



REVIEW ARTICLE

FACTORS INFLUENCING LEVEL OF ADOPTION OF CLIMATE-SMART LIVESTOCK PRACTICES (CSLP) AMONG CATTLE FARMERS IN BAUCHI STATE, NIGERIA

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ABSTRACT

The study examined the adoption of climate-smart livestock practices among cattle farmers in Bauchi State, Nigeria. A multi-stage sampling technique was used in selecting 446 respondents. Data were collected using structured questionnaire and were analysed using descriptive and inferential statistics. The results revealed that the respondents had a mean age, household size, and livestock production experience of 43 years, 10 persons, and 23 years, respectively. Most (91.5%) of the respondents were male and 84.3% were married. Similarly, 33.2% had Qur'anic education. The major CSLP adopted by the respondents were zero-grazing (58.1%), fodder planting (49.1%), and feed conservation through hay/silage (47.1%). Similarly, Zero-grazing (0.58), rotational grazing (0.49), and feed conservation (0.47) recorded the highest adoption indices. Age ($p < 0.05$), household size ($p < 0.05$), access to extension/veterinary services ($p < 0.05$), membership of association ($p < 0.05$), awareness of climate-smart livestock practices ($p < 0.05$), and access to training ($p < 0.05$), significantly influenced the adoption of climate-smart livestock practices. The major constraints to adoption of CSLP were inadequate access to credit (81.8%), inadequate financial resources (70.6%), and high labour requirements for implementing new practices (57.4%). The study concluded that age, household size, access to extension services, training, farmer associations were the factors influencing the adoption of CSLP. The study recommended an improved livestock extension services through regular farmer visits and technical support, improving access to affordable credit to enable investment in climate-smart livestock practices, and expanding farmer training programmes to enhance technical knowledge and promote the adoption of climate-smart livestock practices.

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INTRODUCTION

Livestock production plays an important role in food security, employment, and rural livelihoods in developing countries (FAO, 2023). In Nigeria, the livestock subsector contributes substantially to agricultural production by providing meat, milk, hides, manure, and income for millions of households (Izuogu *et al.*, 2025). Beyond its direct economic contribution, livestock production also serves as an important pathway for poverty reduction and livelihood diversification among pastoral and agro-pastoral households (Bashiru & Oseni, 2025). Climate change has become one of the greatest threats to sustainable livestock production worldwide (FAO, 2021). Increasing temperatures and erratic rainfall have reduced pasture availability and water resources for livestock production (Jellaso *et al.*, 2021). These climatic changes have also increased the prevalence of livestock diseases and reduced animal productivity, particularly in the drylands of sub-Saharan Africa (Iyiola-Tunji, 2021).

Nigeria is among the African countries highly vulnerable to climate variability because a substantial proportion of livestock production is carried out under extensive pastoral systems. Northern Nigeria, including Bauchi State, has experienced increasing pressure from drought, feed shortages, land degradation, shrinking grazing resources, livestock diseases, and farmer-herder conflicts, all of which threaten the sustainability of cattle production. These challenges have heightened the need for sustainable livestock production systems capable of improving productivity while enhancing resilience to climate-related shocks. Climate-smart livestock practices have been promoted as sustainable adaptation strategies for improving livestock productivity while enhancing resilience to climate change (FAO, 2021). Practices such as rotational grazing, fodder cultivation, feed conservation, and improved animal health management enhance feed availability and reduce production risks (Ojo *et al.*, 2024).

Similarly, the integration of climate information services and livestock insurance can strengthen farmers' adaptive capacity and reduce climate-related production losses (Ikpe *et al.*, 2021). Despite the benefits of CSLP, their adoption remains generally low in many developing countries due to several socio-economic, institutional, and technological constraints. Previous studies have identified factors such as farmers' age, education, access to extension services, membership of farmer organizations, access to credit, climate information, and training as important determinants of climate-smart agriculture adoption. However, much of the existing literature in Nigeria has concentrated on crop-based climate-smart agriculture, with relatively few empirical studies examining the factors influencing the level of adoption of climate-smart livestock practices among cattle farmers, particularly in Bauchi State. Bauchi State is one of Nigeria's major livestock-producing states, with cattle production serving as a major livelihood activity for many rural households. However, increasing climate variability continues to expose cattle farmers to declining pasture availability, water shortages, disease outbreaks, and reduced livestock productivity, thereby threatening household income and food security. Understanding the factors that influence farmers' adoption of climate-smart livestock practices is therefore essential for designing effective policies and extension interventions aimed at improving livestock productivity and enhancing resilience to climate change. Against this background, this study examined the factors influencing the level of adoption of climate-smart livestock practices among cattle farmers in Bauchi State, Nigeria. The study attempted to; describe the socio-economic characteristics of the respondents in the study area; describe the level of adoption of climate-smart livestock practices among the respondents; examine the factors influencing level of adoption of climate-smart livestock practices; and describe the constraints to adoption of climate-smart livestock practices among the respondents in the study area;

METHODOLOGY

The Study area: The study was conducted in Bauchi State, Nigeria. It is located between latitudes 9°30' and 12°30' N and longitudes 8°45' and 11°00' E, and shares boundaries with Yobe, Gombe, Taraba, Plateau, Kaduna, Kano and Jigawa States. The State covers approximately 49,259 km² and has a diverse population comprising mainly Hausa, Fulani and Jarawa, among other ethnic groups. The State falls within the Sudan and Sahel savannah vegetation zones, with relatively higher rainfall in the southern part and lower rainfall in the northern part. Annual rainfall ranges from about 1,300 mm in the south to 700 mm in the north, with the rainy season starting earlier and lasting longer in the south. These climatic variations influence agricultural activities across the State. Agriculture is the major economic activity, comprising both crop and livestock production. Major crops produced in the western zone include rice, maize, sorghum and soybean, while millet, sorghum, cowpea and sesame are prominent in the central and northern zones. Livestock production is also widespread and includes the rearing of cattle, sheep, goats and poultry (BSEEDS, 2016).

Sampling Technique and Sample Size: A multi-stage sampling technique was used to select the respondents from the study area. In the first stage, all Bauchi State Agricultural Development Programme (BSADP) zones (Western, Central

and Northern zones) were selected for the study. In the second stage, nine (9) Local Government Areas (LGAs) were proportionately (40%) and purposively selected. The selected LGAs in the respective zones are: Katagum, Gamawa, Giade and Jamaare from Northern Zone, Ningi and Warji from Central Zone, Bauchi, Kirfi, and Toro from Western Zone. In the third stage, two (2) communities from each of the selected LGAs were purposively selected making a total of 20 communities. The purposive sampling was based on the comparative advantage for cattle production. In the final stage, 446 cattle farmers were proportionately (0.5%) and randomly selected for the study. A sample frame of registered livestock farmers in the State was obtained from LPRES Bauchi State office.

Method of Data Collection and Analysis: The study used primary data which were collected using structured questionnaire in line with the specific objectives of the study. and consisted of both closed-ended and limited open-ended questions. Similarly, data collected were analysed using descriptive and inferential statistics in order to achieve the objectives of the study. Descriptive statistics such as frequency distribution tables, means and charts were used to achieve objectives i and iv. The level of adoption of climate-smart livestock practices in the study area. (Objective iv) was analyse using ordered logit regression model. The model is written as:

$$Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots \beta_{16} X_{16} + \varepsilon \quad (1)$$

Where; \

Y_i (the dependent variable) = is the level of adoption of climate-smart livestock practices (low adoption = 1, medium adoption = 2, and high adoption = 3).

P refers to the probability of the variable Y being equal to 1 given the input variable X.

X denotes the input variables or features that are used to predict the outcome Y.

β_0 represents the intercept or bias term, while β_i (where i ranges from 1 to 10) represents the coefficients associated with the input variables X.

ε represents Euler's number, a mathematical constant approximately equal to 2.71828. It is used as the base of the natural logarithm.

a = constant

X_1 = Age (years)

X_2 = Sex (1 = male, 2 = female)

X_3 = Marital status

X_4 = Household size (Number)

X_5 = Education level (years)

X_6 = Access to extension/veterinary services

X_7 = Herd size (Number)

X_8 = Member of association (Yes = 1, no = 2)

X_9 = Access to credit (Yes = 1, no = 2)

X_{10} = Distance from water source (km)

X_{11} = Government support (Yes = 1, no = 2)

X_{12} = Awareness on CSLP (Yes = 1, no = 2)

X_{13} = Average milk production per cow (Quantity)

X_{14} = Access to training on CSLP (Yes = 1, no = 2)
 X_{15} = Land ownership (Yes = 1, no = 2)
 X_{16} = Access to climate information (Yes = 1, no = 2)
 e = error term

Adoption index: The Adoption index was used to achieve objective (iii). Adoption index calculate the extent a cattle farmer adopted climate smart livestock practices. It was calculated as follows:

Adoption index (AI) = (Respondent's total score) / Sum of Total Score ... (1)

Adoption level categories; Non-adopters (AI=0): Very low adopters (AI up to 0.20): Low adopters (AI 0.21 to 0.40): Medium adopters (AI 0.41 to 0.60): High adopters (AI 0.61 to 0.80) and very High adopters (AI greater than 0.80).

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Respondents

Age, household and livestock farming experience of the respondents: The results in Table 1 indicate that 39.7% of the respondents were within the age bracket of 38–50 years, while 36.8% were aged 25–37 years. Respondents within the age of 51–63 years constitute 15.0%, whereas only 6.7% were aged 64 years and above, and 1.8% were between 12–24 years. The mean age of the respondents was 43 years, indicating that the average cattle farmer in the study area was in the middle-aged and economically productive phase of life. Farmers within this age bracket are more likely to combine accumulated farming experience with the ability to appreciate and adopt climate-smart livestock practices aimed at reducing the adverse effects of climate variability. This finding agreed with the study of Alhassan and Haruna (2024) that most farming households involved in climate-smart agriculture were within the active age group, thereby enhancing their capacity to perceive climate risks and adopt appropriate adaptation measures.

Table 1. Distribution of Respondents According to Age, Household and Livestock Farming Experience (n = 446)

Variables	Frequency	Percentage	Mean
Age (years)			
12 - 24	8	1.8	
25 - 37	164	36.8	
38 - 50	177	39.7	43
51 - 63	67	15	
64 and Above	30	6.7	
Household size (Number)			
1 - 6	186	41.7	
7 - 13	124	27.8	
14 - 20	95	21.3	10
21 - 27	26	5.8	
28 and Above	15	3.4	
Experience in Livestock Production (years)			
2 - 12	127	28.5	
13 - 23	109	24.4	
24 - 34	90	20.2	24
35 - 45	90	20.2	
46 and Above	30	6.7	

Source: Field Survey, 2025

The Table also show that 41.7% of the respondents had household sizes ranging from 1–6 persons, while 27.8% had between 7–13 persons. About 21.3% had household sizes of

14–20 persons, whereas only 5.8% and 3.4% had household sizes of 21–27 persons and 28 persons and above, respectively. The mean household size was 10 persons, indicating relatively large households among cattle farmers. The results corroborate with the report of Germer *et al.* (2023) that household labour plays an important role in enhancing climate-smart livestock management across Sub-Saharan Africa by increasing farmers' adaptive capacity to climate change. similarly, Alhassan and Haruna (2024) reported that household size significantly influenced farmers' participation in climate-smart agricultural practices. On livestock farming experience, the results reveal that 28.5% of the respondents had 2–12 years of livestock production experience, followed by 24.4% with 13–23 years of experience. Respondents with 24–34 years and 35–45 years of experience each constituted 20.2%, while 6.7% had over 46 years of livestock farming experience. The mean farming experience was 24 years. Years of livestock farming experience indicate that the respondents have may have indigenous knowledge and practical skills in managing cattle under varying climatic conditions. This is in line with the report of Ume *et al.* (2023) that farming experience significantly enhances farmers' ability to evaluate and adopt improved agricultural innovations because experienced farmers possess better understanding of production risks and technology benefits.

Respondents' Experience in Cattle Production and Herd Size:

The results in Table 2 reveal that 31.4% of the respondents had 1–13 years of livestock production experience, while 30.7% had between 14–26 years. Furthermore, 19.5% had 27–39 years of experience, whereas 15.2% had been in livestock production for 40–52 years. Only 3.1% of the respondents had over 53 years. The mean livestock production experience was 23 years. Years of experience expose farmers to varying climatic conditions, livestock diseases, feed shortages, and other production challenges, thereby enhancing their ability to evaluate and adopt appropriate climate-smart livestock practices. Experienced farmers are more likely to combine indigenous knowledge with improved management practices promoted through extension services, resulting in better adaptation to climate-related risks. The result agreed with the report of Alemu *et al.* (2023) that farming experience significantly increased the likelihood of adopting climate-smart livestock technologies among pastoral households in Ethiopia because experienced farmers possessed better knowledge of livestock management and climate adaptation options. Similarly, Madaki *et al.* (2023) reported that farming experience positively influenced climate change awareness and the adoption of climate-smart agricultural innovations among farming households. The Table also reveals that most (97.3%) of the respondents had between 10 and 77 livestock, while only 1.8% had herd sizes ranging from 78–145 livestock. Less than one percent (0.7%) owned 282 livestock and above, whereas only 0.2% kept between 146 and 213 livestock with an average size of 37 livestock. Farmers managing moderate herd sizes are generally better positioned to implement climate-smart livestock practices because these practices are easier to manage on relatively smaller herds. Conversely, maintaining excessively large herds without adequate feed and water resources may reduce productivity and increase vulnerability to climate shocks. This corroborates with the report from of FAO (2023) that smallholder livestock production systems dominate Sub-Saharan Africa and are

Table 2: Distribution of Respondents According to Experience in Cattle Production, Herd Size and Years of membership in Association (n = 446)

Variables	Frequency	Percentage	Mean
Experience in Cattle Production (years)			
1 – 13	140	31.4	
14 – 26	137	30.7	
27 – 39	87	19.5	23
40 – 52	68	15.2	
53 and Above	14	3.1	
Herd Size (Number)			
10 – 77	434	97.3	37
78 – 145	8	1.8	
146 – 213	1	0.2	
214 – 281	0	0	
282 and Above	3	0.7	

Source: Field Survey, 2025

more responsive to climate-smart livestock interventions aimed at improving productivity and resilience.

Sex, marital status and educational level of the respondents: The results in Table 3 reveal that the most (91.5%) of the respondents were male, while only 8.5% were female. This indicates that cattle production in the study area is male-dominated enterprise. This finding is consistent with the report of Onabu *et al.* (2024) that men are generally more involved in herding, breeding, and marketing activities in livestock production systems, while women tend to participate in supportive livestock management activities. The Table also shows that most (84.3%) of the respondents were married, while 10.1% were single. In addition, 4.0% and 1.6% of the respondents were divorced and widowed, respectively. This implies that most of the cattle farmers had family responsibilities that may influence their production decisions and livelihood strategies. Married farmers are often more concerned with sustaining household welfare, food security, and income generation, which may motivate them to adopt improved livestock management practices capable of reducing production risks and improving productivity. Similar finding was reported by Ayal *et al.* (2024) that household characteristics significantly influenced farmers' decisions regarding the adoption of climate-smart livestock production practices.

Table 3: Distribution of Respondents According to Sex, Marital Status and Educational Level (n = 446)

Variable	Frequency	Percentage
Sex		
Male	408	91.5
Female	38	8.5
Marital Status		
Single	45	10.1
Married	376	84.3
Divorced	18	4
Widowed	7	1.6
Educational Level		
Primary	72	16.1
Secondary	97	21.7
Tertiary	19	4.3
Adult and Literacy	35	7.8
No Education	75	16.8
Qur'anic Education	148	33.2

Source: Field Survey, 2025

The results further reveal that 33.2% of the respondents had Qur'anic education, while 21.7% and 16.1% had secondary and primary education, respectively. Similarly, 16.8% had no

formal education, whereas 7.8% and 4.3% had adult literacy and tertiary education, respectively. This indicates varying levels of educational attainment among the respondents, although formal education beyond the secondary level was relatively low. Education plays an important role in enhancing farmers' ability to acquire, understand, and utilize information relating to improved livestock production and climate-smart technologies. This finding agrees with Kanu *et al.* (2025) who reported that education as one of the major socio-economic factors influencing the adoption of climate-smart agricultural practices. Similarly, Izuogu *et al.* (2025) reported that level of education was among the major determinants of climate-smart agriculture adoption.

Type of climate-smart livestock practices adopted by the respondents: The results in Table 4 show that more than half (58.1%) of the respondents adopted zero-grazing as climate-smart livestock practice which was ranked 1st. This was followed by fodder planting (49.1%) and feed conservation through hay and silage making (47.1%); which were ranked second and third, respectively. Similarly, 34.5% of the respondents adopted rotational grazing, while 31.2% and 30.9% adopted livestock health management and integration of trees into grazing lands, respectively. The Table also shows that 26.2% of the respondents adopted livestock insurance products, while 21.3% adopted improved drought-tolerant fodder species. In addition, 20.4% and 20.2% adopted water harvesting practices and the use of high-quality feeds, respectively. Similar finding was reported by Bello and Abdullahi (2023) in Kano State, that livestock farmers were less likely to adopt climate adaptation practices that required substantial financial commitment despite being aware of their benefits.

Level of adoption of Climate-Smart Livestock Practices Adopted of the respondents: The results in Table 5 reveal that zero-grazing recorded the highest adoption index with a mean score of 0.58, indicating a high level of adoption among the respondents. Similarly, rotational grazing (0.49) and feed conservation through hay and silage making (0.47) also recorded relatively high adoption levels. The high adoption of these practices suggests that cattle farmers in the study area recognized their importance in addressing challenges associated with feed scarcity, land degradation, and climate variability. The relatively high adoption may also be attributed to the fact that the benefits of these practices are easily observable and can be achieved with limited financial investment compared to some of the more specialized climate-smart livestock technologies. This finding agrees with the report of that grazing management and feed conservation practices were among the most widely adopted climate-smart livestock technologies among cattle farmers in Niger State, Nigeria. The Table also shows that fodder planting (0.31): livestock health management (0.31): integration of trees into grazing lands (0.26): and use of high-quality feeds (0.35) recorded low adoption levels. The results further depict that livestock insurance products (0.20): cultivation of improved drought-tolerant fodder (0.20): water harvesting for livestock (0.20): and adoption of weather forecast and advisory services (0.12) recorded very low levels of adoption. This finding is consistent with the report of Madaki *et al.* (2023) that limited access to climate information significantly limit farmers' adaptation responses. Similarly, the Food and Agriculture Organization (FAO, 2023) reported that inadequate access to financial services and climate information is one of the major

Table 4. Distribution of Respondents According to Type of Climate-Smart Livestock Practices Adopted (n = 446)

Variables	Frequency*	Percentage	Rank
zero-grazing	259	58.1	1 st
Fodder planting	219	49.1	2 nd
Feed conservation (making hay/silage)	210	47.1	3 rd
Rotational grazing	154	34.5	4 th
Livestock health management	139	31.2	5 th
Integration of trees into grazing land fodder trees, shade)	138	30.9	6 th
Use of livestock insurance products	117	26.2	7 th
Cultivating improved, drought-tolerant fodder	95	21.3	8 th
Water harvesting for livestock (dams/ponds)	91	20.4	9 th
Use of high-quality feeds	90	20.2	10 th
Adoption of weather forecast and advisory	90	20.2	10 th

Source: Field Survey, 2025*Multiple response

Table 5. Distribution of Respondents According to Level of Adoption of CSLPs

Variables	Mean	Remark
zero-grazing	0.58	High adoption
Fodder planting	0.31	Low adoption
Feed conservation (making hay/silage)	0.47	Medium adoption
Rotational grazing	0.49	Medium adoption
Livestock health management	0.31	Low adoption
Integration of trees into grazing land fodder trees, shade)	0.26	Low adoption
Use of livestock insurance products	0.20	Very Low adoption
Cultivating improved, drought-tolerant fodder	0.20	Very Low adoption
Water harvesting for livestock (dams/ponds)	0.20	Very Low adoption
Use of high-quality feeds	0.35	Low adoption
Adoption of weather forecast and advisory	0.12	Very Low adoption

Source: Field Survey, 2025; **NB:** Very low adoption (AI up to 0.20): Low adoption (AI 0.21 to 0.40): Medium adoption (AI 0.41 to 0.60): High adoption (AI 0.61 to 0.80) and very High adoption (AI greater than 0.80).**Table 6. Factors Influencing Level of Adoption of Climate-Smart Livestock Practices**

Variables	Coef.	Std. Err	t	P> t
Age	-0.00625	0.002786	-2.24	0.025**
Sex	0.126117	0.063517	1.99	0.048**
Marital status	-0.04424	0.037485	-1.18	0.239
Household size	-0.0313	0.008952	-3.5	0.001***
Educational level	-0.00174	0.003126	-0.56	0.578
Access to extension/veterinary services	-0.2405	0.069385	-3.47	0.001***
Experience in livestock production	-0.00175	0.004928	-0.36	0.722
Herd size	-0.00024	0.000673	-0.36	0.722
Membership of association	-0.36992	0.070839	-5.22	0.000***
Access to credit	0.17255	0.073898	2.33	0.02**
Distance to source of water	0.041612	0.010521	3.96	0.000***
Government support	0.045915	0.0454	1.01	0.312
Awareness on CSLP	0.176924	0.050842	3.48	0.001***
Average milk production per cow	0.013638	0.010691	1.28	0.203
Access to training on CSLP	0.251864	0.068324	3.69	0.000***
Land ownership	-0.02443	0.02042	-1.2	0.232
Access to climate information	0.277257	0.100236	2.77	0.006***

Source: Field Survey, 2025

Table 7. Distribution of Respondents According to Constraints to Adoption of Climate-Smart Livestock Practices

Variables	Frequency*	Percentage
Inadequate access to credit (loans, micro-finance)	365	81.8
Inadequate financial resources (lack of personal savings)	315	70.6
High investments required for new practices	245	54.9
High labour requirement for new practices	256	57.4
Shortage of land (e.g., for fodder cultivation)	225	50.4
Inadequate reliable water for irrigation or livestock	186	41.7
Unreliable market for selling produce or livestock	140	31.4
Poor access to quality inputs (improved seeds, vaccines, tools)	142	31.8
Inadequate technical expertise	129	28.9
Inadequate hands-on support or follow-up after training	108	24.2
Inadequate government incentives	97	21.7
Traditional farming practices and beliefs (cultural resistance to changing methods)	120	26.9

Source: Field Survey, 2025

constraints to adoption of climate-smart agricultural technologies in developing countries.

Factors Influencing Level of Adoption of Climate-Smart Livestock Practices: The results of the regression analysis presented in Table 6 show that age negatively and significantly influenced the adoption of climate-smart livestock practices ($p < 0.05$). This implies that as the age of the cattle farmers increased, the likelihood of adopting climate-smart livestock practices decreased. This finding agrees with Ayal *et al.* (2024) in their study titled “Farmer's Climate Smart Livestock Production Adoption and Determinant Factors in HidebuAbote District, Central Ethiopia”, where age was found to negatively influence the adoption of climate-smart livestock technologies among livestock farmers. Sex significantly ($p < 0.05$) influenced the adoption of climate-smart livestock practices. The positive coefficient indicates that male farmers were more likely to adopt climate-smart livestock practices than female farmers. This may be attributed to the fact that livestock production in Northern Nigeria is male-dominated practice, with men having greater control over livestock resources, decision-making, and access to agricultural information. A similar finding was reported by Oyinbo *et al.* (2021) who reported that gender significantly influenced the adoption of climate-smart agricultural technologies because male farmers generally had greater access to productive resources and extension services.

The Table also reveals that the coefficient of household size was negative and significant ($p < 0.01$) towards influencing the level of adoption of climate-smart livestock practices. This implies that larger households were less likely to adopt climate-smart livestock practices. Larger households may face greater financial pressures due to higher consumption needs, leaving fewer resources available for investment in improved livestock technologies. This finding agrees with Garba *et al.* (2022) who reported that increasing household size reduced farmers' capacity to invest in climate-smart agricultural practices due to competing household expenditures. Similarly, access to extension and veterinary services significantly ($p < 0.01$) influenced adoption of climate-smart livestock practices. The result further reveals that membership of association significantly ($p < 0.01$) influenced the towards influencing the level of adoption of climate-smart livestock practices. Farmer associations provide platforms for information sharing, collective learning, training programmes, and access to agricultural services. Members of associations often receive information on new technologies earlier than non-members. This finding agrees with Ifeanyi-Obi *et al.* (2022) that participation in farmer groups significantly enhanced farmers' adoption of climate-smart agricultural innovations. The coefficient of access to credit was positive ($p < 0.05$) and significant towards influencing the level of adoption of climate-smart livestock practices. This implies that farmers with access to credit were more likely to adopt climate-smart livestock practices than those without access to financial resources. Climate-smart livestock technologies often require investment in improved feeding systems, fodder establishment, water infrastructure, and animal health management. Access to credit enables farmers to finance these investments. This finding agrees with the report of Bala (2021) that access to agricultural credit significantly enhanced the adoption of improved agricultural technologies among farmers.

Table further shows that awareness of climate-smart livestock practices significantly ($p < 0.01$) influenced the level of adoption of climate-smart livestock practices. This finding is expected because awareness represents the first stage in the technology adoption process. Farmers cannot adopt technologies of which they are unaware. The result supports the Technology Acceptance Model (TAM) adopted for this study, which posits that awareness and perception influence behavioural intention and actual adoption. This finding agrees with Madaki *et al.* (2023): who reported that awareness and knowledge of climate change significantly influenced adaptation behaviour among farming households in. The results further reveal that access to training on climate-smart livestock practices was also positive ($p < 0.01$) and significant towards influencing the level of adoption of climate-smart livestock practices. Training programmes provide practical knowledge, demonstrations, and technical skills that enhance farmers' confidence in implementing new technologies. This finding agrees with FAO (2023) that farmer training and capacity-building programmes are vital components for scaling up climate-smart agriculture and livestock innovations. Similarly, access to climate information significantly ($p < 0.01$) influenced the level of adoption of climate-smart livestock practices. Farmers with access to climate information were better able to understand weather variability, and implement appropriate adaptation measures.

Constraints to Adoption of Climate-Smart Livestock Practices:

The major constraints to adoption of climate-smart livestock practices among the respondents in the study area as in Table 7 were inadequate access to credit (81.8%); inadequate financial resources (70.6%); high labour requirement for new practices (57.4%); high investment required for new practices (54.9%); and shortage of land for climate-smart activities such as fodder cultivation (50.4%). Other constraints identified by the respondents include inadequate reliable water supply (41.7%); poor access to quality inputs (31.8%); unreliable markets (31.4%) inadequate technical expertise (28.9%) traditional farming practices and beliefs (26.9%); inadequate hands-on support after training (24.2%); and inadequate government incentives (21.7%). The findings imply that respondent's ability to adopt CSL practices is constrained by inadequate financial capacity and limited access to productive resources. Most climate-smart livestock practices require some level of investment in improved feeding systems, water infrastructure, fodder establishment, animal health management, and climate adaptation technologies. Consequently, farmers with limited financial resources may find it difficult to implement such practices despite recognizing their benefits. This finding agrees with Abdullahi *et al.* (2022) that land scarcity and high investment costs were major barriers to the adoption of improved livestock technologies among livestock farmers in Kaduna State.

CONCLUSION AND RECOMMENDATIONS

The study concluded that age, household size, access to extension/veterinary services, membership of association, awareness of climate-smart livestock practices, and access to training significantly influenced the adoption of climate-smart livestock practices. It is therefore recommended that; government and relevant stakeholders should strengthen

livestock extension services through the recruitment of more extension personnel and regular technical support to cattle farmers. Regular training programmes, workshops, field demonstrations, and farmer field schools should be organized to enhance farmers' knowledge and practical skills on climate-smart livestock practices. In addition, government and financial institutions should provide accessible livestock-friendly credit schemes, strengthen farmers' cooperatives to improve access to finance, extension services, and climate information, and make climate-smart livestock technologies such as improved fodder seeds and livestock insurance more readily available and affordable to encourage wider adoption among cattle farmers.

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