



EFFECTS OF AGRICULTURAL EXTENSION SERVICES ON MILLET
PRODUCTION IN SOUTHERN AGRO-ECOLOGICAL ZONE OF YOBE STATE,
NIGERIA

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ABSTRACT

The study assessed the effects of access to agricultural extension services on millet production in the southern agro-ecological zone of Yobe State. A total of one hundred eighty (180) participants were selected using a multi-stage sampling procedure. The researchers collected data on socioeconomic characteristics, access to extension, and millet yields. The data was analysed using mean values, frequency counts, percentages, and the Heckman (two-step) selection regression model. The results revealed that millet farmers were within the productive age category ($\bar{x} = 45.0$). The cultivation of millet was primarily led by male farmers (75.6%), who possessed a significant amount of farm experience. Access to extension was low. The average millet yield was below the regional average. Age, education, marital status, farming experience, household size, income, credits, cooperative membership, and farm size had a significant influence on access to agricultural extension services. Agricultural extension services had significant effects on millet production in the study area. The study recommended that the Yobe State Agricultural Development Programme (YOSADP) develop a special extension programme with a focus on millet production techniques for the agro-ecological region of Southern Yobe State.

Keywords: Access, Effect, Extension, Services and Production

INTRODUCTION

Agricultural extension services are organizations that assist those involved in agricultural operations in resolving issues and gaining knowledge, skills, and technology to enhance their standard of living and well-being (Davis *et al.*, 2020). Agricultural extension services are a critical input for food and nutrition security globally. They function as a pivotal institutional mechanism for the advancement of agricultural practices and the enhancement of rural development initiatives (Baiyegunhi *et al.*, 2019). Agricultural extension enhances the array of alternatives accessible to farmers, facilitates their comprehension of the potential consequences associated with each choice, and directs them in the process of decision-making pertinent to farm management (Chege *et al.*, 2018). It helps farmers adopt new agricultural technologies, offers advice, shares information, supports the creation of groups, allows for teamwork, and aids farmers in assessing problems and spotting opportunities (Chege *et al.*, 2018). Therefore, an extension organisation can assist millet farmers particularly, in boosting production by adopting improved technologies.

Pearl millet (*Pennisetum glaucum*) represents an annual agricultural species that is widely grown in arid regions across the globe (Jika *et al.*, 2017). It ranks as the sixth most significant cereal globally, following barley, wheat, sorghum, rice, and maize (Desalegn *et al.*, 2017). It is a cereal that is extensively cultivated using rain-fed methods, with 60% of its growing area located in Africa, while Asian nations account for 35%. European countries contribute four (4) percent, and North America only one (1) percent to millet production, primarily for animal feed (Azare *et al.*, 2020). As stated by the Food and Agriculture Organisation (FAO, 2023), millet is capable of thriving in dry regions with limited resources, is adaptable to climate changes, and global production surpasses 10 million tons annually. Thus, millet represents a perfect strategy for developing nations such as Nigeria to enhance



self-sufficiency and lessen dependence on imported cereal crops. Pearl millet is a staple food, rich in high energy, some vitamins, dietary fibre, and many essential minerals (Jukanti *et al.*, 2016). Due to its many nutrients and ease of digestion, it is a great diet for infants younger than six months. Its potential nutritional and therapeutic benefits lower the risk of type 2 diabetes and other human illnesses like cancer, heart disease, and neurological disorders (Arora, 2017).

The relationship between agricultural extension services and millet production in Nigeria plays a crucial role in promoting the growth and development of millet farming in the country. One of the key aspects of agricultural extension services for millet production is the provision of improved seed varieties. Extension agents collaborate with agricultural research institutions to identify and promote high-yielding, disease-resistant millet varieties well-suited to local agro-climatic conditions. However, in developing countries, including Nigeria, a gap exists between agricultural performance and information from research. Limited interaction between extension workers, farmers, and knowledge generators (researchers) is linked to poor extension service delivery (Mapiye and Dzama, 2024). Although technologies can promote millet growth, it appears that there is still limited extension outreach due to a high ratio of extension agents to farm families (Davis *et al.*, 2019), declining extension performance (Owoade *et al.*, 2025a), leading farmers to recycle their local seed varieties, which might be the cause of the low yield.

Idris *et al.* (2023) studied the adoption of millet technologies in Yobe State and found that adoption was high. However, the study did not include access to extension services. The available studies in the area did not evaluate the effects of agricultural extension services on millet production. Therefore, the research investigated the effects of agricultural extension services on millet production in the study area. The specific objectives were to: (i) describe the socioeconomic characteristics of millet farmers in the study area; (ii) ascertain the extent of access to extension services; (iii) describe the average millet yield per hectare; (iv) identify the socioeconomic factors influencing access to agricultural extension services; and (v) estimate the effects of agricultural extension services on millet yield.

MATERIALS AND METHODS

The Study Area

The study was conducted in the southern agro-ecological zone of Yobe State, located between longitudes 10°80' East and 11°77' West and latitudes 11° 20' South and 12° 30' North. The study area is a Sudan savannah which covers Nangere, Potiskum, Fika, and Fune Local Government Areas (LGAs). It has an annual precipitation of between 500 mm and 600 mm. It borders Jakusko Local Government Area to the North, Tarmuwa, Damaturu, Gujba and Gulani Local Government Areas to the East, Gombe State to the South, and Bauchi State to the West (Britannica, 2012). It covers an area of 8,695.2 sq. km. Its semi-arid climate is suitable for agriculture (YOSADP, 2002). The population of the state was estimated at 3,294,137 in 2016 based on the 2006 census (National Bureau of Statistics (NBS), 2025). The climate conditions of the area vary considerably from month to month. The area usually experiences a dry season from November to April and a rainy season from May to October every year. The mean annual temperature for the zone ranges from 24°C to 34 °C. The mean annual humidity ranges from 200mm to 300 mm (National Bureau of Statistics, NBS, 2019).

Agriculture employs over 80 per cent of the population in the State. A wide variety of cereals, including millet, maize, sorghum, rice, and wheat, thrives in the state (Yobe State Statistical Year Book (YSSYB), 2017). The major tribes in this area are Karai-Karai, Ngizim, Bolewa, Ngamo, Fulani, Hausa, and Kanuri, among others.

Sampling Procedure and Sample Size

A multistage sampling procedure was used to select the sample in this study. The first stage involved the purposive selection of two local government areas (LGAs), namely, Nangere and Fune, based on the intensity of millet production. The second stage involved a random sampling of three wards from each LGA, resulting in six (6) wards. The third stage involved the random selection of three communities from each ward, resulting in eight (18) communities. In the fourth and last stage, ten (10) millet farmers were selected from the communities, making a total of 180 respondents as the sample size for the study.

Data Collection and Analysis

The primary data for this study were collected using a questionnaire administered to the selected respondents in the 2023 farming season. Data were collected on socioeconomic characteristics, the extent of access to agricultural extension services, and the average millet production per hectare. Both descriptive and inferential statistics were used to analyse the data for the study. Descriptive statistics (means, frequency counts and percentages) were used to achieve the specific objectives i, ii, and iii while inferential statistic (Heckman's two-step selection regression model) was used to achieve the specific objectives iv and v.

The Heckman (two-step) selection regression model, which is suitable for eliminating bias in non-random selection, was used owing to its appropriateness and suitability. The model was first presented by Heckman and Robb (1986). It is worth noting that access to extension services is not randomly distributed among the millet farmers. To avoid selection bias and erroneous conclusions, a non-random selection equation was employed. The first step involved the selection of millet farmers who had access to extension services (using the probit regression procedure). The second step (the selection equation) involved only those millet farmers with access to extension services, and how it has affected their millet production. The first model is expressed as:

The model is expressed as:

$$Y_i = X_i\beta_i + U_i \quad \dots(1)$$

Where;

Y_i = access to agricultural extension services (1 if the millet-producing farmer had access to extension services, and 0 otherwise)

X_i = vector of explanatory variables. X_1 = age (years) X_2 = sex (male = 1; female = 0)

X_3 = marital status (1 = married; 0 = otherwise) X_4 = household size (Number)

X_5 = level of education (years spent in formal education) X_6 = household income (₦)

X_7 = cooperative membership (1 = member, 0 otherwise) X_8 = farming experience (years)

X_9 = access to credit (1 = have; and 0 = no access) X_{10} = farm size (hectares)

β_i = coefficient of explanatory variables U_i = error term

The second step, or outcome equation, measured the effect of extension services on millet production. It is given as:

$$Z_i = W_i\alpha_i + e_i$$

...(2)

Where;

Z_i = total millet farm productivity (yield) kg/ha W_i = vector of explanatory variables, where;

W_1 = Age (years) W_2 = Sex (1=Male, 2=Female)

W_3 = Marital status (1 = married; 0 = otherwise) W_4 = Household size (Number)

W_5 = Level of education (years spent in formal education) W_6 = Household income (₦)

W_7 = Cooperative membership (1 = member; 0 otherwise) W_8 = Farming experience (years)

W_9 = Access to credit (1 = have; and 0 = no access) W_{10} = Farm size (Millet =



Hectare)

α = coefficient of explanatory variables

e_i = error term.

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Respondents

Table 1 shows that the majority (75.6%) of the respondents were male. This implies that male household heads were the major millet producers. The implication is that male farmers are more likely to access extension services and use new knowledge than female farmers. This corroborates the finding of Alkali *et al.* (2021), who revealed that most (85.6%) of the millet farmers in the Central Zone of Borno State were males. The table shows that the majority (77.8%) of respondents were 50 years old or below. Only 22.2% respondents were above 50 years, while the mean age was 45.00. This implies that respondents were within the productive age group. The younger farmers are more receptive to new ideas than older ones. This finding on mean age is similar to the findings of Bello *et al.* (2023) and Owoade *et al.* (2025b), who reported 28.0 and 36.9, respectively.

Table 1: Socio-economic characteristics of the respondents

Variables (n=180)	Frequency	Percentage	Mean ($\bar{x}$)
Sex			
Male	136	75.6	
Female	44	24.4	
Age (years)			
18-30	40	22.2	
31-40	46	25.6	45.0
41-50	54	30.0	
51 and above	40	22.2	
Education level			
No formal education	85	47.2	
Primary education	53	26.1	
Secondary education	33	18.3	
Tertiary education	15	8.4	
Marital status			
Married	114	63.3	
Single	47	26.1	
Widowed	19	10.6	
Household size			
1-5	49	27.2	
6-10	71	39.4	
11-15	37	20.6	7.0
16-20	14	7.8	
More than 20	9	5.0	
Farming experience (Years)			
1-5	44	24.5	
6-10	72	40.0	
16-20	42	23.3	16.0
11-15	22	12.2	
Farm size (Ha)			
1-2	43	23.9	
3-5	88	48.9	
6-8	40	22.2	
9-11	7	3.9	4.3
More than 11	2	1.1	

Source: Field Survey, 2024

The results on educational attainment reveal that 52.8% of the respondents had formal education. This implied that more than half of the respondents could read, write, and comprehend information about extension services. The findings of Ibrahim *et al.* (2023) and Owoade *et al.* (2025b), who reported that millet farmers were educated, support the finding. The major implication is that the education level of millet farmers directly influences their ability to adopt modern farming practices and technologies.

Furthermore, the table reveals that the majority (63.3%) of the respondents were married. Only 26.1% and 10.6% were single and widows, respectively. The implication is that there would be information sharing among the millet farmers, because married farmers need to boost food production. The finding that the majority of the millet producers were married aligns with the findings of Garba and Haruna (2023) and Ibrahim *et al.* (2023). On farming experience, only 24.5% of the respondents had 1-5 years of experience, 40.0% of the respondents had 6-10 years of experience. Those with 11 to 15 years of farming experience were 12.2%. The mean year of experience was 16.

The result showed that most farmers had significant experience in millet production. The finding of Owoade *et al.* (2025b) on the mean year of experience of 14.5 among the millet farmers aligns with the finding. Table 1 reveals that the farmland used by 48.9% of the respondents for millet farming was between three and five hectares, while 1.1% of the respondents cultivated more than 11 hectares. The mean farm size was 4.3 hectares. This result implied that millet production in the study area was small-scale. According to Ibrahim *et al.* (2012), farm size is an important contributor to the quantity and types of technology required.

Respondents' Access to Agricultural Extension Services

The results presented in Table 2 show access to agricultural extension services among the farmers. The results confirmed a low number of farmers who accessed extension services. Out of the sampled farmers, only 48.3% had access to extension services. Low access to agricultural extension services limits millet farmers' ability to adopt modern technologies, manage post-harvest losses, cope with climate change, and improve productivity. Mukhtar *et al.* (2018) and Midamba *et al.* (2022) reported similar results that only (35.0%) and (42.5%) of respondents accessed extension services, respectively. The table shows that 51.7% of the respondents had rare access to extension services. Only 28.7% and 19.6% of the respondents interacted with the extension agent on a monthly and fortnightly basis, respectively. The result suggested that farmers' level of access to extension services was low. Therefore, the farmers may continue to use practices that reduce future productivity. The finding aligns with that of Owoade *et al.* (2025a) about a decline in extension performance in Yobe State.

Table 2: Access to agricultural extension services by the respondents (n=180)

Access to agricultural extension services	Frequency	Percentage
No access	93	51.7
Have access	87	48.3
Extent of access to agricultural extension services		
Rarely	45	51.7
Monthly	25	28.7
Fortnightly	17	19.6

Source: Field Survey (2024)

Average Millet Production per Hectare by the Respondents

Table 3 shows that the average of millet production per hectare was 436.69kg. The majority of respondents (42.2%) obtained 301 – 600 kg per hectare, 39.4% produced 100–300 kg, and only 1.1% produced 1101–1300 kg per hectare. The results showed that the average millet yield (436.69kg/ha) was low compared to the average yield per hectare on farmers' fields and the yield potential of improved varieties in northeast Nigeria (Ajeigbe *et al.* 2020; Esther



et al. 2023). Low average yield per hectare suggests limited adoption of improved agricultural technologies and practices. Farmers may fail to adopt these technologies due to low extension services.

Table 3: Average Millet-based Yield (Kg/ha) among Farmers

Millet production (Kg/ha)	Frequency	Percentage	Mean ($\bar{X}$)
100 -300	71	39.44	436.69
301 - 600	76	42.22	
601- 900	13	7.22	
901 -1100	18	10.00	
1101 -1300	02	1.11	

Source: Field Survey (2024)

Socioeconomic Factors Influencing Respondents' Access to Agricultural Extension Services

Table 4 reveals the results of Heckman's two-step selection regression model of the influence of socioeconomic factors on respondents' access to agricultural extension services. The results presented in the table show that the influence of sex on respondents' access to agricultural extension services was not significant. The table reveals that age had a significant positive influence on the respondents' access to agricultural extension service at 5% significant level. This implies that older millet farmers are more likely to access different extension services. The result is probable because older farmers have a comparative advantage in terms of capital accumulation, contacts with extension, and creditworthiness. The finding is not consistent with that of Ikoyo-Eweto *et al.* (2023), who reported a significant negative relationship between the age of farmers and access to extension services at 1% level of significance.

Furthermore, the table reveals that education had a significant positive influence on respondents' access to agricultural extension service at 1% significant level. This implies that education plays a pivotal role in determining a farmer's ability to access and effectively utilise agricultural extension services. The findings of Wossen *et al.* (2017) and Masanja *et al.* (2023), who also reported that education is positively related to extension contacts, corroborate the finding. Marital status had a positive and significant influence on respondents' access to agricultural extension services at a 1% level. The implication is that being in a marriage relationship influences millet farmers' access to agricultural extension services. Generally, marriage makes an individual more responsible and stimulates economic development. Similar findings were reported by Badstue *et al.* (2020), and Midamba and Kizito (2022) that access to extension services was high among married farmers.

Moreover, household size had a positive and significant influence on the respondents' access to extension services at 5% level of significance. The implication is that farmers with larger households are more likely to access extension services than farmers with smaller household sizes. This finding is consistent with that of Togba *et al.* (2022), who asserted that large households use more extension services to maximise their farm output and meet their food demands. The results further show that the farming experience of the household head had a positive and significant influence on access to extension services at 1% level of significance. This implies that the farming experience accelerates the extent of access to extension services. The reason may be that household heads with substantial farming experience can assess the potential of the services. Contrarily, Rehman *et al.* (2023) found a non-significant relationship between the farming experience and farmers' access to agricultural information. The table reveals that household income had a significant and positive influence on farmers' access to

extension services at the 1% level of significance. The positive influence implies that farmers with a higher income level are more likely to demand extension services. This is because farmers with higher incomes can afford the costs associated with accessing these services. The finding concurs with Abate *et al.* (2014), who found that income generated from farm sales had a positive effect on the rate of access to extension services.

Table 4: Influence of socioeconomic factors on access to agricultural extension services among Millet Farmers

Variables	Coefficient	Standard error	z
Sex	0.0730	0.0748	1.0 ^{NS}
Age	0.0373	0.0165	2.3 ^{**}
Education level	0.6417	0.1207	5.3 ^{***}
Marital status	0.2681	0.0291	9.2 ^{***}
Household size	0.2414	0.0801	3.0 ^{***}
Farming experience	0.0896	0.0355	2.5 ^{***}
Household income	0.2458	0.0402	6.1 ^{***}
Access to credit	0.0937	0.0338	2.8 ^{***}
Cooperative membership	0.1978	0.0678	2.9 ^{***}
Distance from extension office	-0.0032	-0.0016	2.1 ^{**}
Farm size	0.3475	0.1175	3.0 ^{***}
_cons	1.4682	0.7568	1.9 ^{**}
/athrho	0.4102	0.1581	2.6 ^{***}
/lnsigma	0.8251	0.0527	15.7 ^{***}

Source: Field Survey (2024) **Note:** **, *** are significant at 5% and 1% respectively NS = Not significant

The Table further reveals that access to credit had a significant positive influence on farmers' access to extension services at the 1% level. This implies that credit availability enables millet farmers to seek extension services. Credit provides the financial resources needed to implement new techniques and purchase inputs recommended by extension agents. This finding aligns with that of Midamba *et al.* (2022), who reported a positive relationship between access to credit and access to agricultural extension services. Furthermore, cooperative membership had a significant positive effect on the respondents' access to extension services at 1% level of significance. This is because the farmer's group could provide members with extension information and or the procedures, they could use to access it. This finding is consistent with a priori expectations and with the finding of Masanja *et al.* (2023), who found that group membership had a positive and statistically significant association with access to extension services.

The table further shows that farm size had a positive and significant influence on the respondents' access to extension services at 1% level of significance. This implies that the probability of accessing extension services is higher for farmers with large farms. Farmers with larger farm sizes are more likely to be involved in commercial agriculture, which requires up-to-date knowledge and practices. The finding is consistent with the finding of Abdallah and Abdul-Rahaman (2016) who reported that farm size has been shown to positively affect the likelihood of obtaining agricultural extension services.

Effects of Agricultural Extension Services on Millet Production

Table 5 presents the findings of Heckman's 2-step selection regression model on the effects of agricultural extension services on millet production among the respondents. Table 4 reveals that the coefficient of sex (0.0999) was positive but was not significantly related to production. This implies that, irrespective of sex, production could be increased with an increase in agricultural extension services in the study area. Table 4 further reveals that age had



a positive and significant influence on millet production at 1% level. The implication is that as farmers increase in age, their vigour and strength tend to decrease, but they are more experienced at managing their farms by engaging labour. The finding is contrary to that of Alabi (2023), who reported that declining output is associated with farmers' increase in age. Furthermore, the farmers' level of education had a positive and significant impact on millet output at the 5% level. The finding implies that the more the education, the more the millet output. The finding aligns with Anigbogu *et al.* (2015), who reported that farmers' level of education had a significant effect on farm. The coefficient of marital status (0.8484) had a significant positive effect on millet production at 5%. The positive coefficient of marital status may also be a result of the combined efforts of pooling funds to utilise technologies, as opposed to those of respondents who were single and divorced. This finding agrees with Coker *et al.* (2018), who found a significant positive relationship between marital status and the technical efficiency of cowpea farmers.

The table further reveals that household size had a positive and significant influence on millet production at 5% level, meaning that the output of millet farmers will increase with an increase in household size. This implies that larger households may have more labour to allocate to farming activities, potentially increasing productivity more than smaller households. The finding of Mukhtar *et al.* (2018) was contrary to the finding because the more the household size the less the millet production. The table reveals that farming experience had a positive and significant influence on millet production at 1% level. This implies that more farming experience would lead to more millet production. This finding is consistent with that of Erick *et al.* (2017), who found a significant positive relationship between farming experience and groundnut output. Moreover, household income had a positive and significant influence on millet production at the 1% level of significance. The finding implies that household income can provide the cash necessary for the procurement of inputs where sufficient credit is not obtainable. The finding is supported by the one reported by Mukhtar *et al.* (2018), who found that off-farm income positively and significantly influenced millet production.

Furthermore, Table 5 further shows that access to credit (0.2397) affected millet output positively and significantly at the 1% level. This implies that an increase in access to credit leads to an increase in millet production. The implication is that farmers with access to credit will adopt improved seeds, fertiliser and pesticides to boost yields and income. This is supported by the findings of Mukhtar *et al.* (2018), who found that access to credit had a positive and significant relationship with millet production. The table further reveals that cooperative membership had a positive and significant influence on millet production at 5% level. This implies that being a member of a cooperative society could increase millet output. This finding aligns with Obi-Egbedi and Ojo (2019), who found that membership in a cooperative association, had positive and significant influence on yam production. The table further reveals that farm size had a significant positive influence on millet production at 1% level. This implies that an increase in farm size would increase millet production. The size of a farm plays a critical role in millet production. Larger farms can benefit from economies of scale, allowing for more efficient use of resources and higher productivity. The finding is consistent with the findings of Ajah and Nmadu (2012) and Lawal and Adigun (2012) that farm size had a significant influence on the farm output of farmers.

Table 5: Effects of agricultural extension services on Millet production

Variables	Coefficient	Standard error	Z
Sex	0.0999	0.7108	0.1
Age	0.3015	0.1229	2.5***
Education level	0.0588	0.0270	2.2**
Marital status	0.8484	0.3483	2.4**
Household size	0.7692	0.3573	2.2**
Farming experience	0.4488	0.1588	2.8***
Household income	0.7301	0.1194	6.1***
Access to credit	0.2397	0.0822	2.9***
Cooperative membership	0.9182	0.4587	2.0**
Farm size	0.3475	0.1175	3.0***
Constant	1.5580	0.7568	2.1**
Rho	0.7402	0.3485	2.1**
Sigma	0.1139	0.0455	2.5***
Lambda	0.2613	0.0916	2.9***

Source: Field Survey (2024) Note: **, *** are significant at 5% and 1% respectively

CONCLUSION AND RECOMMENDATIONS

The study concluded that most millet farmers were mature and active, capable of making appropriate decisions. Most of them were married and had a moderate household size. They acquired significant experience as millet farmers. Access to extension services was poor. Age, education, marital status, farming experience, household size, income, credit, cooperative membership and farm size had a significant influence on access to agricultural extension services. Agricultural extension services had significant effects on millet production in the study area. The study recommends based on the findings that the Yobe State Agricultural Development Programme (YOSADP) should increase the development of specialised extension programme that focuses on millet production techniques, best practices, and technologies in Southern Yobe State's agricultural landscape.

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