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Determinants of smallholder farmers' access to agricultural extension services: Evidence from northern Ghana

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Abstract
The agricultural extension system in Ghana continues to face institutional and structural challenges that limit equitable service delivery. This study examines the determinants of access to extension services among 299 maize farmers in Yendi Municipality, Northern Region, Ghana, using a cross-sectional survey. Binary logistic regression was employed to identify factors influencing farmers' access, while Friedman and Kendall's coefficient of concordance tests were used to rank perceived barriers. The findings reveal that marital status, farm size, ownership of a mobile phone, and years of education significantly influence access to extension services. In contrast, gender, age, rural residence, and access to credit were not significant predictors. The model demonstrated strong explanatory power. Ranking results indicated significant differences in farmers' perceptions, with a high level of agreement. Key constraints include illiteracy, limited ability to use electronic extension platforms, unfavourable extension-to-farmer ratios, and inadequate financing. Overall, access to extension services is driven more by household location, income, education, and digital connectivity than by basic demographic characteristics. The study recommends that the Ministry of Food and Agriculture and development partners address literacy gaps, bridge the digital divide, strengthen extension capacity, and improve financial support to ensure inclusive and effective service delivery.

Keywords: Smallholders, agricultural extension, services, Ghana

Introduction
Agricultural extension services are crucial for combating food insecurity because they provide farmers with information, training, and encouragement to adopt improved farming methods that make their farms more productive and sustainable (Raji, Ijomah, & Eyieyien, 2024) [50]. In Africa, extension systems are becoming more diverse, with public, private, and nonprofit actors all working together. This is because public systems are too busy, leading to growing private-sector involvement (Demisse, Awulachew, Adenew, & Mengiste, 2011) [68]. However, it is still hard to get agricultural information to many people because traditional methods, such as in-person conversations or radio broadcasts, are either too expensive or insufficiently specific to meet the needs of all farmers (Fabregas, Harigaya, Kremer, & Ramrattan, 2022) [15]. Contemporary extension systems function within intricate socio-economic and environmental frameworks, encompassing climate variability, technological advancement, and demographic transitions (Shimali, Mangheni, & Kabahenda, 2021) [55]. Smallholder productivity remains limited because they lack easy access to advisory services, even though these services are very important for rural development (Mapiye, Makombe, Molotsi, Dzama & Mapiye, 2021). To boost productivity, many farmers need to adopt better technologies, and extension services are critical in this regard (IFPRI, 2023). Effectiveness relies on institutional capacity, farmers' socio-economic characteristics, and suitable communication channels.
In sub-Saharan Africa, extension systems are changing into multi-channel systems that use ICT-based platforms, group training, demonstrations, mass media, and face-to-face interactions (Norton & Alwang, 2020; Anderson & Feder, 2007) [5, 47]. Demonstrations and other participatory methods work very well (Ramnarace, Abdullah, Vallejo, & Salguero, 2021), while e-extension tools such as radio, TV, and mobile phones are growing but remain limited

by infrastructure and literacy issues (Dey & Prayagraj, 2024; Addison *et al.*, 2024) [46]; there are still critical problems with the structure. Evidence from countries such as South Africa, Kenya, and Ethiopia indicates limitations, including insufficient staffing, funding, infrastructure, technical capacity, and fragile extension farmer relationships (Khapayi and Celliers, 2016; von Maltitz *et al.*, 2021; Maake & Antwi, 2022; Wekesa *et al.*, 2025; Agwu *et al.*, 2023; Megerssa, Gemede & Jarsa, 2020) [1, 14, 28, 36, 39, 63, 64].

These pieces of evidence show that both the capacity of institutions and the socio-economic status of farmers affect their access to extension services. In Ghana, extension delivery increasingly employs radio, mobile phones, NGOs, and farmer groups (Tamimu, 2022) [61]. Nonetheless, empirical research on the determinants of access, especially in northern Ghana, remains scarce. Current literature frequently reduces access to mere interactions with extension agents, neglecting alternative avenues such as group training, demonstrations, and ICT-based services (Hassan, Adam, & Damba, 2018; Wossen, Berger, & Di Falco, 2017) [13, 22, 66].

Due to the transition towards pluralistic and ICT-integrated systems (Anderson & Feder, 2007; Somanje, Mohan, & Saito, 2021) [5, 57], assessing extension access solely through agent contact is insufficient. Consequently, it is imperative to analyze the factors influencing farmers' access to extension within a multi-channel framework. This is especially important in Yendi Municipality, where agriculture is a major source of income despite poor infrastructure. A better understanding can help improve the targeting and delivery of extension services in northern Ghana.

Materials and methods

The 2021 Population and Housing Census (PHC) reports that Yendi Municipality, in Ghana's Northern Region, is predominantly rural and has about 154,000 residents. The main source of income in the area is through agriculture, with more than 80% of the population being smallholder farmers. The Ministry of Food and Agriculture (MoFA) primarily provides extension services to these farmers, but challenges such as low extension-to-farmer ratios and logistical issues make this area a good setting for examining the ease of accessing extension services.

The paper utilized a cross-sectional survey design with a quantitative methodology. Primary data were collected during the 2024 maize production season using a structured questionnaire administered to heads of maize-farming households. Extension access was assessed multidimensionally as exposure to at least one delivery channel, encompassing extension agent visits, group training, demonstrations, field days, or ICT-based media such as radio, television, and mobile phones. Farmers who had not been exposed to any channel were considered to have no access (0). This multi-channel operationalization is in line with modern extension systems (Somanje *et al.*, 2021; Maake & Antwi, 2022) and works with binary logistic regression to make estimates [36, 57].

The questionnaire included demographic, socioeconomic, communication, and institutional variables and was pretested prior to the main survey. The municipality is made up of people from many different ethnic groups (for example, Dagomba, Konkomba, Bassari, and Komba), so enumerators were chosen based on their proficiency in the language. Cochran's (1977) formula, which is commonly used in survey research, Uakarn, Chaokromthong, & Sintao, (2021) [12, 30, 62], was used to determine the sample size, given the unknown number of people in the population.

The method used by Cochran (1977) [12] starts by defining the theoretical sample size of an infinite population (n_0) which is modified to represent the known population size (N). Accordingly, a sample size of the finite population (n) is calculated using a correction factor, where n_0 is the numerator in the formula:

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}}$$

Where n is the sample size,

P is the $population\ proportion$ assumed at 50% (0.5), n_0 is the ideal sample size of an infinite population, z is 1.96 at a 95% confidence level in the standard normal distribution, and e is the level of precision/margin of error, which is 0.05. First, the theoretical sample size for an infinite population (n_0) was calculated:

$$n_0 = \frac{z^2 \times p \times (1-p)}{e^2} \rightarrow \frac{1.96^2 \times 0.5 \times (1-0.5)}{0.05^2} \rightarrow \frac{0.9604}{0.0025} = 384.16 \approx 385$$

This theoretical sample size (n_0 = 385) is the numerator in the formula of correction of the finite population. Replacing the Cochran (1977) [12] formula of the finite population with the known population of maize farmers in the 2022 ATT group in the Yendi Municipality (N = 1,393) (Tamimu, 2022) yielded [61]:

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}} \approx n = \frac{385}{1 + \frac{385 - 1}{1393}} \approx n = \frac{385}{1.28} = 300$$ maize farming households.

The 300 respondents were then equally distributed across the selected communities.

A multistage sampling was utilized. First, the maize farmers were deliberately chosen because they are the predominant group in the municipality. The municipality was then stratified into four AEAs. Third, five communities were randomly picked from each zone. Afterwards, 15 farmers from each community were randomly selected, resulting in 300 respondents. The household (maize-farming) was used as a major unit of sample.

Factors that determine extension service accessibility to farmers was analyzed using binary logistic regression since the dependent variable, extension access, was treated as dichotomous (Hosmer, Lemeshow, & Sturdivant, 2013; Long & Freese, 2014; Wooldridge, 2010) [24, 34, 65], formally given as

$$P(Y_i = 1|X_i) = \frac{\exp(X_i\beta)}{1 + \exp(X_i\beta)}$$

$$\log\left[\frac{P(Y_i = 1|X_i)}{P(Y_i = 0|X_i)}\right] = X_i\beta$$

Alternatively, it can be expressed in log-odds version

Y_i = binary response variable of farmer $_i$, X_i = a set of explanatory variables, which are the *socio-economic, institutional, and technological factors of farmers*, and *0* = a set of parameters that are to be estimated. This model allows the direct interpretation of estimated coefficients as odds ratios, which is especially helpful for understanding how changes in explanatory factors affect farmers' likelihood of

using extension services (Hosmer *et al.*, 2013; Peng, Lee, & Ingersoll, 2018) [24, 48].

The explanatory variables were gender, age, household size, years of education, possession of a mobile phone, access to radio and television, membership in farmer-based organizations, and location (rural/urban). Odds ratios were used to interpret the estimated coefficients, and multicollinearity was assessed using the Variance Inflation Factor (VIF). All determinants-of-access analyses were conducted using STATA and SPSS.

Results and Discussions

Socio-economic, institutional, and technological characteristics of respondents: Table 1 presents the demographic, socioeconomic, and institutional factors that affect maize farmers' access to extension services in Yendi Municipality. The gender distribution (mean = 0.756) indicates that 75.6% of respondents were male, highlighting male predominance in agriculture and increased engagement with extension agents due to socio-cultural barriers that restrict women's participation (Hassan *et al.*, 2020; Hassan *et al.*, 2018; Komba *et al.*, 2020; Forbang *et al.*, 2019) [16, 22, 23, 30]. The average age was 36.61 years (ranging from 24 to 65), indicating that most people were of working age. Younger farmers are generally more open to new ideas and extension services, but older farmers can also benefit from production-related advice (Pervaiz *et al.*, 2020; Maake & Antwi, 2022) [49]. Marital status (mean = 0.880) indicates that 87.9% of respondents were married, implying potential labour availability and household stability, which may increase engagement with extension services, although institutional factors are more influential (Hammond *et al.*, 2023) [20, 36].

Location (mean = 0.933) indicates that 93.3% of respondents live in rural areas, suggesting that field-based and ICT-supported extension methods such as demonstrations, farm visits, radio, and mobile communication are needed (Hassan *et al.*, 2020; Tamimu, 2022) [61]. Being close to cities may make it easier to get services (Al-Hassan *et al.*, 2013), but the fact that most of the area is rural shows that outreach-oriented systems are needed. The average number of people living in a household was 10.69, with a range of 3 to 24. This is typical of northern Ghana, where families tend to be large. Larger households may offer labour to facilitate agricultural operations and the adoption of innovations (Gatheru *et al.*, 2021); however, evidence indicates that household size does not consistently affect access to extension services, particularly under financial constraints (Koech & Karani, 2017) [17, 29].

Table 1: Descriptive Statistics of Respondents

Variable	Mean	Std. Dev.	Min	Max
Gender	.7558528	.4303006	0	1
Age	36.61204	6.97238	24	65
Marital status	.8795987	.3259758	0	1
Location (rural/urban)	.9331104	.2502496	0	1
Household size	10.68896	5.144253	3	24
Farm size	13.12375	5.873505	1	30
Years of education	11.59197	6.412608	0	18
Mobile phone ownership	.7792642	.415438	0	1
Access to radio	.6755853	.4689406	0	1
Access to TV	.3143813	.4650473	0	1
FBO membership	.6789298	.4676704	0	1
Access to extension	.8795987	.3259758	0	1
Access to credit	.6555184	.4759956	0	1
Maize yield (Productivity)	6.779264	2.258044	2	12

Source: Field survey (2025)

The average farm size was 13.12375 acres, ranging from 1 to 30 acres. This implies that there are smallholder and relatively larger farms in the study area. Larger sizefarm farms tend to enhance farmers' ability to adopt better technologies and access extension services by increasing resource availability. The same correlations between farm size and involvement in extension activities have been reported in South Africa (Loki & Mdoda, 2023) and India (Nagar, Nauriyal & Singh, 2021) [33, 43].

The average level of education among farmers was 11.59197 years of schooling with a variance value of 0-18 years. Education increases agrarian households' likelihood of receiving agricultural information from extension media; this information is then interpreted and used by farmers. Research in Uganda and India has identified that education is a key indicator of the ability of farmers to seek and receive extension support and also adapt to better agricultural practices (Midamba, Muteti, Mpofu, Ouko, Kwesiga, Ouya, & Chepkoech, 2022; Nagar *et al.*, 2021) [40, 43]; however, there are other indications that the extension programmes can unfairly favour more educated farmers unless communication tools are tailored to appeal to less literate farmers (Ndlovu and Masuku, 2021) [45]. Farmers' access to extension information is often enhanced due to the use of communication assets. The findings indicate that 77.9 per cent of farmers have mobile phones (mean = 0.7792642). This has implications for the high possibility of digital communication tools being utilised in extension delivery. Beshah (2024) discovered that in Ethiopia, advisory services (via mobile devices) enhanced the availability and access to agricultural information in a timely manner. Nevertheless, researchers in Zimbabwe and Tanzania suggest that digital extension systems may be limited by low digital literacy, inadequate infrastructure, and unreliable network connectivity (Musungwini, van Zyl, & Kroeze, 2022; Sanga *et al.*, 2013) [11, 42, 53].

On the same note, access to radio was reported by 67.6% of farmers (mean = 0.6755853), confirming that radio remains a useful tool for delivering agricultural information. The use of radio as an extension communication channel has been popular in some African countries such as Nigeria, Eswatini, Kenya, and Uganda (Ahmed & Adisa, 2017; Sikhondze, 2020; Kansiime, Mugambi, Rware, Alokit, Aliamo, Zhang, Latzko, Yang, Karanja, & Romney, 2022) [2, 27, 56].

Nevertheless, mass media platforms, such as radio, usually offer fewer interactive learning opportunities than face-to-face extension processes, such as demonstrations and field visits (Damba *et al.*, 2020) [13]. Conversely, access to television was relatively low at 31.4 percent (mean = 0.3143813), reflecting infrastructure challenges such as unreliable electricity supply and lower affordability of television sets in rural settings. Television has the potential to enhance visual learning in agricultural practices, but its use in rural extension communication remains limited (Yekinni & Afolabi, 2019) [67].

There is also institutional involvement of farmers. The findings showed that 67.9 percent of farmers are members of farmer-based organizations (FBOs) (mean = 0.6789298). Farmer groups, in most cases, offer valuable opportunities for group learning, training, and propagation of agricultural information. Kamanda (2022) found that group-based extension strategies increased training attendance and knowledge transfer among Sierra Leonean farmers; however, Hasan, Kolpona, Shahin, Sojib, and Sarmin (2024) argued that organizational weaknesses can sometimes limit their effectiveness [21, 26].

Extension services were fairly accessible in the study area, with 87.9 per cent of farmers indicating they had access (mean = 0.8795987). This percentage is relatively high because it reflects the conceptualization applied in this study, which is expansively positioned; it not only relates to access to extension officers but also to exposure to extension programmes, demonstrations, climate education, and advisory information accessed via media and online platforms. This contrasts with previous studies that quantified exposure to extension agents primarily through direct contact (Atube, Malinga, Nyeko, Okello, Alarakol & Okello-Uma, 2021; Hassan *et al.*, 2018). The current research reveals the dynamism and plurality of modern-day extension systems through the integration of various communication channels, a point also emphasized by Tamimu (2022) [9, 22, 61].

These findings also reveal that 65.6 per cent of farmers can access credit (mean = 0.6555184), and this can be used to implement better agricultural practices and apply extension recommendations.

Lastly, maize productivity was 6.779264 bags per acre, and yields ranged from 2 to 12 bags per acre. This kind of variation can result from differences among farmers in access to extension services, inputs, and labour. Other settings have also reported similar yield differences associated with productivity differences, which were in part due to farmers' differences in access to extension information and their ability to receive and apply recommended practices (Nagar *et al.*, 2021; Midamba *et al.*, 2022). Nevertheless, Ainab (2022) [3, 40, 43] found that extension advice may be less effective at promoting productivity when farmers are constrained by structural factors, including limited capital and input shortages. Abdul-Latif (2024), therefore, summarized these findings: extension services' productivity effect is highly reliant on reinforcements such as access to inputs and follow-up support. Generally, the descriptive findings demonstrate the significance of demographic characteristics, socioeconomic status, communication resources, and institutional involvement in shaping farmers' relationships with the agricultural extension service in Yendi Municipality.

Determinants of Access to Agricultural Extension Services: The results (Table 2) show socioeconomic, institutional, and communication variables that influence farmers' access to agricultural extension services in Yendi Municipality. The overall fit of the model is good, with LR = 0.780, 8.48 (11) = 170.48 (p = 0.000), and Pseudo R^2 = 0.775, indicating that the variables included in the model explain about 77.5 percent of the variation in farmers' access to extension services. It implies that this model is also successful at capturing the key factors influencing farmers' use of extension services in Yendi Municipality.

Among the variables of importance, marital status was a significant positive predictor of extension service accessibility for farmers (coefficient = 6.491, p = 0.029), with an odds ratio of 658.60. This shows that married farmers were more likely to receive extension services than unmarried farmers. Part of what can explain the magnitude of this relationship is the sociocultural construction of rural households in Northern Ghana, where household headship is more specifically related to marital status. Given that the respondents in this study were heads of household, there is a high likelihood that married people will be the main decision-makers and points of contact for extension agents and agricultural programmes. According to sociological perspectives, marriage can also provide an institutional basis for forming households and economic collaboration, thereby increasing involvement in livelihood-related activities (LotusArise, 2022). Sarku, Addi and Attoh (2025) and Lawal (2023) [31, 35, 54] have reported similar observations, indicating that family obligations made farmers more likely to participate in agricultural programmes and facilitated interaction among extension agents and farmers in Liberia, respectively. Given the implication that unmarried and younger farmers are less visible to extension providers, there is a need for targeted outreach strategies to ensure wider inclusiveness.

The relationship between farm size and farmers' access to extension services was also positive and statistically significant (coefficient = 0.530, p = 0.010). The odds ratio of 1.70 indicates that an increase in farm size by one unit raises the likelihood of accessing extension services by an average of 70 per cent. This finding is consistent with extension services' tendency to focus on farmers with higher production potential, especially where extension resources are limited. Anang and Amerino (2024) and Midamba and Kizito (2022) [4, 40] found similar results: larger cocoa farms in Ghana and Uganda, respectively, were visited more often by extension agents. Sahu Bishnoi, S., Sharma, P. R., Satyapriya, Mahra, G. S., Burman, Barua, Madhavan, Sangeetha, Sinha, Singh, Wason, Joshi, and Sharma (2024) [52], however, pointed out that these patterns may be unfavourable to the smallholder farmers, as they tend to have less access to extensions despite being the majority among agricultural producers. This discovery implies that policies should be systematically implemented to include smallholders in the transfer of extension services in Yendi Municipality.

Table 2: Determinants of Farmers' Access to Extension Service Delivery

Variable	Coefficient	Odds Ratio (Exp (Coef.))	z	p-value
Gender	0.206	1.23	0.22	0.827
Age	0.045	1.05	0.93	0.351
Marital status	6.491	658.60	2.19	0.029**
Location (rural = 1)	0.939	2.56	0.69	0.493
Farm size	0.530	1.70	2.57	0.010**
Ownership of phone	2.335	10.33	2.80	0.005***
FBO membership	-2.981	0.05	-1.82	0.069*
Years of education	0.620	1.86	2.50	0.013**
Access to radio	0.615	1.85	0.39	0.694
Access to television	1.183	3.27	1.31	0.192
Credit access	-0.205	0.81	-0.19	0.853
Constant	-12.121	0.000006	-2.53	0.012**

Source: Field Survey (2025)

Number of observations = 299; LR $\chi^2(11) = 170.48$; Prob > $\chi^2 = 0.000$; Log likelihood = -24.71; Pseudo $R^2 = 0.775$; Significance: *** = 1%, ** = 5%, * = 10%

Owning a mobile phone was also a strong predictor (coefficient = 2.335, p = 0.005). With an odds ratio of 10.33, farmers who have mobile phones are actually more than ten times as likely to have access to extension services. This shows how much agriculture is shifting toward digital tools. It fits with what Masanja, Shausi and Kalungwizi (2023) [38] found in Tanzania they pointed out how handy mobile tech is for closing the gap in extension services. Kansiime *et al.* (2022) had similar findings in Uganda, especially in rural areas where personal meetings with extension agents are difficult. However, Atsbeha and Gebre (2021) [7, 18, 27] warned that even though just owning a phone opens doors in Ethiopia, people with less digital know-how often women and folks with less education can still be left behind.

So, for Yendi Municipality, SMS tips or farmer WhatsApp groups can really increase how many people extension services can reach. Still, that only works well if farmers are trained on how to use those apps and messages.

Farmers' years of education also count in determining their accessibility. Years of schooling showed a real effect (coefficient = 0.620, p = 0.013). With an odds ratio of 1.86, each year of education raised the chance of using extension services by 86 percent. Sumo *et al.* (2022) [59] also found similar results in Liberia literate farmers were found to have the ability to understand and apply extension recommendations. Too, Midamba *et al.* (2022) [40] noticed the same pattern in Uganda. In a similar argument in favour of this, Sarku *et al.* (2025) [54] found that in Ghana, low literacy kept people from making good use of extension advice, even if they had the information; they argued that print-based communication often fails in rural Ghana due to poor reading comprehension. So, getting more farmers into basic literacy classes alongside agriculture programs can really boost how well these extension services work. Education not only eases farmers' efforts to contact extension agents but also gives farmers a real shot at using all these digital and printed materials on their own.

On the contrary, gender was statistically insignificant (coefficient of 0.206, p = 0.827) even though the odds ratio of 1.23 indicates a slightly higher probability of male farmers gaining access to extension. This finding is similar to that of Nagar *et al.* (2021) [43], who found that gender was not a uniform predictor of access to extension services across regions. Nonetheless, this is contrary to the results of Atsbeha and Gebre (2021) [8, 18], who reported gender differences in Ethiopia, with women farmers' access to extension services much lower. The lack of a meaningful gender effect in Yendi might suggest the need to enhance gender inclusivity in the extension programmes, though the discrepancy should be monitored closely to maintain a balanced number of participants.

Similarly, age was not statistically significant (coefficient = 0.045, p = 0.351), with an odds ratio indicating a 5% increase in access to extension services per additional year of age. This is in line with Sumo *et al.* (2022) [59], who also found no significant age influence on extension access in Liberia. Nonetheless,

Kansiime *et al.* (2022) found that younger farmers in Uganda were more prone to digital extension sources. Thus, age might also moderate the method of engagement and not the means of access [27].

The location (rural and peri-urban location) was also insignificant (coefficient = 0.939, p = 0.493). This indicates that geographic location had no influence on access to extension services in Yendi Municipality. Sahu and Chaudhury (2025) [51] also reported similar results, stating that institutional capacity, rather than spatial location, explained the disparities in extension access. Nevertheless, Lee, McNamara, and Ho (2023) [32] emphasized that the level of physical infrastructure constraint may keep restricting access to extensions in some scenarios. Meanwhile, Kansiime *et al.* (2022) also argued that rural-urban extension service gaps can be reduced through the use of mobile communication technologies [27].

Remarkably, the relationship of membership in the farmer-based organizations (FBOs) with extension services access was inverse and nearly significant (coefficient = -2.981, p =.069), odds ratio = 0.05. This result is contrary to various investigations that specify positive outcomes of group membership in the context of extension participation. As an example, Masanja *et al.* (2023) [38] have shown that FBO membership enhanced farmers' access to extension services tremendously in Tanzania, whereas Midamba *et al.* (2022) [40] found the same in Uganda. The insignificant relationship in Yendi Municipality could be a result of certain farmer groups being poorly structured or inactive and, therefore, not effective channels for delivering extension services. The organizational capacity and functional roles of the FBOs can thus be strengthened to enhance their role in the dissemination of the extension services.

Radio and television access also had insignificant influence on household heads' access to extension services (coefficients = 0.615 and 1.183; p = 0.694 and 0.192, respectively). These media may at times be significant in the transmission of agricultural information; however, they do

not seem to have a significant influence on direct interaction with extension services. Nagar *et al.* (2021) [43] also discovered that the mass media played an insignificant role in increasing involvement in extension programmes without supplementary interpersonal interaction. Hassan *et al.* (2024) also argued that using interactive radio programmes and mobile feedback mechanisms could significantly influence the level of farmer participation, suggesting that mass media are most effective when combined with other communication methods. Lastly, credit access was also statistically insignificant (coefficient = -0.205, p = 0.853), indicating that financial access itself does not determine farmers' access to extension services. This outcome is consistent with Nagar *et al.* (2021) [43], who found that credit did not consistently relate to access to extensions across regions. Nevertheless, for input provision and training services, credit can increase participation in extension programmes (Midamba *et al.*, 2022; Sumo *et al.*, 2022) [40, 59]. The insignificance in Yendi could also be due to limited integration between credit systems and extension programmes, as most farmers rely on informal credit sources that are not linked to advisory services. In general, the results suggest that household heads' marital status, farm size, mobile phone ownership, and education influence their access to extension services in Yendi Municipality. The findings underscore the growing influence of human capital and digital connectivity in determining farmers' involvement in current agricultural advisory systems.

Conclusion and Recommendations

The findings of the study indicate that marital status, farm size, mobile phone ownership, and education substantially affect farmers' access to extension services, underscoring the significance of household structure, production scale, digital accessibility, and human capital. On the other hand, gender, age, location, and access to radio, TV, and credit were not significant factors. These results show that strengthening rural digital infrastructure, especially by making mobile networks more reliable and internet access cheaper, should be a top priority for policymakers. Telecommunications companies and agricultural institutions can work together to offer mobile-based advisory services like SMS, interactive voice response, and mobile apps. It is also very important to help farmers learn to read and write. Including adult and functional literacy programs with agricultural content in development plans can help farmers better understand extension messages and use digital platforms more effectively. Also, the Ministry of Food and Agriculture (MoFA) needs to work with banks and other financial institutions, such as the Agricultural Development Bank, to make it easier for farmers to access low-interest loans, input subsidies, and group-based financing. This will help farmers who are struggling with finances and encourage them to adopt new technologies. Finally, although distance to extension offices was the least limiting factor, it is still important to decentralize extension delivery through community-level centers, mobile units, and demonstration farms to make services more accessible and ensure everyone can use them, especially in remote areas.

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