

Article

Integral Perception Analysis on Agricultural Extension Capacity: Empirical Evidence from Ugandan Dairy Farming

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Abstract

To support farmers in their transition towards sustainable agriculture, sub-Saharan Africa needs a more effective extension. Thus, effective improvements based on a clear view of current and desired extension capacity are necessary. As in the past, mostly one-sided studies have been conducted. This paper proposes a more integral approach based on both characteristics and viewpoints of both farmers and extension workers. Capacity to provide effective extension and advisory services (EAS), or extension capacity, is defined and analyzed with mixed-research methods using data from 471 Ugandan dairy farmers, from three distinct production systems and 67 extension workers. Extension capacity is determined by farmers' satisfaction, the frequency of delivering EAS to farmers, and the perceptions of both farmers and extension workers on the use of appropriate methods to deliver EAS. Results revealed moderate satisfaction across production systems, with a pronounced negative effect of long working experiences on the frequency of delivery. Positively influencing factors for delivery frequency are intrinsic motivation and the number of in-service trainings received by extension workers. On-farm demonstrations, individual farm visits, the use of contact farmers, and farmer training are perceived as the four most effective delivery methods among dairy farmers in Uganda. Given the moderate farmer satisfaction, low frequency of delivery, and slight mismatch between the perceived effective delivery methods and those being used, the study concludes that the current extension capacity remains low. However, low-hanging fruits for improvement include increasing in-service training opportunities, employing extension workers on contractual basis and motivating extension workers.

Keywords: context; extension workers; farmers' characteristics; production systems; satisfaction



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1. Introduction

In many sub-Saharan African (SSA) countries, transition to sustainable agriculture implies coping with novel challenges. One of these challenges is the change from a mere expansion of agricultural area, as has often been observed in the past, to greater productivity growth. Such a shift is presumed to be a more sustainable pathway for increasing food production for the region's ever growing population [1]. In this context of fundamental shifts, farmers need information and knowledge to improve agricultural productivity, which boils down to an increased demand for a performant extension system. Extension and advisory services (EAS), however, still face numerous challenges, such as a high farmer-to-extension

worker ratio, inadequate funding, lack of practical skills among extension workers, and little consideration of farmers' experiences and knowledge [2]. Such challenges may make the existing EAS ineffective [3,4] and limit farmers' access to extension services. This slows down fundamental changes and calls for reforms that improve the effectiveness of EAS in SSA countries.

Several studies assessed EAS effectiveness in SSA countries, but they mostly used non-integral approaches. In particular, these studies have mostly focused one-sidedly on the perceptions of extension workers [5–7], thus neglecting farmers as EAS users. Hence, an increasing need has emerged to understand farmers' perceptions, especially their satisfaction with EAS. Although some recent studies [8,9] tried to remediate this, they still ignored other fundamental characteristics, for example, farmer heterogeneity; yet farming in SSA countries is highly heterogeneous [10,11]. Differences in views and heterogeneity in farming reveal an obvious need to evaluate EAS using more integral approaches [5]. One notable framework to ensure more integrality comes from Birner et al. [12], who focused on four major components: contextual factors such as farmer characteristics, EAS characteristics, quality of services, and the impact of the services provided. The Birner et al. [12] framework not only reveals the drivers of good performance in an existing extension system but also allows exploration of areas for improvement.

Although some sources in the literature adapted the framework of Birner et al. [12] to assess EAS, most of them still provided partial analyses. For instance, Namyanya et al. [4] only focused on agricultural extension managers, and Ragasa et al. [7] on extension workers, to determine the factors affecting the performance of agricultural extension in Congo. Several other studies have been conducted in this area [13,14], yet none of them actually revealed the capacity of extension workers to provide effective EAS. Furthermore, knowledge on perceptions of farmers and extension workers regarding the most effective methods of delivering EAS is still missing [6,15,16]. Research thus needs a more integral approach in analyzing the perceptions of farmers and extension workers and a broader set of criteria to provide a more holistic view of extension capacity. In order to come to a more effective extension, there is not only a need to understand the characteristics and perceptions of the farmers who receive the services but also those of the extension workers themselves.

The overall objective of this study is to determine the capacity to provide effective EAS, or extension capacity, while accounting for farmers' and extension workers' characteristics and perceptions of the services currently provided. Extension capacity is determined by farmers' satisfaction, the frequency of delivering EAS to farmers and the perceptions of both farmers and extension workers on the use of appropriate methods to deliver EAS. Extension capacity is considered to be high when farmers' satisfaction is high, extension workers frequently deliver EAS to farmers, and the methods used for delivery are perceived to be appropriate, and vice versa. The analysis therefore foresees a broad set of criteria; among others are farmer satisfaction, effectiveness of delivery methods and frequency of delivering EAS. This study proposes a novel analytical framework that builds further on Birner et al. [12] and is applied to a case of Ugandan dairy farming (Section 3). The framework of Birner et al. [12] is selected because of its holistic approach in evaluating extension systems. The specific research objectives are to (i) assess farmers' satisfaction with the current EAS across different production systems, (ii) determine the frequency at which extension workers provide EAS and the factors that influence it, and (iii) recommend the most effective EAS delivery methods as perceived by farmers and extension workers.

2. Analytical Framework

Based on evidence from the literature, this section aims to build, an analytical framework (Figure 1) that allows for an integral but practical analysis of extension capacity. The framework must serve as an anchor for deriving constructs and criteria for analysis and for designing reform options. Inspired by the system-based evaluation approach of Birner et al. [12], the framework starts from both the farmers' and the extension workers' sides. As most of the existing studies on EAS performance have focused only on either farmers or extension workers [4,5,7–9,17], comprehensiveness can be increased by using empirical data from different stakeholders in the system [18]. Studies that combine evidence from both farm and advisor sides are, however, still scarce. Therefore, the analytical framework is clearly structured around two blocks, characterizing farmers and extension workers.

Further structuring of the framework foresees that outcomes need to be usable for appropriate recommendations for agricultural extension policy reforms. This ultimate goal operationalizes the overall research objective that sees the extension capacity as intermediate goal to account for farmers' and extension workers' characteristics and perceptions of the currently provided and future services. This allows for the use of a broad set of criteria. Birner et al. [12] already listed extension capacity criteria such as human resources (staff numbers, training levels, skills, and experience), as well as physical infrastructure and vehicles. They also explain that financial resources available to advisory services are a particularly important capacity variable, but the literature has scarcely defined this term, despite its importance in increasing the effectiveness of the EAS provided.

Therefore, extension capacity is defined in the current study as the ability of the existing extension system to provide EAS that enable farmers to achieve their farming objectives. This yields a broader view on extension capacity encompassing satisfaction with the service received, the frequency at which extension services are received/provided and the mode/method of delivery used. This allows the introduction of both characteristics and perceptions of concerned parties into the framework. To measure satisfaction, our study computed farmers' satisfaction index (FS_i) based on affordability, participatory nature, availability, timeliness, fairness, relevance, customer care, fairness and usefulness of EAS [8,17]. The first research objective (RO1) is to unravel farmers' satisfaction. Using empirical data collected on the aforementioned constructs, a farmers' satisfaction index was calculated (details in Section 3). Next, in research objective two (RO2), frequency was captured in terms of number of trainings conducted by extension workers monthly and the factors influencing this number. Finally, the delivery methods perceived by farmers and extension workers as the most effective are assessed in research objective three (RO3).

Further refinement of the framework takes account of the influence of farmers' and extension workers' context, characteristics and perceptions on extension capacity. Farmers are characterized by their farm size, age, household income, monthly milk sales, farm location, education levels, farming experience, gender, ownership of smartphones, and willingness to pay for EAS. The respective extension worker needs to understand the characteristics of farmers within his area of service to be able to provide effective EAS to them. This is because farmer characteristics affect their extension needs, hence indirectly influencing extension capacity. These characteristics also determine to which production system the farmer belongs (farmer context of operation). According to our study, there are three possible production systems: small-scale subsistence, medium-scale intensive and large-scale extensive.

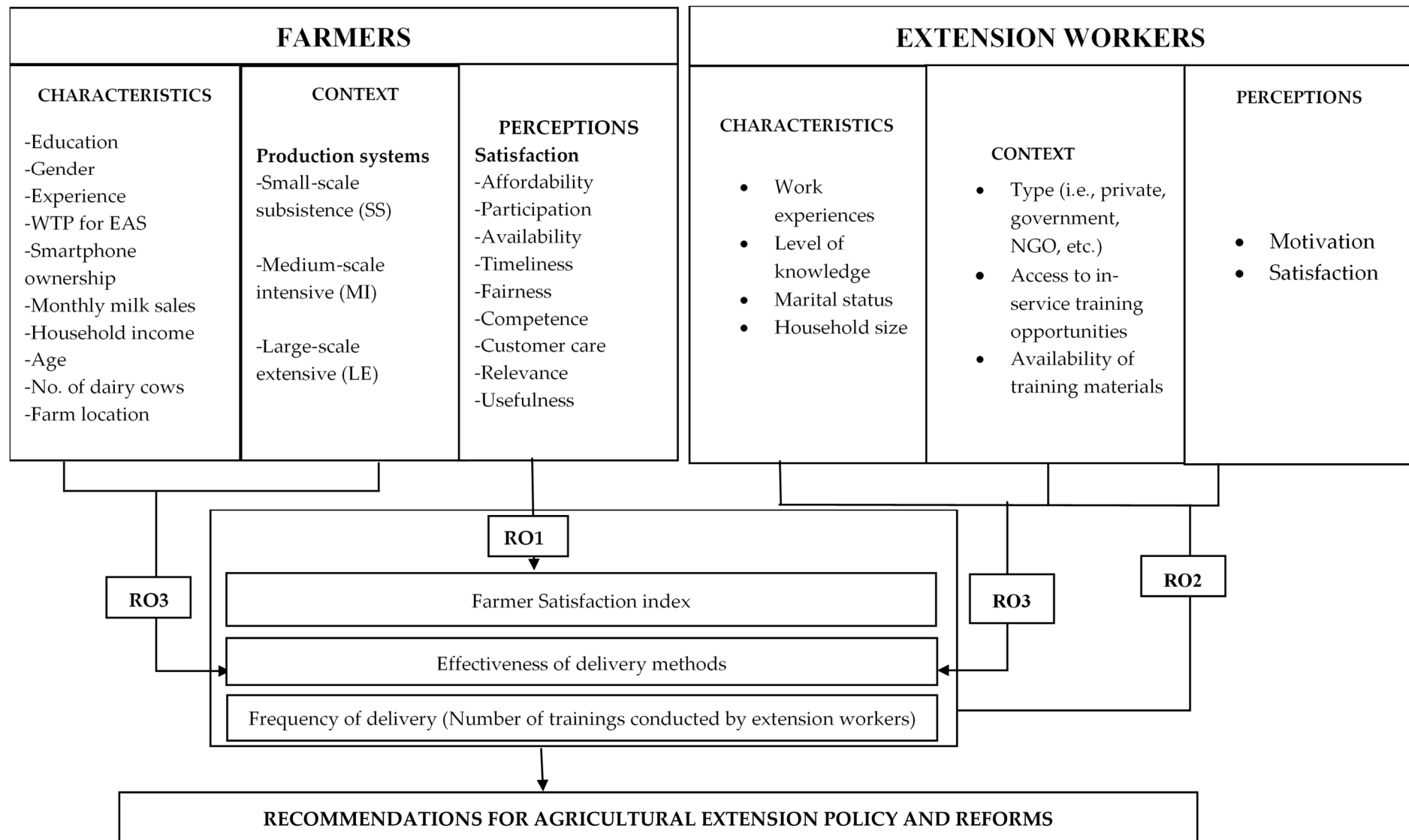


Figure 1. Proposed analytical framework for the study adapted from Birner et al. [12]. (RO1 = Research objective one, RO2 = Research objective two and RO3 = Research objective three).

According to our framework, characteristics of extension workers, such as their age, work experience, level of knowledge of different animal production management practices, and household size, are likely to influence their capacity to provide EAS to farmers. The extension context, which includes access to in-service training opportunities, availability of training materials, and type of organization, may also influence extension capacity. More explanation of the variables is given in the next section.

The proposed analytical framework should not only allow for a richer evaluation of the current EAS but also facilitate exploration of avenues to improve the system. Given the main components described above, the findings of this study can help to come up with agricultural extension policy recommendations and reforms. As such, the integral framework not only bridges farmers' needs with extension capacity but also allows for combining descriptive research on the satisfaction of both farmers and extension officers with the current system and explorative research on alternative, improved EAS characteristics and designs.

3. Materials and Methods

3.1. Study Area and Data Collection

Data were collected from Kabarole, Kamwenge, Ibanda, and Mbarara Districts of Uganda (Table 1). Uganda was selected due to its ongoing search for an appropriate EAS system. This search started in 2014, after the operations of a former EAS organization (National Agricultural and Advisory Services (NAADS)), which was more private-oriented, were terminated, and the function of agricultural extension was transferred back to the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). A study by Sebaggala and Matovu [19] showed that farmers' yields have since stagnated or even decreased. In the scarce situation of output gains, these are attributed to the expansion of cultivated land rather than to productivity increases. This observation shows that the transfer from NAADS to MAAIF did not realize its goals and suggests a huge gap in the provision of EAS. This gap calls for considerable efforts to strengthen the capacity of agricultural extension in the quest for alternatives.

Table 1. Farmer distribution in the sampled districts.

District	Farmers Interviewed	Percent (%)	Farmers Considered for Analysis	Percent (%)
Ibanda	112	23.2	111	23.5
Kabarole	128	26.6	124	26.3
Kamwenge	121	25.1	118	25.1
Mbarara	121	25.1	118	25.1
Total	482	100.0	471	100.0

To contribute to this, mixed-research methods, that is, Focus Group Discussions (FGDs), Key Informant Interviews (KIIs) and face-to-face household surveys, were used to collect data. Mixed-research methods facilitated data triangulation and helped to obtain detailed data. Using a structured questionnaire, researchers collected data from 482 dairy farmers between August and September 2020 but retained 471 after data cleaning. To characterize current extension capacity, data were also collected from 67 dairy extension workers using a structured questionnaire in March 2022. Of the total dairy extension workers interviewed, 36 were from the government, 7 from NGOs and 24 operated privately. Almost all the dairy extension workers employed by the government and NGOs in the study area were interviewed. However, due to difficulties involved in identifying private extension workers, only 24 were interviewed, even though their number is presumed to be much higher.

In March 2022, qualitative data were collected using nine FGDs of 5–12 dairy farmers and seven KIIs with district veterinary officers (DVOs), leaders of dairy cooperative societies, and organizations providing EAS to dairy farmers (Figure 2). The period between the two surveys was necessary because some of the questions in the extension workers' questionnaire and Focus Group Discussion (FGD) guide were formulated based on the results obtained from the farmers' household survey. During the period between the two data collection phases, there was little economic activity due to the COVID-19 outbreak. Hence, it is assumed that the time lag did not substantially affect responses in the second phase.

During the first data collection phase, farmers were selected using the lists provided by the DVOs. To identify dairy farmers who participated in FGDs, a random stratified technique based on the district of origin and production systems was used. As such, the perceptions of dairy farmers in different production systems were analyzed. The list of farmers used in the second phase was generated from those who had been interviewed and classified into production systems in the first phase. All public extension staff employed in the livestock division were interviewed, except for six who were not in their districts of operation at the time of data collection. The private extension workers were selected using a snowball sampling method, as their official lists could not be found in the respective district offices. Snowball method, being a non-probabilistic technique, does not guarantee that all simple units of the population have a chance to enter the sample. The individuals, the researcher interviews depend on the person previously interviewed; the researcher is not familiar with the actual distribution of the population and the sample. Furthermore, given that the initial respondents tend to name the persons they know best and who share the same opinions, it is very likely that the subjects possess the same features and characteristics [20]. Due to these disadvantages, the data collected from private extension workers are considered non-representative and may not easily be generalized. The NGO extension workers interviewed were only those from NGOs officially known by district officials to provide EAS to dairy farmers in the study area. The KIIs were conducted with leaders who had spent at least eight years in leadership positions within organizations that provide EAS to dairy farmers in the study area. This period represented the time when agricultural extension was transferred back to MAAIF.

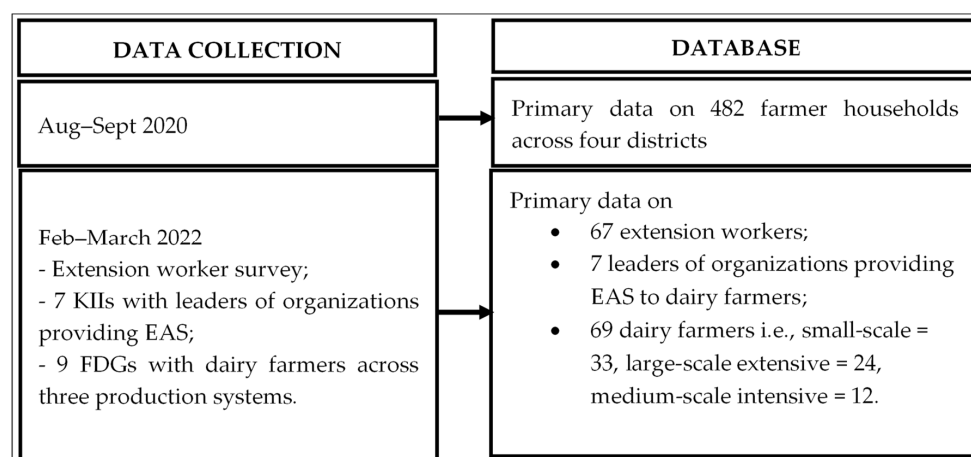


Figure 2. Breakdown and types of data collected and used in the current study.

The farmer questionnaire covered socioeconomic characteristics, dairy production, farm management practices, and access to EAS.

Based on Ganpat et al. [17], 29 statements regarding the provision of EAS were adapted and presented to farmers to estimate their satisfaction with EAS (Supplementary Material S1). To compute the satisfaction index, farmers were asked to indicate their level of agreement

with the statements grouped into nine constructs: affordability, participatory nature of the services, availability, timeliness, fairness, competence, customer care, relevance and usefulness. To estimate these constructs, various statements measured on a five-point Likert scale were presented to the farmers. For instance, to estimate affordability, the following statements, measured on the five-point Likert scale (1 = strongly disagree, 2 = somehow disagree, 3 = neutral, 4 = somehow agree and 5 = strongly agree), were presented to farmers:

The dairy extension officer helps me without expecting anything in return.

Dairy extension officers do not overcharge for their services.

All dairy extension services in this area are affordable for me.

The questionnaire for extension workers included questions about their socio-demographics, frequency of provision of EAS in terms of the average number of farmer training sessions conducted per month, their skills, motivation, satisfaction, availability of training materials, and type of training received. Furthermore, questions on perceived farmer satisfaction, availability of in-service training opportunities, methods used to deliver EAS, and ranking of the perceived effectiveness of these methods were presented in this questionnaire. Ten statements adapted from Asadi et al. [21] were used to estimate intrinsic motivation (Supplementary Material S2). Each was measured on a seven-point Likert scale, indicating the extension workers' level of agreement with the presented statements (1 = entirely disagree, 2 = mostly disagree, 3 = somehow disagree, 4 = neither agree nor disagree, 5 = somehow agree, 6 = mostly agree, and 7 = entirely agree).

3.2. Data Analysis

The data obtained from the two surveys were entered, cleaned, and processed using SPSS version 25. Data from the farmer household survey were analyzed, and farmers were classified into three different production systems in a research outcome from Ahikiriza et al. [10]. This earlier study revealed that farmers in the study area belonged to small-scale subsistence (SS), large-scale extensive (LE), and medium-scale intensive (MI) production systems. Owing to data incompleteness, two of the extension workers were eliminated, and the dataset remained with sixty-five extension workers for further analysis.

Descriptive statistics, including means, minimums, maximums and standard deviations, for farmers and extension workers were computed. The means were also compared to determine whether there were any significant differences in the perceptions of farmers across different production systems. Cronbach's alpha was used to test the reliability of the statements used to measure farmer satisfaction. All constructs had a Cronbach's alpha greater than or equal to 0.7, which confirmed internal consistency among the statements (Table 2). This indicates the suitability of the constructs used to estimate overall farmer satisfaction.

Table 2. Cronbach's alpha for the statements used to measure different constructs of farmer satisfaction.

Construct	Number of Statements	Cronbach's Alpha
Affordability	3	0.824
Participation	3	0.740
Availability	3	0.811
Timeliness	4	0.715
Fairness	2	0.749
Competence	2	0.799
Customer care	2	0.779
Relevance	6	0.808
Usefulness	4	0.822

Farmers' satisfaction index (FS_i) was computed to measure the extent to which they were satisfied with the EAS. This index (Formula (1)) was derived from the outcomes for each statement and construct for each farmer. First, R_i is calculated; its scores varied between 29 and 145. Standardization through Formula (1) brought this back to a range of 20–100.

$$\text{Farmer Satisfaction Index (FS}_i\text{)} = \frac{R_i}{R_{\max}} \times 100 \quad (1)$$

R_i = Total score of a certain farmer after summing up the scores from 29 statements.

$R_{\max}$ = The highest possible total score, i.e., 145.

One-way analysis of variance (ANOVA) was used to assess significant differences in the satisfaction indices across production systems. A non-parametric Kruskal-Wallis test was used to check for mean differences in individual constructs across production systems. Frequencies and percentages were used to establish the most effective extension delivery methods as perceived by extension workers.

The average number of farmer training sessions conducted by extension workers per month was used as proxy to assess the frequency of delivery of EAS to farmers. A negative binomial regression model was used to determine the factors influencing this number. The number of farmer trainings conducted per month ranged from zero to twelve and was the dependent variable. The dependent variable, being a count data variable with a mean that differed from its variance, made the negative binomial regression model the most appropriate for this prediction.

Since no previous study has investigated the factors that influence the frequency with which extension workers deliver EAS, the selection of independent variables (Table 3) was based on qualitative insights obtained during our interaction with farmers and extension workers. These variables are marital status, work experience, household size, intrinsic motivation index, number of in-service trainings received, type (in this case, being a private extension worker), and the knowledge index. The level of knowledge was proxied by a knowledge index generated based on 13 topics considered key for dairy farm management in this study. These topics include pasture growing and management, nutrient composition of different pastures, appropriate feed rations, hay and silage production, estrus cycle observation, artificial insemination, mastitis detection, detection of other major diseases, selection of the right acaricide, milk marketing strategies, milk processing techniques, farm structures, farm economics, and profitability. These knowledge topics were measured using a seven-point Likert scale. The overall regression is done with a negative binomial regression model, based on Gujarati [22], and specified as follows:

$$Y_i = \mu_i + u_i \quad (2)$$

Y_i is independently distributed with a mean μ_i for each extension worker.

μ_i is expressed as:

$$\mu_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + \cdots + \beta_k X_{ki} \quad (3)$$

where u_i is the error term, and X 's are some of the variables that might affect the mean value (μ_i).

Therefore, to predict the negative binomial regression model, we substituted μ_i with Expression (3) in Equation (2).

$$Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + \cdots + \beta_k X_{ki} + u_i \quad (4)$$

Table 3. Description and measurement of independent variables in the negative binomial regression.

Name of the Variable	Description of the Variable
Marital status	Marital status of the extension workers (1 = Married, 0 = Not married)
Work experience	Extension workers' experience in their current workplace (years)
Household size	Number of people living in the extension worker's household
Knowledge index	Computed index ($\frac{x_i}{x_{max}} \times 100$), based on the perceived level of knowledge, extension workers had on the 13 major dairy farm management topics. x_i = total score of a certain extension workers after summing up the scores from the 13 practices and x_{max} = observed highest total score, i.e., 91
Intrinsic motivation index	Computed index ($\frac{x_i}{x_{max}} \times 100$), based on the 10 statements (Supplementary Material S2) used to measure intrinsic motivation. Total score of extension workers after summing up agreement level with the 10 statements. x_{max} = highest total score = 70
No. of in-service trainings	In-service trainings received since the extension worker joined his/her current workplace
Private extension worker	Being a private extension worker (1 = Yes, 0 = No)

During FGDs, pairwise matrix ranking allowed farmers to rank their preferred extension delivery methods based on their perceived effectiveness. Pairwise ranking refers to the process of ranking a set of options using head-to-head pairs to judge which option is the most preferred overall. Data from this exercise were later summarized using word clouding in the Results Section to confirm the methods highly ranked by farmers.

The extension workers, on the other hand, were asked to rank various delivery methods in order of their perceived effectiveness, and the findings were later summarized. With such an analysis, the study was able to conclude on the most effective delivery methods as perceived by both farmers and extension workers as one of the variables under extension capacity, as described in the analytical framework.

4. Results

4.1. Characteristics of Dairy Farmers and Extension Workers in the Study Area

Small-scale subsistence farmers (SS) allocate the least amount of land to dairy farming and have the lowest daily milk production, monthly milk sales, and number of dairy cows owned. Large-scale extensive (LE) farmers have moderate amounts of all the aforementioned variables, except that they allocate the largest amount of land to dairy farming. Medium-scale intensive (MI) farmers produce the highest amount of milk per cow, have the highest milk sales and largest number of dairy cows, are more dependent on hired labor, and allocate a moderate amount of land to dairy farming. The proportions of SS, LE, and MI in the total sample were 82.6%, 11.5%, and 5.9%, respectively. With respect to extension, most of the MI farmers (89%) are willing to pay for EAS and are, on average, willing to pay more for the provided EAS (USD 19.9) compared to farmers in the other two production systems. In fact, they were already paying the highest amount of money (USD 24.2) for the services received during the previous extension worker's visit. However, for all three production systems, the amount farmers are willing to pay is lower than that paid to extension workers during the previous visit. Only 37.4% of the interviewed dairy farmers owned smartphones (Table 4).

Table 4. Key characteristics of farmers in the three dairy cattle production systems.

Name of the Variables	SS_mean (n = 389)	LE_mean (n = 54)	MI_mean (n = 28)	Total Sample Mean (SD)
Age of the major dairy farming decision maker (Years)	56.0 ^a	60.4 ^a	58.6 ^a	56.6 (13.6)
Dairy farming experience (Years)	26.9 ^a	36.1 ^b	31.3 ^{a,b}	28.2 (14.2)
Monthly milk sales (USD)	144.7 ^a	421.0 ^b	1135.8 ^c	235.0 (320.7)
Average monthly household income (USD)	324.5 ^a	662.1 ^b	2134.5 ^c	404.4 (452.2)
Land owned by the household (acres)	27.6 ^a	157.4 ^b	61.4 ^c	44.5 (55.0)
Land allocated to dairy farming (acres)	17.9 ^a	121.0 ^b	41.75 ^c	31.1 (43.1)
Number of dairy cows	18.2 ^a	58.4 ^b	68.4 ^b	25.8 (27.4)
Monthly hired labor costs cow ⁻¹ (USD)	1.8 ^a	1.8 ^a	3.1 ^a	1.9 (2.2)
Distance to the nearest trading center (Km)	7.3 ^a	29.0 ^b	2.5 ^a	9.6 (51.6)
WTP per visit (USD)	9.6 ^a	9.7 ^a	19.9 ^b	10.3 (14.1)
Actual amount paid for the EAS during the last visit (USD)	14.3 ^a	21.4 ^a	24.2 ^a	15.7 (19.5)
Name of the categorical variables	SS (%)	LE (%)	MI (%)	Total sample (%)
WTP for extension services (Yes)	79.7	75.5	89.3	79.8
Smartphone ownership (Yes)	33.5	50.0	64.3	37.4
Education levels				
No formal education	10.9	22.2	7.4	12.0
Primary education	35.8	22.2	14.8	33.0
Secondary education	26.5	22.2	18.5	25.5
Tertiary education	26.8	33.3	59.3	29.5
Members of cooperative society (Yes)	26.7	50.0	50.0	30.9

WTP = willingness to pay; SS = small-scale subsistence; LE = large-scale extensive; MI = medium-scale intensive; a–c = significant differences ($p = 0.05$).

Extension workers, on average, were 36 years old. This result indicates that extension workers are relatively young, despite the oldest being 67 years old. Most of them have worked for about 1–5 years and, on average, earn a gross income of USD 304 per month. The mean household size of most extension workers is approximately five, although 15% of them were not married. The majority of the extension workers were male (82%) and almost all of them (98.5%) owned smartphones (Table 5).

Table 5. Major characteristics of dairy extension workers (n = 65).

Name of the Variable	Frequency	Percent	Min	Mean	Max	SD
Age (Years)			24.0	36.3	67.0	9.0
24–34	34	52.3				
35–44	20	30.8				
45 and above	11	16.9				
Household size			1.0	4.8	13.0	2.8
1	10	15.4				
2–6	41	63.1				
6 and above	14	21.5				
Experience (Years)			0.2	7.0	35.0	6.5
<1	1	1.5				
1–5	34	52.3				
6–10	19	29.2				
11 and above	11	16.9				

Table 5. Cont.

Name of the Variable	Frequency	Percent	Min	Mean	Max	SD
Gross income (USD)			82.5	304.0	1100.1	166.2
80–200	13	20.0				
201–321	35	53.8				
322–442	6	9.2				
443 and above	11	16.7				
Knowledge index			46.2	74.0	94.5	9.0
45–60	3	4.6				
61–75	11	16.9				
76 and above	51	78.5				
Level of motivation of extension workers			1.0	5.1	7.0	1.3
1–3	7	10.8				
4	6	9.2				
5–7	52	80				
Extension workers' satisfaction			1.0	4.6	7.0	1.5
1–3	16	24.6				
4	6	9.2				
5–7	43	66.2				
Trainings conducted per month			0	3.4	12	4.0
0	30	46.2				
1–5	28	43.0				
6–10	6	9.2				
11 and above	1	1.5				
In-service trainings received			0.0	2.9	20.0	4.5
0	14	21.5				
1	21	32.3				
2	12	18.5				
3 and above	18	27.7				
Smartphone ownership (Yes)	64	98.5				
Gender (Male)	53	81.5				
Marital status						
Married	51	78.5				
Not married	14	21.5				
Availability of training materials						
Never available	4	6.2				
Rarely available	21	32.3				
Sometimes available	24	36.9				
Mostly available	6	9.2				
Always available	10	15.4				
Preferred frequency of in-service trainings						
Monthly	4	6.2				
Every after two months	3	4.6				
Quarterly	9	13.8				
Every after four months	9	13.8				
Once a year	35	53.8				
Once in two years	5	7.7				

Results also show that 80% of extension workers in the study area are motivated, 11% are demotivated, and the remaining are neither motivated nor demotivated. Two-thirds of the extension workers (66%) were satisfied with their current working conditions. In contrast, almost half of them (46%) did not conduct even a single farmer training in an entire month. Our interaction with extension workers revealed that failure to conduct farmer training sessions is attributed to: (i) difficulty in mobilizing farmers; (ii) low attendance by farmers, particularly when no handouts such as pasture seeds and transport refund were available; and (iii) lack of training materials. In line with this finding, only a quarter (15%) of the interviewed extension workers perceived training materials to be always available. Additionally, during a KII, one of the DVOs mentioned that *the available extension grant has been reducing over years because it is assumed that farmers' extension needs reduce every year*. However, this is far from reality because new challenges, knowledge, and technologies come up each year. To respond to such challenges, extension workers should unburden farmers with their visits. The reduction in the extension grant confirms that currently there are limited funds available to provide training materials.

Results further reveal that the average knowledge index of extension workers is 74%, indicating the need to train extension workers regularly to close the existing knowledge gap (26%). Moreover, the majority of extension workers had larger knowledge gaps regarding artificial insemination (64.3%) and milk processing techniques (35.7%). Worse still, 21.5% of the extension workers had never received any in-service training, although most of them had, on average, worked for seven years as extension workers. By the nature of their role, extension workers need to be extremely knowledgeable because they have to provide accurate and relevant advice to farmers at all times. To keep them knowledgeable, the majority of extension workers indicated a need for at least one in-service training per year.

4.2. Farmers' Satisfaction with EAS

The majority (SS = 83.3%, LE = 85.1% and MI = 89.3%) of the farmers in the three production systems had a farmer satisfaction index (FS_i) in the range of 50–79%. However, more than 10% of the SS farmers had an FS_i below 50%. This finding indicates that for every ten SS farmers, one was dissatisfied with the provided EAS. This proportion is lower for MI farmers. The mean farmer satisfaction indices for the SS, LE and MI production systems were 64.5, 66.2, and 70.2, respectively. The mean FS_i of MI farmers was significantly higher than that of SS farmers. Contrary to the above results, about 78% of extension workers perceived farmers to be satisfied with the provided EAS. Some extension workers emphasized that *if farmers were not satisfied, they would never call them back for services*.

The mean perceived affordability and availability of EAS for SS and LE farmers were below 50% (Table 6). This reveals that such farmers perceived EAS as costly and unavailable. There was a significant difference in the perceptions of SS and MI farmers, but no significant difference was found between LE and MI farmers. Due to limited availability, farmers resort to treating animals by themselves or even contacting extension workers from other districts when dealing with advanced cases.

Unlike the perceived affordability and availability that scored low, other constructs such as customer care/politeness, competence and usefulness were rated high (>70%) across all production systems. However, no significant differences were observed for these aspects across the three production systems. The findings further revealed that moderate enhancements were necessary concerning timeliness, participatory nature, fairness and relevance of the EAS provided.

Table 6. Average farmers' attitudes towards the received extension and advisory services (EAS).

Construct	Small-Scale Subsistence (n = 389)	Large-Scale Extensive (n = 54)	Medium-Scale Intensive (n = 28)	Total Sample (n = 471)
Availability	46.3 ^a	46.7 ^a	59.0 ^b	47.1
Affordability	47.5 ^a	48.1 ^{a,b}	56.7 ^{b,c}	48.1
Timeliness	60.7 ^a	63.4 ^a	64.5 ^a	61.3
Participation	66.8 ^a	66.3 ^{a,b}	75.5 ^{b,c}	67.9
Fairness	67.7 ^a	68.3 ^a	71.1 ^a	67.9
Relevance	67.4 ^a	70.5 ^{a,b}	73.7 ^{b,c}	68.1
Usefulness	73.2 ^a	74.8 ^a	76.8 ^a	73.6
Competence	74.7 ^a	75.3 ^a	76.8 ^a	74.9
Customer care	82.5 ^a	86.7 ^a	81.8 ^a	82.9

a–c show significant differences in farmers' attitudes across the three production systems.

4.3. Factors Influencing the Frequency of Delivery of EAS to Dairy Farmers

To determine the frequency of delivery of EAS to dairy farmers, the average number of farmer training sessions conducted per month by extension workers was used as a proxy. Results from a negative binomial regression revealed four major factors that influence the frequency with which extension workers deliver EAS. First, the number of in-service trainings received by the extension worker had a positive influence on his/her frequency of delivering EAS ($\beta = 0.096$). This was expected and means that increasing the number of in-service trainings attended by a particular extension worker increases the average number of farmer trainings he/she conducts per month by 0.096 units, thus increasing the frequency of service delivery, which may in turn increase the availability of extension services and improve capacity.

Second, being a private extension worker is associated with a low average number of trainings conducted. This means that, on average, government extension workers provide EAS more regularly than private extension workers do. Third, results revealed a negative relationship between years of experience and the average number of training sessions conducted per month. This implies that more experienced extension workers are likely to conduct less farmer training sessions than their newly recruited counterparts. Last, intrinsic motivation of extension workers positively influences their frequency of delivery of EAS. Surprisingly, there was no significant relationship between extension workers' knowledge index and their frequency of delivery of EAS to dairy farmers (Table 7).

Table 7. Factors affecting the average number of farmer trainings conducted per month.

Name of the Variable	Coefficient (β)	p-Value
Marital status	−0.174	0.592
Household size	0.071	0.318
Working experience	−0.151	0.008
Knowledge index	−0.002	0.928
Intrinsic motivation index	0.034	0.077
No. of in-service trainings	0.096	0.026
Being a private extension worker	−1.298	0.009

Log likelihood = −109.210, prob > chi2 = 0.001; pseudo R² = 0.098, prob ≥ chibar = 0.000.

4.4. Perceived Effectiveness of Extension Workers and Farmers Regarding Different EAS Delivery Methods

Extension workers reported that individual farm visits are the most commonly used EAS delivery method, although results indicate that they perceived on-farm demonstrations in farmer groups as the most effective method (Table 8). This implies that the EAS delivery

method perceived as the most effective is not the most commonly used. Results also indicated that extension workers perceived the use of lead/contact farmers and training workshops as the third- and fourth-most effective methods, respectively. Conversely, extension workers perceived the use of Information Communication Technologies (ICTs), such as WhatsApp groups and other related apps, as the least effective method. This result could be attributed to the fact that most farmers do not own smartphones, and those who own them mainly use them for basic communication purposes. Hence, those farmers may not know how to operate most applications on their smartphones. This was further stressed during the KIIs that, *“although farmer WhatsApp groups would have been one of the quickest ways to share information with farmers, majority of the dairy farmers are small-scale subsistence who do not own smartphones”*. The limited ownership of smartphones makes it difficult to launch their use in the delivery of EAS, regardless of their potential.

Table 8. Extension workers’ perceived effectiveness of different EAS delivery methods.

EAS Delivery Method	Rank (%)								Rank
	1	2	3	4	5	6	7	8	
On-farm demonstrations in farmer groups	56.9	24.6	12.3	4.6	1.5	0.0	0.0	0.0	1
Individual farm visits	35.4	33.8	13.8	6.2	3.1	4.6	0.0	3.1	2
Lead farmer/contact farmer approaches	3.1	20.0	27.7	23.1	13.8	6.2	4.6	1.5	3
Classroom training/workshops	0.0	12.3	13.8	23.1	18.5	10.8	15.4	6.2	4
Linking farmers to input suppliers	0.0	0.0	7.7	10.8	36.9	27.7	16.9	0.0	5
Linking farmers to new markets	1.5	0.0	1.5	4.6	13.8	30.8	16.9	9.2	6
Farmer group trainings on new technologies	1.5	7.7	21.5	20.0	7.7	12.3	38.5	12.3	7
Use of WhatsApp groups and other related apps	0.0	1.5	1.5	6.2	6.2	7.7	7.7	69.2	8

The results further revealed that farmers perceived individual farm visits, use of lead farmers, demonstration farms, and training workshops as the four most effective EAS delivery methods. These preferences differ slightly across the production systems (Figure 3). For instance, among SS and LE farmers, farm visits are considered the most effective, while MI farmers perceived lead farmers as the most effective delivery method. Farmers, however, emphasized that these methods should not be used in isolation but rather in complementarity. Furthermore, during the FGDs, SS farmers reported that farm visits should be complemented with the use of lead/contact farmers selected at the village level, given the limited number of extension workers. Contact farmers can act as early adopters of new improved technologies (NITs), from whom other farmers, also known as follower farmers, can learn.

SS farmers added that for very advanced NITs, demonstration farms should be set up at either sub-county or district levels. Consequently, different farmer groups can visit demonstration farms with the help of their area extension workers to enhance farmers’ knowledge and skills. Farmers believe that workshops, radio stations, TVs, and newspapers should mainly be used to create awareness about emerging technologies, knowledge and challenges. To gain hands-on experience, farm visits, lead farmers and demonstration farms were preferred. Similar to the extension workers’ perceptions, farmers perceived the use of ICTs as the least effective delivery method. In fact, in some production systems,

farmers never mentioned it as a possible source of extension information because they had never used any ICT technique to receive related EAS.



Figure 3. Most effective extension delivery methods as ranked by farmers (the larger the word, the more effective the method is perceived to be and vice versa).

5. Discussion

Farmers differ in farming contexts. In our Ugandan case, this is confirmed by the fact that they belong to three different production systems. Such differences not only affect the kind of knowledge and technologies required by farmers, but also the type of extension services required, as well as the mode of delivery [23]. Differences in resource endowments and production constraints are likely to result in social exclusion regarding access to EAS [24], thus affecting farmers' perceptions of the provided EAS. As such, there is a need to provide extension recommendations that are better tailored to the needs of individual farmers to help them make better-informed decisions [25].

Currently, the perceptions of both farmers and extension workers indicate that dairy farmers in the study area are only moderately satisfied with the EAS they currently receive. To improve satisfaction among those who are still dissatisfied, extension workers should endeavor to provide more context-specific EAS [26]. Moreover, results revealed that farmers' satisfaction differed slightly across the three production systems, although all farmers perceived EAS to be unaffordable and less available, with this being most apparent for SS and LE farmers. This is further supported by the fact that the amount farmers were willing to pay was lower than what they paid to extension workers during their previous farm visits. Thus, harmonizing the costs involved in the provision of EAS, for example, through cost sharing, could increase the affordability of dairy EAS [27]. To improve availability, Christiaensen and Rutledge [28] suggested integrating peer-to-peer extension approaches, such as use of contact farmers, into the existing traditional pluralistic extension system. Moreover, contact farmers within farming communities are more likely to be available than extension workers. However, the literature suggests that selected contact farmers should be those closer to, or more representative of, the average farmer rather than progressive farmers [29]. Furthermore, there is a need for intensive training on

the technology packages that contact farmers should transfer to other farmers. Regardless of the importance of training, study results reveal that almost half (46%) of the extension workers complete a whole month without conducting a single training session. This negatively affects availability of EAS; hence, there is a need to ensure that more training sessions are conducted per extension worker.

Our study further revealed that increasing in-service training opportunities can positively influence the frequency at which extension workers deliver EAS. The positive relationship between in-service training and the average number of farmer training sessions can be ascribed to the improved competency levels of extension workers [30]. To achieve this, peer training can be explored [31]. In peer training, extension workers who attend a particular type of training can, in turn, train others upon completion. Increased interactions between extension workers with particular skills and those without can facilitate transfer of such skills to those that lack the skills. Furthermore, digital platforms and virtual training methods could be explored, since 98.5% of extension workers own smartphones. The use of such platforms may reduce the cost of conducting in-service training for extension workers.

Currently, public extension workers have higher frequency of providing EAS than private extension workers. This could be due to their mandate and ease of access to training materials. For instance, government extension workers have access to extension grants, whereas private extension workers do not receive such grants. As private extension workers usually help farmers when they cannot reach government extension workers, collaboration between the two types of extension workers could yield positive results in improving the availability of EAS. Moreover, some studies [32,33] have found that private extension workers are more competent and perform better than public extension workers. Increasing the number of public extension workers may increase the frequency at which farmers receive EAS and, hence, the capacity of extension workers to provide EAS.

Surprisingly, extension workers with longer working experiences had less contact with dairy farmers. This could be attributed to complacency tendencies among those who have been in the system for a long time. Thus, the government could consider employing extension workers on contract basis to ensure that contracts are renewed only based on satisfactory performance. This may increase the availability of EAS and reduce the perceived exploitation of farmers in terms of exorbitant costs for the services provided.

Consistent with the farmers' perceptions, extension workers perceived on-farm demonstrations as the most effective EAS delivery methods. This indicates that extension workers are aware of the preferred advice delivery methods for dairy farmers. Surprisingly, on-farm demonstrations are not the most commonly used method, although they are perceived as the most effective. This may need to be followed up to understand why this is so. The three other effective methods of delivering EAS mentioned by both farmers and extension workers were farm visits, use of contact farmers and farmer training. Notably, both farmers and extension workers consider the use of ICTs, such as WhatsApp groups and other related apps as the least effective delivery method. This contradicts the findings of Mohammed and Abdulai [34], who reported that employing ICT-based extension delivery can help accelerate progress in yields, farm net returns, and knowledge scores among soybean farmers in Ghana. This shows that although Ugandan dairy farmers have not yet embraced ICT-based extension services, they can learn from other countries that have registered success stories. The sector could also look into increasing in-service training opportunities for extension workers targeting the use of ICTs to promote ICT use among farmers. Such in-service training programs can enable extension workers to provide intensive training to farmers on the potential and functionality of ICT-based tools.

6. Conclusions

This study evaluated the extension capacity while accounting for farmers' and extension workers' characteristics and perceptions of the services currently provided using a broad set of criteria. This makes the analysis more integral than similar extension research done in the past. As such, our proposed analytical framework helped evaluate the current capacity and propose future improvements.

Empirical evidence from Ugandan dairy farming shows that both farmers and extension workers perceived low capacity in the existing extension system to provide effective EAS. Although farmers belonged to three different production systems, they all perceived the currently provided EAS as moderately satisfactory. This confirms that a one-size-fits-all model, as currently applied in the provision of EAS, does not work because it satisfies neither the more progressive nor the least progressive farmers. Together with the perceived effectiveness of farm-oriented approaches (on-farm demonstrations, individual farm visits, the use of contact farmers, and farmer training), it is necessary to restructure the EAS currently provided to dairy farmers in the study area. In-service training opportunities and materials should be availed to restructure and improve the capacity of extension workers to provide EAS. Furthermore, increased collaboration between private and government extension workers needs emphasis.

Applying an integral analytical framework to concrete local data provides a clear picture of what can be done in the future to improve the capacity of the extension system on the side of both farmers and extension workers.

The current study mainly defined farmer heterogeneity solely based on statistical categories. Thus, future studies can consider estimating extension capacity using an integral analytical framework to capture farmers' heterogeneity in terms of a sociotechnical and institutional lens, structural asymmetries in access, institutional embeddedness, and social capital.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su18052275/s1>, S1: The 29 statements used to construct the farmer satisfaction index FS_i; S2: Statements used to measure intrinsic motivation of extension workers.

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