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Determinants of smallholder farmers' satisfaction with agricultural extension services in Embu County, Kenya

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Abstract

Agricultural extension services (AES) positively foster agricultural sustainability through knowledge transfer of agricultural technologies, hence enhancing household food security among the rural poor. However, information on farmers' satisfaction with AES is limited in many areas within Kenya, although these services have been offered to farmers for decades. This study assessed smallholder farmers' satisfaction with AES in Embu County in Kenya and identified its associated household demographic, socio-economic, and institutional determinants. Data were collected from 396 farmers using a structured interview schedule through a cross-sectional survey with a multistage stratified sampling procedure. Data analyses were performed using the Cumulative Link Mixed Models (CLMMs) with a random effect for the village ID to adjust the results for the correlation of farmers' satisfaction within the village. This study revealed that 10.1 %, 38.6 %, 43.2 %, and 8.1 % of the farmers were very satisfied, moderately satisfied, moderately dissatisfied and very dissatisfied with AES, respectively. The results of the multivariable CLMM analysis identified education level, off-farm income, the land tenure system, frequent extension contact, and access to credit as significant determinants of farmers' satisfaction with AES. The findings will help policy makers and extension workers to develop context-specific AES that take into account farmers' extension needs, thereby improving the AES delivery system and enhancing agricultural development in the area.

Keywords: Agricultural productivity, advisory services, extension, smallholder farmers, satisfaction

1 Introduction

Agriculture is a significant contributor to the world's economic development as it employs about one billion people worldwide besides being an important source of raw materials, foreign exchange, basic food, and income to more than half of the developing country's population (Loizou *et al.*, 2019). Globally, agricultural extension services (AES), also known as agricultural advisory services, have been introduced to enhance agricultural productivity and sustainability, to improve the dissemination of useful information such as prices of crops, livestock/crop management and marketing, and to introduce new or hybrid seed varieties as well as to communicate new agricultural technologies to farmers (Muyanga & Jayne, 2006). AES remains the primary and most efficient way of reaching rural and global farming households. In Kenya, AES services are mainly provided by the government, private commercial companies such as those dealing with inputs and outputs supplies, non-commercial companies such as Non-Governmental Organisations (NGOs), and other stakeholders including producer and farmer organisations (Muyanga & Jayne, 2006).

AES has contributed to various spheres such as climate change mitigation by disseminating climate change information to farmers in developing countries (Afsar & Idrees, 2019; Antwi-Agyei & Stringer, 2021). It also assists in problem-solving and participating in agricultural knowledge and information system delivery (Danso-Abbeam *et al.*, 2018). Furthermore, extension workers provide relevant information that enriches farmers' knowledge, changes their attitudes, passes new technologies, and assists them in solving farming-related problems (Kassem *et al.*, 2021). Exten-

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sion personnel offer services such as linkage with sources of farm inputs and credit, information on marketing, workshops, and training for farmers, demonstrations of improved agricultural production practices, organising tours, visits, or excursions to large farms, home welfare improvement services, and information on environmental conditions (Kingiri, 2021).

Despite the relevance of AES, smallholder farmers in many developing countries do not have access to quality extension and advisory services and are dissatisfied with extension services (Elias *et al*., 2016). This is because the delivery of AES has been faced with numerous challenges including inadequate support from extension personnel thus not able to meet farmers' farm needs (Mamun-ur-Rashid *et al*., 2018), poor interdependence between research and extension, limited funds, and poor farmer participation in extension schedules (Ashraf & Yousaf Hassan, 2021). In Kenya, AES are provided by government in a top-down approach that is highly criticized for being inflexible, non-participatory and also thought to be a major contributor of low agricultural productivity (Muyanga & Jayne, 2006). There has been also a decline in the delivery of AES over the years due to low budgetary allocation, decreasing resources in the public sector, and decentralization of AES to the county-level government (Kyambo *et al*., 2021). The sector is also faced with inefficiencies in the delivery of extension services attributed to inadequate and unstable funding, poor logistic support for field staff, and the use of poorly trained personnel (Conradie, 2016). Other challenges include ineffective agricultural research extension linkages, insufficient and inappropriate agricultural technologies for farmers, and inadequate extension agents (Bruce & Costa, 2019; Kassem *et al*., 2021). Inadequate or lack of access to AES and relevant agricultural information hampers the capacity of farmers to address their daily challenges and delays the achievement of its vast benefits. In this respect, it is essential to ensure that the outcomes of AES are compatible with farmers' expectations (Mapiye *et al*., 2021).

In sub-Saharan Africa, there is an ineffective and insufficient flow of information and knowledge to farmers as a result of many challenges facing various extension service approaches (Olayemi *et al*., 2021). The performance of AES depends on the ability of farmers to continuously participate in them, which in turn reflect their satisfaction. However, there is little or no literature in Kenya that focuses on farmers' satisfaction with AES, which could be influenced by various factors. Furthermore, the development of context-specific AES that take into account farmers' needs and the agro-ecological environment is crucial for improving the quality of AES and farmers' satisfaction level with extension services. This study therefore, sought to determine the levels of satisfaction of farmers with AES in Embu County in Kenya and also identify its demographic, social-economic and institutional determinants. The findings from this study will help in the improvement of AES delivery system and farm productivity in the study area. Furthermore, this will also assist in the development of a cost-effective broad-based extension system that meet farmers' needs and expectations.

2 Materials and methods

2.1 Study area

This study was conducted in Embu County (Fig. 1), an area with limited information on farmers' satisfaction with AES despite these services being offered for decades. Six wards were purposely selected due a high number of smallholder farming households, and extension services have been offered to farmers in the area by government, private, non-governmental organisations, and producer and farmer organisations for a long period of time. The study area lies between 1,000 and 2,070 m above sea level and covers an area of 253.4 km^2 with 177.3 km^2 being arable land (KNBS 2019). The area receives bimodal rainfall that ranges between 800 mm and 1500 mm annually. The long rain season occurs between March and June, while short rains occur from October to December. Dairy farming and crop agriculture are the main economic activities practiced in the area. Dairy cattle mainly the Friesian and Ayrshire breed and their crosses, goats and poultry are the main livestock kept. Tea and coffee are the main cash crops grown in the area, while bananas, maize, beans, cassava, and vegetables are the primary food crops cultivated.

2.2 Study design, sample size estimation and sampling procedure

A cross-sectional survey design was used to collect data between January and February 2023. The sample size (n) for the number of farmers (represented by households) to be interviewed was estimated using the formula $n = N/(1 + N \times e^2)$, which is used when the target population size is known (Chaokromthong & Sintao, 2021). The target population (N) in this study was 43,198 smallholder livestock and crop farming households in the selected six wards (KNBS, 2019) while the level of precision (e) was taken to be 0.05. Using these parameters, the estimated required sample size was 396 farmers.

The study adopted a multistage stratified sampling procedure. From each ward, one sub-location and a village were selected through simple random sampling. A list of

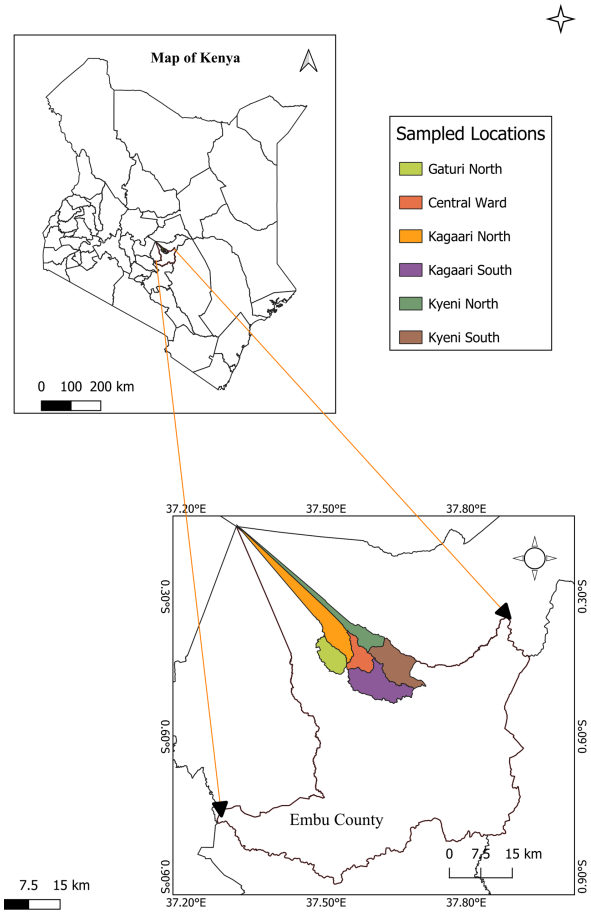

Fig. 1: *Map of Kenya and details of the study sites.*

all smallholder farmers' households in the selected villages was then obtained from the area administrators. The number of households to be interviewed per village was proportional to the total number of households in each selected village thus more households were interviewed in villages with high number of households. This was determined using the proportional sampling allocation formula; $n_i = N_i \times n/N$, where N_i is the total number of households for farmers in the selected villages, n is the estimated sample size of 396 farmers, and N is the total number of households in the selected wards (Kothari, 2004). The surveyed households in each village were selected through simple random sampling.

2.3 *Data collection*

Data on household demographic, socio-economic, and institutional factors known to influence farmers' satisfaction with AES were collected through face-to-face interviews using an interview schedule uploaded in KoboCollect, an open-source mobile-phone based data collection application. Farmers' satisfaction with AES (dependent variable) was measured using a Likert scale with four categories (1 = very dissatisfied, 2 = moderately dissatisfied, 3 = moderately satisfied, and 4 = very satisfied). Prior to actual data collection, the interview schedule was pre-tested with 20 randomly-selected farmers in one village within the study area and with similar characteristics as the study villages.

2.4 *Data analysis*

The interview questionnaire data collated into one MS excel file was downloaded from KoboCollect, and cleaned. Using the R software environment (version 4.1.3), preliminary descriptive analyses were done to compute the frequencies and percentages of the respondents by the various household demographics, socio-economic and institutional factors (independent variables). Further estimation of the frequencies and percentage distribution of the farmers' levels of satisfaction with AES and by categorical variables was also conducted. These estimates were obtained through cross-classification tables created using the gmodels package (Warnes *et al.*, 2018). The DescTools package was then used to derive the 95 % confidence intervals (CI) for these estimates (Signorell *et al.*, 2021). The χ^2 test was further performed to assess whether categorical variables significantly influenced farmers' satisfaction with AES. Quantitative discrete factors were first subjected to normality test for residuals using the Shapiro-Wilk test prior to analyses. For variables that were statistically significant ($p \leq 0.05$), an indication that the linearity assumption was not met, we created categorical and log-transformed versions for each variable and used them in turns in the analyses. Quantitative variables were also summarised using median and range due to right skewness of the data.

These data were further analysed using Cumulative Link Mixed Models (CLMMs) with a logit link function being defined in the models (Christensen, 2019). The choice of these models was informed by the dependent variable measured in ordinal scale and the hierarchical clustered structure of the data (within villages) due to the sampling design used. These models were implemented using the clmm function in ordinal package (Christensen & Christensen, 2015). The model parameters were estimated using the adaptive Gauss-Hermite quadrature approximation method with ten quadrature points. To identify candidate variables for multivariable analysis, univariable CLMMs were first fitted for all independent variables. Variables with p values of ≤ 0.05 were then used to fit a maximum (global) multivariable CLMM. Non-significant variables ($p > 0.05$ in this model were removed via backward stepwise elimination approach to get a final minimum CLMM with lowest Akaike's Information Criteria (AIC) and only significant predictors. While fitting the univariable and multivariable CLMMs, the vil-

lage ID was included a random effect while the other independent variables were entered as fixed effects. The final model was specified by the equation below, adapted from Christensen (2019).

$$\begin{aligned}\text{logit}(P(Y_i \leq j)) = \theta_j - \beta_1(\text{education}) - \beta_2(\text{off farm income}) \\ -\beta_3(\text{land tenure}) - \beta_4(\text{frequency of receiving AES}) \\ -\beta_5(\text{access to credit}) - \beta_6(\text{distance to AES}) - \mu(\text{village ID}) \\ i = 1, \ldots, n, j = 1, \ldots, J = 1\end{aligned}$$

The above model denotes the cumulative probability of the ith rating falling in the j^{th} level (category) or below, where i index all observations and $j = 1,\ldots, J$ index the dependent variable categories ($J = 4$) while the cut-points (threshold coefficients) are given by $[\theta_j]$. The village effects were taken to be random and normal: $\mu(\text{village ID}) \sim N(0, \delta 2\mu)$. The included random effect in the models allowed the estimation of the intra-cluster (within-village) correlation coefficient (ICC), a measure of how the dependent variable was correlated among farmers within villages. The ICC given as a proportion of between-group variance over total variance, was estimated using the performance package (Lüdecke *et al*., 2021) from the random effect variance of the final CLMM. The goodness of fit of the final CLMM was evaluated by comparing the AIC value obtained from this model to that generated from a null model created with an intercept as the only fixed effect. We also compared the results from the advanced CLMM analyses with those obtained from the conventional cumulative link models (CLMs), also referred as ordered logit models (Agresti, 2012), fitted without a random effect for village ID.

3 Results

3.1 Descriptive results for household demographics, socio-economic and institutional characteristics of farmers

A total of 396 smallholder farmers comprising 202 (51.0 %) males and 194 (49.0 %) females were interviewed as shown in Table 1. All the interviewed farmers had received AES for crop and/or livestock production from both public and private sectors. The included households had a median family size of 4, while the median age of the farmers was 50 years. Most of these farmers (86.4 %) were 36 years old and above. The median number of years of farming experience was 20. About 65.7 % of the farmers had more than 11 years of farming experience. All the respondents were engaged in diversified farming activities, rearing livestock as well as crops. The main crops grown in the area were tea, coffee, bananas, khat, macadamia, mangoes, avocado

Table 1: *Household demographics, socioeconomic and institutional characteristics of farmers (n = 396).*

Variable	*Category*	*%*
Gender	Male	51.0
	Female	49.0
Household family size	≤4 members	67.4
	≥ 5 members	32.6
Age household head (years)	≤35	13.6
	36-50	41.4
	≥51	45.0
Farming experience (years)	≤10	34.3
	11-20	19.9
	≥21	46.7
Marital status	Married	78.3
	Single	9.6
	Widow	10.4
	Widower	1.8
Education level	Non-formal education	12.4
	Primary education	40.4
	Secondary education	34.6
	Tertiary education	12.6
Occupation	Farming only	74.5
	Farming and business	22.5
	Farming and salaried	2.5
	Farming, salaried and business	0.5
Farm size (ha)	< 1	34.3
	1-2	49.9
	>2	15.9
Land tenure	Owned with title	62.4
	Owned no title	33.3
	Rented in	4.3
Livestock species kept	Poultry only	16.9
	Cattle only	6.8
	Goats only	3.3
	Poultry and cattle	21.0
	Cattle and goats	1.3
	Poultry, cattle and goats	22.2
	Poultry, cattle, goats and sheep	2.3
	Poultry, goats and pigs	26.3
Decision maker livestock production	Male	44.2
	Female	55.8
Decision maker crop production	Male	46.0
	Female	54.0
Incur labor costs	No	69.8
	Yes	30.2
Labor sources	Family	73.7
	Hired	26.3
Off-farm income	No	65.3
	Yes	34.7
Consult extension agents	Yes	51.0
	No	49.0
Frequency of receiving AES	once per year	14.7
	2 times per year	28.0
	3 times per year	15.2
	4 times per year	42.2
Access to credit	Yes	34.9
	No	65.2
Sources of credit	Banks	39.9
	Farmer groups (FG)	27.5
	SACCO and banks	20.3
	Banks, FG	5.1
	FG and SACCO	2.9
	Banks, SACCO and FG	4.4
Credit use	Farming (farm)	36.2
	Farm and school fees	41.3
	Farm, medical and school fees	22.5
Farmer group participation	No	70.4
	Yes	29.6

Notes: SACCO, savings and Credit Cooperative Society. AES = Agricultural extension services.

Table 2: *Results of variables found to be significantly associated with farmers' satisfaction with agricultural extension services (AES) based on the univariable cumulative link mixed model (CLMM).*

Fixed effects	*Category*	*Estimate (SE)*	*Odds ratio (95% CI)*	*P-value**
Education level	Non-formal education		Ref.	
	Primary education	0.91 (0.32)	2.48 (1.31-4.67)	0.005
	Secondary education	1.16 (0.33)	3.20 (1.68-6.13)	0.001
	Tertiary education	1.38 (0.39)	3.98 (1.84-8.62)	0.001
Years of farming experience	≤10 years		Ref.	
	11–20	0.59 (0.27)	1.81 (1.06-3.09)	0.030
	21	-0.17(0.22)	0.84 (0.54-1.29)	0.436
Off-farm income	No		Ref.	
	Yes	0.48 (0.20)	1.62 (1.09-2.40)	0.016
Land tenure system	Owned no title deed		1.00 (Ref.)	
	Owned title deed	0.35 (0.21)	1.42 (0.95-2.12)	0.089
	Rented in	1.68 (0.50)	5.37 (2.03-14.23)	0.001
Decision maker for livestock	Male		Ref.	
	Female	-0.48 (0.20)	0.62 (0.42-0.91)	0.015
Incur labour cost	No		Ref.	
	Yes	0.45 (0.21)	1.57 (1.04-2.37)	0.031
Sources of labour	Family		Ref.	
	Hired	0.60 (0.22)	1.82 (1.19-2.79)	0.006
Consult extension agents	No		Ref.	
	Yes	0.38 (0.19)	1.47 (1.00-2.14)	0.049
Frequency of receiving AES	1 time per year		Ref.	
	2 times per year	-0.27 (0.30)	0.77 (0.42-1.38)	0.375
	3 times per year	0.42 (0.36)	1.53 (0.76-3.07)	0.232
	4 times per year	1.02 (0.30)	2.79 (1.55-5.00)	0.001
Distance to AES†	-	0.44 (0.15)	1.55 (1.15 -2.10)	0.004
Access to credit	No		Ref.	
	Yes	0.44 (0.15)	1.55 (1.15-2.10)	0.004

*P-values were significant at ≤ 0.05. †Distance to AES was included as a log transformed variable hence there are no categories for this variable. Ref: reference category; CI: confidence interval; SE: standard error.

and various vegetables, while poultry, sheep, goats, cattle and pigs were the main livestock. However, farmers showed different preferences for specific livestock species, as shown in Table 1. A high percentage of farmers (51.0 %) reported consulting extension agents, with the median distance to these agents being 2 km.

3.2 Analysis of factors influencing farmers' satisfaction with Agricultural extension services

The different categories of farmers' satisfaction with AES were 10.1 % (very satisfied), 38.6 % (moderately satisfied), 43.2 % (moderately dissatisfied) and 8.1 % (very dissatisfied). Results showing farmers' satisfaction by categorical independent variables are shown in supplementary file 1. The results from the univariable CLMMs that analysed the associations between the farmers' satisfaction with AES and independent variables with village ID as a random effect are given in Table 2. These results showed that education level, years of farming experience, whether farmers had sources of off-farm income, land tenure system, gender of the decision maker for livestock production, sources of labour, whether farmers incurred labour costs and consulted extension agents; frequency of receiving AES, distance to agents offering AES (as a log transformed variable), and access to credit were all significant determinants of farmers' satisfaction with AES. The categorical variables that were not significantly associated with the satisfaction of farmers with AES included farmer's gender, marital status, occupation, gender of decision maker for crop production and whether farmers belonged to a group or a local organization. Quantitative variables such as age, household family size, farm income per year, and farm size were not identified as significant factors influencing farmers' satisfaction with AES from the analyses done using both log-transformed and cat-

Table 3: *Results of variables found to influence farmers' satisfaction with agricultural extension services (AES) based on the multivariable cumulative link mixed model (CLMM).*

Fixed effects	*Category*	*Estimate (SE)*	*Odds ratio (95 % CI)*	*P-value**
Education level	No formal education		Ref.	
	Primary education	0.80 (0.34)	2.22 (1.14-4.30)	0.019
	Secondary education	0.73 (0.35)	2.08 (1.04-4.16)	0.038
	Tertiary education	1.08 (0.41)	2.96 (1.30-6.72)	0.009
Off-farm income	No		Ref.	
	Yes	0.59 (0.21)	1.80 (1.19-2.73)	0.006
Land tenure system	Owned no title deed		1.00 (Ref.)	
	Owned title deed	0.17 (0.22)	1.19 (0.77-1.82)	0.433
	Rented in	1.18 (0.52)	3.27 (1.18-9.01)	0.022
Frequency of receiving AES	1 time per year		Ref.	
	2 times per year	-0.20 (0.32)	0.82 (0.44-1.52)	0.523
	3 times per year	0.41 (0.37)	1.51 (0.73-3.13)	0.264
	4 times per year	1.13 (0.31)	3.10 (1.68-5.72)	<0.001
Access to credit	No		Ref.	
	Yes	0.54 (0.28)	1.71 (1.09-2.68)	0.018
Distance to AES†		0.44 (0.15)	1.56 (1.14-2.13)	0.005

Ref: reference category; CI: confidence interval; SE: standard error; *P-values were significant at ≤ 0.05.
†Distance to AES was included as a log transformed variable hence this variable has no categories. The number of observations in the final model were 384 while the log likelihood was -402.88.

egorical versions of these variables. All statistically non-significant (p >0.05) variables by univariable CLMMs were excluded in the subsequent multivariable CLMM analysis.

The results of the final multivariable CLMM fitted to the data with village ID as a random effect to adjust the analysis for the correlation of the dependent variable among farmers within villages are shown in Table 3. These results revealed that farmers' satisfaction with AES varied significantly by education level. Farmers with primary, secondary and tertiary education were more satisfied with AES compared to those without formal education. Also, farmers with sources of off-farm income were more satisfied with AES than those without. Land tenure system was also identified as a significant predictor of farmers' satisfaction with AES. Those who rented in farms were more satisfied with AES relative to those who did not own title deeds. However, the level of satisfaction with AES did not differ significantly between farmers with title deeds and those without. This study also observed an ordinal increase of farmers' satisfaction with the frequency of receiving AES, although statistically significant differences were only found between those who received these services four times (maximum observed frequency) versus those who received once per year. In addition, farmers who had access to credit were significantly more satisfied with AES compared to those without access to credit. The results also revealed a linear relationship between farmers' satisfaction with AES and distances to AES agents.

The variance of the random variable (village ID) calculated from the final multivariable CLMM was 0.09. From the random effect variance constituents, we estimated an ICC of 0.03. Based on the LRT test, none of the fixed effects in the final model showed significant interactions since all the LRT χ^2 p-values were more than 0.05. Upon comparison of the null intercept model with the final multivariable CLMM, the latter had a better fit of the data due to a low AIC value. The AIC estimates were 915.98 and 835.77 for the null and final models, respectively. Results from the additional analyses also demonstrated that CLMMs yielded better outputs than the conventional CLMs. The univariable and multivariable results from CLM analyses are presented in supplementary files 2 and 3, respectively.

4 Discussion

This study assessed farmers' satisfaction with agricultural extension services in Embu County. The results showed that less than 50 % of the respondents were either moderately (38.6 %) or very satisfied (10.1 %) with AES in the area. Given that agriculture is the main economic activity in the area and in Kenya as a whole, the low level of farmer satisfaction with AES observed in this study could have a significant impact on household food security and exports of cash crops grown in the area due to lack of farmer motivation and poor results from extension services. It could also

lead farmers to seek alternative extension services, thus affecting agricultural sustainability (Montes de Oca Munguia *et al*., 2021). Satisfaction with AES among farmers was also not correlated with villages, as shown by the significantly low intra-cluster correlation coefficient (0.03) calculated in this study. This finding suggests that farmers' satisfaction with AES was independent of villages and could be due to the different AES received by farmers in villages for crop and/or livestock production and their perceived quality and effectiveness.

This study also found a significant positive relationship between farmers' satisfaction with AES and their level of education. Farmers with tertiary, secondary and primary education were significantly more satisfied with AES than those with no formal education. However, another study conducted in the Eastern Caribbean showed contrasting results, as farmers with lower levels of education were more satisfied with AES relative to those with secondary and tertiary education (Ganpat *et al*., 2014). Furthermore, several other studies found no significant relationship between education level and farmers' satisfaction with AES, for example in India (Joshi & Narayan, 2019), Ethiopia (Elias *et al*., 2016) and Egypt (Kassem *et al*., 2021). Through education, farmers acquire skills and knowledge, as well as the ability and confidence to achieve their goals. Educated farmers are likely to be more aware of available AES and also more willing to use extension information than those without formal education. The lower levels of satisfaction among farmers without formal education than among those with high levels of education could also be attributed to the use of inappropriate approaches or tools to reach the former category.

Farmers with sources of off-farm income were also found to be more satisfied with AES than those without, consistent with other studies (Elias *et al*., 2016). Related to this, access to credit was also identified as an important determinant of farmers' satisfaction with AES. Whereas this is also a common finding reported by other studies (Kassem *et al*., 2021). These factors are related to the derived benefits from AES. In general, farmers with off-farm income and access to credit are likely to have higher agricultural productivity and higher farm income as they are able to meet their farming needs including paying for extension services and purchase of farm inputs. Indirectly, this could positively influence their satisfaction with extension services.

The findings from this study also showed that farmers who consulted extension agents were more satisfied than those who did not. Furthermore, farmers' satisfaction increased with the frequency of receiving extension services in agreement with several other studies, for example in India (Joshi & Narayan, 2019), Eastern Caribbean States (Ganpat *et al*., 2014) and Ethiopia (Elias *et al*., 2016). As noted by Ganpat *et al*., (2014), farmers with more frequent extension visits are more exposed and have an opportunity to learn about innovations that could increase their agricultural productivity relative to those visited less frequently. The frequent extension visits also allow farmers to seek explanations for failed or ineffective extension services offered in the previous visits hence building a positive relationship between the farmer and AES providers. Although it is expected that farmers near extension agents are likely to be more satisfied than those far away due to proximity to extension services providers, our results showed a linear relationship between farmers' satisfaction and distances to AES agents. This finding could be attributed to the different extension services sourced by farmers. However, more studies are required to elucidate this finding.

According to land tenure system, farmers who rented in land were more satisfied with AES compared to those who did not own title deeds. Statistically significant differences were not found between farmers with title deeds and those without. We argue that this finding could be because farmers who rent in farms often use the best farming practices including regularly seeking extension services in order to derive maximum benefit from their investment. Indeed, our further analysis showed that 71 % of farmers who rented in land consulted AES agents four times per year compared to 44.1 % who did own title and 34.8 % who did not own title. Frequent consultation of AES providers as argued previously, is a key determinant of farmers' satisfaction because farmers are able to acquire knowledge and skills, receive technical advice and information, and guidance on how to structure and develop organisations for farmer which results in higher agricultural yields and economic stability.

Years of farming experience was also a significant predictor of farmers' satisfaction with AES. Significant differences were observed between farmers with 11-20 years of experience versus those with less than 10 years but not between those with more than 21 years of experience and less than 10 years. While this finding does not show an ordinal increase in satisfaction with years of farming experience, older farmers are likely to seek AES compared to young farmers as they are more experienced (Agholor *et al*., 2013). On the contrary, young farmers are flexible and are quick to adopt new technologies compared to old farmers who are more sceptical and unwilling to risk implementing innovations (Ganpat *et al*., 2014). In terms of gender, women were more satisfied than men as decision-makers in livestock production. This finding could be due to the fact that a higher percentage of women (56.4 %) belonged to agricultural groups compared to men (43.6 %). There are many

benefits to farmers belonging to an agricultural group, such as access to AES information and linkages for market access to farm inputs and outputs. However, overall, this study found no significant association between farmers belonging to a group or organisation and satisfaction with AES. Households that could afford hired labour were also more satisfied than those that relied on family labour only. This is because they were more likely to implement extension advice, for example on cropping practices and adoption of new technologies, which helped them to increase their agricultural productivity and other farm related benefits.

Given that data were analysed using the CLMMs accounting for the clustering of the dependent variable within villages, one of the limitations of this study is that the estimated sample size was not adjusted for design effect (i.e., variance inflation factor, VIF) due to lack of prior data on within-village ICC estimates in the study area and other similar settings. Nevertheless, future studies will benefit from our study, for instance, in sample size estimation since we calculated an ICC value which is often a neglected concept in many studies investigating farmers' satisfaction with AES. Based on the sensitivity analyses performed to compare outputs from CLMMs and the traditional CLMs, the former produced more significant factors further justifying the application of these advanced models in data analyses. Moreover, pooled data were also collected from farmers who received AES for crop and/or livestock production from public and private sectors and thus analyses could not be performed for data segregated by these groups. However, to the best of our knowledge this being the first empirical study in the area, it will form a significant baseline for future studies.

5 Conclusion

This study has shown that farmer satisfaction with AES is low, so more efforts are needed to ensure that farmers are fully satisfied and benefit from the various extension services offered in the area. This will ultimately increase farmers' productivity, food security and alleviate poverty in the area. Furthermore, fully satisfied farmers are also likely to try out new agricultural technologies and services, which could lead to increased agricultural productivity. We conclude that the level of education, having a source of off-farm income, land tenure system, extension contact, distance to AES service providers, and access to credit are key drivers of farmer satisfaction with AES in our study area.

The main policy implication is that there is a need to provide high quality extension services that are tailored to the local agro-ecological conditions to meet farmers' needs, expectations and preferences as this can elicit negative behaviours and emotions. For instance, the heterogeneity of farmer satisfaction with AES and the lack of correlation of farmer satisfaction with AES within study sites indicate that a 'one size fits all' approach to agricultural extension is not appropriate for farmers. Therefore, policy makers should develop and disseminate farmer crop and livestock farmer-specific extension designs to improve the capacity of the extension system to meet the evolving needs and expectations of farmers. It is also crucial for the AES providers in the area to conduct regular satisfaction surveys to measure their effectiveness, relevance, accessibility, and assurance. This can be done by establishing a monitoring and evaluation system in the area to provide feedback for improvement of extension system which remain weak in many developing countries. Finally, we recommend further studies to elucidate farmers' satisfaction with AES from the private and public sectors and for different farming activities such as crop versus livestock production.

Conflict of interest

The authors declare that they have no conflict of interest.

Data availability statement

All data collected and analysed in this study are included in this manuscript. All raw data are available without any reservation upon request from the corresponding author.

Supplement

The supplement related to this article is available online on the same landing page at: https://doi.org/10.17170/kobra-2024093010896 .

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