Multinomial Logistic Regression Model in Identifying Factors of m4agriNEI in CSA Innovations

Salam Prabin Singh[*] . R.J. Singh . J.K. Chauhan . Ram Singh . L. Hemochandra

School of Social Sciences, College of Post-Graduate Studies, CAU, (Imphal), Umiam, Meghalaya

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ABSTRACT

The impact of climate change has been evidence, creating a threat not only to environment but also human being too and it is imperative to act before it's too late. An array of mitigation and adaptability practices are headed under Climate-Smart Agriculture (CSA) practices which are agricultural approaches that sustainably increases productivity, adaptation and reduces greenhouse gases. The study was, henceforth developed to identify factors for m4agriNEI in enhancing CSA innovations. The Agro-Advisory Services (AAS) of mobile based agro-advisory system in Northeast India (m4agriNEI) consents the registered farmers to solve their farming related problems which also directly helped them in decision making to choose the best alternatives available. A sampled of 65 registered farmers were selected from the four project districts *viz.* Ri-bhoi, East Khasi Hills, West Khasi Hills and West Jaintia Hills districts of Meghalaya, based on the criteria of proactive average calls of 5 times a week and above made by them. Multinomial logistic regression was administered and consequently the factors *viz.* 'Timeliness', 'Relevancy', 'Economy' and 'Accuracy' of m4agriNEI were found to be statistically significant in influencing the CSA innovations by registered farmers of m4agriNEI. The model revealed that having the Cox & Snell R^2 and the Nagelkerke R^2 values of 0.557 and 0.633 respectively, determined the variability between 55.70 and 63.30 per cent of the dependent variable *i.e.* 'Adaptation Intention to enhancing CSA innovations' in explaining the factors. The overall predictive accuracy for the present model was 72.30 per cent, signifying that the model was expedient.

1. Introduction

Climate change is fact an environmental challenge. Its impact has been affected not only to environment but also human beings too. The influence of climate change has immensely affected agricultural production due to changes in rainfall pattern, temperature, floods, droughts, negative effects on water & land resources, dry and cold spells, sunshine hours, emergence of new pathogens, diseases to crops & animals *etc*. (IPCC 2014). CSA is an agricultural approach that sustainably increases productivity, adaptation and reduces greenhouse gases (FAO 2010). CSA practices has been proved in reducing climate change impact and sustainably increased in crop

production (Westerann et al. 2015). Major domains of CSA practices entail energy-smart (Zero tillage/Minimum tillage), water-smart (Drip irrigation, Drainage management, Covers crop method *etc.*), carbon-smart [Integrated pest management (IPM), agro forestry, fodder management, concentrated feeding for livestock *etc.*] knowledge-smart (Contingent crop planning, Seed and Fodder banks, Improved crop varieties *etc.*), Climate smart housing for livestock (Crop insurance, Weather based crop agro-advisory *etc.*) (Chhetri et al. 2017). The collaborative research project - m4agriNEI between CPGS and Digital India Corporation (formerly Media Lab Asia) which is an innovative mix of mobile and web applications along with Toll Free IVRS based farmer specific advisory system in which the system allows transmitting need based Agro-Advisory Services (AAS) through voice, text, images and videos from both end (farmer to expert and back).

*Corresponding author: devsalam20@gmail.com

With the advent of Agro-Advisory Services (AAS) of m4agriNEI to farmers, about 12325 farmers have been benefited (Singh 2018). The m4agriNEI project allows transmitting need based information encompassing the domains of sustainable crop production intensification, control of pest and diseases of crops, soil and water conservation, conservation and sustainable use of genetic resources of agricultural crops, livestock production and management, building synergies with local institutions for enhanced crop production *etc*. which are climate smart in their content and upsurges in their income. But many of these control tactics are highly sensitive to the environment and climate change, which may render them less effective. With this sensitiveness and vulgarised problems of the climate change, innovation to its adaption in terms of farmers' innovations towards CSA practices become inevitable for the subsistence of small and marginal farmers. The present study attempt to imply multinomial logistic regression model to identify the factors which enhance the CSA innovations by the registered farmers of the project.

2. Methodology

The present study used descriptive research design in order to obtain pertinent and precise information with respect to the identified variables of the study. The study was conducted in four project districts *viz*. Ri-bhoi, East Khasi Hills, West Khasi Hills and West Jaintia Hills districts of Meghalaya. With the criteria being a respondent who have made proactive average calls of five times a week and above were considered in the sampling frame and a total of sixty five registered farmers were selected. A structured interview schedule was developed for collecting data.

2.1 Variables

The variables of the study are briefly described in the following.

2.2 Independent Variables

The study includes a set of independent variables to understand the extent and differentials in the level of adaptation intention in enhancing CSA innovation by the registered farmers. The independent variables undertaken for the study were 'Timeliness', 'Accuracy', 'Relevancy', 'Economy' and 'Completeness' of information of AAS of m4agriNEI.

2.3 Dependent Variable

The study embraces 'Adaptation Intension in enhancing CSA innovation by the registered farmers' as dependent variable.

2.4 Statistical Tools

Multinomial Logistic Regression (MLR) was employed to identify the factors of m4agriNEI in enhancing the CSA innovations of registered farmers. The MLR model was carried out with the following null and alternate hypotheses.

H_0: There was no significant difference between null model and the final model.

H_1: There was significant difference between null model and the final model.

Here, the null model is the model without independent variables whereas final model with independent variables. The dependent variable in the analysis namely 'Adaptation Intention to enhancing CSA innovations' has been assumed three nominal outcomes of 'Low', 'Medium' and 'High Adaptation Intention' with nominal values of '1', '2' and '3' respectively due to set of five distribution free independent variables *viz.* 'Timeliness', 'Accuracy', 'Relevancy', 'Economy' and 'Completeness of information of AAS of m4agriNEI'. 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 = 1 categories. These 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 considered redundant. Therefore, $\pi_j(x) = P(Y = j \mid x)$ at a fixed setting of *x* for explanatory variables, with $\sum_j \pi_j(x) = 1$. For observation at that setting, the study considered the counts at the 1 categories of Y as multinomial with probabilities $\{\pi_1(x), \ldots \ldots \pi_3(x)\}$. The reference category was 'Low Adaptation Intention to enhancing CSA innovations'.

3. Result and Discussion

A perusal of Table 1 below divulged that the probability of the model chi-square (102.75) was <0.001 which was significant at 1% level of significance (*i.e.* p<0.01). Hence, the null hypothesis is rejected and alternate hypothesis is accepted. It could also be suggested that there is high significant between the factors of the AAS of m4agriNEI *viz.* 'Timeliness', 'Accuracy', 'Relevancy' and 'Economy' of information of AAS of m4agriNEI with 'Adaptation Intention to enhancing CSA Innovations'.

Table 1. Model fitting Information

Model	Model Fitting Criteria -2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	108.907			
Final	56.007	52.901***	22	.001
(*** p <0.01)				

3.1 Strength of multinomial logistic regression relationship:

The Pseudo-R squares *viz.* Cox and Snell R2 and the Nagelkerke R2 values of 0.557 and 0.633, as apparent from the Table 2 divulged that between 55.7% and 63.3% of the variability between factors such as *viz.* 'Timeliness', 'Accuracy', 'Relevancy', 'Economy' and 'Completeness of information of AAS of m4agriNEI'and the adaptation intention to enhancing CSA innovations by the registered farmers of m4griNEI.

Table 2. Pseudo R-Square

Cox and Snell R2	Nagelkerke R2
0.557	0.633

3.2 Relationship of independent variables and dependent variable using likelihood ratio test:

Ascertaining the relationship between independent and dependant variables, the study employs the 'Likelihood ratio test'. The 'Likelihood ratio test' evaluates the overall relationship between an independent variables and dependent variable. From the Table 3, it can also be concluded that factor 'Timeliness of information' and 'Accuracy of information' were significant at 1% with respect to the 'medium' and 'high' categories of Adaptation Intention to enhancing CSA innovation. Similarly, factors 'Economy of information' was significant at 5% with respect to the 'medium' and 'high' categories of Adaptation Intention to enhancing CSA innovation. Moreover, factor regarding 'Relevancy of information' was significant at 10% with respect to the 'medium' and 'high' categories of Adaptation Intention to enhancing CSA Innovation. However, 'Completeness of information of AAS of m4agriNEI' appears non-significant.

The above results inferred that that more concentration of respondents in medium category of timeliness of information and maximum number of sample farmers at high category of accuracy of information led to medium and high categories of adaptation intention in enhancing CSA innovations by the registered farmers. Maximum accumulation of respondents at high category of relevant of Information led to medium and high categories of adaptation intention in enhancing CSA innovations by the registered farmers. Similarly, maximum accumulation of respondents in medium category at economy of information led to medium and high categories of adaptation intention in enhancing CSA innovations by the registered farmers.

Table 3. Relationship of independent variables and competency level of farmers using Likelihood Ratio Tests

Effects	-2 Log Likelihoo of Reduced Model	Chi-Square	df	Sig.
Intercept	56.007	0.00	0	.00
Timeliness	74.009***	18.003	4	.001
Economy	70.708**	14.702	6	.023
Relevancy	64.224*	8.217	4	.084
Accuracy	72.299***	16.292	4	.003
Completeness	63.343	7.337	4	.119

(*** p <0.01, **p < 0.05 and *p < 0.10)

Conclusion

Based on the findings of the study, four factors *viz.* 'Timeliness', 'Accuracy', 'Relevancy' and 'Economy' of information of AAS of m4agriNEI' plays a vital role in innovating CSA practices among the registered farmers. However, Completeness of information towards farmers was found to be negative effect towards innovating CSA by the registered farmers. Therefore, 'Timeliness', 'Relevancy', 'Economy' and 'Accuracy' are the identified as factors of AAS *i.e.* m4agriNEI which are led to enhance the CSA innovations among the registered farmers. The present study accomplished that Innovation concepts are no longer metaphors in m4agriNEI, there is necessity for continuous guidance from such AAS, so that farmers can augment their capacity to surge the productivity besides innovating their efforts in their local agricultural farming setting. Prerequisites of awareness among the farmers about agricultural market information, creating aware of financing system, dissemination of information at right place at right time is mandatory for the farmers to enhance better livelihood.

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