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Assessment of Attitude-Behaviour Dynamics in Climate Change Adaptation among Wheat (*Triticum Aestivum*) Farmers in Kaduna State, Nigeria

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Abstract

This study investigated wheat farmers attitude behaviour gap in climate change adaptation in Kaduna State, Nigeria. It used 159 farmers selected through multi-stage random sampling technique. Descriptive and inferential (Binomial test and Pearson Product Moment Correlation (PPMC)) techniques were used to analyse data of the study. Results revealed that most (79.25%) of the farmers practiced mixed cropping system and majority (45.91%) of them had a negative attitude toward climate change adaptation strategies. Some adaptation strategies effectively used include: changes in planting dates of crops (91.82%), changes in harvesting dates of crops (89.94%), fertilizer application (86.79%), alteration in timing of land preparation activities (83.65%) and cropping adjustments systems (79.25%). While some of the interventions to bridge attitude-behaviour gap of adopting climate change adoption strategies were: strengthening agricultural extension system ($\bar{x}$ = 3.25), improving access to credit facilities ($\bar{x}$ = 3.13), provision of incentives to farmers ($\bar{x}$ = 3.06) and adoption of a model farmer approach ($\bar{x}$ = 2.93). Binomial test revealed that majority of farmers (58.49%) held an unfavourable attitude toward the climate change mitigation strategies they were familiar with, while PPMC revealed that farming systems predominantly practiced by wheat farmers are significantly influenced by their attitudes toward climate change adaptation strategies. The study thus recommended that: Government bodies, non-governmental organizations, and other stakeholders must invest in agriculture by strengthening agricultural extension systems; and given the widespread use of mixed cropping and mixed farming as strategies to stabilize farm income, government policies should actively support and strengthen these practices.

Keywords: Attitude-behaviour, climate change, adaptation strategies, wheat production, farmers, farming systems.

INTRODUCTION

Climate change remains a major threat to global agriculture, with negative impacts already evident in crop yields, growing seasons, and rural livelihoods (Harshad *et al*., 2024). Wheat, a staple food for billions cultivated across diverse agro-ecological regions, is particularly vulnerable to climate-induced stresses such as drought, heatwaves, and irregular rainfall (Intergovernmental Panel on Climate Change (IPCC, 2021)). These impacts are especially alarming in regions dominated by smallholder farming, where food security is highly vulnerable (Grote *et al.*, 2021).

In response to these challenges, a range of adaptation strategies have been promoted, including adjusting planting schedules, adopting stress-tolerant wheat varieties, improving irrigation, practicing conservation agriculture, and diversifying income sources. These measures have proven effective in reducing vulnerability and strengthening resilience to climate variability (Venu Prasad *et al.*, 2023).

However, a major and often overlooked challenge is the attitude–behavior gap: farmers may recognize climate change and support adaptation, yet fail to translate these attitudes into actual behavioral change (Niles *et al.*, 2016). Evidence shows that awareness and concern do not always lead to meaningful action (Penasco & Grossman, 2025). Farmers may acknowledge climate risks and the benefits of adaptation while continuing traditional practices that increase vulnerability. This gap reduces the effectiveness of policies and extension services aimed at improving agricultural resilience. Contributing factors include limited financial resources, labor shortages, insecure land tenure, institutional weaknesses, and psychological, cultural, and social barriers (Belle *et al.*, 2024).

The attitude–behaviour gap refers to the disconnect between wheat (*Triticum aestivum*) farmers' positive attitudes toward climate change adaptation and their actual adoption of adaptation practices (Song and Zhu, 2025). Although many farmers recognize climate risks such as rising temperatures, irregular rainfall, drought, pests, and declining soil fertility, and support measures like improved seed varieties, irrigation, and soil conservation, implementation often remains limited. This gap is influenced by factors such as inadequate finance, poor access to climate information, weak extension services, limited technical knowledge, and restricted access to improved technologies (Mishra *et al.*, 2026). It suggests that positive attitudes alone are not enough to ensure behavioural change in climate adaptation among wheat farmers.

Although the attitude–behavior gap has gained attention, empirical studies focused on wheat farmers remain limited, particularly in developing regions with high climate risk and low adaptive capacity (Ali, 2019). Moreover, much of the literature treats farmers as purely rational actors, neglecting the psychological and contextual influences on decision-making (Nuthall & Old, 2018). Addressing this gap is therefore crucial for improving resilience and productivity in wheat-based farming systems under climate stress.

Objectives of the study

i. Ascertain farming system mostly practiced by wheat farmers in the study area.
ii. Determine farmers' attitude to climate change adaptation strategies on wheat production.
iii. Identify which adaptation strategies are most effective for use by wheat farmers.
iv. Identify interventions that can bridge attitude-behaviour gap of adopting climate change adaptation strategies.

Hypotheses of the study

Hoi: There is no significant difference between farmers with favourable and those with unfavourable attitudes toward climate change adaptation strategies for wheat production.

Hoii: The farming systems predominantly practiced by wheat farmers are not significantly influenced by their attitudes toward climate change adaptation strategies.

Methodology

Area of study

Kaduna State, the study area, is located in Nigeria's North-West geopolitical zone at approximately 10°20′N latitude and 7°45′E longitude, covering about 46,053 km². It shares boundaries with Niger State to the west; Zamfara, Katsina, and Kano States to the north; Bauchi and Plateau States to the east; and the Federal Capital Territory (FCT) Abuja and Nasarawa State to the south. Kaduna State is widely regarded as a center of commerce, education, and culture in north-western Nigeria and is popularly known as the "Centre of Learning." The state capital, Kaduna city, is one of the 23 local government areas (LGAs) (Okwuokenye & Petu-Ibikunle, 2021). Kaduna State is Nigeria's third most populous state, with an estimated population of 9,032,200 in 2022 (Kaduna State Population Statistics, 2022). It has a rich cultural heritage, and about 80% of the population depends on agriculture for their livelihood (Okwuokenye & Petu-Ibikunle, 2021). Hausa is the dominant language, while English is the official language.

The study employed a multi-stage random sampling technique conducted in several stages. First, two agricultural zones were randomly selected in Kaduna State, Nigeria: Kaduna Central and Kaduna North. In the second stage, two LGAs were randomly selected from each zone (Chikun and Kaduna North from Kaduna Central, and Makafi and Sabon Gari from Kaduna North). Stage three involved the random selection of two towns from each LGA, giving a total of eight towns. This was followed by the random selection of 20 farmers from each town, producing a total sample size of 160 farmers. These farmers were administered the questionnaire, of which 159 (99.38%) were considered suitable for analysis.

Primary data used for the study were collected using structured questionnaire and interview schedule. These instruments were administered to literate and illiterate farmers respectively.

The reliability of the instruments was determined using test-re-test method. The test produced correlation coefficient of 0.65 which implied that the instrument was highly reliable.

Descriptive statistics were used to analyse objectives one, two and three. On the other hand, a Likert scale was employed to generate mean scores for interventions aimed at bridging the attitude–behaviour gap in the adoption of climate change mitigation strategies (objective four).

The scale ranked from strongly agree (coded 4), agree (coded 3), disagree (coded 2) and strongly disagree (coded 1). It produced a weighted mean of 2.50. Interventions to bridge attitude-behaviour gap of farmers with mean score of 2.50 indicated that the farmers agreed that the factors were effective interventions to bridging attitude behaviour gap of climate change adaptation strategies. Where the values were less than 2.50, it implies otherwise.

Hypothesis 1 was analyzed using the Binomial test and it was used to determine if significant difference exist between farmers with favourable and those with unfavourable attitudes towards climate change adaptation strategies for wheat production. The binomial distribution formula is presented below:

b(x;n,p) = nCx*px*(1-p) n-x ------- (Eq. 1)

where; b = binomial probability;

x = total number of farmers (with favourable and unfavourable attitudes towards climate change adaptation strategies for wheat production).

p = probability of success on an individual trial;

n = number of trials.

Hypothesis 2 (farming systems predominantly practiced by wheat farmers are not significantly influenced by their attitudes toward climate change adaptation strategies) was analysed with Pearson Product Moment Correlation (r). It produces value that ranges between -1 to +1, which respectively implies perfect positive and perfect negative relationship between variables X (farming systems) and Y (attitudes toward climate change adaptation strategies). The formula is specified as:

$$r = \frac{n\sum XY - (\sum X)(\sum Y)}{\left(\sqrt{n\sum X^2 - (\sum X^2)}\right)\left(n\sum Y^2\right) - \left(\sum Y^2\right)} \text{----------Eq. 2}$$

Decision Rule: The alternative hypothesis is accepted if there is a statistically significant influence of X (farming systems) on Y (farmers' attitudes toward climate change adaptation strategies) and that the standard error, E is less than half the value of the parameter estimates, X.

RESULTS AND DISCUSSION

Farming systems adopted by the respondents

The farming systems practiced by the farmers are shown in Table 1. The results represent multiple response from the wheat farmers and the results revealed that most (79.25%) practiced mixed cropping system. Other farmers practiced sole cropping system (25.79%), mixed farming system (55.97%) and irrigated farming system (13.84%). About 21.38% and 71.07% practiced farming system involving improved technology and that which involved traditional technology respectively. Through personal communication, the farmers noted that they mostly engage in mixed cropping system because they really want to produce as many other crops as possible just to economically secure themselves in case of uncertainty. This result was supported by the findings of Anosike *et al.* (2022) which showed that majority (75%) of the farmers in Kaduna State practiced mixed cropping system.

Table 1: Farming systems adopted by the respondents

Farming systems operated by the farmers	Frequency	Percentage	Mode
- Sole cropping system	41	25.79	
- Mixed farming system	89	55.97	
- Mixed cropping system	126	79.25	
- Irrigated farming system	22	13.84	
- Farming system involving improved technology	34	21.38	
- Farming system involving traditional technology	113	71.07	Mixed cropping system

Source: Field survey, 2024; n = 159

Farmers' attitude to climate change adaptation strategies on wheat production

Table 2 illustrates farmers' attitudes toward various climate change adaptation strategies employed in wheat production, particularly in relation to modern agricultural technologies. The results reveal that disposition towards improved seeds emerged as the most preferred adaptation strategy, representing 42.14% and also constituting the modal response, indicating that it was the most widely accepted option among farmers. This finding implies that farmers consider improved seed varieties to be an effective response to climate-related challenges in wheat production, likely because of their adaptability to changing climatic conditions and capacity to enhance productivity.

Additionally, irrigation was identified as a key adaptation strategy by 27.04% of the farmers. This suggests that a substantial proportion of respondents acknowledge the significance of effective water management in reducing the adverse effects of erratic rainfall patterns and prolonged dry conditions associated with climate change.

Conversely, mechanization for adaptation accounted for 18.24%, reflecting a relatively moderate level of acceptance among the respondents. This pattern may be linked to constraints such as the high cost of machinery, limited accessibility, and insufficient technical expertise required for operation. Meanwhile, weather forecasting recorded the lowest proportion, with only 12.58% expressing a favorable attitude toward its use as an adaptation strategy. The low level of preference may be attributed to inadequate access to dependable climate information, low awareness, or limited confidence in weather prediction systems among farmers.

This result is in line with findings of Myeni and Moeletsi (2023) who found that farmers increasingly perceive improved seed varieties, such as drought-tolerant, heat-resistant, and early-maturing cultivars as an effective strategy for minimizing climate-related risks in wheat production. This perception is largely attributed to the ability of these seed varieties to withstand adverse climatic conditions and enhance productivity.

Table 2: Farmers attitude to climate change adaptation strategies on wheat production

Attitude toward modern agricultural technologies	Frequency	Percentage	Mode
Disposition towards improved seeds	67	42.14	
Irrigation	43	27.04	
Weather forecasting	20	12.58	
Mechanization for adaptation	29	18.24	
Total	159	100.00	Disposition towards improved seeds

Source: Field survey, 2024.

Climate change adaptation strategies effectively used by wheat farmers

Climate change adaptation strategies effectively used by wheat farmers are presented in Table 3. Strategies adopted by at least 50% of respondents were regarded as effective. About fourteen strategies were identified as being commonly used in wheat production. Using multiple responses, the most widely adopted strategies included changes in planting dates (91.82%), harvesting dates (89.94%), fertilizer application (86.79%), altered timing of land preparation (83.65%), and cropping system adjustments (79.25%). Other strategies included intercropping (79.25%), zero or minimum tillage (76.73%), contour cropping on slopes (71.07%), expansion of cultivated land (69.81%), and planting improved climate-resistant varieties (63.52%). Afforestation or reforestation (59.12%), crop rotation (57.23%), water management and irrigation (52.83%), and growing different crop types (52.20%) were also widely adopted. These results suggest that wheat farmers employ a wide range of strategies to reduce climate risks. These findings agree with Malhi *et al.* (2021), who reported similar strategies for overcoming climate impacts. Likewise, Obabire *et* al. (2022) identified comparable measures to address climate-induced declines in farm output and food security. The result implies that the study findings align with existing empirical evidence, thereby enhancing the credibility of the results and indicating that the identified strategies are widely recognized as effective responses to climate change in agriculture.

Table 3: Adaptation strategies effectively adopted by wheat farmers

Effectively used adaptation strategies	Frequency	Percentage
- Changes in planting dates of crops	146	91.82*
- Changes in harvesting dates of crops	143	89.94*
- Fertilizer application	138	86.79*
- Alteration in timing of land preparation activities	133	83.65*
- Cropping adjustments systems	126	79.25*
- Inter-cropping system	126	79.25*
- Adoption of zero or minimum tillage system	122	76.73*
- Contour cropping across hill / slopes	113	71.07*
- Expansion of cultivated areas.	111	69.81*
- Planting new and improved crops varieties that can resist climate change	101	63.52*
- Afforestation/ reforestation initiatives	94	59.12*
- Practicing crop rotation system	91	57.23*
- Apply water management and irrigation systems	84	52.83*
- Practicing mixed cropping system	83	52.20*
- Laws against deforestation activities	73	45.91
- Changes in planting depth of seeds and seedlings.	67	39.62

**Effectively used adaptation strategies; Source: Field survey, 2024.*

Interventions to bridge attitude-behaviour gap of adopting climate change mitigation strategies

Table 4 shows interventions that could be adapted to bridge attitude-behaviour gap amongst wheat farmers. The first, second, third and fourth interventions were: strengthening agricultural extension system ($\bar{x} = 3.25$), improving access to credit facilities ($\bar{x} = 3.13$), provision of incentives to farmers ($\bar{x} = 3.06$) and adoption of a model farmer approach ($\bar{x} = 2.93$) respectively. The other interventions which respectively ranked fifth, sixth and seventh interventions include: advancing reminders to farmers on use of strategies ($\bar{x} = 2.84$), increase information sharing amongst farmers ($\bar{x} = 2.66$), involve farmers in planning their programmes ($\bar{x} = 2.66$), farmers participation in provision of solution to farm challenges ($\bar{x} = 2.58$) and promoting mechanized wheat farming to reduce labour intensity and encourage greater female participation in wheat cultivation in the area ($\bar{x} = 2.52$). The interventions are numerous and in various ways help to bridge wheat farmers' attitude-behaviour gap of mitigating climate change effects. The findings of Cano and Campos (2024) align with this result, as they also concluded that integrating these practices offers synergistic benefits, enabling farmers to effectively address climate-related challenges while simultaneously enhancing their agricultural productivity and income. Enhancing access to credit facilities can help address cost barriers, which Zaka *et al.* (2025) identified as a major constraint to adopting agricultural technologies that mitigate the effects of climate change. Promoting mechanized wheat farming to reduce labour intensity and encourage greater female participation is supported by Adebayo (2018), who notes that the physically demanding nature of wheat cultivation discourages women's involvement, leaving men as the primary labor contributors. This is further reinforced by cultural norms that grant men greater decision-making authority, which can ultimately limit farm productivity.

Table 4: Interventions of bridging attitude-behaviour gap of mitigating climate change effects

Interventions of bridging attitude-behaviour gap	Mean	Standard Dev.
- Strengthening agricultural extension system	3.25*	0.58
- Improving access to credit facilities	3.13*	0.61
- Provision of incentives to farmers	3.06*	0.63
- Identifying and adoption of a model farmer approach	2.93*	0.65
- Advancing reminders to farmers on use of strategies	2.84*	0.68
- Increase information sharing amongst farmers	2.66*	0.71
- Involve farmers in planning their programmes	2.66*	0.72
- Farmers participation in provision of solution to farm challenges	2.58*	0.76
- Promoting mechanized wheat farming to reduce labour intensity and encourage greater female participation in wheat cultivation in the area	2.52*	0.63
- Monitoring of farmers farming activities	2.31	0.73
- Establishing a feedback mechanism to the farmers	2.11	0.75

**Interventions of bridging attitude-behaviour gap = mean ≥ 2.50; Source: Field survey, 2024.*

Test of difference in proportion of farmers with favourable and unfavourable attitudes towards climate change adaptation strategies

Hypothesis one examined the relationship between the proportions of wheat farmers with favourable and unfavourable attitudes toward climate change adaptation strategies, as presented in Table 5 using a binomial test. The results showed that most farmers (58.49%) held an unfavourable attitude toward the mitigation strategies they were aware of, while 41.51% had favourable attitudes. A significant difference was observed between farmers with favourable and unfavourable attitudes, and this was statistically significant at the 1% level. Therefore, the alternative hypothesis was accepted, indicating a significant difference in attitudes toward climate change adaptation strategies in wheat production. The largely unfavourable attitudes among wheat farmers may be linked to the production losses they continue to experience, possibly due to inadequate implementation of adaptation measures. This finding of farmers' unfavorable disposition toward climate change mitigation strategies is consistent with the view of Opuama *et al.* (2025), who reported that the adverse effects of climate change on arable crops have given rise to their unfavourable attitude to adaptation strategies and significantly undermined farmers' food security. This finding also supports Atube *et al*. (2021), who noted that many farmers lack the capacity to adapt effectively to climate change, contributing to food shortages.

Table 5: Respondents satisfaction level with climate change adaptation strategies on wheat production

Respondents level of satisfaction	Frequency	Proportion	Prob. Level
Favourable attitude (score: > 20)	66	0.4151	0.001
Unfavourable attitude (score: 20 & below)	93	0.5849	
Total	159	1.00	

Source: Field survey, 2024

Relationship between farming system practiced by farmers and their attitudes to climate change adaptation strategies

The Pearson Product Moment Correlation was used to analyze the relationship between wheat farmers' predominant farming systems and their attitudes toward climate change adaptation (Table 6). Most farmers (79.25%) practiced mixed cropping (see Table 1), while 58.49% showed an unfavorable attitude toward adaptation strategies. The extent of losses is likely linked to farmers' limited capacity to adopt climate change adaptation measures, which contributes to their negative attitudes. The dominance of mixed farming may reflect a coping strategy to offset climate-related losses.

The results showed that the farming system was the outcome variable (Y), while attitude toward adaptation was the determinant variable (X). The parameter estimate for X was 0.5918, with half of this value (0.2959) exceeding its standard error

(0.1339), indicating statistical significance. Therefore, the alternative hypothesis was accepted, confirming that farming systems are significantly influenced by farmers' attitudes toward climate change adaptation strategies. The correlation coefficient (r = 0.6135) indicates a positive relationship between attitudes and farming systems. This supports Ibrahim and Johansson (2021), who reported that farmers' awareness shapes their attitudes and, in turn, their farming practices and environmental outcomes.

Table 6: Relationship between farming system practiced by farmers and their attitudes to climate change adaptation strategies

Statistical variables	Parameter estimates
Parameter estimate of variable X	0.5918
Standard error of variable X	0.1339
Correlation coefficient "r"	0.6135
R^2	0.6642
Half of parameter estimate of variable X	0.2959

Source survey, Field survey, 2024

Conclusion and Recommendations

The study examined the farming systems used by wheat farmers and their attitudes toward climate change adaptation strategies. Results showed that mixed cropping (79.25%) and mixed farming (55.97%) were the dominant systems, driven largely by farmers' efforts to secure their livelihoods against climate uncertainty. However, many farmers (58.49%) displayed unfavorable attitudes toward adaptation strategies, likely due to ongoing production losses and limited capacity for effective implementation.

Although several strategies were widely known and used, such as changes in planting (91.82%) and harvesting (89.94%) dates, fertilizer use (86.79%), adjusted land preparation timing (83.65%), and intercropping (79.25%), farmers' attitudes remain a major barrier to broader adoption. This attitude–behaviour gap underscores the need for interventions such as stronger extension services ($\bar{x}$ = 3.25), improved access to credit ($\bar{x}$ = 3.13), incentives ($\bar{x}$ = 3.06), and participatory planning ($\bar{x}$ = 2.58).

Statistical analysis also revealed a significant difference between farmers with unfavourable (58.49%) and favourable (41.51%) attitudes, along with a positive relationship between attitudes and farming systems. These findings suggest that attitudes strongly shape farming practices, with mixed farming likely serving as a coping strategy for farmers with limited adaptive capacity.

Recommendations

In line with results of the study, the following were recommended:

Government bodies, non-governmental organizations, and other stakeholders should invest in agriculture by strengthening extension systems. This can be done through regular training of extension workers to provide accurate climate change information and promote effective adaptation strategies, thereby improving farmers' knowledge and encouraging positive behavioral change.

Given the widespread use of mixed cropping and mixed farming to stabilize farm income, government policies should support and strengthen these practices by promoting crop–livestock integration, intercropping, and the distribution of diverse, climate-resilient seed varieties.

Financial constraints remain a major barrier to adopting climate adaptation strategies. To address this, farmers' access to affordable credit should be improved, alongside financial incentives such as input subsidies and climate risk insurance to encourage greater investment in adaptation measures.

Targeted awareness campaigns and behavior change communication (BCC) initiatives should be developed to challenge negative perceptions and unfavorable attitudes toward climate change adaptation. Featuring successful model farmers can help build trust and motivate wider adoption among farming communities.

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