CLIMATE RISK PERCEPTION AMONG SMALLHOLDER RICE FARMERS IN OGUN STATE: A GENDER - BASED ANALYSIS

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ABSTRACT

The study investigated rice farmers' gender-based perceptions of climate change and its impact on farming risks. Using a multi-stage sampling procedure, Ilaro and Ikenne zones were purposively chosen. At initial sampling phase, six blocks were randomly chosen from the zones. In the final phase, 24 communities were randomly selected, and ten farmers were chosen from each community, for a total of 240 smallholder farmers. The analysis employed Tobit regression and the Climate Risk Perception Index. Male rice farmers predominated in the area. Regression results confirmed the significance of sex, education, household size, extension officers' visits, farm income and farming experience. The Risk Perception Index revealed that over 76% of farmers across both genders ranked pest invasion as the most critical climate change risk ever experienced. However, females were more sensitive to climate risks. The study suggested that the Ogun State Agricultural Development Agency should improve farmers' training through increased extension visits during the rice production cycle to reduce exposure to climate change risks.

Keywords: Climate impact; Gender analysis; Rice production; Risk perception Index; Tobit

INTRODUCTION

Agriculture is a vital human activity, transcending being a source of livelihood and clothing, to include the provision of shelter (Liliane and Charles, 2020). Risk is generally defined as an event with a determinable probability of occurrence; whereas, climate risks include weather changes that have effects on the ecosystem, particularly agricultural activities, that result from potential climate shifts (Dhar *et al.*, 2023; Huang *et al.,* 2024; Lidskog, 2025).

Climate risk, hence, combines hazard and vulnerability exposure (Masum, 2019). The inherent consequences of climatic change on agricultural output and income, therefore, shapes farmer's perception or observation of the attendant danger (Dhar *et al.,* 2023; Huang *et al.,* 2024; Lidskog, 2025). Farmers therefore need to understand the nature of climate risks to plan and implement survival strategies to mitigate them. Grain food crops, including rice, are susceptible to such risks. Rice, botanically referred to as *Oryza sativa*, is the most widely eaten grain food worldwide, providing half of the world's calories and serving as an essential component of daily diets across diverse cultures. Its consumption is expected to grow by 28 per cent in 2050 (Zhu *et al.,* 2018)**.**

The environment, no doubt, has an important effect on crop cultivation. In fact, rice farmers have noted its economic importance, as increased temperature during the critical rice growth phase often leads to reduced yield (Elegbeleye *et al.,* 2023). This, however, guides rice farmers' choices when responding to weather-related dangers, weather or atmospheric perception, and deployment of risk-reduction strategies(O'Neill *et al.*, 2022; Fierros-González and Lopez-Feldman, 2021)**.** In Nigeria, erratic rainfall, volatile temperatures, and the increasing frequency of critical weather events such as droughts and floods are major climate issues that significantly affect smallholder rice farmers, who account for most of rice production. These adverse effects threaten agricultural output, increase food insecurity, and hamper the economic stability of rural farmers. This is a common trend in regions like Ogun State, which is a major rice-producing area in southwestern Nigeria. Assessing people's risk perceptions is essential for developing policy interventions that support climate-resilient agriculture and strengthen resilience; this cannot be overemphasised (van Valkengoed and Steg, 2019). At the centre of it, the significance of gender roles in rice farming has garnered attention among the research community, governments, and non-governmental organisations, with interest in gender equality and climate change within the agricultural development space (Bessah (Bessah *et al*., 2021).

Despite the growing recognition of climate-induced risks, smallholder rice farmers in Ogun State were noted to lack the resources, knowledge, and required technical support necessary to address the endemic challenges of climate change. These farmers face critical gaps in their understanding of climate risks and their ability to respond to them. Studies on agricultural impacts of climate to address this issue in Ogun state abound. While Ojo and Baiyegunhi, (2021), Fasakin *et al.,* (2024), and Solaja *et al.,* (2024) worked on farmers' perception of climate risk in Nigeria and the sub-Saharan African countries, the studies never took into account the actual context of smallholder rice farmers in Ogun State. This matters because rice farmers' decisions and production in the state are shaped by localised factors such as land tenure systems, access to irrigation, and social networks. It is therefore important to put rice farmers' perceptions of the risks that accompany climate change into perspective. The findings would inform policy guidance and interventions that enhance climate resilience. Given that rice is a major staple crop in Nigeria, increasing resilience in rice farming is not only vital for food security but also for the economic well-being of rural households. This research consequently intends to bridge this scholarly gap by investigating a gender analysis of climate risk perception of smallholder rice farmers in Ogun State, Nigeria.

REVIEW OF LITERATURE

Theoretical Review

Theory of Planned Behaviour: Planned behavior firstly presented by (Ajzen, 1991) included four fundamental variables: subjective belief (SN), experienced behavior control (PBC), behavior (AT), and behavioral intention (BI). The theory subsumed the attitude intention behavior paradigm which states that an individual's behavioral intention directly affect their actions (Xu *et al.,* 2021). It renders a reasonable prediction about how people behave. In order to increase the anticipated precision of the model, other researchers have incorporated additional features into the theory of planned behavior (Savari and Gharechaee, 2020; Xu *et al.*, 2021). To, therefore, improve the theory, more frameworks were built by scholars to enhance the model's capacity for prediction (Savari and Gharechaee, 2020; Xu *et al.,* 2021). This was necessary because people's actions to mitigate climate change were influenced by their views of the dangers, particularly how these risks affect their farm operations (Tong *et al.,* 2019). This shows that farmers' attempts to reduce weather-related hazards are directly informed by the risks they face in carrying out their activities.

The Decomposed Theory of Planned Behaviour (DTPB): The DTPB yielded more impact than the Theory of Planned Behaviour (TPB) in explaining and forecasting people's behaviours. The theory recorded more success because it divides behavioral beliefs into three distinct belief dimensions of self-efficacy, resource facilitation circumstances, and technology facilitation conditions. The decomposed theory goes further to investigate the elements of perceived behavioral control, defining facilitating conditions as people's perceptions of the organizational and technological resources, such as opportunities, knowledge, and resources, that can be utilized for averting obstacles towards economic activity (Venkatesh *et al.,* 2003).

The Value-Belief-Norm Theory (VBN) in Pro-Environmental Behaviour: The theory is used to clarify pro-environmental behaviour in a variety of contexts (Ahn and Kwon, 2022; Han *et al.*, 2020; Yakut, 2021). It is therefore a widely applied theory, especially in studies of environmental behaviours. This theory thus has implication on researches on farmers' perceptions of interaction with the environment in light of climate change, which has grown in the past decade (Karki *et al.*, 2020). Actions or strategies, therefore, taken to adapt to such climate change-related risks threatening various aspects of society become imminent. To this end, human subjective assessments of climate-change-linked risks clearly reflect risk perception. Therefore, farmers with a positive mindset about climate change's possibilities tend to have developed staunch adaptation ability towards changing climate conditions (Sorvali *et al.,* 2021).

Theoretical Framework

This empirical research is underpinned by the decomposed theory of planned behaviour. Disaggregating the key cognitive constructs of attitudes, normative influences, and perceived control into distinct operational determinants lends credence to its adoption. Away from the traditional socio-psychological approaches, the decomposed theory of behaviour perceived control into self-efficacy or cognitive capacity and resource-facilitating conditions, otherwise referred to as external structures. Within this context, climate risk perception is the fundamental cognitive precursor influencing smallholder rice farmers' adaptation awareness and decision-making. While the theoretical dimensions are captured using the Climate Risk Perception Index, the Tobit regression model is formulated to examine the core components of the decomposed theory of planned behaviour among smallholder rice farmers in Ogun State. In this study, self-efficacy is represented by formal education and years of farming experience. These are believed to enhance a farmer's cognitive ability to discern and process changes in the environmental situation. Farm income, household size, and the rate of visits by extension services are used as proxies for resource-facilitating conditions. This subsumes all financial capital, domestic labour capacity, and institutional information access. Unequal access to resource control and institutional exposure that shapes farmers' perceived behaviour is represented by gender.

The functional relationship mapping the adopted theory to the Tobit regression model is specified as

$$CRPI^* = f(self-efficacy, resource-condition, structural-context) \qquad eq.1$$

The explicit expression of *eq.1* in econometric form is shown below;

$$CRPI_i^* = \beta_0 + \beta_1 Edu_i + \beta_2 Exp_i + \beta_3 Ext_i + \beta_4 Farm\_Inc_i + \beta_5 HHsize_i + ... + \beta_k Sex_i + ... + \varepsilon_i \qquad eq.2$$

$$CRPIi = \begin{cases} CRPIi^* & if\ CRPIi^* > 0 \\ 0 & if\ CRPIi^* \leq 0 \end{cases}$$

Where Self-efficacy captures education and farming experience; Resource facilitating conditions for extension visits, farm income, household size, credit access, credit amount and cooperative membership; Structural context are sex, age, marital Status, etc; ε is the error term

Empirical Review

The discussion on climate risk has been examined by various scholars, to include Bureau members in the IPCC's Sixth Assessment Cycle culminating into special reports for wider use in a range of situations. Tamang, (2023) explained the concept of climate change to encompass its possibility to have negative effects or consequences on both natural and human systems. Hence, human perception or reaction to this adverse climate change is known as climate risk. Climate risks tend to be the result of dynamic interactions among exposure to and sensitivity to the impacted ecological systems as well as climate-related hazards.

In the work done by Ackerl *et al.*, (2023), study data on climate change hazards, adaptability, and resiliency tactics employed by East African rural farmers, were reviewed and extracted from 30 articles drawn from the repository of Science Web published between 2000 and 2022. The study provides a comprehensive analysis of the factors that affected East African farmers' choices about climate change adaptation strategies. These included age, gender, family size, economic status, assets, land and animal ownership, education, and training. Furthermore, in a separate study on East African farming households', Ackerl *et al.*, (2023) observed that female-headed homes were quicker to notice temperature changes, while households headed by male on the other hand, had more tendency to implement various alternative methods of adaptation. While rural farmers in East Africa have employed adaptation and resilience strategies, future success requires more sophisticated weather forecasting which will pave way for early warning mechanism.

Adzawla *et al.,* (2019) in their work on farmers adaptability to evolving weather, found that survival measures cut across both genders. Farmers' implemented adaptability measures include resetting planting dates, cultivating tolerant breeds and early-ripening seed varieties, intercropping, mixed farming, row planting, and replenishing farm plots, among others. Studies have also found that trading and commerce tends to diminish women's participation in farming activities that assist farmers in their adaptation to shifting climatic conditions. This infers on the relevance of women in farming (Tavenner *et al.,* 2019). Gender issues are therefore significant in examining the relationship between risk perception and agricultural output performance. This goes further to predict or establish women's sense of climate risk perception in farming activities (Kim and Kreps, 2020; Meng *et al.,* 2021)**.** Both male and female crop farmers benefits when climate change adaptation strategies are collectively put into practice.

Raj *et al.,* (2020) investigated the effect of gender-based disparity on farming practices outcome. The study identified two strategies for addressing observed disparities between male and female farming households. Noting that the female gender suffers more relegation, the strategies targeted the creation of capacity-building procedures that focused on women's usage of weather and climate data, which were converted, in value-added, to useful information that helps to reduce agricultural productivity risks. This research was corroborated by Ginbo and Hansson, (2023), which investigated how gender differences in adaptation and climate change adaptation were impacted by spouses' perceptions in Senegal, Uganda, and Kenya. Intra-household data were collected from 1,274 separately interviewed male and female spouses. The work was predicated on the presumptions about adverse weather patterns and the attendant harm inflicted on farm produce. It was discovered that the adaptation gap tends to narrow because of women's increased use of water and soil conservation measures. It was suggested that female spouses needed to be enlightened as to the implications of their actions in relation to climate risk on farming practices. The study also addresses the endogeneity challenge in the CRP by using exogenous weather shocks during data collection. Both genders were noted to adopt the CCA, given their higher CRP levels. However, the study found that women with higher CRP were more likely to implement water and soil conservation measures, thus rapidly reducing the adaptation gap.

In domains where people or groups face multiple options to choose from, the use of parameters from a multiple variate choice model has been found to dominate such investigations (Lee *et al.,* 2018). This is especially true when policy experts and decision-makers face stringent choices among several conflicting possibilities. Estimated coefficients provide defensible judgments essential for efficient forecasting and useful prediction. Qualitative response models, including logit, probit, and tobit regressions, fall within this purview. (Kariyasa and Dewi, 2011; Shivaswamy *et al.,* 2019) mentioned that the suitability of the logit, probit, and tobit models in explaining adoption decisions that involve bivariate options was great. Studies have adopted several variants of these models, including ordered probit, ordered logistic, multinomial logit, and multinomial probit. Since decisions about farmer adaptation are usually collectively made, the relevance of the multinomial logit and multinomial probit, are therefore important in such analysis.

METHODOLOGY

The study uses primary data collected through a survey of rice farmers in Ilaro and Ikenne, Ogun State, Nigeria. Compared with other areas in the state, the selected zones are known for relatively high cultivation of Ofada rice, a staple food among the inhabitants of Ogun State, as indicated by their appreciable tonnage of planted rice. However, other locations, such as Obafemi-Owode, produce higher yields. The four zones that made up the Ogun State Agricultural Development Programme (OGADEP) served as rice farmers' selection strata. Ilaro and Ikenne were purposively selected because of their rice production capacity. Three blocks were chosen from each zone, for a total of six blocks. Using simple random sample technique, two farm settlements were further chosen from each of the six blocs, while a total of 24 communities were randomly selected from them. Finally, ten (10) farmers were chosen from the communities using systematic random sampling. The total sample size used in the study is 240 rice farmers.

The *study* used a Tobit regression model to examine the elements influencing climate risk. Adopting this model enhances previous evaluations by pinpointing household and socioeconomic factors that affect the probability of farmers using different primary adaptation strategies. It employs a multivariate discrete choice econometric model to investigate the relationships between each adaptation option and a shared set of explanatory factors simultaneously (Nhemachena and Hassan, 2007).

Factors affecting climate hazard perceptions are functionally modelled as;

$$\left.\begin{aligned} &Yit *= \beta o + \sum_{m=1}^{M} \beta\, mXm + \varepsilon it, \\ &Yit = \ Yit,\ if\ Yit > \ 0 \\ &Yit = \ 0,\ if\ Yit < \ 0 \\ &\qquad\qquad i=1,\ \dots\dots\ n \\ &t=1,\ 2,\ \dots\dots t \end{aligned}\right\} \qquad eq.1$$

Yit is observed values of components influencing climate risk perception. *n* stands for the number of variables observed locations, *t* for number of periods, and *M* for number of variables. Constant term is β_0, which is the coefficient and m^{th} covariate is βm. The latent equation of the Tobit equation is as specified;

$$y_i = \begin{cases} X_i\beta + u_i & \text{if} \quad X_i\beta + u_i \text{ greater than } 0 \\ 0 & \text{if} \quad X_i\beta + u_i \text{ less than or equal } 0 \end{cases} \qquad eq.2$$

$i = 1,2 \ldots \ldots .. n$

Where; Y_i = predictor, being climate risk perception ($0 \leq CRPI \leq 1$); β = estimated parameter; X_i = adopted explanatory variables [X_1= Sex (male indicates 1, female indicates zero), X_2 =Farmer's age in (Years), X_3 = Marital status (Single: 1, Married: 2, Divorced:3, Others), X_4 = Education status of farmers (Years), X_5 = Farmer's experience (Years), X_6 = Visitation by extension officer (No of Visits), X_7 = Size of the respondent farmland (Ha), X_8 =Income from non-farm activities (₦), X_9 = Household size (No of persons), X_{10}= farmer's income (₦), X_{11}= Amount of credit received (₦), $X_{12=}$ Participation in cooperative societies (Yes =1, No =0)]; U_t = stochastic/error term-value

The climate perception index determines the Perception of rice farmers in relation to risks that come along with alteration in the climate. This study conforms with previous empirical applications among farmers in Nigeria (Ojo and Baiyegunbi, 2021; Iqbal *et al*., 2016). In the first stage the respondent reads through and choose from a list of Climate Change Impact CCI (E_j) comprising seven indications. If an indicator is present, 1 is supplied; 0 otherwise. At the subsequent stage, comparative relevance signal is determined using a 5-point rating scale (Rm). The least significant indicator receives a value of 1, while the most significant signal receives a score of 5. The weighted score is denoted by (Wq). 1 was represented as a bigger number for 5, and 0.2 as a smaller number for one. Each CCRPI is determined such that indicators are added as follows:

$$CCRPI_i = \sum_{j=1}^{7} E_j . R_m . W_q \qquad eq.3$$

Where j = Climate change indicators (j=1,2, ..., 7); Ej = Binary indicator of the effect of Climate Change (Ej = 1 if present, 0 otherwise); Rm = severity rating ($1 \leq Rm \leq 5$); Wq = Weight scaled between 0.2 and 1 ($0.2 \leq Wq \leq 1$) such that for factors not believed to have impact, a zero weight is assigned.

RESULT PRESENTATION

The socioeconomic characteristics by gender, of smallholder rice farmers in the research area are presented in Table 1, and subsequently discussed below.

Table 1: Socioeconomic Features of Farmers by Gender

		MALE			FEMALE	
Variable	**Freq**	**%**	**Mean**	**Freq**	**%**	**Mean**
Age(Yrs)						
20-30	11	4.58		6	2.50	
31-40	36	15.0	45.31	24	10.0	
43.74						
41-50	74	30.83		27	11.25	
50+	46	19.17		16	6.67	
Total	**167**	**69.58**		**73**	**30.42**	
Education						
Primary	147	61,25		54	22.50	
Secondary	19	7.92	4.44	17	7.08	5.23
Tertiary	1	0.42		2	0.83	
Total	**167**	**69.58**		**73**	**30.42**	
Household						
< 6	29	12.08		25	10.42	
6-10	121	50.42	7.75	45	18.75	6.67
> 10	17	7.08		3	1.25	
Total	**167**	**69.58**		**73**	**30.42**	
Farm Income						
< 100,000	7	2.92		6	2.50	
100,001-200,000	37	15.42		26	10.83	
200,001-300,000	58	24.17	309, 220.4	25	10.42	
262,856.2						
300,001-400,000	33	13.75		9	3.75	
400.001-500,000	20	8.33		3	1.25	
> 500,000	12	5.0		4	1.67	
Total	**167**	**69.58**		**73**	**30.42**	
Non-Farm Inc.						
< 20,000	90	37.50		46	19.17	
20,001-50,000	72	30.0	16,522.16	24	10.0	15,438.36
50,001-100,000	5	2.08		3	1.25	
Total	**167**	**69.58**		**73**	**30.42**	
Credit Accessed						
< 100,000	131	54.58		61	25.42	
100,001-200,000	26	10.83		9	3.75	
200,001-300,000	3	1.25	72,320.36	0	0.0	66,520.55
300,001-400,000	2	0.83		0	0.0	
400,001-500,000	3	1.25		3	1.25	
> 500,000	2	0.83		0	0.0	
Total	**167**	**69.58**		**73**	**30.42**	
No of Ext. visit						
1-5	155	64.58		69	28.75	
5-10	12	5.0	2.26	3	1.25	1.64
> 10	0	0.0		1	0.42	
Total	**167**	**69.58**		**73**	**30.42**	

Field Survey, 2024

Farmers' Socioeconomic Features by Gender

Smallholder rice farmers are predominantly male, accounting for about 70% of farmers in the zones, while their female counterparts represent just 30%. This is consistent with research conducted in other regions of Nigeria, where males predominated the rice production sub-sector (Amusa *et al.*, 2022; Onubogu, 2023). With the mean ages of male and female rice farmers ranging between 45 and 44 years, a higher proportion of smallholder rice farmers across both genders were in their prime working years. This reflects rice farming's requirement for heavy physical labour. The studies also confirmed a proliferation of energetic, able-bodied working-age people in the farming sectorwas also confirmed in the studies by ElDidi *et al.,* (2020), Osabohien *et al., (*2021), and Osabohien and Al-Faryan, (2024). Although formal education improves farmers' climate impact awareness and understanding of risk factors, less than 10% of both genders had secondary school education. However, over 60% of male smallholder rice farmers completed primary school, while only 23% of their female counterparts had the same level of education. This indicates that educational attainment is generally low among these farmers (Emenyonu *et al.,* 2020; Fahad *et al.,* 2020; Ojo and Baiyegunhi, 2021).

All genders had appreciable household size, indicating that there were enough hands in the study area to assist in farm work during the planting season when rice is being grown, and during harvesting. This is a necessary requirement in farming activity, and the finding agrees with Dissanayake *et al.,*(2022) and Fadare *et al.,* (2014). Nonetheless, benefits in terms of farm income, non-farm income, and received credit were found to be highly skewed towards male smallholder rice farmers rather than females. The mean income for male rice farmers was about ₦309,220.40 per production cycle, significantly higher than that of their female counterparts, at ₦262,856.20. Male smallholder rice farmers also made non-farm income of ₦16,522.16 on average, while female rice farmers made ₦15,438.36. In addition, male rice farmers had credit access of about ₦72,320, while female farmers had less access. This indicates that male rice farmers are financially better off. While male rice farmers had more access to better extension services, as indicated by the higher visit ratio of 2.3 to 1.6, female farmers could not be said to have access to the same level of extension services. This is substantiated by the fact that while male farmers tend to be more available, female rice farmers still had to do various chores, go to the markets on a regular basis and attend to other matters.

Tobit Regression Output

Tobit regression's diagnostic statistic captures the overview of the parameters affecting male and female rice farmers' perception of climate risk. The estimated statistics of the Tobit regression in this study capture the influence of socioeconomic and institutional parameters on the climate risk perception index of smallholder rice farmers. From the result table above, Sex, educational attainment, household size, income generated on farm, size of farm, experience in farming, and visits by professional agents are the statistically significant explanatory factors. The coefficient of sex is -0.0241 and statistically significant at the 5% level, indicating that as the proportion of male farmers increases, their climate risk perception index decreases. This contrasts with their female counterparts. Educational level among rice farmers was significant. The coefficient indicates that more years of schooling influence farmers' perception index of climate risk. This ascertains an earlier discovered fact that increased formal education increases avenues to raise farmers' perception of climate risk (Famuyini (Famuyini and Akinola, 2018; Obayelu *et al.,* 2014).

Table 2: Socioeconomic Factors and Rice Farmers Climate Risk Perception

Dependent Variable: *Climate Risk Perception Index (CRPI)*

Variables	*Coefficient*	*Std. Error*	*t-value*
Sex *(X_1)*	-0.0241**	0.0263	-2.37
Age *(X_2)*	-0.0015	0.0017	-0.87
Marital status *(X_3)*	-0.0019	0.0334	-0.06
Education *(X_4)*	0.0234***	0.0051	4.62
Household size *(X_9)*	0.0118**	0.0048	2.45
Farm Income *(X_{10})*	-1.63e-07*	8.51e-08	-1.92
Credit received *(X_{11})*	7.30e-09	9.98e-08	0.07
Farming experience *(X_5)*	0.0043*	0.0022	1.95
No of extension visit *(X_6)*	0.140**	0.0055	2.54
Farm size *(X_7)*	0.0246**	0.0131	0.87
Non-farm Income *(X_8)*	-7.67e-08	8.28e-08	-0.93
Farmers Ass. Membership *(X_{12})*	0.0085	0.0271	0.31
C	0.7559***	0.0815	9.27
LR Chi2 (12)	*53.64*		
Prob > Chi2	*0.000*		
Log likelihood	*49.51*		

** 10% significant level; ** 5% significant level; *** 1% significant level*

Source: Field Survey, 2024

This also holds true for household size, which is also significant at 5%, while the estimated coefficient suggests that an increase in its size will cause a 1.2% increase in rice farmers' perception index. Therefore, larger households tend to have a higher level of perception of climate risks. This may be because larger households tend to include members of various groups (formal or informal) with access to climate risk information. The negative coefficient of farm income, which was statistically significant at 1%, suggests that farmers who earn more in a production cycle are likely to have a lower level of climate risk perception. This could be explained by the profitability of the enterprise, as production relies on best and sustainable practices to earn more, which have little to do with the understanding of climate risk (Bell, 2024; Pretty and Bharucha, 2014).

On the contrary, increases in years of farming experience leads to increased perception of climate risks. The gradual but continuous joining of cooperative organizations and farmers' groups may have been responsible for this. This tends to enhance their ability to access sufficient information about climate risk. This is consistent with Apata (2011) and Ojo and Baiyegunhi (2021) , who revealed that farmers with more years of experience perceive climate variability issues at higher levels. The positive and significant coefficient of visits by extension officer indicates that farmer perceptions improve as more extension agents visit rice farmers. While the significant probability statistics (Prob> chi2) indicate that the model is a good fit, the log-likelihood value of 49.51 suggests that the estimated parameters were able to capture almost 50% of the variability in rice farmers' climate risk perception.

This result shows that the systemic advantages enjoyed by male farmers, such as higher education and more extension visits, exerted a strong positive influence on their risk perception. However, the underlying gender effect revealed that female farmers displayed greater risk sensitivity, despite operating under relatively unfavourable structural constraints.

Climate Risk Perception Index (CRPI) – A Gender-based Assessment

The study found that about 55% of male farmers confirmed observing climate variation. However, this level of observation was lower among females. Only about 26% observed shifts in climatic factors. This is attributable to differences in climate change knowledge between the two genders. Male smallholder rice farmers were noted to have moderate climate change knowledge of about 44%, compared with 15% among female smallholder rice farmers. Among rice farmers who never had in-depth knowledge about climate change risks but had frequently heard about it, about 53% of them were male farmers, while 21% were female.

Table 3: Perception of Smallholder Rice Farmers on Climate Risks

	Male		***Female***	
Risk Indicator	*Mean*	*Rank*	*Mean*	*Rank*
Pest Invasion	0.76	1st	0.74	1st
Reduced Yield	0.75	2nd	0.72	4th
Erratic Rainfall	0.71	3rd	0.72	3rd
Drought	0.69	4th	0.73	2nd
Flooding	0.69	5th	0.67	6th
Soil Erosion	0.66	6th	0.68	5th
CRPI	***0.69***		***0.60***	

Source: Author's Computation, 2024

Table 3 above shows the average Climate Risk Perception Index (CRPI) for male and female smallholder rice farmers as 0.69 and 0.60, respectively. Male smallholder rice farmers therefore tend to be more exposed to various climate risks during rice farming seasons. Close observation also shows that the three highest risks borne by male rice farmers in the study area were pest invasion, reduced yield, and erratic rainfall patterns. Rice producers highlighted erratic rainfall as a climate change concern because of its severe effects on rice cultivation. This aligns with previous findings that higher rainfall intensity adversely affects rice cultivation and reduces yields (Tan *et al.*, 2021; Onyeneke *et al.*, 2021). While female rice farmers also faced pest invasion and erratic rainfall patterns, drought was widely cited as their third-highest risk challenge. Onyeneke *et al.,* (2021) confirmed that drought can cause considerable damage to rice crops. Pest invasion seems to be a collective concern to both genders in the area. Pest attack on crops is known to be aided by unfavourable atmospheric conditions that enhance pest breeding and disease infestation. This damaging effect extends to post-harvesting and storage stages, thus diminishing output, income and welfare (Tefera, 2012).

Notably, a breakdown of each risk indicator shows that female farmers are more sensitive to climate threats. Although male rice farmers scored a higher overall average index, perhaps in response to certain favourable exposures, females tend to be keener and more sensitive to critical hazards that could directly impede farm productivity. The descriptive table showed that female smallholders assigned higher average individual risk perception values to climate threats that could compromise farming than males. While they ranked drought as the second overall threat with a mean score of 0.73, male farmers ranked it as 0.69.

Further, they also ranked soil erosion fifth with an average score of 0.68, but male farmers ranked it at 0.66. The same trend shows for erratic rainfall and pest invasion, which averaged near peak severity levels. This validates their stronger cognitive sensitivity to climate risk hazards despite lower financial strength, less access to extension contacts, and lower education levels.

DISCUSSION

The study's gender-based analysis, profiling socio-economic attributes of smallholder rice farmers, underscores the inherent critical inequalities that shape their agricultural outcomes. Male small households who constitute the vast majority of rice farming population were noted to be in their prime working ages. This reflects the general practice among farmers in the country, where farming activities are dominated by young, strong males (Amusa *et al.* 2022; Onubogu, 2023). The involvement of strong individuals in the sector is necessary given that rice cultivation requires a lot of manual labour. This was validated by ElDidi *et al.* (2020), Osabohien *et al.* (2021), and Osabohien and Al-Faryan (2024). However, systemic resource disparities persisted, with substantially higher seasonal farm incomes and non-farm earnings accruing to male smallholders. They were also opportune to access more credit than the females. The frequency of advisory outreach from extension officers was also less favourable to female rice farmers, while male farmers received relatively more extension visits. The heavy domestic and commercial duties borne by female farmers may be linked to their unavailability for extension sessions. Hence, their availability tends to be restricted at moments when extension officials come around for training and counselling.

Education through schooling enhances farmers' analytical capacity and discernment in interpreting environmental variations. This builds on the research discoveries of Famuyini and Akinola (2018) and Obayelu *et al.* (2014). Farming experience also expands risk awareness, thus supporting empirical findings enunciated in the works of Apata (2011) and Ojo and Baiyegunhi (2021). Long-term exposure to climate change shaped how seasoned farmers perceive climate variability issues.

Interestingly, wealthier rice farmers seem able to cushion the effects of reduced farming income caused by adverse climatic conditions through non-farming income sources. This is evident from the observed negative correlation between farm income and climate risk perception. This may go further to enhance this category of smallholder farmers to deploy better, agronomic practices that shelters their rice fields. Through this, their farm operations may be protected from any such environmental threats, as conceptualized by Bell (2024) and Pretty and Bharucha (2014). As found by Dissanayake *et al.* (2022) and Fadare *et al.* (2014), while sizable farming households provide needed labour supply during the planting and harvesting phases, they equally broaden farmers' social networks, through which climate risk information is collected and distributed across various other farm households.

Ironically, the inferential results show reduced climate risk perception among male farmers as they increase in number, while the descriptive index places them at a higher average than their female counterparts. It is pertinent to mention that the descriptive advantage, here noted, may likely be connected to the privileged access to higher education, extension services and more financial resources at their disposal. However, they never seem bothered by the implications, compared with their female counterparts. Despite facing myriads of constraints in finances, time, extension exposure, and funding, female farmers paid more attention to the evolving ecology that threatens them, as driven by climate change. This finding corroborates the discoveries of Adekunmi (2022) and Ujoh *et al.* (2019).

The research provides a practical framework for strengthening climate-resilient rice farming to support food availability in Ogun State and, by extension, Nigeria. Suffix to say that in Nigeria, vulnerable smallholder farmers who are susceptible to erratic rainfall, temperature shifts, and extreme climate events account for the majority of rice production. This aligns with the highlights by Gil-Clavel *et al.* (2025), Li *et al.* (2024), and Rana *et al.* (2019). Rice, being a foundational staple food crop commonly found in the dietary menu of all households, its cultivation requires concerted efforts and attention. The study has also shown that climate adaptation measures cannot be modelled as a one-size-fits-all; rather, interventions must target localised factors, where gender-specific resource gaps would be taken into consideration.

CONCLUSION AND RECOMMENDATIONS

This study has established that rice farmers' climate risk perception is, no doubt, a precursor to their diverse adaptation responses, shaped by their localized socio-economic characteristics. Most farmers, across both genders, were aware of environmental changes, though they perceived atmospheric alteration and disruptions to varying degrees. Sex, formal education levels, farmers household sizes, income from farm, and the frequency of extension visits were confirmed as critical determinants that shapes farmers understanding of the climate risk vulnerabilities.
The study therefore recommends;

i. Intensification of professional extension outreach through the Ogun State Agricultural Development Programme (OGADEP). There is a need to scale up the frequency and quality of advisory visits per rice production cycle. Extension officers need the specialised training required to better educate smallholder rice farmers on shifting weather trends, risk mitigation strategies, and other areas that support their farming activities.
ii. Bridging the gender gap in agricultural training and extension outreach. This is necessary to overcome the long-standing structural barriers faced by female smallholder rice farmers. Importantly, training schedules and locations need to accommodate their domestic, economic and commercial responsibilities to ensure they are not disenfranchised from equitable access to climate risk information and survival tools.

iii. Expand calibrated financial literacy and credit access through financial institutions and agricultural cooperatives. Broaden targeted credit facilities and inputs to smallholder rice farmers, with specific concessionary terms for female farmers who have been identified as in need of credit facilities. This helps the financially vulnerable farmers to transition away from high-risk practices to improved rice farming methods.

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APPENDIX I

Tobit Regression Output

Tobit regression. Determinants of climate perception

Tobit regression

Number of obs = 240
LR chi2(12) = 53.64
Prob > chi2 = 0.000
Pseudo R2 = 1.208

Log likelihood = 49.51

EjRm	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]
Sex	-0.0241**	0.0263	-2.37	0.019	-0.0758 0.0276
Age	-0.0015	0.0017	-0.87	0.386	-0.0048 0.0018
Marital status	-0.0019	0.0334	-0.06	0.955	-0.0675 0.0637
Education	0.0234***	0.0051	4.62	0.000	0.0134 0.0334
Farming experience	0.0043*	0.0022	1.95	0.052	-0.0000 0.0086
No of extension visit	0.140**	0.0055	2.54	0.012	0.1292 0.1508
Farm size	0.0246**	0.0519	2.11	0.036	0.0011 0.0503
Non-farm Income	-7.67e-08	8.28e-08	-0.93	0.354	-2.39e-07 8.58e-08
Household size	0.0118**	0.0048	2.45	0.015	0.0024 0.0212
Farm Income	-1.63e-07*	8.51e-08	-1.92	0.056	-3.30e-07 4.08e-09
Credit received	7.30e-09	9.98e-08	0.07	0.942	-1.89e-07 2.03e-07
Farmers Ass. Membership	0.0085	0.0271	0.31	0.754	-0.0447 0.0617
C	0.7559***	0.0815	9.27	0.000	0.5958 0.9160

3 left-censored observations at EjRm <= 0
222 uncensored observations
15 right-censored observations at EjRm > 1