecting the decision of value addition in the first stage (first hurdle), and the extent of utilization of value addition in the second stage (second hurdle). However, it was critical to test the suitability of the Double Hurdle and Tobit model using the log-likelihood ratio test (LR). The LR recorded a value of 113.6 which was significant at a 1% significant level. This result led to the conclusion that the DH was more appropriate than Tobit model. The DH model recorded the log pseudolikelihood of -570.95 which was found to be significant at a 1% level of significance ($p = 0.000$) and the Wald Chi-square value was 59.73, showing the model fitted significantly better.

Determinants of decision to utilize banana value addition

The results of the factors influencing the decision to utilize banana value addition are shown in Table 6. The results demonstrate that the primary occupation of the agripreneur positively and significantly influenced the probability of embracing value-addition activities at a 1% level of significance. The likelihood of adding value increased by 144.33% for farmers whose primary occupation is farming compared to those with other occupations. This implies that agripreneurs whose main economic activity is farming have a higher likelihood of taking part in value addition. Those who rely on farming as their main source of livelihood spend their full time on the farm, hence producing more surplus for value addition. This finding is similar to a study that revealed that smallholder farmers engaged in farming adopted banana technologies (Barbra and Sam, 2020).

There was a positive and significant influence of the quantity of banana produced on the decision to add value among agripreneurs at a 5% significance level. This indicates that as production increases, more surplus becomes available for value addition. This result is similar to Osondu et al. (2023), who stated that women farmers in Nigeria producing more cassava had higher chances of participating in cassava value addition.

Distance in kilometers from the agripreneur's home to the output market was positive and significant at a 5% significance level. This plausibly means that agripreneurs who covered longer distances to the output market from their homes had a higher likelihood of adding value than those who stayed near the output market. As the distance from the agripreneur's home increases by 1 km, the propensity to add value to banana fruit increased by 18.91% *ceteris paribus*. The study aligns with studies suggesting that dairy farmers nearer the marketplace had lower chances of adding value to milk in Ethiopia (Beyene et al., 2017). However, the study's finding disagreed with Maku et al. (2022), suggesting that the longer the distance to the market, the lesser the likelihood of youths participating in maize value addition. The type of roads, for instance, Murram road, had a positive and significant effect on the decision to add value to banana and plantain at a 1% level of significance.

Table 6. Tier 1: Probit regression estimates for determinants of banana value addition decision to utilize.

Variable	Marginal Effect(dy/dx)	Robust Std. error	P>|z|
Gender of the agripreneur (0= Female 1= Male)	- 0.229	0.361	0.525
Primary level of education (1 =Yes, 0= Otherwise)	-0.733	0.464	0.114
Secondary level of education (1 =Yes, 0= Otherwise)	0.221	0.465	0.635
Tertiary level of education (1 =Yes, 0 =Otherwise)	-0.328	0.663	0.620
Main occupation (1= farming, 0= Otherwise)	1.443	0.405	0.00***
Household size (Number)	0.115	0.120	0.337
Marital status of agripreneur (1 =Married, 0= Otherwise)	-0.517	0.414	0.211
Age of agripreneur (Years)	-0.008	0.017	0.656
Farm size owned (Acres)	-0.224	0.247	0.365
Quantity of banana fruit harvested in kg	0.000	0.000	0.029**
Number of trainings received (Number)	0.377	0.112	0.001***
Distance to the nearest market in kilometres	0.189	0.057	0.001***
Access to murram Road 1 =Yes, 0 Otherwise)	2.413	0.444	0.000***
Access to tarmac Road (1= Yes, 0= Otherwise)	0.093	0.436	0.831
Group membership (1= Yes, 0= Otherwise)	0.940	0.507	0.064*
Access to credit facilities (1= Yes, 0= Otherwise)	-0.609	0.316	0.054**
Access to extension contacts (Number)	0.628	0.213	0.003***
Constant	-6.218	1.361	0.000***
Number of observations	201		
Wald Chi^2	59.73		
Prob> Chi^2	0.000		
Log Likelihood	-570.95		

***, **, * denote significance at 1, 5, and 10% levels, respectively.

Road types were categorized as Earth, Murram, and Tarmac roads. Access to Murram road increased the probability of adding value by 241.33%. Murram roads are a type of rough roads with gravel. This type of road was better than earth roads, which are not passable during the rainy season, hence having a positive coefficient. Road networks act as a proxy to access markets. They are a key factor in value-addition decisions because they enable goods to reach the market in good condition and on time. Good road networks reduce transaction and transportation costs, allowing agripreneurs to maximize their profits. This result conforms with Maku et al. (2022), suggesting that developing rural infrastructure will improve agricultural production and further enhance the uptake of new agricultural technologies in rural areas.

The number of agricultural value addition trainings received by agripreneurs had a positive and significant influence on the decision to engage in banana value addition at a 1% significance level. This means that with an increase in one training, the probability of undertaking banana value addition increased by 37.71%, keeping other explanatory variables constant. Trainings enable agripreneurs to access value-addition information, knowledge, and skills, and also empower them to choose the most profitable form of value-addition activities. This finding is similar to Kirimi et al. (2021), who stated that smallholder banana farmers who received training were more likely to utilize banana value addition in Kenya. However, the study concluded that these trainings were inadequate; therefore, awareness creation on value addition could accelerate the adoption process.

Group membership was positively significant at a 10% significance level. Being a member of a social group or cooperative raises the propensity to add value to banana fruit by 93.99%, *ceteris paribus*. This possibly means that being in a group or cooperative enables agripreneurs to easily receive incentives such as information, market access, and value addition technologies. This aligns with the finding of Tijani (2022), who stated that farmers who participate in groups tend to adopt tomato value-addition technologies as well as improved agricultural technologies, respectively. However, the finding conflicts with that of Wondim et al. (2023), who found that cooperative membership, had a negative influence on the adoption of value addition of fish processing in Nigeria.

Access to credit negatively and significantly influences the probability of banana value addition at a 10% significance level. This possibly means that the more agripreneurs easily obtain credit, the propensity for adding value to banana fruit decreases by 60.89%, keeping other explanatory variables constant. This possibly means that banana agripreneurs who received credit did not use it for value addition; instead, they used

Table 7. Tier 2: Truncated regression estimates for determinants of extent of utilization of banana value addition.

Variable	Coefficient	Robust Std. Error	P>|z|
Gender of the agripreneur (1= Male, 0= Female)	-9319.92	7568.596	0.218
Primary level of agripreneur (1 =Yes, 0= Otherwise)	14651.14	13253.43	0.269
Secondary level of agripreneur (1 =Yes, 0= Otherwise)	20077.06	17049.54	0.239
Tertiary level of agripreneur 1 =Yes, 0= Otherwise)	19762.4	23411.44	0.399
Main occupation (1=farming, 0= Otherwise	7530.79	10926.58	0.491
Household size (Number)	-369.02	214.40	0.897
Marital status of agripreneur (1 =Married, 0= Otherwise)	-15490.03	8394.99	0.065*
Age of agripreneur (Years)	178.15	430.44	0.679
Farm size owned (Acres)	-369.02	6370.95	0.800
Quantity of banana fruit harvested (Kg per acre)	10.15	3.58	0.005***
Number of trainings received (Number)	307.89	4433.90	0.945
Distance from home to output market (Kilometres)	796.81	1468.02	0.587
Access murram Road (1 =Yes, 0= Otherwise)	9503.58	1468.02	0.455
Access tarmac Road (1= Yes, 0= Otherwise)	40221.17	12719.05	0.006***
Group membership (1 =Yes, 0= Otherwise)	34755.29	14762.52	0.290
Access to credit facilities (1 =Yes, 0= Otherwise)	-16554.71	32840.5	0.156
Access to extension contacts (Number)	9174.154	11662.07	0.027**
Constant	151698.50	4153.84	0.066*
Sigma constant	11505.5	82504.28	0.000***
Number of observations		201	
Wald Chi^2		59.73	
Prob> Chi^2		0.000	
Log Likelihood		- 570.95	

***, **, and * denote significance at 1, 5, and 10% levels.

such credit for other agricultural activities. This finding is contrary to Jacob et al. (2023) and Osondu et al. (2023).

The number of extension visits received by agripreneurs had a positive and significant influence on the decision of banana value addition at a 1% significance level. Upon receiving one more extension visits, the probability of adding value to banana fruit increased by 62.81%. Banana agripreneurs gain access to information on agricultural technologies through available extension services; for instance, information on how to transform their raw banana fruit into other usable products (Osondu et al., 2023). This finding is in line with Agoh (2021).

Determinants of extent of utilization of banana value addition

Truncated regression was used to analyse the extent of utilisation of banana value addition in step two (Tier 2). The extent was measured as the amount of banana value added in kg. The results are presented in Table 7 Tier 2. Extension contacts by agripreneurs from extension service providers positively and significantly influenced the kilogram of banana fruit value added at 5% significant level. The implication of this is that an increase in one extension contact would increase the volume of value-added bananas by 9174.15 kg, *ceteris paribus*. Extension contacts enable the promotion of value-addition skills through the transformation of information, trainings, workshops, and seminars. This finding is in agreement with the study of Musyoka et al. (2020) that that an increase in one extension contacts increased the quantity of mangoes that were used in value addition.

The quantity of banana fruit harvested per acre determines the volume to value added. The quantity of banana harvested in kg positively and significantly influenced the extent of banana value addition at 1% level of significance. Addition of one kilogram of banana fruit harvested, the volume of banana fruit value-added increased by 10.15 kg. This plausibly means agripreneurs adding value, produced more bananas to serve for the surplus used to add value. The result conforms with that of Orinda et al. (2017). While it contradicts Oluwatayo et al. (2022) who documented more quantities of cassava harvested does not increase the extent of value addition because more quantities are wasted because it is a bulk and highly perishable crop.

The type of roads accessed by agripreneurs to output market was broken into Earth, Murram, and Tarmac. Tarmac roads positively and significantly influenced the extent of banana value addition at a 1% significance level. The more agripreneurs accessed Tarmac roads, the volume of bananas that was value-added increased by 40,221.17 kg. Roads are used as a proxy to access

the markets. Well-constructed roads enable agricultural products to reach in the market faster and timely. This is similar to Maku et al. (2022).

Marital status (being married) had a negative and significant influence on the quantity of bananas value added at 10% significant level. A unit increase in the number of married couples decreased volume of bananas value-added by 15490.03 kg, *ceteris paribus*. This is possibly because married couples had more family members with many mouths that fed on bananas than singles. This finding is contrary to Okeke et al. (2022) who reported that married couples invested more in cassava value addition in Nigeria.

CONCLUSIONS AND RECOMMENDATIONS

Findings from the study highlighted the following conclusions.

Compared to non-value adders, value adders were significantly younger, produced larger quantities of bananas, traveled longer distances from their homes to output markets through access to Murram and Tarmac roads, received a higher number of trainings and extension visits, and depended on farming as their primary occupation. However, they owned smaller sizes of land, and only a few of them had access to credit. Furthermore, slicing and drying, and flour milling were the most utilized banana value addition activities in the area, followed by sorting and grading and crisps making.

The current study provided information on the factors that influence the decision of small-scale banana agripreneurs to participate in banana value addition and the extent of their participation decisions. The results revealed that different factors influenced the decision to participate in banana value addition and the extent of value addition.

The results indicated that the number of agricultural trainings, the number of extension visits, group membership, quantities of bananas produced, farming as the main occupation, distance to the output market, and type of roads accessed significantly influenced the decision of agripreneurs to utilize or not to utilize banana value addition positively.

On the other hand, access to credit had a negative significant effect on the decision to add value to banana fruit or not. Regarding the extent of value addition, the number of extension visits, quantities of bananas produced, and type of roads had a positive and significant influence, while marital status (being married) had a negative influence on the proportion of bananas value added.

Contribution to knowledge

The study contributes to both theoretical and empirical literature and provides insights to banana agripreneurs regarding the status of banana value addition activities. While the focus of this study was on Kisii county, Kenya, its implications extend to developing countries with the aim of improving the banana value chain, promoting food security, and enhancing livelihoods through value addition. To the best of the authors' knowledge, literature on the decision and extent of banana value addition was not available, making this study an empirical contribution to existing literature. The factors influencing the decision and extent of participation in banana value addition could be explored in formulating and implementing policies and strategies aimed at promoting banana value addition agri-enterprises by improving factors that ensure the sustainable utilization of these value addition activities. Based on the study findings, the following recommendations were highlighted:

1. Relevant stakeholders, the government, and developmental agencies should implement policies to promote the use of banana value addition activities among agripreneurs. During the formulation and implementation of such policies, there should be a focus on socio-economic and institutional factors influencing both decisions to utilize and the extent of utilization of value addition. These factors include extension contacts, quantity of bananas produced, and type of roads.
2. The Kenyan government should collaborate with extension service providers and the Kenya Industrial Research and Development Institute officers to enhance the provision of agricultural training for agripreneurs. These training programs should encompass farmer field schools, workshops, seminars, demonstrations, and agricultural shows aimed at promoting and disseminating technologies related to banana value addition.
3. Government and private organizations should establish policies to govern and manage agripreneur groups. These policies should ensure that agripreneurs receive services such as credit, training, and value addition equipment as a group. This approach will facilitate information sharing and create awareness about banana value addition innovations, thereby increasing the adoption process.

Suggestions for future research

This study was limited to institutional factors (group membership, access to credit, access to extension, extension contacts, distance to nearest market, number of trainings, experience in banana farming, road type) and socio-economic factors (farm size in acres, main occupation, area under banana production in acres, gender, age, education level, household size) influencing the decision and extent of banana value addition in Kisii County, Kenya. The study, therefore, suggests further studies to be conducted as follows:

1. Future research may consider conducting a

comparative study on the determinants of value addition in other developed or developing countries that are potential banana-growing regions. The study could encompass the entire value chain, including small-scale agripreneur processors, retailers, and wholesalers. Additional factors such as banana variety, perception, livestock equivalence, access to market information, household income, and other technological attributes (such as, accessibility, affordability, complexity, and usability of the technology) could be explored.

2. Further studies need to be conducted on the effect of banana value addition on household income.

3. Another study can be conducted on consumer perception of value-added banana products and the factors influencing consumer acceptance and willingness to pay for such products.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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REFERENCES

Agoh EC (2021). Factors influencing gender participation in the adoption of value addition to sweet potato technologies among post-harvest processors in Imo State, Nigeria. The International Journal of Agriculture, Management and Technology 5(1):262-271.

Al-Dairi M, Pathare PB, Al-Yahyai R, Jayasuriya H, Al-Attabi Z (2023). Postharvest quality, technologies, and strategies to reduce losses along the supply chain of banana: A review. Trends in Food Science and Technology 134:177-191. https://doi.org/10.1016/j.tifs.2023.03.003

Alleluyanatha E (2022). Factors influencing cassava processing among smallholder farmers in Benue State, Nigeria. International Journal of Agriculture and Rural Development 25(1):6152-6158

Barbra W, Sam W (2020). Socio-economic factors and their influence in the adoption of agricultural technologies under subsistence economy: A Case of Tissue Culture Banana in Uganda. Current Agriculture Research Journal 8(3):1-10.

Beyene B, Geta E, Mitiku A (2017). Determinants of producers' participation decision and level of participation on milk value addition at farm level: In the case of Esssera Woreda Dawuro Zone, Southern Ethiopia. Journal of Economics and Sustainable Development 8(3):12-22.

Cochran WG (1977). Sampling Techniques, (3rd Edition) New York: John Wiley and Sons, Inc. https://doi.org/10.1002/bimj.19650070312.

Cragg JG (1971). Some statistical models for limited dependent variables with application to the demand for durable goods. Econometrica 39:829-844

Donkor E, Onakuse S, Bogue J, de los Rios Carmenado I (2018). Promoting value addition among farmers in the cassava food value chain in Nigeria. British Food Journal 120(9):2047-2065. https://doi.org/10.1108/BFJ-01-2018-0030

Easwari S, Maruthupandi K (2020). Recent Research Issues in Banana Production and Marketing Aspects. (1st Edition) Delhi, India: Scripown Publications pp. 1-14.

Esheya S (2023). Factors determining value addition to cassava in Ebonyi North agricultural zone of Ebonyi State, Nigeria. Journal of Agricultural Science and Environment 23(1):49-60.

Food and Agricultural Organization (FAO) (2020). Food Outlook: Biennial report on global food markets. Rome. http://www.fao.org/3/ca6911en/ca/i6911en.pdf

Gebre GG, Fikadu AA, Gebeyehu TK (2022). Is banana value chain in East Africa sustainable? Evidence from Ethiopia. Resources, Environment and Sustainability 8:1-10. https://doi.org/10.1016/j.resenv.2022.100060

Gemechu, GE, Abewoy D, Jaleto K (2021). Post-harvest Loss Assessment of Banana (Musa spp.) at Jimma Town Market. Journal of Plant Studies 10(1):1-7.

Horticultural Crop Directorate (HCD) (2020) Validation report 2019-2020 Retrieved from horticulture. agriculture authority.go.ke, 2nd October 2023.

Jacob A, Adam SU, Fausat AF (2023). Effects economic of cassava value addition on the income of small-scale farmers in Oshimili North, Delta State, Nigeria. Journal of Arid Zone Economy 1(2):89-102.

Jalawadi S, Jagadeesh RC, Naik N, Basavaraj N, Kantharaju V, Mulla SW (2021). Studies on organoleptic evaluation of banana genotypes. Journal of Pharmacognosy and Phytochemistry 10(1):553-556.

Karienye D, Kamiri H (2020). Trends of banana production among smallholders' farmers due to rainfall and temperature variations in Mount Kenya Region, Kenya. Budapest International Research in Exact Sciences 2(2):213-227. https://doi.org/10.33258/birex.v2i2.904

Karienye DK, Nduru GM, Kamiri HW (2021). Climate variability and adaptation among smallholder banana farmers in mountain regions of Kenya. Geography, Environment, Sustainability 14(1):161-170. https://doi.org/10.24057/20719388-2019-27

Kathuri DN, Ndirangu SN, Gichimu B (2021). Adoption of banana (Musa spp) production technology among small-scale farmers in Embu West Sub-County, Kenya. Journal of Agricultural Extension 25(4):109-118. http://eoi.citefactor.org/10.11226/v25i4

Keba A, Yilma B (2022). Analysis of factors affecting banana market participation in the case of Assosa zone of Benishangul gumuz regional state, Ethiopia. Journal of Agricultural Research Pesticides and Biofertilizers 3(4):1-4. http://doi.org/02.2022/1.1065.

Khoza TM, Senyolo GM, Mmbengwa VM, Sound P (2019). Socio-economic factors influencing smallholder farmers' decision to participate in agro-processing industry in Gauteng province, South Africa. Cogent Social Sciences 5(1):1-14. https://doi.org/10.1080/23311886.2019.1664193

Kikulwe EM, Okurut S, Ajambo S, Nowakunda K, Stoian D, Naziri D (2018). Postharvest losses and their determinants: A challenge to creating a sustainable cooking banana value chain in Uganda. Sustainability 10(7):1-19.

Kirimi FK, Nyambane CO, Njeru LK, Mogaka HR (2021). Extension training for banana value addition among smallholder farmers in Meru and Tharaka-Nithi counties, Kenya. African Journal of Agricultural Research 17(4):690-696. https://doi.org/10.5897/AJAR2021.15477

Kolapo A, Omopariola OE, Adeoye AO, Kolapo AJ (2020). Adoption of improved processing technology among African locust bean processors in south-west, Nigeria. International Journal of Agricultural Research Innovation and Technology 10(1):123-128. https://doi.org/10.3329/ijarit.v10i1.48104

Kumar RS, Achudhan S (2021). Perceived Usefulness of Banana Pseudostem Processing and Value Addition among Farmers in Coimbatore District of Tamil Nadu. Journal of Extension Education 33(2):6679-6682. https://doi.org/10.26725/JEE.2021.2.33.6679-6682

Kyomugisha H, Sebatta C, Mugisha J (2018). Potato market access, marketing efficiency, and on-farm value addition in Uganda. Scientific African 1:1-14. https://doi.org/10.1016/j.sciaf.2018.e00013

Lalitha M, Nagalakshmi R, Madhavi M, Kumar KR, Subbaramamma P (2022). Effect of potting media and bio stimulants on the growth of banana plantlets cv. grand naine under ex vitro conditions. The Pharma Innovation Journal 11(8):1334-1339.

Www.thepharmajournal.com.
Maku M, Kitambo E, Mugonola B (2022). Drivers of youth participation in maize value addition in Gulu district, Uganda. African Journal of Science, Technology, Innovation and Development 15(1):45-58. https://doi.org/10.1080/20421338.2021.2015171
Marimo P, Caron C, Van den Bergh I, Crichton R, Weltzien E, Ortiz R, Tumuhimbise R (2020). Gender and trait preferences for banana cultivation and use in Sub-Saharan Africa: A literature review. Economic Botany 74:226-241.
Masud YS, Gacheru J, Ogada MJ, Mcharo M, Maghenda M, Akula LA, Kambura (2022). Diversity of nematodes and endophytic fungi associated with bananas cultivated in Taveta Sub County. African Journal of Horticultural Science 20 (2022):99-116.
Mkandawire VJ, Bett Hk, Gathungu E (2018). Determinants of participation in value addition activities among farmer groups in Ntchisi District, Malawi. Malawi. Journal of Economics and Sustainable Development 9(20):1-9.
Mohamed Z, Rezai G, Shamsudin MN, Mahmud MM (2022). Evaluation of agribusiness program on youth decision and participation level in micro and small horticultural enterprises in Tanzania. International Journal of Science and Research 11(6):1-13. https://doi.org/10.21275/SR22601004542
Muigai JK, Gathungu GK, Thogori M (2021). Socio-economic factors affecting uptake of banana value addition among smallholders in Chuka Sub-County, Tharaka Nithi County, Kenya. Asian Journal of Agricultural Extension Economics and Sociology 39(1):22-34.
Musyoka JK, Isaboke HN, Ndirangu SN (2020). Farm-level value addition among small-scale mango farmers in Machakos county, Kenya. Journal of Agricultural Extension 24(3):85-97. https://doi.org/10.4314/jae.v24i3.8
Muthee AI, Gichimu BM, Nthakanio PN (2019). Analysis of banana production practices and constraints in Embu County, Kenya. Asian Journal of Agriculture and Rural Development 9(1):123-132
Natukwatsa P (2021). Factors influencing the adoption of value addition in banana among smallholder farmers in Ruhumuro sub-county, Bushenyi district, Uganda. Unpublished undergraduate thesis, Makerere University, Uganda. https://doi.org/10.4314/dujopas.v7i4b.14
Ngenoh GC, Kariuki IM, Gathungu EW, Kiprop SK (2020). Factors influencing the choice of marketing strategies among cassava microenterprises in Kenya. African Crop Science Journal 28(1):117-129. https://doi.org/10.4314/acsj.v28i1.9S
Nkwain K, Odiaka EC, Ikwuba AA, Nkwi GE (2021). Analysis of post-harvest losses of banana and the economic wellbeing of farmers in Boyo Division, North West Region of Cameroon. Dutse Journal of Pure and Applied Sciences 7(4b):78-88. https://dx.doi.org/10.4314/dujopas.v7i4b.14
Obaga BR, Mwaura FO (2018). Impact of farmers' participation in banana value addition in household welfare in Kisii Central Sub-County. International Academic Journal of Social Sciences and Education 2(1):25-46. http://www.iajournals.org/articles/iajsse.
Okeke AM, Salami AO, Nkemjika FS (2022). Investment decision and level of investment in marketing of value-added products of yam and cassava in Benue State, Nigeria. Agro-Science 21(3):75-84.
Olumba CC, Onunka CN (2020). Banana and plantain in West Africa: Production and marketing. African Journal of Food, Agriculture, Nutrition and Development 20(2):15474-15489. https://doi.org/10.18697/ajfand.90.18365
Oluwatayo I, Idiaye C, Yusuff M (2022). Intensity and profitability of smallholder cassava farmers' participation in value addition in Afijio Local Government Area of Oyo State, Nigeria. Applied Studies in Agribusiness and Commerce 16(1):1-12. https://doi.org/10.19041/APSTRACT/22/0
Omondi W, Bett H, Njagi T (2020). Influence of Collective Action Participation on Technical Efficiency among Smallholder Producers: A Case of Banana Farmers in Kisii and Nyamira, Kenya. Journal of Food Security 8(3):105-116. https://doi.org/10.12691/jfs-8-3-4
Orinda M, Patience M, Job L (2017) Analysis of the determinants of sweet potato value addition by smallholder farmers in Kenya. Journal of Economics and Sustainable Development 8(8):1-11. https://core.ac.uk/reader/234647840
Osondu CK, Ogbonna SI, Udah SC (2023). Impact of adoption of cassava value added technologies on women cassava farmers welfare in Abia State, Nigeria. Global Journal of Agriculture and Veterinary Science 1(1):1-11.
Ronoh EK, Kanali CL, Ndirangu SN, Mung'atu JK, Muchui MN (2022) Assessment of Banana Harvesting and Postharvest Handling Practices among Smallholder Farmers in Nyeri and Tharaka Nithi Counties. In Proceedings of the Sustainable Research and Innovation Conference.
Singh R, Kaushik R, Gosewade S (2018). Bananas as underutilized fruit having huge potential as raw materials for food and non-food processing industries: The Pharma Innovation Journal 7(6):574-580. https://www.researchgate.net/publication/327136284
Subbaiah KV, Jagadeesh SL, Manjula R, Rani NS (2018). Value-added studies in banana as a commercial enterprise. Journal homepage: http://www. ijcmas. Com 7(3):1-5. https://doi.org/10.20546/ijcmas.2018.703.xx
Sugianti C, Imaizumi T, Thammawong M, Nakano K (2022). Recent Postharvest Technologies in the Banana Supply Chain. Reviews in Agricultural Science 10:123-137. https://doi.org/10.7831/ras.10.0_123
Survey of Kenya (SOK) (2022). Ministry of Land, Housing and Urban Development. https://lands.go.ke/department-of-survey/.
Tarekegn K, Asado A, Gafaro T, Shitaye Y (2020). Value chain analysis of banana in Bench Maji and Sheka Zones of Southern Ethiopia. Cogent Food and Agriculture 6(1):1-20. https://doi.org/10.1080/23311932.2020.1785103
Thangavelu R, Saraswathi MS, Uma S, Loganathan M, Backiyarani S, Durai P, Swennen R (2021). Identification of sources resistant to a virulent Fusarium wilt strain (VCG 0124) infecting Cavendish bananas. Scientific Reports 11(1):1-14. https://doi.org/10.1038/s41598-021-82666-7.
Tijani SA (2022). Determinants of utilisation of tomato value addition technology among beneficiaries in Oyo State, Nigeria. Agricultura Tropica et Subtropica 55(1):169-184.
Wahome CN, Maingi JM, Ombori O, Kimiti JM, Njeru EM (2021). Banana production trends, cultivar diversity, and tissue culture technologies uptake in Kenya. International Journal of Agronomy 2021:1-11. https://doi.org/10.1155/2021/6634046.
Wondim D, Aynalem M, Fekadie A, Fentahun G (2023). What are the factors determining participation decision and level of participation in milk value addition? Evidence from Northwest Ethiopia. Preprints. https://doi.org/10.20944/preprints202305.1566.v2.
Wooldridge JM (2010). Econometric Analysis of Cross Section and Panel Data. 2nd eds. MIT Press.
Zinabu A, Bikila T, Temsgen O, Diriba A (2019). Review on the production and marketing of banana in Ethiopia. World Journal of Agriculture and Soil Science 2(1):1-9.