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Research Article

Determinants of Famers Access to Agricultural Extension Services in Lare District, Gambella Region, Ethiopia

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Abstract— Agricultural extension services play a vital role in disseminating information, knowledge, and technologies to farmers, enabling them to improve agricultural practices, boost productivity, and enhance livelihoods. However, farmers in remote areas face significant challenges in accessing these services due to issues such as distance, lack of transportation, inadequate infrastructure, cultural beliefs, and limited social networks. This study employed a simple random sampling technique to select kebelles, and respondents were chosen using a lottery method. Data analysis included descriptive statistics, inferential statistics, and a binary logistic regression model. The findings reveal that farmers' access to agricultural extension services is constrained by insufficient infrastructure, a shortage of qualified personnel, and persistent cultural and traditional practices. The study also highlights the essential roles of agricultural extension services in providing education, training, technology transfer, advisory services, and market information. Key determinants identified include age, fertilizer utilization, and credit access, which negatively impact access, while extension contact positively influences it. The study recommends enhanced support from donors to improve infrastructure, establish more extension offices and training centers, and increase the number of skilled workers. Furthermore, government organizations and NGOs should prioritize educating farmers on fertilizer and pesticide use, improving access to credit and financial resources, and organizing regular training programs to support sustainable farming practices.

Keywords— Access, agricultural extension services, determinants, farmers, Lare district

1. Introduction

Agriculture is a cornerstone of rural livelihoods and economic sustenance in developing countries, as highlighted by [1]. In these regions, agriculture contributes roughly 30% of the Gross Domestic Product (GDP), with sub-Saharan Africa being a key example. Approximately 90% of the rural populations in these nations depend on agriculture for their income and subsistence. In East Africa, agriculture not only accounts for about 40% of GDP but also supports nearly 80% of the population's livelihoods [2], [3].

In Ethiopia, agriculture plays a pivotal role, contributing 46% of the GDP and employing 85% of the population [4]. Smallholder farms dominate the sector, covering 96% of Ethiopia's cultivated area. Despite some production growth since 2000, this has primarily resulted from expanded land use rather than intensified farming practices. Consequently, crop yields in Ethiopia remain low compared to global standards [5].

Numerous international studies have underscored the critical role of knowledge-driven agricultural extension services in boosting farm productivity, enhancing agricultural management, and diversifying farming systems, ultimately leading to higher incomes for farmers [6], [7]. Over time, these services have evolved beyond merely disseminating technology and farm management techniques to encompass broader advisory roles, including risk management, environmental sustainability, and marketing support [8]. Such services significantly influence farming communities' decisions and practices, leading to more diverse and improved outcomes [9].

Agricultural extension services now involve contributions from the public and private sectors, as well as non-governmental organizations, offering farmers a wider range of resources and guidance [10]. These services aim to bridge the knowledge gap that impedes the adoption of innovative technologies, which is often exacerbated by low expected profits and perceived risks [11]. Recognizing this, many sub-Saharan African countries have invested in agricultural extension services for over four decades, yet there remains a lack of rigorous evidence on their impacts on rural farming households [12].

In Ethiopia, agricultural development strategies emphasize transforming subsistence farming into a market-oriented sector. Agricultural extension services are integral to this transformation, supported by both government and non-governmental organizations promoting modern inputs as yield-enhancing technologies [13]. These services are instrumental in poverty reduction and livelihood improvement [14], [15].

Studies across sub-Saharan Africa have identified numerous factors influencing access to agricultural extension services, including age, gender, education, farm size, income, farming experience, and extension visits. Research from Ethiopia highlights the significance of gender, education, landholding, livestock ownership, and distance from service agencies as key determinants [16].

While prior studies have explored the determinants of farmers' access to agricultural extension services, such as those by [17], [18], [19], limited research exists on the specific factors influencing access in the Lare District of Ethiopia's Gambella Region. This study fills this gap by examining the factors that determine farmers' access to agricultural extension services in the Lare District.

The paper is structured as follows: Section 1 provides an introduction, establishing the research context, objectives, and significance. Section 2 presents the related work, and Section 3 outlines the methodology, detailing the research design, data collection processes, and analytical techniques to ensure rigor and replicability. Section 4 presents the results and discussion, offering a comprehensive analysis of the findings and interpreting them in relation to existing literature to highlight their implications. Finally, Section 5 concludes the study by summarizing its key contributions and proposing future research directions to address identified limitations and explores related areas.

2. Related Work

Previous researchers have identified household-level factors, including income, education, land ownership, and access to information, as crucial determinants of participation in agricultural extension programs in Sekota, Ethiopia [20]. Limited education and resource constraints have been noted as significant barriers. Similarly, some studies have emphasized the importance of tailored extension services in promoting climate-smart agricultural practices, particularly focusing on access to training and awareness of climate risks [21]. Scholars have also highlighted persistent gender disparities in accessing extension services, which are influenced by cultural norms and male-dominated systems, and have suggested gender-sensitive policies to empower women farmers [22].

Other studies have explored the role of ICT-based advisory services in reducing information gaps for Ethiopian farmers, particularly in providing timely market and weather data [23], [24]. Some researchers have discussed challenges such as resource shortages, untrained personnel, and poor infrastructure, while suggesting opportunities through decentralization and improved resource allocation [25]. Others have found that socio-economic factors, including income, literacy, and asset ownership, significantly impact access to extension services, with trust in agents playing a critical role [26].

Earlier researchers have underscored the importance of institutional capacity, such as adequate staffing, agent training, and sufficient budgets, in enhancing farmers' responsiveness to extension programs [27]. Other studies have demonstrated that secure land tenure encourages farmers to engage with extension services and adopt recommended technologies [28]. In Ethiopia, the pivotal role of extension agents in improving productivity has been recognized, though their effectiveness is often constrained by insufficient training and communication barriers [29]. Finally, other researchers have noted that financial constraints and resistance to change, particularly among older farmers, hinder the adoption of technologies promoted through extension services [30].

In conclusion, prior studies reveal that household-level factors, gender disparities, and institutional capacities significantly influence access to agricultural extension services. Tailored approaches, ICT innovations, and secure land tenure are critical for addressing challenges such as resource shortages, untrained personnel, and financial constraints. Addressing these barriers through gender-sensitive policies, improved training, and resource allocation can enhance the adoption of extension services and modern agricultural practices, fostering sustainable productivity.

3. Method

3.1 Description of Study Area

The study was conducted in Lare District, one of the 13 administrative districts in the Gambella Region, western Ethiopia, approximately 85 km from Gambella Town. The district covers an area of 685.17 km² and is bordered by the Eastern Nuer Zone and Jekow District to the southeast, Itang Special District to the south, and the Republic of South Sudan to the north. Administratively, it consists of 28 kebelles, with a population of 31,406 (16,145 males and 15,261 females) [31].

The district's geography features marshlands and grasslands, receiving annual rainfall of 1,900–2,100 mm. Temperatures can soar to 45°C in March and drop to 27°C–31°C in August during the rainy season. Economically, it is characterized by an agro-pastoral livelihood system, with residents engaged in livestock rearing, crop farming, fishing, hunting, and wild food gathering. The district supports the cultivation of crops such as corn, maize, sweet potatoes, sesame, and peanuts, leveraging rain-fed and flood-receding agriculture [32], [33].

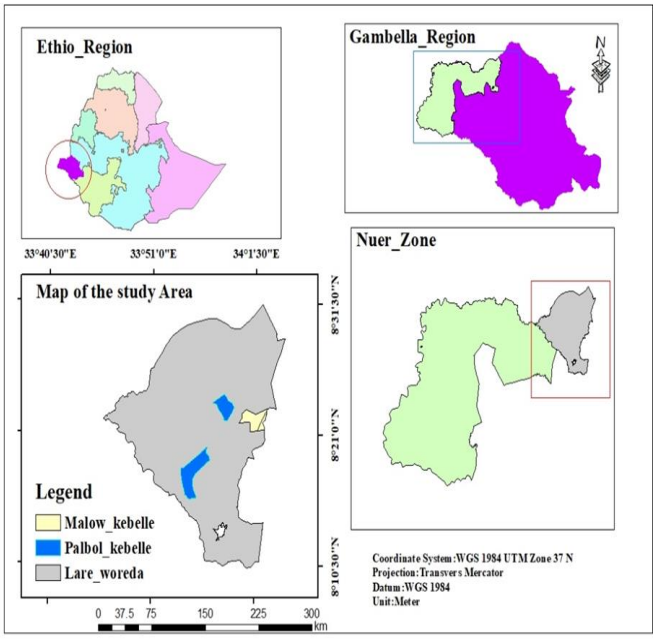

Figure 1. Map of the study area

3.2 Research Design

This study adopted a mixed research design, integrating both quantitative and qualitative methods. This approach was chosen to triangulate data from diverse sources, thereby ensuring a comprehensive and reliable analysis of farmers' access to agricultural extension services. By combining these methodologies, the study captures both measurable trends and in-depth contextual insights.

3.3 Sampling Technique and Sample Determination

A two-stage sampling procedure was used to select the study participants. In the first stage, a simple random sampling technique was used to select two kebelles (Malow and Palbol) from the district's 28 kebelles, ensuring that each had an equal probability of selection. In the second stage, respondents within the selected kebelles were identified using the lottery method to ensure randomness and minimize selection bias.

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

$$n = \frac{(1.645)^2 * 0.5(1-0.5) = 270}{(0.05)^2}$$

Assuming p=0.5 for maximum variability and a 95% confidence level (Z=1.645) with a margin of error of ±5% (e= 0.05), the calculated sample size was 270 respondents. This approach aligns with the recommendations of previous scholars to ensure representativeness in the absence of precise population variability data [34], [35].

3.4 Types, Sources and Methods of Data Collection

Data for this study were collected from both primary and secondary sources to ensure a comprehensive dataset. Primary data, encompassing both qualitative and quantitative information, were obtained directly from the sampled respondents through focus group discussions, key informant interviews, structured interview schedules, and field observations. Secondary data were gathered from various documents, including reports and publications from national, regional, and district agricultural and rural development offices, agricultural projects, journals, internet resources, and books. The integration of these diverse data sources enriched the study, providing both depth and contextual relevance to the findings.

3.5 Methods of Data Analysis

Data analysis employed a combination of descriptive statistics, inferential statistics, and econometric modeling using SPSS software version 24. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize and describe the data. Inferential statistics, such as chi-square tests for categorical data and t-tests for numerical data, were utilized to explore relationships and differences within the dataset. For econometric analysis, a binary logistic regression model was applied to assess the factors influencing farmers' access to agricultural extension services.

The binary logistic regression model was chosen for its suitability in analyzing binary response variables, where the outcome has two possible states (e.g., access or no access). This model evaluated the impact of selected sociodemographic, institutional, and economic factors on access to extension services. Predictor variables included both numerical and categorical data. The functional form of the model adhered to specifications, ensuring alignment with established econometric principles and a robust analytical framework [36], [37].

The logistic regression equation can be expressed as:

$$P(Yi = 1) = \frac{1}{1+e^{-(\beta 0+\beta i Xi)}} \quad (2)$$

For ease of exposition, we write Equation (2) as:

$$P(Yi = 1) = \frac{1}{1+e^{-Zi}} \quad (3)$$

$$1 - P(Yi = 1) = 1 - \frac{1}{1+e^{-Zi}} = \frac{1}{1+e^{Zi}} \quad (4)$$

Therefore, we can write:

$$\frac{P(Yi = 1)}{1 - P(Yi = 1)} = 1 - \frac{1+e^{Zi}}{1+e^{-Zi}} = e^{Zi} \quad (5)$$

Equation (5) represents the odds ratio, which compares the probability of farmers having access to extension services with the probability of them having no access. By taking the natural logarithm of equation (5), we derive the following expression.

$$Li = Ln\left(\frac{P(Yi = 1)}{1 - P(Yi = 1i)}\right) = Zi \quad (6)$$

The log of the odds ratio (Li) is linear in both the independent variables and the parameters. By incorporating the stochastic error term (ui), the logit model can be expressed as follows.

$$Zi = \beta 0 + \beta 1X1 + \beta 2X2 \dots \dots \dots \beta nXi + ui \quad (7)$$

Where: β0: is an intercept andβ1, β2……βn: are the slopes of equation in the model. Xi: represent the vector of sample respondent's characteristics.

4. Results and Discussion

4.1 Result

4.1.1 Statistical test for categorical variables

The study found no significant relationship between gender and access to agricultural extension services ($\chi 2$ = .000, p = .950). This suggests that extension services are distributed equitably regardless of whether households are male- or female-headed. Structural or contextual factors, rather than gender, likely play a greater role in determining access.

Similarly, no significant association was observed between educational level and access to services ($\chi 2$ = .083, p = .774). This indicates that literacy alone does not impact farmers' engagement with extension services, underscoring the importance of adaptable communication and training methods.

Ownership of farmland showed a marginally significant association with access to extension services ($\chi 2$ = 3.343, p = .067). Landowners appear more inclined to utilize these services due to their vested interest in productivity, although non-landowners may also seek access through alternative means.

A strong relationship was identified between fertilizer use and access to extension services ($\chi 2$ = 69.804, p = .000). This underscores the pivotal role of extension personnel in promoting modern farming inputs, although environmental factors may moderate this influence in certain contexts.

Regular contact with extension personnel was strongly associated with access to services ($\chi 2$ = 60.542, p = .000). This highlights the importance of outreach in encouraging technology adoption and sustainable practices. However, outreach challenges, such as resource limitations in remote areas, remain barriers.

Access to credit exhibited a strong positive relationship with access to extension services ($\chi 2$ = 53.092, p = .000). Credit availability facilitates the adoption of practices and technologies promoted by extension personnel, reinforcing its role as a key enabler.

Table 1. Test for categorical variables

Variable	Data set	F	%	χ^2	Sig.
Gender	Male	168	62	.000	.995
	Female	102	38		
Educational level	Illiterate	155	57	.083	.774
	Literate	115	43		
Farmland ownership	No	119	44	3.343	.067***
	Yes	151	56		
Fertilizer utilization	No	175	65	69.804	.000*
	Yes	95	35		
Extension contact	No	152	69	60.542	.000*
	Yes	118	31		
Credit access	No	186	56	53.092	.000*
	Yes	84	44		

Source: Survey Data (2024). *&***=significant level at 1% and 10%.

4.1.2 Statistical test for continuous variables

The average age of respondents was 48.42 years (SD = 15.927), and the t-test showed no significant difference in mean age (t = 1.270, p =.025). This finding suggests that age does not significantly influence farmers' access to agricultural extension services. It implies that other factors, such as education or geographic location, may have a stronger impact on access.

The respondents had an average farming experience of 5.49 years (SD = 2.756), and the t-test results indicated no significant difference in mean farming experience (t = .738, p = .461). This suggests that the duration of farming activity does not necessarily correlate with access to extension services, indicating that other variables may play a more prominent role.

The average livestock holding size was 10.01 Tropical Livestock Units (SD = 8.831). The t-test results revealed no significant difference in livestock ownership (t = .463, p = .644). This finding suggests that livestock ownership does not substantially affect farmers' access to extension services, indicating that services are equitably available regardless of livestock scale.

The mean household income was 4,782.91 ETB (SD = 4,190.878), with no significant difference detected by the t-test (t = .776, p = .439). This result implies that household income alone does not determine access to agricultural extension services. Other factors, such as the capacity to adopt farming innovations, may have a greater impact.

The average distance to the nearest market was 5.01 km (SD = 3.001). The t-test showed no significant difference in market distance (t = 1.010, p = .313). This finding indicates that proximity to markets does not significantly influence access to extension services, suggesting that factors like transportation and infrastructure availability may have a greater effect.

Table 2. Test for continuous variables

Variable	Mean	Std. Deviation	t-test	Sig.
Age	48.42	15.927	1.270	.205
Farming experience	5.49	2.756	.738	.461
Livestock holding size	10.01	8.831	.463	.644
Household incomes	4782.91	4190.878	.776	.439
Market distance	5.01	3.001	1.010	.313

Source: Survey Data (2024).

4.1.3 Challenges faced by farmers

Farmers in the Lare District face numerous challenges in accessing agricultural extension services, which hinder their productivity and livelihoods. The study identified key obstacles, with cultural beliefs and traditional practices (26%) being the most significant, often discouraging the adoption of modern agricultural techniques. Inadequate infrastructure and resources (21%) and a shortage of qualified workers (20%) further limit the effective delivery of services. Financial constraints (13%) make it difficult for farmers to afford services or recommended inputs, while communication barriers (12%) impede knowledge transfer. Additional challenges include the distance to extension offices (6%) and seasonal constraints (2%), which affect accessibility and the timing of services.

Table 3. Challenges faced by farmers

S.No	Challenges	Frequency	Percentage
1.	Lack of infrastructure	58	20
2.	Shortage of extension workers	54	21
3.	Communication barrier	32	12
4.	Cultural belief and traditional practices	69	26
5.	Financial constraints	35	13
6.	Distance to extension office	15	6
7.	Seasonal change	7	2
	Total	**270**	**100**

Source: Software Output (2024).

4.1.4 Roles of agricultural extension services

The study underscores the multifaceted contributions of agricultural extension services in addressing diverse agricultural challenges. Key roles identified include providing advisory services (36%), facilitating technology transfer (29%), offering education and training (20%), and delivering market information (15%). These results highlight the critical importance of extension services in enhancing farmers' knowledge, promoting the adoption of innovative practices, and improving access to market opportunities, ultimately supporting agricultural development and productivity.

Table 4. Roles of extension services to the farmers

S.No	Roles	Frequency	Percentage
1.	Education and training	55	20
2.	Technology transferee	78	29
3.	Advisory services	97	36
4.	Market information	40	15
	Total	**270**	**100**

Source: Software Output (2024).

4.1.5 Factors influence farmers' access to extension services

The binary logit model analysis highlights four significant factors influencing farmers' access to agricultural extension services in the Lare District: age, fertilizer utilization, credit access, and extension contact. These variables, among the eleven tested, were identified as key determinants shaping access.

Age was found to have a negative and significant effect ($p < 0.05$) on access to extension services. For every year decrease in a farmer's age, the likelihood of accessing these services increased by a factor of 0.961. This suggests that younger farmers are more likely to engage with extension services, potentially due to their adaptability and openness to adopting modern agricultural practices.

Fertilizer utilization showed a highly significant negative relationship ($p < 0.01$) with access to extension services. A decrease in fertilizer utilization increased the likelihood of accessing these services by a factor of 0.005. This finding, while counterintuitive, may be linked to the district's naturally fertile soil, reducing the perceived necessity for fertilizers and driving farmers to seek alternative advisory services.

Credit access emerged as a significant positive determinant ($p < 0.01$), with increased credit availability rising the likelihood of accessing extension services by a factor of 0.003. Access to credit enables farmers to invest in essential inputs like fertilizers and improved seeds, fostering greater engagement with extension programs.

Extension contact was the strongest positive factor ($p < 0.01$) influencing access to agricultural extension services. Regular interactions with extension personnel improved farmers' access to information on innovative practices and technologies, which likely enhanced their overall productivity.

Table 5. Binary logit model result

Variable	B	S.E.	Sig.	Exp(B)
GNDR	.552	.603	.360	1.736
AGE	-.040	.020	.045**	.961
EDLVL	.394	.625	.528	1.484
FMEPR	.107	.119	.372	1.113
FMOWN	.351	.600	.559	1.420
LHSZ	.024	.029	.397	1.025
HICME	.000	.000	.145	1.000
FLZUT	-5.341	.813	.000*	.005
CRDACS	5.729	.919	.000*	.003
EXTNCT	4.680	.717	.000*	.009
MRLD	-.031	.100	.757	.970

Source: Software Output (2024). *&**, significant level at 1% and 5%.

4.2 Discussion

The challenges and opportunities associated with agricultural extension services in rural areas, including the Lare District, align with findings from prior studies in Ethiopia and beyond. Research has consistently highlighted inadequate infrastructure, scarce resources, and a lack of skilled personnel as critical barriers to accessing agricultural services [38]. These deficiencies constrain farmers' adoption of modern farming techniques and technologies, limiting agricultural productivity and economic growth. The shortage of qualified extension workers exacerbates these issues by depriving farmers of essential expert guidance, further reinforcing systemic challenges in service delivery.

Socio-cultural factors, including cultural beliefs and traditional practices, play a significant role in shaping farmers' willingness to adopt innovative agricultural methods. Previous studies have identified these factors as formidable barriers, often rooted in long-standing practices and mistrust of modern approaches [39]. Financial constraints further compound these challenges by limiting farmers' ability to invest in essential inputs and tools. Addressing these intertwined issues requires multifaceted strategies, such as providing financial support, tailored training programs, and enhanced access to modern technologies, which collectively empower farmers to overcome both traditional and financial obstacles.

Geographic barriers, such as the distance to extension offices, are another major constraint, particularly in rural and remote regions. Studies emphasize the negative impact of geographic isolation on farmers' ability to access timely information and support [40]. Investments in infrastructure, including transportation networks and digital communication technologies, are essential to mitigate these challenges. Improved connectivity not only facilitates the delivery of extension services but also enables extension workers to reach more farmers, especially in underserved areas.

Seasonal challenges, while less frequently reported, are significant in agricultural contexts where farming activities peak during certain periods. Similar challenges have been documented in Tanzania, where seasonal demands limit the availability of farmers and extension workers for consultations [41]. To address this issue, strengthening institutional capacities, such as increasing the workforce or integrating digital outreach tools, could improve service delivery during critical farming periods, ensuring that farmers receive the support they need when it matters most.

The role of agricultural extension in providing education, facilitating the adoption of modern farming techniques, and transferring innovative technologies has been well-documented. Studies confirm that these efforts enhance farmers' productivity by promoting more efficient and sustainable practices [42]. Similarly, the provision of advisory services and market information has been shown to significantly impact farmers' decision-making and resource management. For instance, research in Egypt revealed that farmers who accessed market information were better able to plan their sales and maximize profits, contributing to both individual and sectorial growth [43].

Other studies have explored the influence of demographic and environmental factors on agricultural extension service utilization. For example, while some research found no significant relationship between age and access to services [44], others identified a positive correlation in specific contexts, such as Tanzania, where older farmers were perceived as more experienced and reliable participants in extension programs [45]. Similarly, fertilizer utilization patterns reflect regional variations; in areas with naturally fertile soils, farmers may bypass fertilizers [46]. However, even in such regions, balanced soil nutrient management remains crucial for optimizing productivity, emphasizing the need for continuous awareness campaigns [47].

Credit access has consistently emerged as a critical enabler of agricultural innovation, encouraging farmers to adopt modern technologies and increasing their engagement with extension services [48], [49]. However, scholars note that credit access alone does not guarantee the adoption of recommended practices, as multiple factors influence farmers' decisions [50]. This highlights the complexity of agricultural decision-making and the necessity for robust extension programs that integrate complementary factors, such as infrastructure development, market access, and supportive government policies, to achieve meaningful and sustainable impacts [51], [52].

5. Conclusion and Future Scope

The study concluded that several constraints significantly hindered farmers' access to agricultural extension services in Lare District. Key barriers included a lack of infrastructure and resources, a shortage of qualified extension workers, and the influence of cultural beliefs and traditional practices. The study also highlighted the critical role of agricultural extension services in delivering education and training, facilitating technology transfer, providing advisory services, and offering market information to farmers. Analysis using the binary logistic regression model revealed that age and fertilizer utilization significantly and negatively influenced farmers' access to extension services, while credit access and extension contacts were significant factors positively influencing access. To improve farmers' access to agricultural extension services, a comprehensive strategy is essential. Key actions include enhancing infrastructure, such as building additional extension offices and training centers, and increasing the number of qualified extension agents. Awareness campaigns, in collaboration with local organizations, should highlight the benefits of extension services. Strengthening farmer training through workshops, demonstration farms, and field days will promote best practices. Extension agents should incentivize technology adoption through subsidies and tailored support, while also improving access to market information. Agricultural offices must educate farmers on sustainable practices, proper fertilizer use, and pesticide management to boost productivity and minimize environmental impact. NGOs should facilitate access to credit to support the adoption of improved practices. These coordinated efforts will enhance agricultural extension services in Lare District, fostering long-term sustainability and improving farmers' livelihoods.

This study highlights several avenues for future research and practical interventions. First, further studies could explore innovative strategies to address the identified constraints, such as leveraging digital platforms or community-based extension approaches to mitigate infrastructure and resource limitations. Second, research could investigate the role of integrating cultural beliefs and traditional practices into extension services to enhance acceptance and effectiveness among farmers. Third, longitudinal studies could assess the

long-term impact of interventions, such as increasing the number of trained extension workers and improving credit access, on agricultural productivity and farmers' livelihoods. Additionally, future research could focus on gender-specific barriers to accessing extension services, given their potential to deepen inequities. Expanding the scope to include the evaluation of modern technologies and their adoption in similar agro-pastoral contexts would also be valuable. These efforts would provide a broader understanding of the systemic changes required to strengthen agricultural extension services in Lare District and beyond.

Data Availability
The data are available from the corresponding author upon request.

Conflict of Interest
There is no conflict of interest in this article.

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Authors' Contributions
Chuol Bor conducted a literature review, conceptualized the study, and contributed to protocol development, including securing ethical approval and participant recruitment. He also performed data analysis, wrote the initial draft of the manuscript, reviewed and revised it, and approved the final version for submission.

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