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Perception of farmers towards climate change: A formative measurement PLS-SEM Approach

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Abstract
Climate change is an imminent threat to agricultural sustainability, rural livelihoods, and food security. Agricultural producers (farmers) are key stakeholders and should take on the leadership role in adopting Climate Change Mitigating Strategies (CMS) to reduce and minimize the adverse impact of climatic factors. This study uses PLS-SEM to investigate the impact of farmers' perception and knowledge levels on CMS adoption. A standardized questionnaire was used to interview key farmers about their perceptions towards change of climatic conditions, awareness of its impact, and willingness to adopt or implement climate-mitigating activities. The proposed model indicates that perception and awareness are two variables that shape the determinants of CMS. As part of the study, several key findings show that perception significantly increases the likelihood of farmers adopting CMS, while awareness of climate change also has a positive effect. This study augments the literature on adoption strategies for climate change by policymakers, extension, and practitioners involved in rural development practice.

Keyword: PLS-SEM, climate change, farmers' perception, awareness level, climate mitigating strategies

1. Introduction

Climate change, which is categorized by several issues such as increasing global temperatures, extreme variability in rainfall patterns, prolonged droughts, flooding, and extreme weather events, is widely regarded as one of the most pressing challenges humans will face in the twenty-first century, with far-reaching consequences for natural ecosystems as well as economic stability, food security, and human health (Jatav *et al.*, 2024) [17]. The effects of climate change are already visible across the world, and countries like India, where agriculture has continued to be part of the backbone of the rural economy in many communities, are especially vulnerable (Datta *et al.*, 2022) [10]. Agricultural sensitivity to climate change means that increases or decreases in precipitation, or slight increases in temperature, can negatively impact crop yields, reduce rural income, increase pest invasions, and increase food insecurity. Crops that are the dietary staples of the population, such as rice, wheat, and maize, contain some of the most affected macro-crops by unpredictable monsoon patterns, heat nights, and the ever-increasing frequency of droughts. With this in mind, farmers are able to take on this role by becoming both producers of food and managers of natural capital, perception and awareness of climate change among farmers will determine what actions they develop to adapt and obtain sustainability (Fierros-González & López-Feldman, 2021) [14]. Perceptions among the farmers are their understanding and interpretations of the changes that they experience directly, e.g., altered weather patterns, reduced productivity, an increase in both the frequency and intensity of extreme events, along with the centrality of how people make sense of the urgency of taking adaptive measures within the broader systemic nature of climate change (Tripathi & Mishra, 2017) [29]. When farmers perceive climate change as a serious and immediate threat, it is found that they are then more willing to take measures to mitigate and adapt (Akponikpe *et al.*, 2010) [3]. On the other hand, those who were able to attribute alterations to natural cycles may have been hesitant to take any type of action. Awareness is closely tied to knowing about the impacts and drivers of climate change, as well as knowing what options exist to cope with these impacts, where to access information, for education and training by extension services, and the local community. (Alemayehu & Bewket, 2017) [4]. Perception and awareness are building blocks of the thinking behind adaptive behaviour, yet they are not free of misinformation, uncertainty, and psychological biases, which may inhibit or enhance adaptation. It is clear that climate action for the agriculture sector cannot be relied upon to be solely based on technological advancement and policy frameworks, but rather, we must also consider the cognitive, perceptual, and behavioural dimensions of farmers, who will ultimately decide whether and how adaptation will occur in reality.

So, there are numerous studies focused on sustainable agriculture practices so as ensure food security, however, few studies have focused on Odisha. There is also need to address how perception and awareness level motivates famers in adoption such practices. With this backdrop, this research highlights the significance of perception and awareness of farmers in adoption of climate change mitigating strategies.

2. Conceptual Framework and Hypothesis Development

The framework of the study is based on behavioural and cognitive views of climate change adaptation and highlights how individual perception and awareness influence adoption of Climate Mitigation Strategies (CMS). The model is based upon the Theory of Planned Behaviour (Ajzen, 1991) [2] and aspects of the Knowledge-Attitude-Practice (KAP) framework, both of which maintain that the behavior of individuals is directly influenced by their cognitive assessments and awareness of environmental phenomena. When applied to climate change, perception refers to farmers' subjective assessment of climate variability and associated risks. Farmers who perceive climatic change factors as a major risk to agricultural productivity and livelihood security exhibit a higher possibility of adopting proactive mitigation strategies. Compounding that perception is farmers' level of awareness or familiarity and understanding of climate change causes, impacts, and solutions. The more farmers are aware of climate change, the more likely it is that informed decisions may be made regarding sustainable agricultural practices. Thus, the proposed theoretical model concludes that perception and awareness are both established as exogenous constructs on the model, meaning they directly predict the endogenous construct, i.e., whether or not farmers will adopt CMS. In this context, indicators do not require to be correlated but collectively forms awareness level and perception. This study characterizes the Climate Mitigation Strategies (CMS) in the positive sense of a latent construct that represents the overall adoption of sustainable agricultural practices by farmers. The CMS includes a variety of ways of diversification: diversified cropping systems, irrigation efficiency, risk management and bio-inputs etc. Collectively, the CMS captures the effort by farmers to mitigate and adapt to the impacts of climate change. The formative instruments used in the study are given in Table 1. The Figure 1 shows the theoretical relationship between the three constructs. With this discussion, the following hypotheses are examined:

H_1: Perception has a positive influence on the adoption of Climate Mitigating Strategies

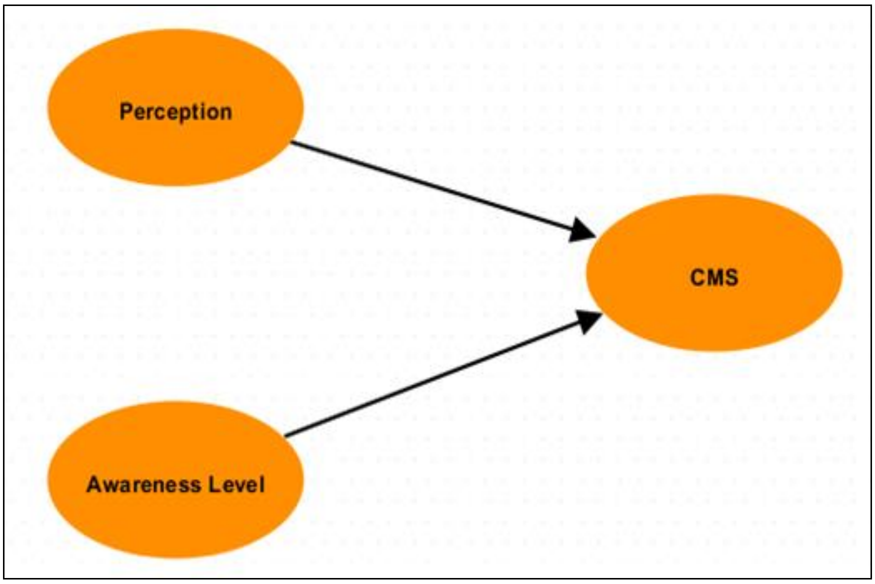
H_2: Awareness Level has a positive influence on the adoption of Climate Mitigating Strategies.

Table 1: Description of Instruments

Construct	Variable	Description	Sources
CMS (Climate Change Mitigation Strategies)	CMS1	Crop diversification/intercropping	(Sorgho *et al.*, 2020; Young and Ismail, 2019) [27, 30]
	CMS2	Integrated pest management/bio-inputs	(Diarra *et al.*, 2021; Sonko *et al.*, 2020) [12, 26]
	CMS3	Risk management (crop insurance uptake)	(Biswal & Bahinipati, 2022; Dragos *et al.*, 2023) [9, 13]
	CMS4	Irrigation efficiency (drip/sprinkler, scheduling).	(Marie *et al.*, 2020; Assaye *et al.*, 2020; Adego *et al.*, 2019) [19, 6, 1].
PER (Perception)	PER 01	Perceived rise in temperature	(Patel *et al.*, 2023) [22]
	PER 02	Perceived change in rainfall pattern	(Dendir & Simane, 2021; Patel *et al.*, 2023) [11, 22]
	PER 03	Perceived yield impacts	(Balasha *et al.*, 2023) [7]
	PER 04	Increase in pests/diseases/weeds attributed to climate	(Balasha *et al.*, 2023; Subedi *et al.*, 2023) [7, 28]
AL (Awareness Level)	AL 01	Awareness of causes (anthropogenic vs natural)	(Mase *et al.*, 2017; Tripathi & Mishra, 2017) [20, 29]
	AL 02	Awareness of local impacts (on yield, water, pests)	(Salman Chowdhury *et al.*, 2025)
	AL 03	Awareness of adaptation practices	(Ali & Erenstein, 2017; Magesa *et al.*, 2023) [5, 18]
	AL 04	Awareness/use of weather/ICT advisories (forecasts, agromet)	(Bedeke *et al.*, 2019; Mulinde *et al.*, 2019) [8, 21]
	AL 05	Awareness of resource-efficient practices (IPM, bio-fertilizer, DSR).	(Sahoo *et al.*, 2025; Ricart *et al.*, 2025) [24, 23]

Source: Author's Compilation

Theoretical Model



Source: Author's Compilation

Fig 1: Theoretical model

3. Methodology

The study seeks to investigate how farmers' awareness and perception of climate change affect their adoption of climate-mitigating measures. We employed PLS-SEM using ADANCO software as the preferred method of analysis for studying such associations and interactions between the constructs. PLS-SEM is appropriate for exploring complex cause-and-effect linkages among latent variables, and captures the direct and indirect effects of the relationship between awareness and perception on decision making regarding mitigation strategies. For the empirical dimension of the study, we collected primary data via a structured questionnaire survey. Reponses collected from sample of 200 farmers in Bargarh district, Odisha. The study employs stratified random sampling for a good representation of various demographic/socioeconomic groups of farmers.

4. Results and Discussion

Table 2: Formative Constructs measurements

Construct	Item	Outer Loadings	Outer weights	VIF
Perception	PER 01	0.6426	0.0946	1.7028
	PER 02	0.7132	0.2380	1.5934
	PER 03	0.6986	0.3255	1.4813
	PER 04	0.8960	0.6049	1.4860
Awareness	AL 01	0.7497	0.1097	2.0879
	AL 02	0.6132	0.3054	1.1657
	AL 03	0.8651	0.5591	1.9932
	AL 04	0.5431	0.0930	1.2137
	AL 05	0.6573	0.3129	1.3584
Climate Change Mitigating Strategies	CMS 01	0.8368	0.4089	1.6570
	CMS 02	0.8002	0.3718	1.5695
	CMS 03	0.6232	0.2058	1.3843
	CMS 04	0.7390	0.3140	1.4910

Source: Author's Compilation

Table 2 presents the results of the formative construct measurements. The loadings indicate how well each indicator relates to its construct. In overall, the loading values of each item are more than 0.5, with respect to CMS CMS 01, CMS 02 and CMS 04 are highest loadings and CMS 03 is weaker. The relating contribution of each indicator were measured in outer weights. The weights are significant and PER 04 is having highest weights of 0.6049, whereas AL 04 is having lowest weight of 0.0930. Thereafter, all the items were tested for multicollinearity with VIF values. The results are found to be below threshold limit of 3, hence there are issue of collinearity.

Table 3: Structural Model (R^2)

Construct	R^2	Adjusted R^2
CMS	0.6191	0.6154

Source: Author's Compilation

Table 3 presents the R^2 and adjusted R^2 for Climate Mitigating Strategies (CMS). The R^2 value, which is equivalent to 0.6191, means that approximately 61 percent of the variance in CMS is explained by the predictors in the model, with a very high explanatory power. This demonstrates substantial input of the independent constructs (i.e., Awareness Level and Perception), conveying the overall significant explanatory power to the dependent variable in the context of farmers adopting any type of climate-mitigating practice. The adjusted R^2 value at 0.6154 is slightly less than the R^2 value because it accounts for the number of predictors, along with the sample size in the model. However, the minor discrepancy of the adjusted R^2 and R^2 values illustrates that the model is not significantly over fitted, therefore adding more reliability. Thus, these values suggest that Awareness Level and Perception together demonstrate a highly dependable and qualified explanation for farmers' adoption of climate mitigating strategies, affirming the model's strength presented in this study, and the use of the model would be reliable for further analysis and policy recommendations.

Table 4: Inter-construct correlations inference

Effect	Original coefficient	Standard bootstrap results				
		Mean value	S.E	t-value	Prob. (2-sided)	Prob. (1-sided)
Awareness Level <-> CMS	0.7142	0.7291	0.0501	14.2653	0.0000	0.0000
Perception <-> CMS	0.7432	0.7563	0.0536	13.8770	0.0000	0.0000

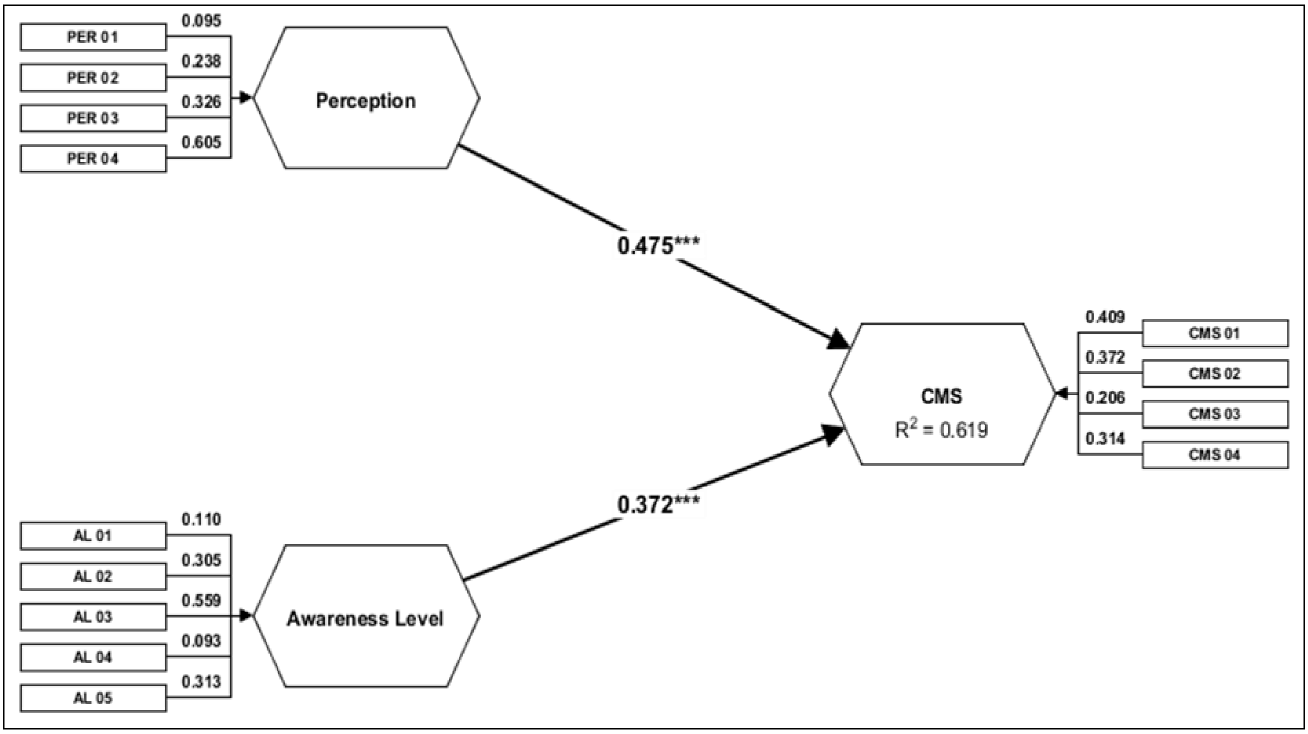
Source: Author's Compilation

Table 4 is the evidence for the inferential inter-construct correlations between Awareness Level, Perception, and Climate Mitigating Strategies (CMS). The importance of the relationships can be seen between awareness and CMS with respectively very strong correlations of 0.7142 (original) and 0.7291 (mean bootstrap). The same can be said about the correlation between perception and CMS which also demonstrated a very strong correlation of 0.7432, 0.7563 (mean bootstrap). Overall, these findings demonstrate that farmers awareness and perceptions of climate change are positively and closely associated with their extent of participation in climate mitigating strategies.

Table 5: Path Coefficients

Independent variable	Dependent variable	Hypothesis
	CMS	
Awareness Level	0.3722	Supported
Perception	0.4753	Supported

Source: Author's Compilation



Source: Author's Compilation

Fig 2: Bootstrapping Measurement Model

The structural model result, as depicted in Figure 2, shows that both Perception and Awareness Level affect CMS significantly and positively. Perception shows as the path coefficient of 0.475, and Awareness Level shows a coefficient of 0.372, indicating these constructs significantly affect the change in CMS. The model describes a major proportion of the variance in CMS, with an R^2 value of 0.619, which indicates that 61.9% of the variability in CMS is affected by Perception and Awareness Level. In formative measurement models, outer loadings should be checked for threshold limit. In respect of outer weights, if weights are significant then the contribution can be interpreted (Hair *et al*., 2017, 2019) [15, 16]. Among the PER and AL, PER exerts a stronger influence suggesting that perception is also important than mere awareness in adoption of mitigating strategies. From the results of Path coefficients (Table 5) it can be conclude that both the hypotheses are supported.

4. Conclusion

The present study examines the role of awareness level and perception in shaping mitigation strategies by the farmers in Bargarh, Odisha. The study analysed 200 responses collected randomly through a structured questionnaire. The results show that both perception and awareness meaningfully and absolutely impact the adoption of Climate change Mitigating Strategies, explaining 61.9% of the variance in CMS. The awareness level is significant however, the perception and attitude with respect to climate changes are more critical in shaping the responses of farmers. The policy makers should conduct awareness campaigns with focusing on shaping their perception and attitude. More specifically, capacity building programmes and localised interventions are more essential in combating the negative impacts of climate change.

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