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Determinants of the choice of mitigation strategies to climate variability adopted by agro-pastoralists in Kano and Jigawa States, Nigeria

Isyaku Suleiman[1], Amina Mustapha[2], Amina Lawan Mustapha[2], Abdullahi Tofeeq Lawal[1], Salmanu Abdusalam Safiyanu[1], and Alasan Alhassan[1]

[1]Department of Agricultural Economics and Extension, Faculty of Agriculture and Agricultural Technology, Aliko Dangote University of Science and Technology Wudil Kano, Nigeria.

[2]Department of Agricultural Economics and Extension, Faculty of Agriculture, Bayero University Kano, Nigeria.

∗ Corresponding author.
E-mail address: Ishaq@kustwudil.edu.ng, alshaqsuleiman10@gmail.com (Suleiman, I.).

Abstract
This study analyzed the determinants of mitigation strategies adopted by agro-pastoralists in Kano and Jigawa States, Nigeria. A multistage sampling technique was used to select 377 respondents from seven Local Government Areas. Primary data were collected through structured questionnaires and analyzed using descriptive statistics and regression techniques. The results showed that agro-pastoralism is male-dominated (100%), with a mean age of 41 years and 25 years of farming experience. Most respondents had an average household size of eight persons, a mean farm size of 3.1 hectares, and an annual income of ₦791,466. The majority were married (92.57%), 60.74% had Qur'anic education, while access to extension services (44.83%), credit (44.03%), and cooperative membership (33.69%) was limited. Multinomial regression results revealed that years of experience, farm size, income, and household size significantly influenced the choice of mitigation strategies at varying levels. The study recommends improving access to credit and financial services to enhance agro-pastoralists' adaptive capacity and promote livelihood diversification.

Keywords: Climate variability, Mitigation strategies, Agro-pastoralists, Farming experience, extension services, farm size

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INTRODUCTION

Agro-pastoralism is an integrated farming system that combines crop cultivation and livestock rearing as the primary source of livelihood. This production system occupies a substantial proportion of the land area in sub-Saharan Africa and contributes significantly to food production, income generation, and employment for millions of rural households (Suleiman et al., 2018). In Northern Nigeria, particularly in Kano and Jigawa States, agro-pastoralism constitutes a major livelihood system, providing food, income, employment, and other socio-economic benefits to rural households. The system is highly dependent on rainfall, rangelands, and water resources, making it particularly susceptible to climate variability. Recent studies in Kano State have reported increasing occurrences of erratic rainfall patterns, prolonged dry seasons, and temperature fluctuations, which negatively affect agricultural production and livelihood security among farming households (Ogundele et al., 2024; Jibrin & Aliyu, 2025). Similarly, evidence from Jigawa State indicates that rainfall variability and recurrent droughts continue to constrain agricultural productivity and limit households' capacity to effectively respond to climatic shocks (Yakubu et al., 2021). Consequently, the sustainability of agro-pastoral livelihoods in the region is increasingly threatened by climate variability and its associated impacts on crop production, livestock management, pasture availability, and household food security.

Climate variability refers to fluctuations in climatic conditions, including changes in rainfall patterns, temperature, humidity, and the frequency of extreme weather events over time beyond normal climatic conditions. It is commonly manifested through delayed onset and early cessation of rainfall, erratic rainfall distribution, prolonged dry spells, recurrent droughts, flooding, and increasing temperature variability. These fluctuations can occur over seasons, years, or decades and have profound implications for agricultural production and natural resource availability. Recent evidence indicates that climate variability is increasing across many regions of Africa, resulting in greater uncertainty in agricultural production systems and heightened livelihood risks among rural populations. (IPCC, 2023; WMO, 2024).

Agro-pastoralists are among the most vulnerable groups to climate variability because their livelihoods depend heavily on climate-sensitive resources such as land, water, pasture, and livestock. Variations in rainfall and temperature directly influence crop growth, pasture regeneration, livestock productivity, water availability, and household income. In Northern Nigeria, climate variability has become increasingly evident through irregular rainfall patterns, rising temperatures, prolonged drought episodes, and occasional flooding events, all of which negatively affect both crop and livestock production (NIMET, 2023). These climatic disturbances have contributed to declining agricultural productivity, increased livestock mortality, pasture shortages, and heightened food insecurity among agro-pastoral households.

The increasing occurrence of climate variability has compelled agro-pastoralists to adopt various mitigation strategies aimed at reducing the adverse effects of climatic shocks and enhancing livelihood resilience. These strategies include crop diversification, livestock diversification, supplementary feeding, water harvesting, irrigation, agroforestry, pasture conservation, migration, and engagement in off-farm income-generating activities. Such measures help households reduce their vulnerability to climatic risks and sustain agricultural production under changing environmental conditions. Studies have shown that the effectiveness of these mitigation strategies depends largely on the capacity of households to access and utilize available resources and institutional support (Tamene et al., 2023; Hassan & Knight, 2023).

Despite the importance of mitigation strategies in enhancing resilience to climate variability, their adoption differs considerably among agro-pastoral households. While some households adopt multiple mitigation measures, others adopt few or none due to differences in socioeconomic characteristics, resource endowments, institutional support, and access to information.

Understanding the determinants of mitigation strategies adopted by agro-pastoralists is essential for designing effective policies and interventions that enhance adaptive capacity and strengthen livelihood resilience. Although several studies have examined adaptation to climate change in sub-Saharan Africa, empirical evidence on the factors influencing the adoption of mitigation strategies among agro-pastoralists remains limited, particularly in Northern Nigeria where climate variability continues to intensify. Therefore, this study seeks to examine the determinants of mitigation strategies adopted by agro-pastoralists in response to climate variability. The findings will provide useful information for policymakers, development agencies, and extension organizations in formulating strategies aimed at improving resilience, reducing vulnerability, and promoting sustainable livelihoods among agro-pastoral communities.

LITERATURE REVIEW

Agro-pastoralism is thus a system of engaging in a mixed agricultural and pastoral lifestyle, combining both crop cultivation and livestock farming as integral components of their livelihoods and sometime go on transhumance during the dry season to make use of pastoral resources (water and fodder) that are often randomly distributed in space of and time (Sy, 2010; Hiernaux et al., 2014a, 2015b). Although distribution of livestock species depends on geographic location, climatic condition and history of pastoralism, the most common species of pastoral livestock at the global scale are cattle, goats and sheep. Nevertheless, roughly 15 different livestock species are found in different pastoral forms and geographic regions.

The Nigeria livestock industry constitutes a very important national resource with a great deal of untapped potentials. Livestock contribute significantly to the nutritional, socioeconomic and cultural requirements of Nigerian. The larger ruminants are particularly important in increasing and improving crop and Livestock production through the use of these animals as sources of farm and on-farm power, notably their use for animal traction. Livestock production is fundamental in agricultural economies especially where climatic conditions and environmental location make livestock farming the most practicable option since they play multifaceted roles in the livelihoods of households who keep them (Cecchi, *et al.,* 2010).

Climate variability has become one of the most pressing challenges confronting agricultural production systems globally, particularly in sub-Saharan Africa where livelihoods depend heavily on rain-fed agriculture and livestock production. Agro-pastoralists, who combine crop cultivation with livestock rearing, are especially vulnerable to climate-induced risks such as erratic rainfall, prolonged droughts, floods, heat stress, and land degradation. These climatic disturbances adversely affect crop productivity, livestock performance, pasture availability, water resources, and household food security. Consequently, agro-pastoral households adopt various mitigation and adaptation strategies to reduce their vulnerability and enhance livelihood resilience (Tamene et al., 2023; Hassan & Knight, 2023).

The adoption of mitigation strategies, however, is not uniform across households. Differences in socioeconomic characteristics, institutional support, resource endowments, and environmental conditions influence the capacity of agro-pastoralists to respond effectively to climate variability.

Several empirical studies have identified key determinants that shape the choice and intensity of mitigation strategies among farming households in developing countries.

RESEARCH METHOD AND MATERIALS

The study area

The study was conducted in Kano and Jigawa States, located between latitudes 9^0 33" to 12^0 37" North and longitudes 7^0 34 to 9^0 25" East and latitudes 11°N and 13°N and longitudes 8°E and 10°35'E, respectively. Both situated within the Sudan Savannah ecological zone of northern Nigeria. This zone extends across north-western Nigeria and is characterized by low annual rainfall (generally below 1000 mm) and a prolonged dry season lasting six to nine months. These conditions support sparse vegetation dominated by short grasses and scattered drought-resistant trees (Olofin, 1987; Ayoade, 2004).

Compared to the Guinea Savannah, vegetation in this zone is less dense due to lower rainfall and longer dry periods (Areola, 2001). The ecological characteristics of the Sudan Savannah favour agro-pastoral production systems, where crop cultivation mainly millet, sorghum, rice, and groundnut are integrated with livestock rearing, including cattle, sheep, and goats (Mortimore, 2009; Food and Agriculture Organization, 2018). Due to the availability of grazing land and water points, the Sudan savannah serves as an important zone for pastoral and agro-pastoral livelihoods, attracting herders and farmers across the northern region. The zone is also among the most densely populated regions of northern Nigeria (see Figure 1), as both crop farming and livestock production are dominant livelihood activities (Mortimore, 2009).

Sampling approach and model

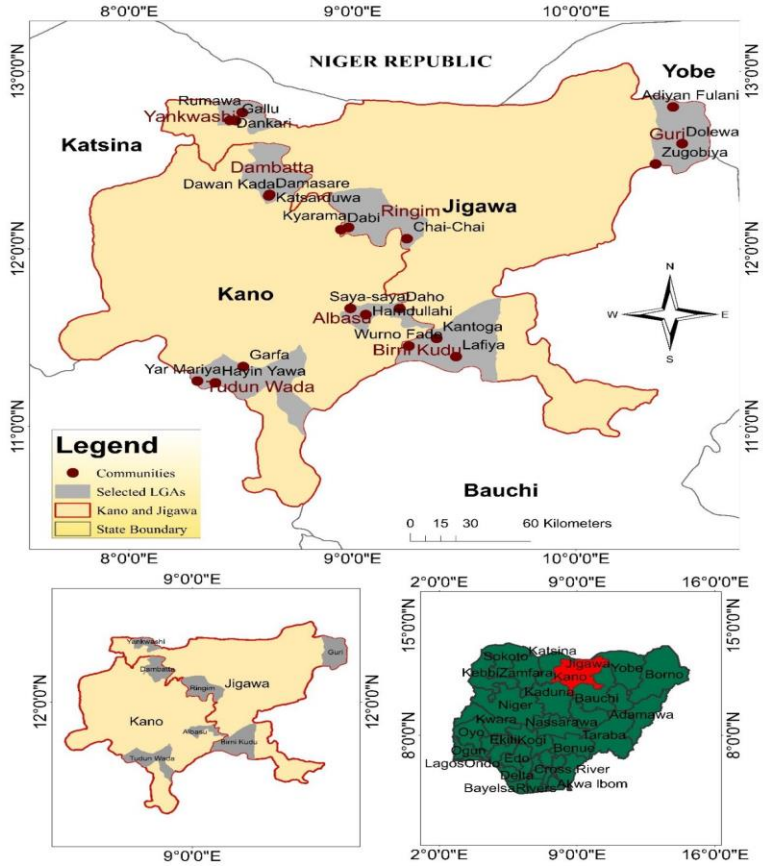
A multistage sampling procedure was applied to select the States, Local Government Areas and communities covered by the study. The first stage involved the purposive selection of Kano and Jigawa States in the Sudan Savannah of Nigeria based on the high concentration of agro-pastoralists. The second stage, involved purposive selection of Tudun wada, Danbatta and Albasu from zone I, II, and III, respectively, while four (4) LGAs across four (4) ADP zones were and selected in Jigawa State. The LGAs are Guri, Ringim, Birnin Kudu, and Yankwashi, from Hadejia, Gumel, Birnin Kudu, and Kazaure zones, respectively based on the high concentration of agro-pastoralists. The third stage also involved purposive selection of three (3) communities in each Local Government Area based on high concentrations of agro-pastoralists. Therefore, the selected communities from Kano State are: Yarmaraya, Garfa, and Hayin yawa from Tundun Wada LGA; Katsarduwa, Damasare, and Dawan Kada from Danbatta LGA; and Hamdullahi, Daho, and Saya-Saya from Albasu LGA; while Zugobiya, Adiyan Fulani, and Dolewa were selected from Guri LGA; Chai-Chai, Dabi, and Kyarama from Ringim LGA; Wurno Fade, Lafiya, and Kantoga from Birnin Kudu, and Rumawa, Gallu, and Dankari from Yankwashi in Jigawa State. Reconnaissance survey conducted with the aid of *Meyatti Allah* and *Fuldan* to unveil the lists of 1492 agro-pastoralists in the aforementioned LGAS selected. Finally, the Rao-soft sample size calculator at 95% level confidence was used to draw a proportionate random sample size of 377 agro-pastoralists, which were included for this study.

Primary data was collected and analysed using descriptive statistics such as frequency and percentage and a multinomial logistic regression model was used to determine the influence of agro-pastorals' socio-economic characteristics on their choice of mitigation strategies. The model was thus specified as follows:

$Ci = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 \ldots\ldots + \beta_nX_n \ldots\ldots U_i$ (1)
where:

CA_i = Choice of mitigation strategies (Herd splitting, non-farm income, off-farm income, use of crop residue and adjusting planting date)
X_1 = Age (years), X_2 = Household size (numbers), X_5 = Year of experience, X_3 = Level of education (formal=1, non-formal=2), X= farm size (ha), and X_7 = Income (naira).

Figure 1. Map of Nigeria showing Kano and Jigawa States and the Study Areas



Source: Geography Department Bayero University Kano

RESULT PRESENTATION AND DISCUSSION

The results from Table1 indicate that agro-pastoralists in Kano and Jigawa States are relatively young and active, with a mean age of 40 and 41 years, respectively, suggesting a workforce capable of adapting to climate variability and adopting improved practices. This aligns with Ibrahim et al. (2021), who reported a majority of agro-pastoralists within the economically active age group. Agro-pastoralists also possessed substantial farming experience, averaging 25 years across the two states, reflecting strong indigenous knowledge and familiarity with local environmental conditions. This is consistent with previous studies (Olaniyi et al., 2018; Bello et al., 2017; Adamu, 2018). Household sizes were relatively large, with a mean of 6 persons in Kano and 9 in Jigawa, and an overall average of 8 persons. While large households provide labor for farming activities, they also increase pressure on resources and heighten vulnerability to food insecurity under climate stress, as noted by Adebayo

(2018) and Ojo (2021). Furthermore, agro-pastoralists operate on small landholdings, with an average farm size of about 3.1 hectares across the states. Such limited land size constrains the adoption of climate-resilient practices and increases susceptibility to climate variability. This finding supports Ayinde (2020) who reported small average farm sizes. The findings indicate that mean annual income of agro-pastoral household heads is ₦792,366.41 in Kano and ₦945,242.65 in Jigawa, with a pooled mean of ₦791,466. This reflects modest earnings typical of smallholder agro-pastoralists in northern Nigeria, which constrain their ability to invest in climate adaptation measures such as irrigation, drought-resistant crops, and income diversification. This finding is consistent with Ayanlade et al. (2018), who reported that agro-ecological and socio-institutional factors influence income variability, and also aligns with Adefolu et al. (2020), who observed that this annual income was inadequate for substantial climate-resilient investments.

Table 1. Socio-economic characteristics of agro-pastoralists in Kano and Jigawa States

Variable	Kano Frequency (%)	Jigawa Frequency (%)	Pooled Frequency (%)
Age			
20-29	33 (25.17)	24 (9.76)	59 (15.50)
30-39	31 (23.67)	94 (38.21)	125 (33.16)
40-49	27 (20.61)	67 (27.24)	94 (24.93)
50-59	32 (24.43)	39 (15.85)	72 (19.1)
60-69	8 (6.12)	21 (8.94)	27 (7.16)
Mean	40	41	41
Years Experience			
1-10	16 (12.21)	33 (13.41)	49 (13)
11-20	39 (29.77)	91 (36.99)	133 (35.27)
21-30	37 (28.24)	68 (27.64)	105 (27.85)
31-40	23 (17.56)	26 (10.57)	49 (13)
41-50	16 (12.22)	28 (11.39)	41 (10.88)
Mean	26	24	25
Household size			
1-7	86 (65.65)	111 (45.12)	204 (54.08)
8-14	32 (24.43)	83 (33.74)	115 (30.51)
15-21	6 (4.58)	35 (14.23)	41 (10.88)
22-28	5 (3.82)	9 (3.66)	9 (2.39)
29-35	2 (1.52)	8 (3.25)	8 (2.14)
Mean	6	9	8
Farm size(ha)			
0.5-2.8	78	106	184 (48.8)
2.9-5.3	38	102	145 (38.46)
5.4-7.7	10	21	28 (7.43)
7.8-10.1	4	16	18 (4.78)
10.2-13	1	9	2 (0.53)
Mean	3.62	3.87	3.1
Annual income (₦)			
100,000-1,280,000	110 (83.97)	203 (82.44)	319 (84.61)
1,281,000-2,461,000	12 (9.16)	21 (8.64)	31 (8.22)
2,462,000-3,642,000	5 (3.82)	8 (3.25)	13 (3.44)
3,643,000-4,823,000	3 (2.29)	9 (3.66)	3 (0.79)
4,824,000-6,000,000	1 (0.76)	5 (2.03)	11 (2.94)
Mean	792,366.41	945,242.65	791,466

Field Survey, 2024

The results in Table 2 shows that all agro-pastoralists are male, reflecting the male-dominated nature of agro-pastoralism in northern Nigeria, where cultural and religious norms assign livestock management and decision-making roles primarily to men. Most agro-pastoralists are married (92.57%), indicating the importance of family labour in livelihood activities. Educational attainment is low, with the majority (60.74%) having only Qur'anic education and few (8.75%) attaining tertiary education, which may limit adoption of modern agricultural innovations. Access to extension services (44.83%) and credit (44.03%) is generally low, constraining productivity and climate adaptation. Additionally, only 33.69% belonged to cooperative organizations, suggesting limited collective action and reduced access to institutional support.

Table 2. Socio-economic characteristics of agro-pastoralist in Kano and Jigawa States

Variable	Kano Frequency (%)	Jigawa Frequency (%)	Pooled Frequency (%)
Marital status			
Single	9 (6.87)	18 (7.32)	27 (7.16)
Married	121(92.7)	226 (91.87)	347 (92.04)
Divorce	1 (0.76)	2 (0.81)	3 (0.8)
Educational level			
Qur'anic education	95 (72.52)	133 (54.06)	228 (60.48)
Primary	14 (10.68)	35 (14.23)	49 (12.99)
Secondary	17 (12.98)	50 (20.33)	67 (17.77)
Tertiary	5 (3.82)	28 (11.38)	33 (8.76)
Access to extension service			
Access	48 (36.64)	111 (45.12)	159 (42.17)
No access	83 (63.36)	135 (54.88)	218 (57.83)
Access to credit			
Access	57 (43.51)	109 (44.31)	166 (44.03)
No access	74 (56.49)	137 (55.69)	211 (55.97)
Membership			
Member	58 (44.27)	70 (28.46)	128 (33.95)
Non-member	73 (55.73)	176 (71.54)	249 (66.05)

Field Survey, 2024

Table 3 presents the results of the multinomial logistic regression, which examined the effect of socio-economic factors on the adoption of different mitigation strategies by agro-pastoralists. The Nagelkerke R^2 value of 0.375 indicates that the model explains approximately 37% of the variation in the dependent variables. The chi-square statistic (166.972), which is statistically significant, confirms that the model has a good overall fit and that the explanatory variables jointly influence the choice of mitigation strategies

For the use of crop residue, years of experience has a negative and highly significant effect ($p < 0.01$), suggesting that more experienced farmers are less likely to adopt this strategy. This may reflect reliance on traditional knowledge systems or resistance to newer practices. Recent evidence shows that farming experience can either enhance or constrain adaptation depending on whether it promotes innovation or reinforces conservative practices (Gashure, 2024; Omotayo et al., 2025). Household size has a positive and significant effect ($p < 0.05$), implying that larger households are more likely to adopt crop residue management due to increased labor availability. This aligns with findings that labor-intensive adaptation strategies are more feasible in households with larger family

sizes (Maziya et al., 2024). Farm size also has a strong positive effect ($p < 0.01$), indicating that agro-pastoralists with larger landholdings were more likely to utilize crop residues. This supports recent studies showing that landholding size enhances farmers' capacity to adopt climate-smart practices due to better access to resources and flexibility in land use (Hassan & Knight, 2023). Income is statistically significant, although its marginal effect suggests that even small increases in income can influence adoption decisions.

For herd splitting, farm size again emerges as a strong and significant determinant ($p < 0.01$), indicating that wealthier agro-pastoralists with more land can better distribute livestock across grazing areas to reduce climate risks. This is consistent with recent findings that asset ownership, particularly land, enhances adaptive capacity among livestock farmers (Onyeneke et al., 2025). Years of experience showed a weak negative relationship ($p < 0.10$), suggesting that experienced farmers may rely on established herd management systems rather than adopting new risk-spreading strategies. Household size and income were only weakly significant, indicating that herd splitting is less labour-driven and more dependent on resource endowment.

In the case of non-farm income diversification, years of experience has a negative and highly significant effect ($p < 0.01$), suggesting that more experienced agro-pastoralists were less likely to diversify outside agriculture. This may reflect specialization in farming or limited exposure to alternative livelihood opportunities. Recent studies confirm that diversification into non-farm activities is more common among younger or less experienced farmers seeking to reduce climate-related risks (Omotayo et al., 2025). Household size positively and significantly influences diversification ($p < 0.01$), indicating that larger households can allocate labor to non-farm activities while maintaining farm operations. Similarly, farm size ($p < 0.01$) increases the likelihood of diversification, suggesting that relatively wealthier households have the financial capacity to invest in non-farm ventures.

Table 3. Socio-economic Factors Influencing the Choice of Mitigation Strategies

Variable	Coefficient (B)	Std. Error	Exp (B)	Sig.
Use of crop residue				
Age	0.46	0.047	1.047	0.328
Years of experience	-0.121	0.043	0.886	0.005***
Household size	0.148	0.071	1.160	0.036**
Income	0.000	0.000	1.000	0.008***
Farm size	0.931	0.226	2.538	0.000***
Constant	-1.757	0.954		0.066
Herd splitting				
Age	0.018	0.052	1.018	0.733
Years of experience	-0.086	0.048	0.917	0.073*
Household size	0.0120	0.074	1.127	0.108*
Income	0.000	0.000	1.000	0.065*
Farm size	0.912	0,228	2.490	0.000***
Constant	-1.774	1.079		0.100
Non-farm income				
Age	0.073	0.047	1.075	0.121
Years of experience	-0.166	0.043	0.847	0.000***
Household size	0.191	0.71	1.211	0.007***
Income	0.000	0.000	1.000	0.386
Farm size	0.752	0.231	2.121	0.001***
Constant	-1.095	0.977		0.263

Source: Field Survey, 2024 Sig. Level: *** 1%, ** 5%, * 10%

For off-farm income diversification (see Table 4), age had a positive and weakly significant effect ($p < 0.10$), implying that older farmers were more likely to engage in off-farm activities. This may be due to accumulated experience, social capital, and access to livelihood opportunities over time. Recent studies indicate that age can positively influence diversification decisions when it is associated with broader livelihood networks and resource access (Abdulai & Huffman, 2022; Doss., 2023).

Years of experience has a negative and significant effect ($p < 0.01$), suggesting that more experienced agro-pastoralists were less inclined to diversify outside agriculture. This supports recent findings that experienced farmers often remain committed to traditional farming systems and may be less responsive to alternative livelihood strategies (Tambo & Wünscher, 2023). Income was positive and significant ($p < 0.05$), indicating that higher income agro-pastoralists were more capable of engaging in off-farm ventures, likely due to better access to startup capital. Similarly, farm size ($p < 0.01$) significantly increases the likelihood of diversification, reinforcing the argument that asset-rich agro-pastoralists have greater adaptive capacity and flexibility (Jayne., et al., 2023).

For adjusting planting dates, farm size again emerged as a strong and significant determinant ($p < 0.01$), indicating that agro-pastoralists with larger landholdings were more likely to adjust their planting schedules in response to climate variability. This finding aligns with recent empirical evidence showing that land access enhances farmers' ability to implement climate smart agricultural practices, including changes in cropping calendars (Arslan et al., 2022).

Years of experience had a weak negative effect ($p < 0.10$), suggesting that more experienced farmers may be less likely to adjust planting dates, possibly due to reliance on indigenous knowledge and established seasonal patterns. This is consistent with recent studies highlighting that while experience can improve risk perception, it may also slow the adoption of new adaptive practices (Partey, et al., 2023).

Table 4. Socio-economic factors influencing the choice of mitigation Strategies

Variable	Coefficient (B)	Std. Error	Exp (B)	Sig,
Off-farm income				
Age	0.86	0.47	1.099	0.068*
Years of experience	-0.125	0.044	0.883	0.005***
Household size	0.056	0.075	1.058	0.453
Income	0.000	0.000	1.000	0.016**
Farm size	0.731	0.232	2.078	0.002***
Constant	-2.367	0.990		0.017
Adjusting planting date				
Age	0.034	0.048	1.035	0.479
Years of experience	-0.074	0.045	0.929	0.100*
Household size	-0.016	0.077	0.985	0.839
Income	0.000	0.000	1.000	0.132*
Farm size	0.944	0.227	2.570	0.000***
Constant	-1.252	0.965		0.195
Nagelkerke	0.375			
Chi-square	166.972			
-2loglikelihood	1257.562			

Source: Field Survey, 2024 Sig. Level: *** 1%, ** 5%, * 10%

CONCLUSION

The study concluded that the choice of mitigation strategies among agro-pastoralists in Kano and Jigawa States is significantly influenced by socio-economic factors such as years of farming experience, farm size, income, and household size. Agro-pastoralist with greater experience and larger farm holdings are more likely to adopt diverse and effective mitigation strategies, highlighting the importance of resource endowment and accumulated knowledge in shaping adaptive capacity. Based on these findings, Government and financial institutions should design and expand accessible and affordable credit schemes tailored to agro-pastoralists to support investment in mitigation strategies.

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