S. Afr. J. Agric. Ext.
Vol. 53 No. 1, 2025: 16-38
10.17159/2413-3221/2025/v53n1a17189

The Challenges of Extension Service Delivery and its Determinants in the Agricultural Extension System: An Insight from a Study in North-Western Ethiopia

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ABSTRACT

The present study examined the significant bottlenecks of extension service and determinants of service delivery in North Western Ethiopia. A total of 120 sample households were randomly selected using a multistage sampling technique to represent the highland, lowland, and midland districts in the former North Gondar zone. Both qualitative and quantitative data were collected. Through descriptive and econometric analysis, the study found that the bottlenecks to the effectiveness of the extension service delivery are highly connected to the poor functioning of farmer training centres, the top-down approach, the limited capacity of development agents, and poor infrastructure. Specifically, the model results for the variables participatory extension approach, integrated extension service, land size, and demonstration showed a positive and statistically significant influence, with coefficient values of 0.734, 0.496, 0.096, and 0.701, respectively. Based on the results, it was concluded that the existing extension service delivery practices were very low due to multiple and interlocking challenges that demand concerted efforts at different levels. Therefore, extension services should be designed based on local problems and challenges, with intimate interaction with farmers and stakeholders and move away from a one-size-fits-all approach.

Keywords: Bottlenecks, One-size-fits-all, Logit Model

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Vol. 53 No. 1, 2025: 16-38
10.17159/2413-3221/2025/v53n1a17189

1. INTRODUCTION

Ethiopian agriculture still plays a pivotal role in the overall gross domestic product (GDP), providing most of the population with employment opportunities. Nearly 80% of the country's population lives in rural areas where agriculture is the main livelihood activity, generating income for household consumption to sustain their livelihoods (IFAD, 2023). Moreover, the sector contributes hugely to foreign currency earnings, estimated to be 32.5 percent of countries' GDP through the export of agricultural commodities (CSA, 2015; NBE, 2021). It is believed that a successful extension system can be a vehicle for the diffusion of new knowledge about agricultural practices, improving production and productivity as well as the income of farmers through the dissemination of new agricultural technologies that are deemed helpful for their farming system (Birkhaeuser et al., 1991; Abate, 2008; Leta et al., 2017; Ketemaw et al., 2022).

Agricultural extension is one of the formal systems applied in many developing countries to shape the direction of agricultural development through the transfer of new state of the art to the farmers through appropriate means of dissemination (Khan et al., 2012; Rickards et al., 2018; Yadov et al., 2023). Ethiopia has a long history of implementing an extension system since 1953, following the establishment of the then-imperial Ethiopian College of Agriculture and Mechanical Arts (MoANR, 2017). Since then, considerable changes have been registered from quantitative perspectives. For instance, the rollout of input distributions has shown improvement from 33 to 71%, while the number of beneficiaries of agricultural extension services has tripled from 3.6 to 10.8 million between 2004 and 2010 (Guush et al., 2018).

However, the production and productivity of agriculture in many parts of Ethiopia have not improved despite the efforts exerted in agricultural extension since its inception in 1950 (MoFED, 2009; IFAD, 2023). Even though the agricultural extension system in Ethiopia is decentralised and well-structured, it is still criticised for its low quality of service and poor monitoring and evaluation system (MoANR, 2017). The extension system is expected to play a paramount role in boosting the production and productivity of the agriculture sector. Since the agricultural system was still characterised by a low level of agricultural service delivery

practice, it couldn't move the existing traditional agriculture into a modern one. A top-down approach also characterised the implementation (Leta, 2018).

Studies have shown that rural farmers, particularly those from disadvantaged and impoverished backgrounds, prioritise agricultural extension over all other service requests to improve living standards and agricultural productivity (Kwapong, 2012; Hamasalih & Layeeq, 2023). On top of that, for sector-wide improvement and sustainability extension, service delivery plays a pivotal role in the rural economy (Blackmore et al., 2015**;** Abu et al., 2024). However, according to the OECD (2010), there are significant obstacles to implementing agricultural extension services because of accessibility issues. Moreover, the supply-driven system in Ethiopia was considered one of the bottlenecks for service delivery (Tewodaj et al., 2009; Leta, 2018). Thus, the present study aimed to document and evaluate agricultural extension delivery services in the North Gondar zone of the Federal Democratic Republic of Ethiopia. Notably, the existing agricultural extension services delivery, as well as the determinants and significant agricultural challenges innate in the study area, were examined through the support of first-hand primary data.

2. METHODOLOGY

The study was conducted in the North Gondar zone, which is currently divided into the North Gondar, Central and West Gondar zones in Amhara National Region State. These zonal administrations cover the lowland, highland and midland agroecology. In this study, both quantitative and qualitative approaches were employed. Put differently, the approach employed in this study was a mixed type. The use of multi-method can help triangulate and augment data for better discussion because it provides greater confirmation of data through triangulation and, on the other hand, to elaborate or develop analysis based on rich details (Miles & Hubermann, 1994; Yeasmin & Rahman, 2012; Creswell, 2009; Dawson, 2009; Bans-Akutey & Tiimub, 2021)

2.1. Sampling Procedures and Techniques

A multistage sampling technique was employed for the overall study of this research. Based on the multistage sampling technique, the Amhara Regional State, specifically the North Gondar zone (former name), was selected purposively since it is the largest zone in the region and can create opportunities to represent the region. Secondly, the North Gondar zone stratified

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based on agroecology to form a homogeneous stratum for the selection of woredas. Accordingly, the woredas were grouped into Dega, Woinadega and Kola. Then after, from the dega Wogera woreda, woinadega dembia woreda and the kola/lowland Metema woreda were selected purposively to have representative woredas in North Gondar. As a continuation of the multistage sampling, kebeles were randomly selected from each stratum. The sample size for this study considered the number of variables to be included in the model. As a result of this, 120 sample households have been used that can be sufficient for the logistic regression that considers 10 explanatory variables (Peduzzi et al., 1996; Srimaneekarn *et al*., 2022)

Multiple data collection techniques wereutilised to gather pertinent data for the specified objectives. To that end, a survey design with the support of well-organised and pre-tested interview schedule has been conducted. At the same time, to substantiate the quantitative data, two (02) focus group discussions were conducted, each composed of 8 and 10 discussants for Metema and Dembia districts, respectively. We have also employed 30 development agents from three of the districts. Moreover, key informant interviews (KII) and observations of the reality were conducted as data collection methods.

2.2. Methods of Data Analysis

Both quantitative and qualitative data were used for this study. As a result, both quantitative and qualitative analysis techniques were recruited. Descriptive statistics such as the mean and econometrics models were utilised to analyse the quantitative data. At the same time, organisation, categorisation, and synthesis of the qualitative data were done to substantiate the results of the quantitative analysis.

The econometrics model (notably the binary logit model) has been used to analyse the determinant factors for extension service delivery practice. Service delivery is a broad concept that combines accessibility and utilisation of the service. In this study, as a proxy for service delivery, the utilisation aspect has been denoted by farmers' satisfaction with the given agricultural extension service. Thus, the dependent variable extension service is considered a dummy variable based on farmers' level of satisfaction with a given extension service. Farmers' evaluation of the existing extension service delivery has been categorised as satisfied and non-satisfied farmers. Thus, based on this categorisation, 1 was given to those who were satisfied with extension service delivery and 0 for those who were not satisfied.

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Based on the following empirical works conducted so far such as Assefa and Gezahegn (2010), Asiedu (2013), Elias et al. (2015), Hazem *et al*. (2021) and Hu *et al*. (2022), the variables indicated in Table 1 are hypothesised to influence extension service delivery which according to this study is proxied with the satisfaction of farm householders with the given extension service delivery.

TABLE 1: Variable Definition and Hypothesis

Variables	Measurement	Variable nature	Hypothesis
Extension service approach (APPROACH)	1= Participatory 0 =non-participatory	Dummy	+
Participation in farmers' field day (FIELDDAY)	1= Participated 0= Not participated	Dummy	+
Development agent's follow-up (FOLLOW-UP)	1= There is follow-up 0= No follow-up	Dummy	+
Location of the farm household from the Office of Agricultural Extension/Development agents (HHLOCT)	Distance in minutes	Continuous	+
Access to multiple extension services to the farmer (INTEGRATION)	1= Yes 0= No	Dummy	+
Access to credit (CREDIT)	1=Access 0= No	Dummy	+
Exposure to the demonstration sites (DEMO)	1=Yes 0=No	Dummy	+
EDU	1= Literature 0=Illiterate	Dummy	+
Age of the household head (AGE)	Age of Household head in years	Continuous	-
LANDHOLD	Landholding in hectares	Continuous	+

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3. RESULTS AND DISCUSSIONS

3.1. The Socio-Economic Characteristics of the Respondents

The socio-economic characteristics of the respondents are presented in Table 2. Most respondents were male (77.5%), whereas female-headed households accounted for 22.5%. Similarly, Jemal (2018) underscores the dominance of male-headed households in Ethiopia. Concerning literacy level, 78.3% of the respondents were illiterate, and 21.7% were able to read and write and had formal education. In terms of marital status, the study found that 73.3%, 15%, 7.5%, and 4.2% of the respondents were married, single, divorced, and widowed, respectively.

TABLE 2: Socio-Economic Characteristics of the Respondents (N=120)

Indicators		**Frequency**	**Percent**
Gender:	Male	93	77.5
	Female	27	22.5
Literacy level:	Literate	26	21.7
	Illiterate	94	78.3
Marital status:	Single	18	15
	Married	88	73.3
	Divorced	9	7.5
	Widowed	5	4.2
Wealth status	Rich	7	5.8
	Medium	46	38.4
	Poor	67	55.8
Indicators	**Mean**	**Min**	**Max**
Age	44.5	21	77
TLU	5.22	0.3	18.11

The respondents ranged between 21 and 77 years old, with an average age of 44.5 years. In this study, the tropical livestock unit (TLU, hereafter) used to measure possession of livestock shows that, on average, the respondents possessed 5.22 TLU with a minimum and maximum

of 0.3 and 18.11 TLU, respectively. 55.8% of the respondents were classified as being poor, 38.4% as medium, and 5.8% were found to be in the rich category. This indicates that most of the respondents in the study area were poor (see the wealth ranking in Appendix IC).

3.2. Agricultural Production Challenges

The agricultural production challenges (Figure 1) in the study area were assessed to determine whether agricultural extension services could respond to the existing problems. The cost of inputs (80.8%), shortage of grazing land (75.8%), and shortage of animal forage (74.2%) were the major challenges faced by the farmers.

The price of agricultural inputs has been seen to be very high due to several factors such as insufficient availability, global price surge as much of the inputs are imported, and an accessibility factor due to remoteness (Kibrom *et al*., 2024) For instance according to Getahun and Mahlet (2022), the current price (as of October 2022) increments as compared to last year estimated to be 150% high, which curtails farmers ability to buy fertiliser. The delay in the distribution of agricultural inputs could further exacerbate the problem.

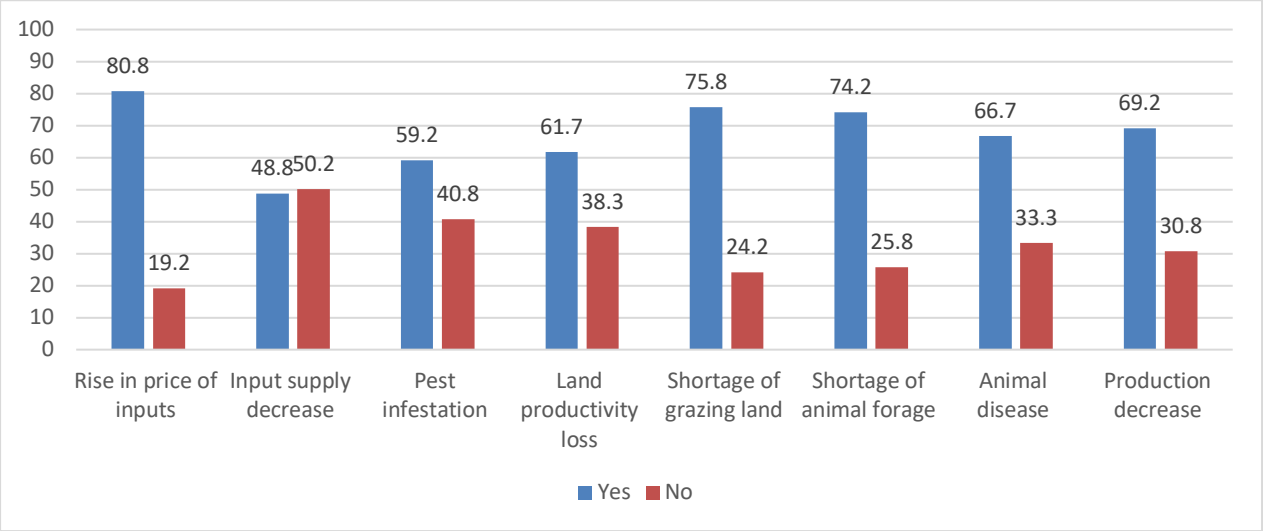

FIGURE 1: Agricultural Production Challenges in the Study Area

The success of agricultural extension delivery depends heavily on farmer training centres, the extension approach, the capacity and satisfaction of development agents, and the existing infrastructure. In contrast to this, the survey results from development agents, as previewed in Figure 2, indicated that non-functional farmer training centres (FTCs hereafter), the top-down

approach, limited capacity of Development Agents (DA), poor infrastructure and the dissatisfaction of development agents had been strongly agreed among development agents with the percentage of 73%, 62%, 51%, 58% and 41%, respectively. According to Ketemaw *et al*. (2022), FTCs are critical for improving crop productivity and farm households' income, but they are poorly functioning in the study area.

The supply-driven or top-down approach is one of the main limitations of extension service delivery in the present study. Such an approach has received strong criticism as it merely focuses on the demand from the government side rather than understanding the context of farmers' needs (Maulu *et al*., 2021). On the other hand, the functionality of farmer training centres in this study is very low, similar to the study conducted in Ethiopia by Suleymen *et al*. (2021). The dysfunction of the extension service delivery can be attributed to poor planning, a lack of capacity, and a limited focus on agricultural marketing (Leta, 2018; Radi et al., 2020; Maulu *et al*., 2021).

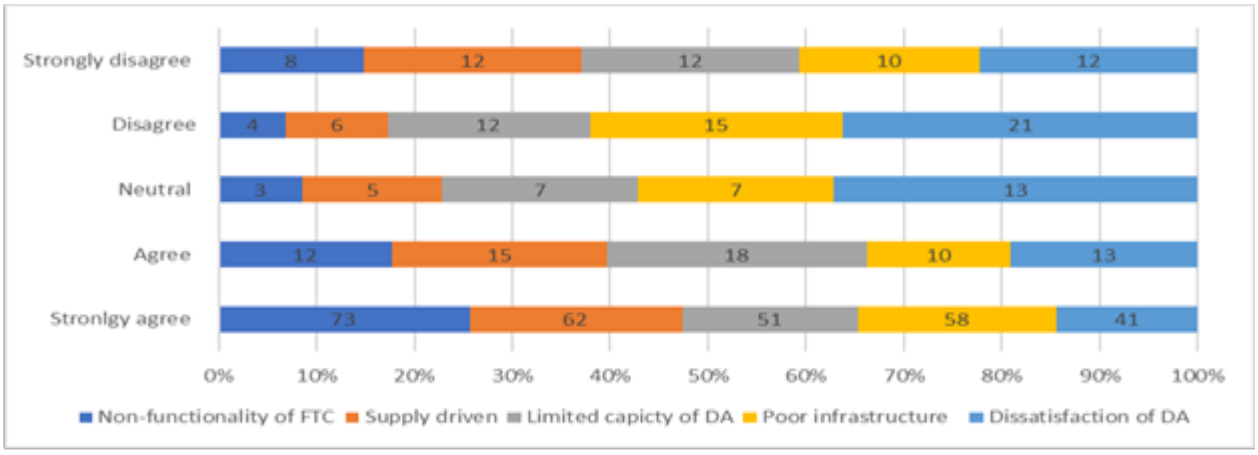

FIGURE 2: Farmer's Attitudes on the Limiting Factors for Extension Service Delivery in the Study Area

In addition to the above descriptive analysis, the challenges in agricultural extension services have been qualitatively assessed through focus group discussions undertaken in Dembia and Metema districts. The results of the discussions help to understand the multidimensional challenges of extension service delivery. The discussions have been synthesised as follows. Firstly, non-functional farming training centres were identified as one of the challenges attributable to poor planning. Secondly, the discussants agreed that there is a limited capacity of development agents and a lack of efforts in capacity development. This is also clearly noted

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from the review results by Leta (2018) and Maulu et al. (2021). The third and most important part of the focus group discussion connected with the limited effort on agricultural marketing extension that inclined to the production aspect. Radi et al.'s study (2020) also confirmed the limited effort given to agricultural marketing extension in Jordan. Moreover, lack of fairness and corruption to some extent, lack of memorandum of understanding for stakeholder integration, lack of commitment among farmers to put training into practice and lack of vehicle facilities for better accessibility of kebeles were also mentioned as additional weakside of the extension system in the discussion. Similarly, studies have shown ineffective extension services in different countries were due to a lack of incentives for extension workers and limited capacity-building efforts (Oluwasusi & Akanni, 2014; Adnan *et al.,* 2023).

In the present study area, one of the key informants in Dembia district meticulously explains that "the extension service they received from the local development agents are not consistent and in synergy with the different agricultural activities instead are driven by top-down campaign based seasonal tasks. Also, bureaucratic multi-tasking was one of the main challenges for public extension service delivery (Blackmore *et al*., 2015), and sometimes political agendas compromise agricultural development. In line with this study, Leta *et al*. (2017) stated that the extension system merely has a brokerage function between the system and the farmer. This signals the need to revisit the extension approach.

3.3. Influencing Factors of Extension Services Delivery in the Study Area

The results of the extension services employed in this study are shown in Table 3. The results revealed that the adoption of extension services observed in the study was very low except for fertiliser use. The role of extension is to provide general service regardless of commodities. However, the extension service is limited to crop production under this study. Livestock extension has been expected to play a pivotal role in improving the income and nutrition of households and, ultimately, rural livelihoods. However, the focus group discussion conducted by Metema and Dembia confirmed that the lack of integration of crop extension with animal extension is the major weakness in agricultural extension service delivery. A similar study in Burkina Faso, Mali, and Benin also revealed a low level of livestock extension service (Pousga et al., 2022).

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Concerning water and soil management, only 58.3% of the respondents were engaged in such training and practices. However, participation in water harvesting practices was very low (29.2%). This indicates that attempts at soil and water management extension activities still require further efforts to improve the prevailing situation. In line with this, the study also recognised a low level of meteorological information dissemination for early warning and preparedness. Nearly 66.7% of the respondents in the study area did not have access to meteorological information.

Relative to other services, the extension service for fertiliser use was higher, accounting for 70.8%. However, the extension role in poultry and dairy cows is very low, at 25% and 28.3%, respectively. The demonstration site's role in the extension service is slightly more than half of the total responses (57.5%). Extension initiatives that provide farmers with appropriate market information can significantly contribute to sustainable agricultural development. However, in the present study, only 38.3% of respondents had access to marketing information. This indicates that, though the production aspect has its problems, it is noted that much emphasis has been given to production while ignoring the marketing extension that helps to connect good producers with market access. As stated above, this study is also similar to the study by Radi et al. (2020). Similarly, the extension service delivery in animal feed, irrigation use, water harvesting and meteorological information access were very low, accounting for 38.3%, 33.3%, 29.2%, and 33.3%, respectively. This implies that much of the extension service is concentrated in distribution, ignoring the other very important services for improving the agricultural sector.

TABLE 3: Extension Service Delivery in the Study Area

Extension services	Response	Frequency	Percent
Fertiliser use	Yes	85	70.8
	No	35	29.2
Improved dairy cow	Yes	34	28.3
	No	86	71.7
Improved poultry	Yes	30	25.0
	No	90	75.0
Demonstration site	Yes	69	57.5

	No	51	42.5
Market access	Yes	46	38.3
	No	74	61.7
Animal feed training	Yes	46	38.3
	No	74	61.7
Soil and water conservation	Yes	70	58.3
	No	50	41.7
Irrigation training and consultation	Yes	40	33.3
	No	80	66.7
Water harvesting	Yes	35	29.2
	No	85	70.8
Meteorological information	Yes	40	33.3
	No	80	66.7

The overall satisfaction of the farmers with the extension delivery services is presented in Figure 3. The results indicate that about 67% of the respondents were dissatisfied with the extension delivery services, while 33% were satisfied. This implies that much still needs to be done to improve the extension service in the study area. The same result has been noticed in East Gojjam, which signals the universality of low levels of extension delivery services in the Amhara region (Elias et al., 2015).

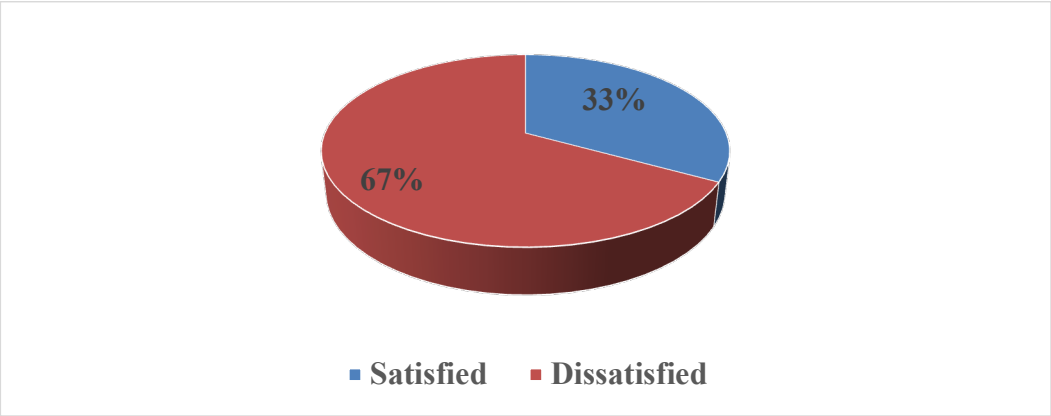

FIGURE 3: Farmer's Satisfaction with Extension Delivery Services

As indicated in the methodology section, the logit model has been used to examine influencing factors in the study area. Before proceeding to the model, the need to test for multicollinearity

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among the various explanatory variables is worth mentioning. Firstly, the discrete variables were tested for correlation, as described in Gujarati (2004) and Shrestha (2020). A multicollinearity test was conducted using the correlation coefficient and variance inflation factor. Accordingly, the correlation should not exceed 0.8 to avoid collinearity problems. Secondly, the variance inflation factor (VIF, hereafter) has been used to test multicollinearity for continuous variables. As shown in Appendix IA and Appendix I B, there is no multicollinearity problem among the discrete variables, which are all less than 0.27.

Similarly, following Gujarati (2004) and Shrestha (2020), the VIF is calculated using the formula below. In the first case, each of the continuous variables was regressed against the other, and finally, using the VIF command in Stata, values were not higher than 1. Thus, the continuous variables also demonstrated no collinearity problem.

$$\text{VIF} = \frac{1}{1 - R^2}$$

Once we confirmed no collinearity problems, we employed all ten variables into a Logit model (notably, binary logit) to identify the most important variables that determine extension service delivery in the study area. As shown in Table 4, out of the total ten explanatory variables hypothesised in this study, four important variables, such as land size, integrated extension service delivery, extension delivery approach and demonstration, significantly influenced extension service delivery in the study area.

However, before detailing the variables, it is crucial to interpret indicators of how the model is good before interpreting the explanatory variables. Firstly, through the classification table, the correct predictions of all the samples used were 90%. In contrast, the sensitivity (correct prediction of satisfied households) is 79.49%, and the specificity (correct prediction of non-satisfied households) is 95.06%. In this study, the chi-square model was also used as one of the indicators to assess how good the model is. To this effect, the model chi-square, specifically the omnibus tests of the model's coefficients value is 91.93 on 10 degrees of freedom, which is highly significant beyond 0.000 level, signifying that the explanatory variables used in the binary logistic regression have joint significant importance in predicting the households' evaluation of the successes of agricultural extension service.

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On the other hand, the Nagelkerke pseudo-R-square was used to determine how well the variables used in the model explain the data variation. In this regard, the variables employed in this study were in a position to explain 60.75 % of the variations. In other words, other variables could influence agricultural extension service determinants.

The land size was found to positively and significantly influence ($p<0.05$) agricultural extension delivery services. A unit increase in land size per hectare increased the access to the extension delivery service by 0.0967. Similar studies also agree that having larger land size would motivate farm households to adopt land-enhancing technologies and, therefore can increase their engagement with extension services (Assefa & Gezahegn, 2010; Hazem et al., 2021; Hu *et al*., 2022).

At the same time, integrated extension services[5] delivery was found to positively and significantly influence agricultural extension services at a 5 % significance level of less than 5% ($p<0.05$). Keeping other factors constant, farmers who received integrated extension service have been found to have extension service satisfaction, which is higher by a factor of 0.496 or 50% than those who weren't exposed to integrated extension service. The possible reflection for this variable is that an integrated approach can help farmers access multiple agricultural services that expand the choice and benefits of farmers in extension service, thereby increasing their satisfaction with the current extension services delivery.

The farmers' perceived approach to extension service delivery, whether participatory or not, was also found to positively and significantly influence the success of agricultural extension services at less than a 1% significant probability level ($p<0.01$). Participation in this study was measured in terms of farmers' involvement in the planning, implementing and evaluating the extension service process. Holding other variables constant extension delivery approach alone influenced the success of agricultural extension service by the factor of 0.734 or 73 % if it is delivered in a way that can participate farmers at all levels of extension services activities. As expected, participation is the basic instrument to bring farmers into the mainstream of extension service programs as it creates an opportunity for farmers' real problem identification. A study conducted in Ghana confirmed that the lack of farmers' involvement in extension service

[5] Integrated extension service here refers to the extension service delivery that departs from a single commodity approach but instead combines broader agriculture and rural livelihood

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delivery is the country's major problem (Asiedu, 2013; Hazem et al., 2021). In this regard, the focus group discussion conducted in Dembia and Metema revealed that farmers only trust what they see in practice. However, it is also understood that such practical exposition of farmers to new activities and technologies is a very tiresome task that can't be achieved given the meagre remuneration and low incentives for development agents.

On the other hand, participation in demonstration sites has been found to positively and significantly influence the success of agricultural extension services at a 1% significant probability level ($p<0.1$). Engaging farmers in demonstration activities increased satisfaction by 0.7012 (70%) while variables were held constant.

TABLE 4: Determinants of Extension Services Delivery in the Study Area

Variables	dy/dx	Std. Err.	Z	P>|z|
APPROACH	.7341844***	.12506	5.87	**0.000**
FIELDDAY	.2446288	.15725	1.56	0.120
FOLLOW-UP	.06584	.10828	0.61	0.543
HHLOCT	.0005906	.00125	0.47	0.636
INTEGRATION	.4965424**	.16721	2.97	**0.003**
CREDIT	.2042154	.19686	1.04	0.300
DEMO	.7012143***	.1158	6.06	**0.000**
EDU	.0139317	.01578	0.88	0.377
AGE	-.0005011	.00553	-0.09	0.928
LANDHOLD	.0967411**	.04725	2.05	**0.041**

Nagelkerke pseudo R-square (%) = 60.75 %

Correct Prediction of all samples (%) = 90.00%

Correct Prediction of satisfied (sensitivity) (%) = 79.49%

Correct Prediction of Non-satisfied (specificity) (%) = 95.06%

Note that: **, *** represent significance levels at 5 % and 1% respectively

On the other hand, even though the variable Development agents (DA) follow-up was found to have a positive and non-significant influence on satisfaction, our focus group discussion revealed that farmers who received continuous follow-up were highly satisfied by the extension service. This can be connected to the continuous nature of technology adoption from awareness creation to the final acceptance and utilisation; farmers require continuous follow-up from

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development agents from immediate consultation and communication. In line with this, the study by Elias et al. (2015) has shown similar results confirming the positive and significant effects of farmers' frequent exposure to development agents.

4. CONCLUSION AND THE WAY FORWARD

In this study, two primary research objectives have been critically analysed. In terms of approach, a mixture of quantitative and qualitative methods was utilised to come up with the following conclusions and recommendations. Firstly, the study boldly identified the major challenges of agricultural activities in the study. These are a low input supply level, higher input prices, shortage of grazing land, and low land productivity. Secondly, the study further identified the bottlenecks to the effectiveness of the extension service delivery. These include poor functioning of farmer training centres, a top-down approach, limited capacity of development agents, and poor infrastructure. Despite this, the study roughly assessed the existing extension activities in agricultural input utilisation, soil and water management, marketing extension, meteorological extension, and livestock extension, which were in line with the major challenges. It is concluded that much of the extension service is concentrated on fertiliser distribution, ignoring the other very important services for improving the agricultural sector.

Based on the results of this study, it is recommended that comprehensive extension planning from input, natural resources management, marketing, and meteorological information be used to gauge the multiple facets of agricultural production challenges in the study area. Moreover, extension services should be designed based on local problems and challenges, with intimate interaction with the farmers, to design relevant and problem-solving technologies rather than using the one-size-fits-all approach.

The study tried to analyse the important determinant factors of extension service delivery. The binary logit econometrics model revealed that, most importantly, household characteristics, notably farm size, organisational efforts such as consistency of development agent's follow-up, integrated approach and demonstration arrangements positively and significantly influenced extension service delivery. At the same time, qualitative responses from focused group discussions added that the low capacity of extension personnel, poor incentives, and lack of commitment by the side of farmers are the other factors that strongly influence extension

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service delivery in the study area. Therefore, appropriate interventions should be designed to address the farmer, the capacity of extension personnel, motivational incentives, and the extension approach itself.

In this study, it is safe to conclude that the existing extension service delivery practices are very low due to multiple and interlocking challenges which demand concerted efforts at different levels. Agricultural and rural development offices at all levels should revisit the service delivery approach to accommodate multiple stakeholders for extension services such as meteorological, marketing and livestock extension. At the same time, there should be a consistent follow-up of farmers at the initial technological attachments to save them from dejection and rejecting the technology. Thus, improving the existing development attachments with the farmers should be further strengthened to improve extension service delivery. The study also confirmed the relevance of the practical attachment of farmers through field days and demonstrations. Thus, field days should be arranged in a participatory way so that every segment of the agricultural society can benefit from practical observation. On top of that, there is a need to consider private agricultural extension service delivery to circumvent the problems of top-down implementation.

5. DISCLOSURE STATEMENT

The authors declare that they have no competing financial or non-financial interests.

6. ACKNOWLEDGEMENT

We authors want to acknowledge the University of Gondar for funding this research project. Secondly, we extend our cordial acknowledgement to respondents, all agricultural professionals, the Agriculture and Rural Development Office, stakeholders, key informants, and enumerators for their genuine response and devotion to the success of this research work.

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Appendix I

Appendix I A: Correlation coefficient among discrete variables

	approach	filedday	followup	integrg	credit	demon
approach	1.0000					
filedday	-0.0424	1.0000				
followup	0.0547	0.0812	1.0000			
integrg	0.1612	0.0182	0.0518	1.0000		
credit	0.1256	-0.0632	-0.0539	-0.0095	1.0000	
demon	0.2741	-0.1108	0.2789	0.2077	0.0917	1.0000

Appendix I B: Variance inflation factor for continuous variables

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. vif
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Variable	VIF	1/VIF
landsize	1.06	0.946574
hhlock	1.04	0.963679
age	1.02	0.981503
Mean VIF	1.04	

Appendix IC: Community based wealth ranking for each district

Wealth ranking	Demiba	Wogera	Metema
Rich (Well-off)	More than pair of oxen, 4 hectares of land, have 1 donkey and goats and sheep, no food shortage, have surplus produces	Pair of oxen, 1 donkey, 3 hectares of land and have goats and sheep's, no food shortage, have surplus produces	3 pairs of oxen, 1 donkey, 10 hectares of land and have goats and sheep's, no food shortage, have surplus produces
Medium	Pair of oxen, Pairs of oxen, 1-3 hectares of land, 1 donkey, 1 hectares of land have	Pairs of oxen, 1 donkey, 0.5 -2 hectares of land, have no food	5-9 hectares of land, have goats and sheep, have no food

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	no food shortage throughout the year	shortage throughout the year	shortage throughout the year
Poor	Have land less than 1 hectare, have no other assets, faces food shortage throughout the year	Have land less than 0.5 hectare, have no other assets, faces food shortage through the year	Less than 5 hectares of land, have no pairs of oxen, donkey and small ruminants, faces food shortage through the year