A Multinomial Logistic Regression on Farmers' Decision on Technology Adaptation for Nutrition-Sensitive Climate Change Vulnerable Agriculture

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ABSTRACT

Agriculture is the most direct route to improving the diet of a person ensuring year-round access to adequate, safe and diverse nutrient-rich food. However, a resilient agricultural production system is the sine-qua-non to sustain food security amidst extreme climate change consequences. The present study made an attempt to imply multinomial logistic regression model to identify the factors which determined the decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture. The study was conducted with proportionate randomly selected 60 farmers of Neemuch and Mandsaur districts representing respectively moderate and high climate change vulnerable Malwa Plateau Agro-Climatic Zone of Madhya Pradesh respectively. Multinomial logistic regression analysis revealed that the Cox & Snell R^2 and the Nagelkerke R^2 values of 0.389 and 0.485 respectively determined that between 38.9% and 48.5% of the variability in dependent variable namely 'Decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture' is explained by the set of independent variables viz., 'Age', 'Level of Education', 'Operational Land Holding', 'Annual Income', 'Awareness on Consequences of Climate Change in Nutrition-sensitive Agriculture', 'Knowledge of Mitigation and Adaptation of Nutrition-sensitive Climate Change Practices in Agriculture', 'Perception on Climate Change in Nutrition-sensitive Agriculture', 'Fatalism', 'Risk Orientation' and 'Social Cohesiveness' used in the model. The overall predictive accuracy for the present model was 71.7%, suggesting that the model was useful.

Keywords: *Multinomial logistic regression model; Cox & Snell R^2; Nagelkerke R^2; Predictive accuracy;*

A resilient agricultural production system is the prerequisite to sustain nutrition and food security amidst extreme climate change consequences in the event of extreme climatic variabilities in any country. Understanding different adaptation technologies to mitigate climate change is critical to tracing how climate change information is incorporated into agricultural decision making (*FAO, 2012*). More than half of India's population of over 1 billion people lives in rural areas and depends on climate-sensitive sectors like agriculture, fisheries and forestry for their livelihoods (*MoEF&CC, 2011*). The impacts of climate change on agriculture come about through changes in variability, seasonality, changes in mean precipitation and water availability, and the emergence of new pathogens and diseases (*Fischlin et al., 2007*).

A resilient climate smart nutrition sensitive agricultural production system is the prerequisite to sustain productivity in the event of extreme climatic variability in our country. Mitigation and adaptation planning requires more than legal frameworks and compliance to ensure that decisions to adapt technologies are effective in meeting the challenges of vulnerability reduction in the context of a changing climate and its impact on agricultural production systems. Decision-making in a changing climate requires new areas of expertise and wider consultation than might typically be involved in traditional "development decision-making," given both the cross-sectoral nature of climate change impacts and the uncertainty regarding the level of climate change and climate variability. Climate change requires societies and communities to change, sometimes quickly, with widening extremes of weather, greater variability in climate patterns, and long-term changes in the local setting. The present study attempt to imply multinomial logistic regression model to identify the factors which determined the decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture.

METHODOLOGY

Exploratory research design was adopted in the study to obtain pertinent and precise information with respect to the identified variables of the study. Madhya Pradesh has been selected purposively for the study. The two districts *viz.*, Neemuch and Mandsaur were purposively selected based on the criteria that agriculturally important and climate affected areas felled within a particular zone, as such to represent Moderate and High vulnerable zone of Malwa Plateau Agro-Climatic Zone (ACZ), respectively. The study had been conducted at Manasa block of Neemuch district and Malhargarh block of Mandsaur district of Madhya Pradesh. Two villages were selected purposively from each of the selected blocks thereby constituting four villages for the study. A total of 60 farmers were selected by way of proportionate random sampling method. The data were collected through structured interview schedule.

The response variable in the analysis namely 'Decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture' had been assumed three nominal outcomes of 'Most Feeble', 'Moderate' and 'Stern' with nominal values of '1', '2' and '3' respectively due to set of ten distribution free independent variables *viz.*, 'Age', 'Level of Education', 'Operational Land Holding', 'Annual Income', 'Awareness on Consequences of Climate Change in Nutrition-sensitive Agriculture', 'Knowledge of Mitigation and Adaptation of Nutrition-sensitive Climate Change Practices in Agriculture', 'Perception on Climate Change in Nutrition-sensitive Agriculture', 'Fatalism', 'Risk Orientation' and 'Social Cohesiveness'. Hence, Multinomial Logistic Regression (MLR) had been implied in the study to draw conclusion from the findings.

The study followed the nominal response: baseline-category multinomial logit regression model. Here Y was a categorical response with J = 3 categories. This three-category logit model for nominal response variables simultaneously describe log odds for all (3/2) pairs of categories. Given a certain choice of 3-1 of these, the rest are redundant.

Therefore, $\pi_j(\boldsymbol{x}) = P(Y = j|\boldsymbol{x})$ at a fixed setting of $\boldsymbol{x}$ for explanatory variables, with $\sum_j \pi_j(\boldsymbol{x}) = 1$. For observation at that setting, the counts at the 3 categories of Y as multinomial with probabilities $\{\pi_1(\boldsymbol{x}), \ldots\ldots\ldots..\pi_3(\boldsymbol{x})\}$. The reference category was 'Stern level categories of decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture'.

RESULTS AND DISCUSSION

A perusal of Table 1 below could divulge that the probability of the model chi-square (29.56) was 0.07 which was significant at 10% level of significance (i.e. p<0.10). Hence, the alternate hypothesis was accepted. As evidence in Table 1, it could be suggested that there existed a relationship between the independent variables viz., 'Age', 'Level of Education', 'Operational Land Holding', 'Annual Income', 'Awareness on Consequences of Climate Change in Nutrition-sensitive Agriculture', 'Knowledge of Mitigation and Adaptation of Nutrition-sensitive Climate Change Practices in Agriculture', 'Perception on Climate Change in Nutrition-sensitive Agriculture', 'Fatalism', 'Risk Orientation' and 'Social Cohesiveness' and the dependent variable namely 'Decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture'.

Table 1. Model Fitting Information

Model	-2log Likelihood	χ^2	df	Sig
Intercept Only	97.361			
Final	67.802	29.559	20	0.077

Further it could be revealed from the Table 2 that the Cox & Snell R^2 and the Nagelkerke R^2 values of 0.389 and 0.485 respectively determined that between 38.9% and 48.5% of the variability in dependent variable namely 'Decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture' is explained by the set of independent variables viz., 'Age', 'Level of Education', 'Operational Land Holding', 'Annual Income', 'Awareness on Consequences of Climate Change in Nutrition-sensitive Agriculture', 'Knowledge of Mitigation and Adaptation of Nutrition-sensitive Climate Change Practices in Agriculture', 'Perception on Climate Change in Nutrition-sensitive Agriculture', 'Fatalism', 'Risk Orientation' and 'Social Cohesiveness' used in the model.

Table 2. Pseudo R^2

Cox and Snell	0.389
Nagelkerke	0.485

Table 3. Likelihood Ratio Tests

Effect	Model Fitting Criteria -2 Log* Likelihood of Reduced Model	Likelihood Ratio Tests χ^2	df	Sig
Intercept	78.571	10.769	2	0.005
Age	69.446	1.644	2	0.440
Education	72.479**	4.677	2	0.096
Operational land	69.407	1.605	2	0.448
Annual Income	69.413	1.611	2	0.447
Awareness on consequences of climate change	72.910**	5.109	2	0.078
Knowledge of mitigation and adaptation of climate change	68.143	0.342	2	0.843
Perception on climate change in agriculture	68.164	0.363	2	0.834
Fatalism	68.182	0.380	2	0.827
Risk orientation	76.251*	8.450	2	0.015
Social cohesiveness	73.890*	6.089	2	0.048

Relationship of Independent and Dependent Variables : The likelihood ratio test, as evident from Table 3 concluded that independent variables viz., 'Level of Education' and 'Awareness on Consequences of Climate Change in Nutrition-sensitive Agriculture' were significant at 10% with respect to 'Feeble' and 'Moderate' categories of 'Decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture' Similarly, independent variables viz., 'Risk Orientation' and 'Social Cohesiveness' were significant at 5% with respect to 'Feeble' and 'Moderate' categories of 'Decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture'.

The results inferred that variability in the level of education of respondents and more concentration of respondents to have middle level of awareness led to feeble and moderate categories of 'Decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture' by respondents. However, concentration at medium level of risk orientation by the respondents and maximum accumulation of respondents at low level of social cohesiveness led feeble and moderate categories of 'Decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture' by respondents.

CONCLUSION

Based on the findings of the study, it is concluded that majority of the respondents i.e. 70.00% belonged to category of 'Stern' level of 'Decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture'. With the Cox & Snell R^2 and the Nagelkerke R^2 values of 0.389 and 0.485 it could be commented that between 38.9% and 48.5% of the variability in dependent variable is explained by the set of ten independent variables in the study. The likelihood ratio test concluded that independent variables *viz*., 'Level of Education' and 'Awareness on Consequences of Climate Change in Nutrition-sensitive Agriculture' were significant at 10% with respect to 'Feeble' and 'Moderate' categories of 'Decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture'. Similarly, independent variables *viz*., 'Risk Orientation' and 'Social Cohesiveness' were significant at 5% with respect to 'Feeble' and 'Moderate' categories of 'Decision on technology adaptation for nutrition-sensitive climate change vulnerable agriculture'.

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