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Evaluating the Availability and Accessibility of Agricultural Extension Services Under the Single Spine System in Uganda. A Case of Smallholder Crop Farmers in Buhweju District

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Abstract

Purpose: This study evaluated the availability and accessibility of agricultural extension services under the Single Spine System, with a specific focus on smallholder crop farmers in Buhweju District.

Methodology: The study adopted a mixed-methods approach, employing both quantitative and qualitative data collection techniques. Structured questionnaires were administered to a sample of 393 smallholder crop farmers and key informant interviews with district agricultural officers and extension workers provided in-depth insights into the delivery of services.

Findings: The results indicate that education was positively and significantly ($P<0.01$) associated with knowledge about the availability of extension services. Farmers with more years of schooling had a greater likelihood of being aware of extension providers. Similarly, larger households with more labor resources (median size = 4) had better access to extension services. Moreover, household land size (median = 3 acres) and income (median = UGX 250,000) were significantly correlated with both availability and access to extension services, with wealthier farmers seeking more information to improve agricultural productivity. The study also revealed that proximity to extension service centers was a critical factor; households closer to sub-county offices (median distance = 1.5 km) had higher knowledge of available services. Access to credit and group membership were also major determinants of both awareness and access to extension services. Challenges were also identified, including limited outreach by extension officers, inadequate allowances, and insufficient logistical support for field officers.

Unique Contribution to Theory, Policy and Practice: The study recommends increased sensitization efforts using local leaders, social media, and community networks, alongside greater support for sub-county agricultural officers to ensure effective service delivery.

Keywords: *Agricultural Extension Services, Single Spine System, Smallholder Farmers, Availability, Accessibility, Education.*

Introduction

Globally, the role of agricultural extension in the transformation of the agriculture sector has been widely recognized. A strong agricultural extension system is crucial for improving agricultural productivity, food security, and household incomes [1]. It enhances farmers' access to knowledge, information, and advice on new technologies, leading to improved agricultural practices and increased household incomes [2]. A well-structured and functioning system ensures timely, appropriate, and quality extension services [3]. Global agricultural extension systems are evolving due to technological advancements and new challenges like population growth, water scarcity, and soil degradation [4]. However, most developing countries struggle to establish effective extension systems [5].

Uganda's Agricultural Extension System has been reformed multiple times to improve crop production, as over half of the population relies on it for food and income [6]. The country's high crop potential is due to low temperatures, bi-modal rainfall, and fertile soils [7]. However, challenges like limited manure use, low-quality seeds, poor post-harvest handling, and dependency on rain-fed production hinder commercialization [8].

In 2014, Uganda transitioned its agricultural extension system from the National Agricultural Advisory Services (NAADS) to the "Single Spine system". This system aimed to eliminate parallel institutional arrangements and build institutional capacity [9]. It transferred the extension function to the Ministry of Agriculture Animal Industry and Fisheries, created a Directorate of Agricultural Extension Services, and separated agricultural input supply from extension service delivery [10]. The single spine system in Uganda focuses on increasing agricultural extension services through strategic enterprises, strengthening technical areas, and enhancing government and non-governmental institutions' capacity [11]. This system aims to help smallholder farmers transition from subsistence to commercial agriculture, ensuring adequate and accessible services. The system considers availability, accessibility, and accessibility in terms of physical, social, administrative, and financial aspects [12].

The adoption of the right practices is crucial for the success of an extension service system. The Ugandan Government, through MAAIF, formulated the National Agricultural Extension Strategy (NAES) in 2016 to improve the performance of the single spine system [13]. The strategy, derived from the National Agricultural Extension Policy, aligns with the Five-Year National Development Plan (NDP II) 2015-2020 [14]. Agricultural extension guidelines and sub-county and district extension staff are recruited to collect baseline data [9]. The single spine system aimed to improve agricultural extension services by promoting good farming practices and transforming the sector from subsistence to commercialized agriculture [10]. However, challenges persist, including COVID-19 impacts and poverty among smallholder farmers and the availability and accessibility of agricultural extension services by smallholder crop farmers.

Uganda's agricultural extension system, reformatted in 2014, has seen a decline in access, with a decline from 23.8% in 2016 [15] to 21% in 2017 [16], 12% in 2018 [17], 5% in 2019 [18]. This has led to low agricultural productivity growth, below the 6% per annum target of the Maputo 2003 Comprehensive Africa Agriculture Development Programme. Despite this, most studies focus on structures, methods, and managers' performance, creating a knowledge gap in the delivery and extension services and facilitating appropriate farming practices requiring immediate attention and a study to assess the availability and accessibility of agricultural extension services by smallholder crop farmers under the single spine system in Buhweju District.

The study's results will aid MAAIF in understanding the progress of the single spine system, promoting information and technological innovations for sector commercialization, and inform the Directorate of Agricultural Extension Services for enhanced performance. The study will provide the local government with information on what actually happens on ground in agricultural extension and what can be done to improve agriculture extension service for proper utilization by the farmers. Finally, farmers will be helped to know the available and accessible extension services in their localities for proper access and benefit.

Materials and Methods

Description of the study area

The research was conducted in Buhweju District, South Western Uganda, which has a population of 120,720 people and 24,912 households. The district has a warm and overcast climate with mono-modal rainfall. With 95.0% of households involved in agriculture, particularly crop growing, and the highest rural population percentage (97.6%), 89.5% of households depend on subsistence farming. The district has a low education level, with 89.4% of individuals aged 15 and above having education below the ordinary levels. The research suggests that more effort should be put into making AES available, accessible, and usable to boost agricultural production, particularly in Buhweju.

Study design and sampling frame

This study employed a cross- sectional survey research design. This involves studying the population at a particular point in time. In this study qualitative and quantitative approaches and techniques were used to collect and analyze data. According to [19], mixed methodology helps to eliminate errors that may arise from using a single method. It is also believed that the findings of the study become more credible because combining the two types of data helps to benefit from both the detailed, contextualized insights of qualitative data and the generalizable, externally valid insights of quantitative data. The primary sources of information were interviews with farmers and key informants. The secondary sources of information were records kept by AEOs and the policy documents from government.

Sample selection and sampling technique

The target population was farmers due to their role of receiving and implementing the extension services. The parent or primary population included all the crop farmers in Buhweju District and these are 23,414 crop farming households according to [16]. The district production officer and the sub county agricultural officers were the key informants due to their key roles in providing extension services and supervising other actors. To determine the sample size for this study, the formula provided by [20] was used as follows:

$$n = \frac{N}{[1+N(e)^2]}$$

Where N= target population n = Sample size, e= degree of freedom/ Level of precision taking confidence level of 95% and margin of error of 5%. Therefore, from the formula, the study used a sample of 393 crop farming households drawn from 23,414 crop farming households in Buhweju district. The unit of analysis in this study was a household.

To select the sample of crop farming households, a multistage sampling procedure was used. In the first stage, Buhweju District was purposively selected because of being the district with the highest percentage of households involved in agricultural production in Uganda according to [16]. In the second stage, crop farmers were purposively because of being the majority compared to animal farmers. A total of 23,414 households out of 24,912 are engaged in crop growing making 94.0% of the total households compared to 16,810 (67.5%) households engaged livestock farming. Then, three sub counties were purposively selected basing on the intensity of agricultural production and from each sub county two parishes were purposively selected due to the intensity of agriculture production and from each parish two villages were randomly selected making a total of 12 villages. Finally systematic random sampling was used to select 393 households from the 12 villages. Here, crop farming households were listed and every fourth Household was selected. Each household was represented by one person preferably the household head or any adult found at home.

For the qualitative aspect, the study also used purposive sampling to select the District Production Officer (DPO) and the sub county AEOs. Purposive sampling was used to select the qualitative sample size members. These were selected because according to [11], agricultural extension services were decentralized to districts and sub counties. It's the districts that report to the directorate of agricultural extension services and the sub county agricultural extension officers are the frontline workers who engage with the farmers most.

3.5. Data Collection Methods and Instruments

The study utilized both primary and secondary data. Primary data was collected using face to face interviews conducted by well-trained enumerators using a well-designed household structured interview guide. Interviews were preferred because majority of the respondents were illiterate [17] and therefore could not read and write. Secondary data was collected by reviewing other scholarly papers, reports and government publications. The study employed Key Informant Interviews

(KIIs) to collect qualitative data in the study area. The key informants were the district production and marketing officer and three sub county agricultural officers.

Data analysis

Data was edited, cleaned and sorted. In handling the objectives one, STATA version 16 was used to obtain descriptive statistics such as means, percentages, Chi-square and t-tests. Qualitative data was were transcribed verbatim to avoid missing out most important information, then coded and analysed under different themes and categories that were of interest to the study objectives. Finally, direct quotations of individual responses that can explain the respondent's views and bring out their voices were identified and presented in the respondent's own words to give more insight into the issues under consideration.

For objective two, an adoption scale was developed and used using sigma scoring method and a Tobit regression model was used to determine the factors that affect adoption levels of SSAES practices by crop farmers and for objective three. Farming households who were producing crops using recommended improved agronomic practices (improved seed, mineral fertilizer, spacing, post-harvest and storage management, harvesting method, application of herbicides and pesticides and weeding method) were considered as full adopters. Non-adopters were those were not using any of the technologies disseminated by government extension workers while partial adopters were those who used less than seven technologies disseminated. The farmers who fully adopted the technologies disseminated were scored 1; the ones who did not apply any of the elements of this technology were a scored 0. The rest of the farmers were scored between 0 and 1 in case a farmer had adopted only one or a few aspects of single spine extension technologies.

The model is explained as equation (1) as follows:

$$\boldsymbol{Y_{i^*} = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ij} + \varepsilon_i} \quad \text{..... Equation (1)}$$

where Y_{i^*} is the latent variable representing the latent extent of adoption of the single spine agricultural extension technologies for household i, βj are the coefficients to be estimated (j = 1, 2,..., k), x_{ij} are the explanatory variables, and ε_i is the random error term that is independently and normally distributed, with mean zero and constant variance $\delta^2(\varepsilon_i \epsilon N[0;\ \delta^2])$.

The observed variable Y_{i^*} represents the proportion of adoption of single spine extension services among farmers, which is expressed using the latent variable Y_{i^*} using equation (3) as follows:

$$\boldsymbol{Y_{i^*} = \begin{cases} 100 & if\ Y_{i^*} \geq 100 \\ Y_{i^*} & if\ 0 < Y_{i^*} < 100 \\ 0 & if\ Y_{i^*} \leq 0 \end{cases}} \quad \text{..... Equation (2)}$$

The Tobit regression coefficients are interpreted in the similar manner to Ordinary Least Squares (OLS) regression coefficients, except that the linear effect is on the latent variable, not the observed one.

$Yi^* = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \ldots\ldots\ldots\ldots + \beta nxn + \varepsilon_i \ldots\ldots\ldots\ldots$ **equation (3)**

yi* is the dependent variable describing the farmers adoption levels of the improved SSAES technologies. Taking numeric values ranging from 1 to 0 where 1 for those adopting the whole package of technological practices as adopters, and 0 not applied any practice and the value between 1 to 0 for those applied any part of technological practices, x_i is a vector of variables explaining whether a farmer adopts single SSAES technologies and ε_i is the error term. The hypothesized list of variables includes gender of the household head, age of the household head, education of household head, and household's access to credit in the locality.

The Tobit regression equation is hypothesized with variables as follows:

Adoption or $Yi = B_0 + \beta_1 AGE + \beta_2 HSX + \beta_3 EDU + \beta_4$ HOUSEHOLDL $+ \beta_5 INC + \beta_6 SDP + \beta_7 FFS + \beta_8 HMS + \beta_9 HFS + \beta_{10} EXW + \beta_{11} FD + \beta_{12} HBF + \beta_{13} F2F + \beta_{14} IPS + \beta_{15} RH5 + \beta_{16} LF$ …… **Eqn (4)**

Where;

B_0 = the intercept of the regression equation;

B_1- β16 = the parameter to be estimated;

AGE = Age group of the household head (measured by completed years of an individual);

HSX= Sex of the household head (1= Male, 0=female);

EDU= Education of the household head measure in years of schooling;

Household labour= Family labour (Number of individuals in the household who contribute their labour in the farming activities);

HMS= Marital status of the household head (1=marriage, 0= otherwise);

HFS= Household's farm size (measured in hectares);

EXW = Extension workers (1=Yes, No=0);

IPS= Input suppliers (1=Yes, No=0);

DP= demonstration plot (1=Yes, No=0);

FD=Field day (1=Yes, No=0);

F2F=Farmer to farmer (1=Yes, No=0);

INC= Household's income from other produce measured in Uganda shillings and

HBF= Household's membership in a farmer group (1=Yes, No=0)

Results and discussion

Demographic Characteristics of crop farming households in Buhweju district

Characteristics like age, gender, occupation, marital status and education level of the household heads are important proxy indicators for individual behaviors and are commonly used as explanatory variables while assessing the availability and accessibility of agricultural extension services by smallholder crop farmers under the single spine system as recorded in table 1 below.

Table1: Demographic characteristics of crop farming households

Demographic characteristics of crop farming households		Percent (n=393)
Gender	Male	70.5
	Female	29.5
Occupation	Production of crops	91.1
	Production of livestock	1.0
	Salaried employment- government	3.3
	Salaried employment-private sector	1.5
	Casual laborer on-farm	3.1
Marital Status	Married	88.3
	Single	2.5
	Divorced	2.3
	Widowed	6.9
Highest Education level of the household head (Years)	Primary	56.8
	O' level	24
	A' level	11.9
	Bachelor degree	5.6
	Postgraduate	2.1

Source: Field data (2023)

Results in table 1 indicate that the majority of the household heads were male (70.5%), while only 29.5% were female. This reflects a gender disparity, with males predominantly taking the lead in crop farming activities. The lower female representation indicates traditional gender roles in the farming community, where men were more involved in decision-making and land ownership. This concurs with the findings of [18] that, most households in Uganda are male headed.

Results also established that an overwhelming 91.1% of the households focused on crop production, showing that farming was the primary livelihood activity for most. Only 1.0% were involved in livestock production, which was notably low, indicating that crop farming dominated over livestock as the main agricultural practice in the area. Non-agricultural activities, such as salaried employment in both the government (3.3%) and private sector (1.5%), as well as casual labor on farms (3.1%), was minimal. This suggests that off-farm income opportunities were scarce, and most households relied on agriculture for their livelihood. This is in line with [11] which spotted that agriculture is still the heart and soul of Uganda as the main occupation of the household heat directly influences the main source of income of the family.

Results established that a significant portion of the household heads were married (88.3%), which reflects the norm of family-based agricultural practices where married couples worked together in farming activities. The low percentages of single (2.5%), divorced (2.3%), and widowed (6.9%) individuals indicate that most of the farming population lived in stable households, which contributed to better division of labor and shared responsibilities in farming. This is supported by [17] findings that most household heads in Uganda are married.

The education levels show that the majority of the respondents had completed only primary education (56.8%), followed by O' level (24%), A' level (11.9%), bachelor degree (5.6%) and postgraduate (2.1%). This indicates relatively low educational attainment, with limited access to higher education. The focus on primary education suggests that most farmers had basic literacy and numeracy skills but lacked more advanced education, which impacted their ability to adopt modern farming technologies or access better economic opportunities.

Quantitative demographic household characteristics of crop farming households

Table2: Quantitative demographic household characteristics of crop farming households

Quantitative demographic household characteristics of crop farming households	N	Range	Min	Max	Mean	Std. Deviation
Age of the household head	393	75	15	90	44.4	14.92
Highest education level (years) of the household head	393	33	0	33	10.0	36.97
Farming experience of the household	393	54	1	55	25.4	30.90
Total number of household members	393	24	1	25	5.6	2.53
Unproductive children	393	10	0	10	1.8	1.80
Unproductive adults	393	8	0	8	0.6	1.28
Productive female adults	393	7	0	7	1.6	1.17
Productive male adults	393	8	0	8	1.4	1.05
Productive children	393	6	0	6	1.1	1.27
Male number engaged other activities	393	3	0	3	0.8	0.69
Female number engaged in other activities	393	4	0	4	0.6	0.79
Acreage planted (acres)	384	50	0	50	3.6	4.95
Amount of credit used yearly (Shillings)	393	4,000,000	0	4.000,000	282,608	377,712

Source: Field data (2023)

The quantitative results presented on table 2 indicate that all the smallholder farmers in Buhweju district were between the ages of 15-90 years and the majority having been engaged in crop farming for 30-60 years with an average of 45 years (Mean=44.39±14.9 years). This indicates that

most of the farmers were adults and mature people who seemingly had the required resources like land and capital to support crop production.

Most of the smallholder farmers had adequate experience in crop farming ranging from 8-40 years with an average of 24 years (Mean=24±16 years). This was quite a big experience in crop farming portraying adequate knowledge about crop farming and associated challenges.

The total number of household members' ranged from 1-25 members. However, majority of the households had total number of members ranging from 3-9 members with an average of 6 members (mean=5.6±2.5 members). This means that most households had a large number of members who assisted in crop farming by either directly involving them in cultivation and other agronomic practices or financing the activities undertaken by hired labour.

However, of the above household members, up to 4 members are often unproductive children (Mean=1.8 ±1.8 members) and up to 2 members are productive children (Mean = 1.1±1.3 members). Up to 2 members are unproductive adults (Mean = 1±1.3 members). Up to 3 members are either productive female adults (Mean = 1.6±1.2 members) or productive male adults (Mean = 1.43±1.1 members).

Up to 2 household members are males engaged in other activities other than crop farming (Mean = 0.8±0.69 members). One household member is a female engaged in other activities other than crop farming (Mean = 0.6±0.785 members).

Majority of the smallholder farmers had an acreage of less than 8.5 acres with an average of 4 acres (Mean = 3.55±4.95 members), reaping an annual income level of less than 660,000 Uganda Shillings with an average annual income level of 282,600 Uganda Shillings (Mean = 282600±377,700 Uganda Shillings).

Availability of agricultural extension services under the single spine system

The study examines the impact of age, farming experience, education, household labor, land size, income, and distance to extension offices on the availability of agricultural extension services among 393 farmers, as shown in table 3

Table3: Quantitative household characteristics and availability of agricultural extension services under the single spine system in Buhweju District

Continuous variables	Availability of extension services							
	(n=393)	No Mean(SD)	Yes Mean(SD)	Overall Mean(SD)	Median (Yes)	t-value	P-value	Sig
Age of household head (Years)	393	44(15)	45(14)	44.34(0.75)	42	-1.1	0.1	
Farming experience of the household (Years)	393	23(14)	22(13)	22(13)	20	0.3	0.392	
Education level of the household head (Years)	393	7(6)	9(4.)	8(5)	7	-3.1	0.001	***
Household labour (people)	393	4(2)	6(3)	4(3)	4	-3.3	0.000	***
Household Land size (acres)	391	2(2)	4(4)	3(3)	3	-6.0	0.000	***
Income of the household (UGX)	393	248980 (375892)	325711 (374855)	287443 (376857)	250,000	-2.0	0.021	**
Distance to extension office (Km)	393	5(6)	3(5)	3(5)	1.5	2.3	0.010	***

Source: Field data (2023)

Regarding age, household heads who said "Yes" to availability of agricultural extension services had a median of 42 years, with no significant difference between those with or said "No" to availability (t-value = -1.1, p = 0.1372), indicating that age does not play a crucial role in service availability. Similarly, farming experience, with a median of 20 years, showed no significant impact (t-value = 0.3, p = 0.3922), suggesting that experience does not affect whether farmers know the existence of agricultural extension services or not.

Education was a significant factor, with farmers "Yes" to availability of agricultural extension services having a higher median of 7 years of education compared to those "No" to availability of

agricultural extension services. The t-value of -3.1 (p = 0.0010) demonstrates that more educated households are more likely to know the existence of agricultural extension services in their localities, supporting findings by [10] who noted that higher education levels enhance farmers' ability to seek agricultural knowledge hence household labor size also played a significant role, with households having a median of 4 people being more likely to know the existence of agricultural services within their localities (t-value = -3.3, p = 0.0006), likely due to their capacity to implement the practices recommended by extension workers.

Land size and income further influenced knowledge about agricultural extension service availability, with farmers who had larger landholdings (median = 3 acres) and higher incomes (median UGX 250,000) being significantly more likely to know the existence of extension services in their areas (t-values = -6.0, p = 0.0000 for land size, and -2.0, p = 0.0217 for income). [21] also found that wealthier farmers tend to know the existence of agricultural extension services, as they are better positioned to invest in modern agricultural practices which calls for more knowledge and skills. Lastly, farmers closer to extension offices (median distance = 2 km) had significantly better knowledge about their existence (t-value = 2.3, p = 0.0102), aligning with [22], who noted that proximity reduces travel costs and time hence improving awareness.

Secondly, categorical variables were examined on how they influence availability of extension services and the results were presented in table 4. From table 4, data showed that among households who did not know the existence of extension services in their localities, 25% reported not having access to credit. This percentage suggests a substantial portion of these households' faced challenges in securing financial resources to support their farming operations. In contrast, among those who knew the existence of agricultural extension services, a significantly higher percentage of 74% reported having access to credit. This indicates a clear advantage of access to credit in agriculture. The chi-square value of 74 further confirms the strong relationship between credit access and extension services. The extremely low p-value less than 0.001, demonstrates that the association between these variables is statistically significant beyond reasonable doubt. In practical terms, this means that the likelihood of such a significant relationship occurring by random chance is highly improbable.

Table 4: Qualitative household characteristics and availability of extension services under the single spine system in Buhweju district

Variables		Availability of extension services (n=393)						
		No % (freq.)	Not sure % (freq.)	Yes % (freq.)	Overall % (freq.)	Chi square	P-value	Sig
Credit Access (1=yes, 0=otherwise)		25(44)	1(1)	74(129)	44 (174)	75	0.0	***
Group belong (1=yes, 0=otherwise)		14(19)	1(1)	85(112)	34(132)	96	0.0	***
Gender of the household head	Male (1=yes, 0=otherwise)	42(117)	5(15)	52(145)	70(277)	3	0.2	
	Female (1=yes, 0=otherwise)	52 (60)	3(4)	45(52)	30(116)	3	0.2	
Marital status of the household head	Married (1=yes, 0=otherwise)	44(152)	4(15)	52(180)	88(347)	4	0.1	
	Single (1=yes, 0=otherwise)	50(5)	0(0)	50(5)	100(10)	1	0.8	
	Divorced/Separated (1=yes, 0=otherwise)	56(5)	22(2)	22(2)	100(9)	7	0.0	**
	Widowed (1=yes, 0=otherwise)	56(15)	7(2)	37(10)	7(27)	2	0.4	
Main Occupation of the household head	Crop Production (1=yes, 0=otherwise)	45(162)	4(15)	51(181)	50(197)	4	0.2	
	Livestock production (1=yes, 0=otherwise)	50(2)	0(0)	50(2)	1(4)	0	0.9	
	Employed salary (1=yes, 0=otherwise)	15(2)	23(3)	62(8)	3(13)	12	0.0	

Source: Field data (2023)

From table 4, the analysis shows that among the 'No' group households on the availability of extension services, 14% reported not to be belonging to any farmer group. This suggests that a significant portion of these farmers may be operating in relative isolation, potentially missing out on the benefits of collective action and shared resources. In contrast, among those who said 'Yes' to availability of extension services, a significantly higher percentage of 85% reported belonging to a farmer group. The chi-square value of 96 confirms the robust relationship between group belonging and extension services. Importantly, the extremely low p-value less than 0.001, provides compelling evidence of the statistical significance of this association.

The analysis results of marital status, specifically looking at the category of "Divorced/Separated" (1=yes, 0=otherwise), provides interesting insights into how this aspect of personal life relates to the availability of extension services. In this case, the results show that among farmers who had divorced or separated, 56% know the existence of extension services in their areas while 22% were unsure about the availability of extension services, and another 22% reported 'No' to availability of extension services. The chi-square value of 7 with a p-value less than 0.05 indicated a statistically significant relationship between marital status (specifically, being divorced or separated) and availability of extension services.

Households were further asked how information about available extension services was communicated to them and community members under the single spine system to understand why some households know the existence of agricultural extension services and others do not know. The results are presented in table 5.

Table 5: Communication modes used to create awareness about the existence of agricultural extension services.

Availability mode	**Percent (n=393)**
Through local leaders	58.27
Through notices	9.67
Through outreach	2.04
Through phone calls	4.58
Through radios	22.65
Others	2.80
Total	100.00

Source: Field data (2023)

Results established that the majority of respondents (58.27%) access extension services through local leaders, highlighting their role as intermediaries. Other modes of availability, such as notices, outreach, and phone calls, have low percentages, suggesting limited reach or effectiveness. Radios was a significant alternative, with 22.65% of respondents accessing extension services through this method. However, 2.80% reported other unspecified methods, suggesting gaps in diversifying access diversifying access channels to improve the overall reach and effectiveness of extension services.

Key partners and their roles in delivery of the agricultural extension services under the single spine system in Buhweju District

Interview responses from the DPO and the sub county officers at Buhweju district revealed how they are prepared to improve delivery of AES.

> "*We usually have annual work plans in place, we have 32 government officers in place, and provide training on E-extension although we have not started using it*". The DPO explained;

> "*We have contact persons in some villages to ease our work as sub county AEO. We always have Continuous Development courses facilitated by the district production department to refresh ourselves*". One sub-county officer explained.

Responses from KII also revealed that delivery of AES involves key partners including government providers such as the district production Department, sub county officers, NAADS and Operation Wealth Creation, Uganda Coffee development Authority (UCDA), Non-governmental Organizations as well as Private prayers. The government players mainly target smallholder farmers because commercial farmers and middle farmers can easily seek extension from other private providers even outside the district. However, NGOs and private providers have specific target groups of people; for example, all tea factories target only tea growers. Besides, most service providers always give priority to the poor, women, youth and even the disabled. In anything we do we make sure those groups of people are given priority. Almost all people in Buhweju live in villages so we do not have that ideal of urban and rural. We encourage our farmers to Join SACCOs so as to brow at reduced interest rates.

According to the DPO, the government providers available in Buhweju District are; the District Production Department (DPD), Sub County officers, NAADs/Operation Wealth Creation (OWC) and Uganda Coffee Development Authority (UCDA).

In his own words, the DPO of Buhweju District explained;

> "*The district production department has only two officers; the District Production and Marketing Officer (DPMO) and the District Commercial Officer (DCO). The department is responsible for making work plans to be followed, distribution of inputs, advising farmers on the proper use of inputs, planning for the agricultural sector*

within the National Policy Framework, providing support supervision of sub county officers, advising District Councils on matters related to the agricultural sector, monitoring all other actors involved in extension and evaluating performance of the agricultural programs and projects and coordinating all other actors in extension service".

"*There are thirty (30) sub county officers in the different sub counties and town councils. Each sub county and town council has at least two government officers. Each of sub counties has an officer specifically for crop production. Sub county officers are responsible for conducting needs assessment, advising farmers on proper agronomic practices, mobilizing farmers into groups, distribution of agricultural inputs, and demonstration of agronomic practices like planting and fertilizer application as well as agricultural data collection*".

The DPO further clarified the differences in roles of NAADS and OWC in delivery of AES. According to the DPO, NAADS procures inputs and then, OWC distributes those agricultural inputs using the already existing Sub County AEO.

Another key player in delivery of AES according to the DPO is Uganda Coffee development Authority (UCDA) whose main role is giving the DPD coffee seedlings to distribute to farmers, advising coffee farmers and other value chain actors on agronomic practices and post-harvest handling, demonstrating good agronomic practices to coffee farmers especially stumping, fertilizer application and soil and water conservation.

Non-governmental Organizations are also considered one of the key players in delivery of AES. According to the DPO, there are three NGOs that were in extension service in Buhweju District including Caritas-Uganda, SNV and International institute of Rural Reconstruction. According to the DPO, Caritas-Uganda aims at improving livelihoods and income of smallholder farmers in Buhweju District through advising farmers on proper agronomic practices and providing farmers with improved seedlings. In addition, SNV (Stiching Nederlandse Vrijwilliger) Netherlands Development Organization has professional trained six extension workers in Buhweju District. On the other hand, international institute of Rural Reconstruction (IIRR) has four trained AEO in the District, in the sub counties of Rwengwe, Karungu, Bihanga, Engaju and Burere. It trains and advises farmers on maize growing and gives out inputs like Fertilizer, seeds and pesticides.

Qualitative responses from the key informants also indicate that private prayers play a critical role in the provision of agricultural extension services and they are majorly in two groups of private actors; tea factories and agro input dealers. In his words, the key informant interviewed on 16th October, 2023 had this to say;

"*We have two group of private actors in Buhweju and these are tea factories and agro input deals. There are four tea factories providing AES to tea farmers. Buhweju tea factory, Global tea factory, Tea Maria factory and Kashenyi Tea factory. Each of these*

factories have two professional AEO on ground to advise tea farmers. These officers have played a key role in demonstrating tea agronomic practices to farmers. These factories also give tea farmers in puts especially fertilizers at subsidized prices and even on credit and buys tea from farmers and middle men". They have cars that collect tea from tea collection centers that are near farmers' gardens. Besides tea factories, there are many agro input dealers in the different parts of the district who sell inputs like herbicides, pesticides, seeds and fertilizers. These advise farmers on the use of the inputs they sell. However, the quality of their services leaves a lot to be desired. Farmers easily ask for guidance from them because they are always available and accessible"

Accessibility of agricultural extension services under the single spine system

The study examined the accessibility of agricultural extension services to smallholder crop farming households in Buhweju District, analyzing factors such as age, farming experience, education, household labor, land size, income, and distance to extension offices and their responses were recorded in table 6 below

Table 6: Quantitative demographic characteristics of households and accessibility of extension services of extension services under the single spine system.

Continuous variables	**Accessibility of Extension services**					
	Yes Mean(SD)	**No Mean(SD)**	**Overall Mean(SD)**	**Median (yes)**	**t-value**	**sig**
Age of the household head (Years)	45(13)	44(15)	44(15)	42	0.7	
Farming experience of the household (Years)	22(12)	23(21)	23(13)	20	-0.7	
Education level of the household head (Years)	10(4)	7(6)	8(5)	10	3.8	***
Household labour (people)	5(3)	4(2)	4(3)	4	2.7	***
Household Land size (acres)	5(4)	3(3)	3(3)	3	5.7	***
Income of the household (UGX)	348831 (441093)	259145 (340425)	287443 (376857)	275,000	2.2	***
Distance to extension office (Km)	3(3)	5(7)	3(5)	2	-2.8	***

From table 6 education of the household head significantly influenced access to extension services, with farmers having a median of 10 years of education. A t-value of 3.8 (***) showed that more educated farmers were more likely to access services. This is consistent with [23] who found that higher education levels enhance the likelihood of seeking agricultural extension support due to better understanding and application of agricultural innovations. Likewise, households with more labor (median of 4 people) were more likely to access services, a finding supported by [21] who noted that larger households have a higher capacity to implement agricultural advice.

Land size also significantly influenced access, with farmers owning larger plots (median of 3 acres) more likely to access extension services. The t-value of 5.7 (***) highlights that larger landowners seek extension services to improve productivity, aligning with [20] who emphasized that wealthier farmers often utilize more services due to their ability to benefit from economies of scale. Income played a similar role, with wealthier households (median income of UGX 275,000) being more likely to access services, consistent with [10] who found that income positively correlates with the adoption of extension recommendations.

Finally, distance to the extension office significantly affected access, with farmers living closer (median distance of 2 km) being more likely to utilize services. A t-value of -2.8 (***) indicates that proximity reduces the cost and effort of accessing services, a finding supported by [21], who observed that shorter distances increase service utilization. These findings highlight the need for policies that improve access for farmers in remote areas and those with lower education levels, smaller landholdings, and limited income.

Qualitative demographic characteristics were also examined on how they influence accessibility of agricultural extension services under the single spine system using a chi-square test and the results are presented in table 7.

Table 7: Qualitative demographic characteristics and accessibility of agricultural extension services to small holder crop farmers under the single spine system

Variables		Accessibility of extension services					
		Yes % (freq.)	No % (freq.)	Overall % (freq.)	Chi square	P-value	sig
Credit Access (1=yes, 0=otherwise)		60(104)	40(70)	44(174)	115.1	0.0	***
Group belong (1=yes, 0=otherwise)		73(96)	27(36)	34(132)	156.0	0.0	***
Gender	Male (1=yes, 0=otherwise)	32(88)	68(189)	70(270)	0.0	0.9	
Marital status	Married (1=yes, 0=otherwise)	33(115)	67(232)	88(347)	3.5	0.1	*
	Single (1=yes, 0=otherwise)	30(3)	70(7)	3(10)	0.0	0.9	
	Divorced/Separated (1=yes, 0=otherwise)	0(0)	100(9)	2(9)	4.2	0.0	**
Main Occupation	Crop Production (1=yes, 0=otherwise)	31(112)	69(246)	91(358)	0.1	0.7	
	Livestock production (1=yes, 0=otherwise)	50.(2)	50(2)	1(4)	0.6	0.4	
	Employed salary (1=yes, 0=otherwise)	46(6)	54(7)	3(13)	1.3	0.2	

Source: Field data (2023)

Results revealed a significant association between credit access and access to agricultural extension services. Farmers with extension services had a higher percentage of access to credit, with 60% in the "Yes" category and 44% in the overall sample. This highlights the interconnected nature of credit and extension services in supporting agricultural activities.

Results found a strong association between farmer group membership and access to extension services. 73% of farmers with extension services belong to an agricultural group, indicating that

extension services facilitate farmers' participation in these groups, providing social networks, knowledge-sharing platforms, and economic support.

The study found a marginally significant association between marital status and extension service accessibility among farmers. Married individuals had 33% access, while single and divorced/separated individuals had 30% and 0% respectively. The overall accessibility was 88%, suggesting a potential trend that warrants further investigation. While the p-value for this association is slightly above the conventional significance threshold (p-value > 0.05), at 0.1 (*), it suggests a potential trend that may warrant further investigation. This result indicates that marital status may have some influence on access to extension services, with married individuals showing a higher tendency towards access compared to their single or divorced/separated counterparts.

Annual extension visits as reported by the interviewed households

Household who affirmed to have accessed agricultural extension services in 2022, were asked how often they did. The frequency of extension visits reported by the interviewed households are shown in figure1.

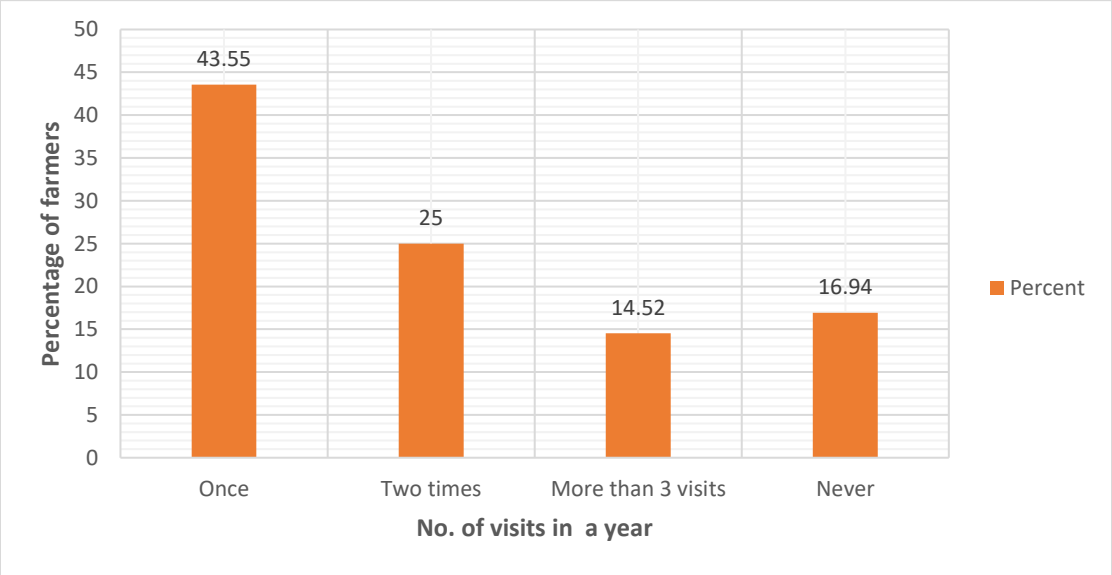

Figure1: Frequency of extension visits as reported by farmers

Source: Field data (2023)

From figure1, a significant portion of farmers (43.5%) in the sample had accessed extension services only once and some households reported never receiving extension visits. This finding highlights a gap in service delivery, as a substantial portion of farmers in the sample have not had any contact with extension services. These farmers missed out on valuable information and support that could enhance their agricultural practices and overall productivity. This underscores the need for improved outreach and engagement strategies to ensure that extension services effectively

reach and benefit a wider segment of the farming community.

However, interviews with the key informants reveled some challenges that hinder accessibility of the available AES especially from the government. These include; high farmer to AEO ratio, inadequate government funding and farmers were not willing to pay for the services, uncoordinated planning of government agencies and departments involved in AES

In his own words, the DPO of Buhweju District further explained that;

"*We have only 5 motorcycles with 30 AEOs that means 25 out 30 AEOs do not have motorcycles to be used for transport. Allowances are very little for example AEO received a total of 600,000 for the first quarter of 2023/2024 and how much is given each quarter depends on how much is received from the central government. Also, we have a problem of diversion of funds. For example, the money that was meant for AES for the whole Buhweju District for the financial year 2022/2023 was diverted to rolling out the PDM meaning that as government, we were not accessible for the whole of that financial year. Late release of government funds which delays the provision of services. Some farmers are not willing to attend meetings organized by government AEOS and Buhweju is hard to reach all these limiting our accessibility"*

One sub county agricultural officer brought to my attention that, there inadequate needs assessment leading to wastage of resources. For example, one key informant revealed to me that seedling of apples was rooting in the former Member parliament's compound without anyone to take them. In addition**,** key informants reported corruption at the district level as what is documented differs from the activities done on ground especially in providing inputs that what is always supplied to farmers is always different from what is in papers.

DISCUSSION OF RESULTS

Availability and accessibility of agricultural extension services to smallholder crop farmers under the single spine system in Buhweju District.

The study empirically sported that, education was positively and significantly ($P<0.01$) related to knowledge about availability of agricultural extension services. Increase in the number of years of schooling of the household head increases the household's ability to be aware of the different extension service providers in one area. This is in line with the findings by [21] who ascertained that, skills, knowledge and awareness farmers get as they advance school improve their reasoning ability and increases their which in turn increases their eagerness to look and get for information from many sources about the available agricultural extension actors in their localities.

The study findings also discovered a strong association between household labor size and availability of agricultural extension services. Households with a median of 4 people were more likely aware of the existence of agricultural extension services with in their sub counties compared to those with less members. This aligns with existing literature as previous studies have demonstrated more labor resources leads to more information, ideals and skills brought together

[23]. This places households with a higher number of members at an advantage of getting information from many sources.

Furthermore, household land size and income showed a statistically significant relationship with availability of agricultural extension services. Households with larger landholdings (median = 3 acres) and higher incomes (median UGX 250,000) were significantly more likely to know the existence of agricultural extension services within their sub counties. This coincides with [21] also found that wealthier farmers are better positioned to invest in modern agricultural practices and therefore may require more knowledge and skills making them to where the extension service providers are in their areas.

In addition to the above, households closer to sub county office (median distance = 1.5 km) had significantly knowledge on the existence of extension service providers with in their sub counties (t-value = 2.3383, p = 0.0102), aligning with [20] who noted that proximity reduces travel costs and time, improving awareness.

From table 4 it is evident that a higher proportion household who said “No” to availability of agricultural extension services in their areas, also had not access to credit for the whole of 2022 and the reverse is true. This concurs with the findings of [10] who discovered that, credit services facilitate farmers’ ability to join groups and groups facilitate their ability to access information from many sources about the available agricultural extension services.

The substantial difference in group membership between those who affirmed the availability of agricultural extension services and those who denied it underscores the importance of collective action in agriculture. Farmers who belong to farmer groups often benefit from knowledge sharing, collective decision-making, and resource pooling [23]. This finding aligns with studies emphasizing the positive impact of group participation on farmers' access to information.

The results on the relationship between marital status, particularly being divorced or separated, and the availability of extension services suggests potential disparities in awareness. Previous research has shown that marital status can influence farmers' decision-making within households [23]. Divorced or separated farmers especially women might have more freedom to move and look for information from different sources compared to those who are married.

Furthermore, results presented in Table 5 shed light on the various communication modes through which farming households are made aware of the existing services. The results align with existing literature on the importance of diverse communication modes in extension service and provide valuable insights into the preferences and patterns of information dissemination among farming communities. The prominence of local leaders underscores the influential role of community leaders in rural areas. Local leaders likely serve as trusted intermediaries who facilitate the flow of agricultural information and resources from providers to farmers. This finding resonates with studies emphasizing the significance of community-based approaches in extension service [25].

The results from Table 6 shed light on the relationships between various socio-economic factors and the accessibility of extension services among farmers. These findings provide critical insights into the factors that influence farmers' ability to access extension services, which, in turn, can have significant implications for agricultural productivity and rural development.

The research results reveals a compelling association between education level and access to extension services. Farmers who have access to extension services tend to have a significantly higher mean education level (7.35 years) compared to those without access (8.04 years). The highly significant t-value (3.8359, $p<0.001$) underscores the role of education as a key determinant of accessibility to extension services. This result aligns with existing literature and is in line with the findings of [22] who asserted that farmers who have studied a bit higher had significantly higher probability of accessing agricultural extension services than their counterparts because education increases awareness and understanding.

Relatedly, households with more labor (median of 4 people) were more likely to access extension services compared to their counterparts, a finding supported by [20] who noted that larger households have a higher capacity to seek and implement agricultural advice. Land size also significantly influenced access, with farmers owning larger plots (median of 3 acres) more likely to access extension services. The t-value of 5.6524 (***) highlights that larger landowners seek extension services to improve productivity, aligning with [19] who emphasized that wealthier farmers often seek and utilize more services due to their ability to benefit from economies of scale. Income played a similar role, with wealthier households (median income of UGX 275,000) being more likely to access services, consistent with [20] who found that more income may translate into heavy investment in agriculture and hence the need for more knowledge and skills.

Again, distance to the extension office was found to significantly affect access, with farmers living closer (median distance of 1.9 km) being more likely to utilize services. A t-value of -2.8499 (***) indicates that proximity reduces the cost and effort of accessing services. This agrees with the findings of by [22] who concluded that farmers located near the extension centers have a higher probability of accessing extension services easily and timely compared to their counterparts because of reduced transport costs and increased awareness about the existence of these services.

The results from the chi-square tests reveal important associations between categorical variables and the accessibility of agricultural extension services among farming households. These associations provide insights into how various factors, such as credit access, group membership, and marital status, are linked to the ability of farming households to access extension services with implications for their agricultural practices and livelihoods.

The results from table 7 demonstrate a strong and highly significant association between access to credit and access to agricultural extension services. Significantly, a higher percentage of households who had access to credit also had access to agricultural extension services. This is so because credit enhances increased investment in agriculture and this require more understanding

of agricultural practices that increase production. This underscores the importance of credit in enhancing agricultural production. This result aligns with previous research emphasizing the importance of credit access in enhancing accesses to credit. [25] also had spotted that farmers who have access to credit have a higher probability of accessing agricultural extension services compared to their counterparts.

The research results also underscore a substantial and highly significant association between group membership and accessibility to agricultural extension services. This finding suggests that belonging to a group facilitates access to agricultural extension services. These groups can provide valuable social networks, knowledge-sharing platforms, and economic support hence facilitating access to agricultural extension services. This result aligns with the findings of [26] who detected that belonging to an association is positively and significantly associated with access to agricultural extension services due to the peer farmers' trainings, information disseminations and sharing of ideas within the group.

The results also indicated a marginally significant association between marital status and the accessibility of agricultural extension services. Although, the p-value for this association was 0.063 (*). It suggests a potential trend that may warrant further investigation. While not statistically significant at the conventional threshold, this result indicates that marital status may have some influence on access to agricultural extension services with married individuals showing a higher tendency towards access compared to their single or divorced/separated counterparts.

Conclusion

Results also established that agricultural officers responsible for extension services are available in all sub counties, but many farmers are unaware of their availability. These officers come from government, NGOs, and private actors. The government should sensitize farmers about their availability and reach out to them, considering social economic factors.

Results also established that agricultural extension services were not easily accessible to smallholder farmers in Buhweju district, largely due to socioeconomic factors and the availability of government and private service providers, such as tea factories and agro-input dealers.

Recommendations

The local governments should prioritize mass sensitization of farmers to create awareness about the available agriculture extension services so that farmers can use the available services. Also, farmers should be sensitized about the importance of agriculture extension services so that they can get interested to seek these services. This can be done using social media and local leaders.

Farmers should also be encouraged to join groups dealing in agricultural production and marketing as groups were seen to be major sources of information, knowledge, and advice. In addition, it is easy for an extension officer to meet farmers in groups compared to individuals given the high farmer to extension officer ratio.

The government should provide the sub county agricultural officers who are the frontline extension workers with adequate allowances to allow them do their work willingly. Also, they should be provided with motorcycles to ease their movement to villages.

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