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Use of Modified Entropy Index and Logit Transformation Model to Access Non-Crop Enterprise Diversification in the Flood Affected Areas of Assam, India

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Abstract: ***Changing climatic condition like increasing density of rainfall, more siltation in the river beds etc., stimulates devastating flood in Assam. Year after year the changing nature of flood in Assam extemporize more risk in agriculture. In such circumstances, risk mitigation and livelihood security in the flood prone agricultural sector of Assam becomes one of the key agendas for development of the small and marginal farmers. Different studies have brought this issue of climate change and risk in agriculture and opined that crop diversification is one of the prolific strategies to mitigate risk and ensure livelihood in agriculture. However, very few studies have mentioned about non-crop enterprise diversification and risk mitigation in the agricultural sector of Assam. Therefore, an attempt has been made to examine the impact of non-crop enterprise diversification in risk mitigation in the flood prone areas of Assam by using Modified Entropy Index and Logit Transformation Model. The findings of the study show that the farmers in the flood prone areas under study diversified more non-crop enterprises than in the flood free areas. Therefore, small and marginal farmers of the flood prone areas of the study can takenon-crop sector to be an effective measure to combat flood like situations.***

Key words: Non-Crop Enterprise Diversification, Risk Mitigation, flood, prolific strategy.

I. INTRODUCTION

Frequent and destructive nature of flood causes huge loses to the farm families of Assam and extemporize more risk in agriculture. Therefore, risk mitigation and livelihood security in the flood prone agricultural sector of Assam becomes one of the key agendas for the small and marginal farmers. Different research studies found thatimproper policy measures and institutional failures in agriculture make the sector more challenging for development.

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The ex-ante coping mechanisms that may be available to farmers to tackle the production risk include contract farming, crop insurance and diversification. While the scope of contract farming and crop insurance are very limited in a developing country many a time farmers take recourse to crop diversification. There is a proliferation of studies in India on the issue of crop diversification as a risk mitigating strategy in agriculture [1, 2, 3, 4, 5].

However, very few studies have taken the issue of non-crop enterprise diversification as a sound strategy to mitigate risk in the flood affected agriculture of Assam. Thus, this study is a modest attempt to cover the issue of non-crop enterprise diversification[1] in context of flood prone agriculture.

Every year large areas come under the grip of floods that cause extensive damages to crops, animal lives and properties. Figure 1.1 shows the crop area affected (percentage of Gross Cropped Area) by flood in the state in some recent years. Limited studies in the literature have identified the association between agriculture and flood in context to Assam. In the study of Mandal[6] andGoyari [3] have found that farmers in the region is practicing crop diversification to deal with the flood. Few researchers addressed their studies on crop diversification responding to flood in Assam. But there have been limited studies exploring the scope of non-crop Diversification including livestock, poultry and fishery subject to flood proneness. The present study is a modest attempt to fill up this void of research which includes the nature and extent of non-crop enterprise diversification in terms of value-wise contribution of each non-crop enterprise to total agricultural value of production. So, this makes the present study novel from the other available studies in the existing literature.

II. OBJECTIVES OF THE STUDY

A. To examine the extent of non-crop enterprise diversification through Modified Entropy Index.
B. To identify the determinants of non-crop enterprise diversification through Logit Transformation Model.

III. METHODOLOGY

This paper is completely based on primary data. The locations for field investigation were limited only to the

[1] Non-crop enterprise diversification is a kind of process through which a farmer shifted his resources from one non-crop enterprises to different non-crop enterprises to generate more profit or to provide insurance. In this study non-crop refers livestock, poultry and fishery.

plains of the Brahmaputra valley of the state. The rationality of the selection of the study area is that about 70 percent of the agricultural activities of the states are done in this valley [7]. The exclusion of the hills is justified primarily on the ground that the agricultural system in the hills is markedly different from that in the plains [8]. Primary data has been collected with the help of the technique of multistage sampling. In the first stage, four non-contiguous districts have been selected purposively from different parts of the plains of Brahmaputra Valley of Assam. As one of the purposes of the study is to capture the impact of flood on non-crop enterprise diversification, therefore, from secondary information regarding the extent and nature of agriculture, intensity of flood etc., these four districts were considered as good representation to fulfill the purpose of the study.

Thus four districts namely Dhubri, Morigaon, Dibrugarh and Lakhimpur had been selected, which fall in four different agro-climatic zones of Lower Brahmaputra Valley (LBVZ), Central Brahmaputra Valley (CBVZ), Upper Brahmaputra Valley (UBVZ) and North Bank Valley (NBV). In the second stage and from each districts one block have been selected which was subsequently followed by selection of four villages randomly from each of the block subject to flood proneness. This choice in relation to flood proneness has been made after consultation with officials of district Agriculture Offices and other informed sources. Finally, 10 per cent of the farm (cultivator) households have been selected at random from each village. This way a sample of 320 farm (cultivator) households from 16 villages have been selected at random as ultimate sample units for detailed observation.

A. Index for measuring Agricultural Diversification

Different studies have attempted to measure diversification, both crop and agricultural, using aggregated and disaggregated data with different indices. Most widely used amongst them are Herfindahl Index (HI), Simpson's Index (SI), Entropy Index (EI), Modified Entropy Index (MEI) [6, 9,10]. Besides, combinations of two or more indices are also prominent in literature [5].In this study to measure non-crop diversification two indices have been used i.e., Simpson's Index and Modified Entropy Index. The details of these two indices are given below.

The Simpson Index is calculated by using the following formula-

$$\text{SID} = 1 - \sum_{i=1}^{n} p_i^2$$

Where, SID is the Simpson Index of Diversity, and Pi is the proportionate value of ith poultry/livestock/fishery activity in the total value of non-crop agricultural sector. The index ranges between 0 and 1. If there exists complete specialization, the index moves towards 0.

The Modified Entropy Index is calculated by using the following formula-

$$\text{MEI} = \sum_{i=1}^{N} \{P_i * \log_N P_i\}$$

The MEI is equal to EI/log N.

Where, MEI is Modified Entropy Index, and Pi is the proportionate value of ith poultry/livestock/fishery activity in the gross value of non-crop agricultural sector. The index ranges between 0 and 1. If complete specialization exists, the index moves towards 0.

EI is the Entropy Index. $\text{EI} = \sum_{i=1}^{N} P_i * \log P_i$

It is worth mentioning that the base of logarithm is shifted to N number of non-crop agricultural enterprises.

B. Pattern of non-crops sector in the study area

Livestock and poultry are found to be an important secondary farm occupation of the farm households in the study area. It is a ready source of cash to buy various inputs for crop production to purchase various household durables and to meet other various transaction needs besides family consumption. In [11], opined that livestock plays a vital role in the country's agricultural economy, contributing to about 30 percent of the GDP of agriculture and allied sector. It also contributes to the food and nutrition security and also to livelihood of farmers and is registering higher growth rate compared to other subsectors of agriculture. Furthermore, the sector acts as a best insurance for farmers against vagaries of nature like flood and drought. Table I shows the percentage distribution of livestock and poultry among the sample farms of the study.

The study shows that except Dhubri, all the flood prone areas of other districts are highly concentrated in livestock and poultry farming as compared to the flood free areas of the study. The causes of high concentration of livestock and poultry farming in the flood prone areas of the study are- the conditions and locations of flood prone areas are conducive for livestock and poultry farming, livestock and poultry farming generates regular income throughout the year from the production of milk, meat, egg etc., the farmers used to sale livestock and poultry before the occurrence of flood etc. Therefore, well planned livestock and poultry farming may be one of the viable strategy to reduce risk and act as an insurance product against flood.

C. Farm Size Wise Share of Crops and Non-crops to Total Gross Value of Output from Agriculture

Total gross value of output in agriculture incorporates the share of the value of the crops grown and the share of value of non-crops that includes the livestock, poultry and fishery assets possessed by the farm households. The farming of non-crops is recognized as one of the best insurance against risk in the vagaries of nature by the National Livestock Policy, 2013. Therefore, more shares of non-crops to total gross value of agricultural output may be a best strategy to reduce risk in the flood affected areas of the study. Therefore, in this section of this paper an attempt is being made to examine the status of both crop and non-crops to total gross value of agricultural output.

Table-II shows that the share of crops to total gross value of output from agriculture is higher than the non-crops in both flood prone and flood free areas of the study.

The study found that the share of non-crops in the flood prone areas of the study is found remarkably well except the sample areas of Dibrugarh. This implies that the farmers of the flood affected areas have given comparatively more emphasis on non-crops (Livestock, poultry and fishery) than the farmers of the flood free areas of the study.

Therefore, well-planned livestock, poultry and fishery farming can be a viable livelihood options exclusively to the farmers of the flood prone areas. Moreover, from the table it has also been observed that there is a close association between farm size and non-crop sector in both flood prone and flood free areas of the study. The overall results show that in almost all the districts of the study, the small and marginal farmers rely more on non-crop sector relatively to the medium and semi medium farmers.

D. Extent of Non-Crop Diversification in the Study Area

Non-crop diversification here refers to the diversification in livestock, poultry, and fishery sector instantaneously. Non-crop diversification can be defined as the shift of resources from one non-crop enterprises to different remunerative non-crop enterprises. Furthermore, to measure the non-crop diversification index in terms of value, the farm gate price has been taken into consideration for each of the non-crop enterprises (Livestock, Poultry and Fishery). Non-crop diversification is considered to be one of the best methods of mitigating risk in the vagaries of natural calamities like flood and drought [11]. Megersa, Markemann, Angassa, Ogutu, Riepho and Zarate[12] in their study showed that livestock diversification in Southern Ethiopia represents an adaptive strategy adopted by the herders with changing climatic and rangeland conditions. As non-crops diversification plays important role in combating risk in the notions of natural calamities, this section of this paper tries to examine the extent of non-crops diversification in the study area subject to flood proneness. The extent of non-crop diversification in the study area is shown in table-III.

Table III shows that Dhubri is more diversified district in terms of non-crops followed by Dibrugarh, Lakhimpur and Morigaon. It is worth mentioning that non-crop diversification flood prone areas are more diversified compared to the flood free areas of the study. Availability of fodder, grazing land, remunerative price of non-crops, less working capital, regular income in the form of milk, meat, egg etc., provide conducive environment to the farmers of flood prone areas to concentrate more on non-crops. The farmers in the flood prone areas of Dhubri could not prepare land for the cultivation of high value crops like vegetable in advance due to water logging in the crops field and concentrated in the production of summer paddy only. Therefore, it is reflected from table-III that they concentrate more on non-crop diversification as an alternative strategy of risk mitigation. In all the four districts of the study non-crop diversification in the flood prone areas are more compared to flood free areas of the study. Therefore, proper livestock, poultry and fishery management in the flood prone areas may be a gainful strategy to reduce risk and enhance farmers' income in the study area.

E. Determinants of Non-Crop Diversification subject to flood proneness

From the results of the paper exhibited that the dominance of non-crops sector in the flood prone areas of the study is more. Table 3.1 indicates that the non-crops enterprise diversification is more in the flood prone areas of the study. Therefore, concentration of no-crop items like livestock, poultry and fishery indicate that the farmers of the flood prone areas may take non-crops diversification as a risk mitigating strategy. By keeping in view the status of non-crop enterprise diversification, this will be very fruitful to identify the influencing factors of non-crops diversification for implications of policy in both flood prone and flood free areas of the study. So, an attempt is also being made to examine the influencing factors of non-crops diversification in the study area.

IV. FACTORS INFLUENCING FARMERS DECISION IN NON-CROPS DIVERSIFICATION

A. Specification of the empirical model

To identify different factors which influence farmer's decision whether to go for diversified non-crop enterprises or concentrate in a few non-crop enterprises a multiple linear regression model has been used. The Simpson index of diversification has been used to measure the extent of agricultural diversification and is taken as the dependent variable Y. The nature of the dependent variable is such that it takes values between 0 and 1. The linear functional form is not appropriate for the present purpose, as the predicted value of the dependent variable from a linear regression model would not necessarily be confined between 0 and 1.To address such type of problem different researchers have used logittransformation methods [5;13]. Hence the following logistic function has been used as the basic model.

$$Y = \frac{1}{1+e^{-z}}$$

Where,

Y= Value of Simpson Index ($0 \le Y \le 1$);

$Z=\alpha+\sum \beta k XK+\varepsilon$ ……………..(1.1)

Y stands for Simpson diversification index ($0 \le Y \le 1$), XK are the factors which influence agricultural and crop diversification, α and β are the two parameters to be estimated and ε is a disturbance term.

It may be noted that as Z goes from $-\infty$ to $+\infty$, Y goes from 0 to 1. Moreover, in spite of the basic model being inherently non-linear, its parameters can be estimated by the linear regression technique by using Z as the repressor. For running the regression, the values of Z can be constructed from those of Y by using the following transformation formula.

Modification of the regression model:
The original form of the model is

$$Y = \frac{1}{1+e^{-z}}$$

Where,

$Z=\alpha+\sum \beta k\ Xk+\varepsilon$

Now,

$$Y = \frac{1}{1+e^{-z}} = \frac{e^{z}}{1+e^{z}}$$

$$\frac{1}{1-Y} = e^{z}$$

Hence, $\log\left(\frac{1}{1-Y}\right) = z$

Thus, we have the final model to be estimated as

$\text{Log}\left(\frac{1}{1-Y}\right) = \alpha+\sum \beta k\ Xk+\varepsilon$

Supposed, $\log\left(\frac{1}{1-Y}\right)$= SI, then the final model will be

$SI=\alpha+\sum\beta kXk+\varepsilon$…………(1.2)

Here, $\log\left(\frac{1}{1-Y}\right)$ is the modified form of the dependent variable, which is notnecessarily bounded between 0 and 1. When $Y\rightarrow 0$, $\log\left(\frac{1}{1-Y}\right)\rightarrow -\infty$ and $Y\rightarrow 1$, $\log\left(\frac{1}{1-Y}\right)\rightarrow \infty$.

The explicit final form of the model to be estimated become -

$$NCD = \log\left(\frac{1}{1-Y}\right) = \beta+\beta 0FSi+\beta 2MDi+\beta 3ICi+\beta 4ESi+\beta 5AGEi+\beta 6HSi+\beta 7EDUi+\beta 8F1i+\varepsilon i. \ldots\ldots (1.3)$$

B. Specification of variables and their expected signs

In this section of the study different variables of the model have been specified along with their expected signs.

V. RESULTS AND DISCUSSION

Before estimating the regression model, the Breusch-Pagan test has been applied to check for the presence of heteroscedasticity in the data sets for the equation 1.3. The test shows the presence of heteroscedasticity in the data sets. Subsequently, the problem has been corrected by estimating White heteroscedasticity consistent robust standard errors. The results of regression analysis for influencing factors of non-crop diversification are shown in the table –V.

In the regression model farm size is found to be negative and significant at 1 percent level of significance.It specifies that farm size has negative impact on non-crops diversification. Small size of farms creates favorable environment for rearing livestock, poultry and fishery. Secondly the coefficient of household size is also found to be significant at 1 percent level of significance and it has positive impact on non-crops diversification. From the result it can be expected that large family size may provide more man powers in rearing of non-crops item in the household. Factors like flood proneness and extension service in the regression model also found to be significant at 1 and 5 percent level of significance.

VI. CONCLUSION AND POLICY IMPLICATIONS

The overall findings of the paper show that the farmers in the flood affected areas distillate more on non-crop agriculture enterprises than in the flood free areas of the study. In addition to this small and marginal farmers (mainly in the flood prone areas) find non-crop sector as remunerative farm option in their day to day life. However, the fundamental challenge to the non-crops agriculture sector in Assam is that the sector is completely unorganized in nature. Very few among the farm families were found to be organized in nature. Therefore, they were unable to access all the available benefits from the government side. Moreover, institutional failure in the flow of subsidized capital and extension services to the non-crop sector found to be major hindrances for its development agenda. Therefore, proper policy measures need to be initiated within this sector to achieve optimization in the process of agriculture development in Assam.

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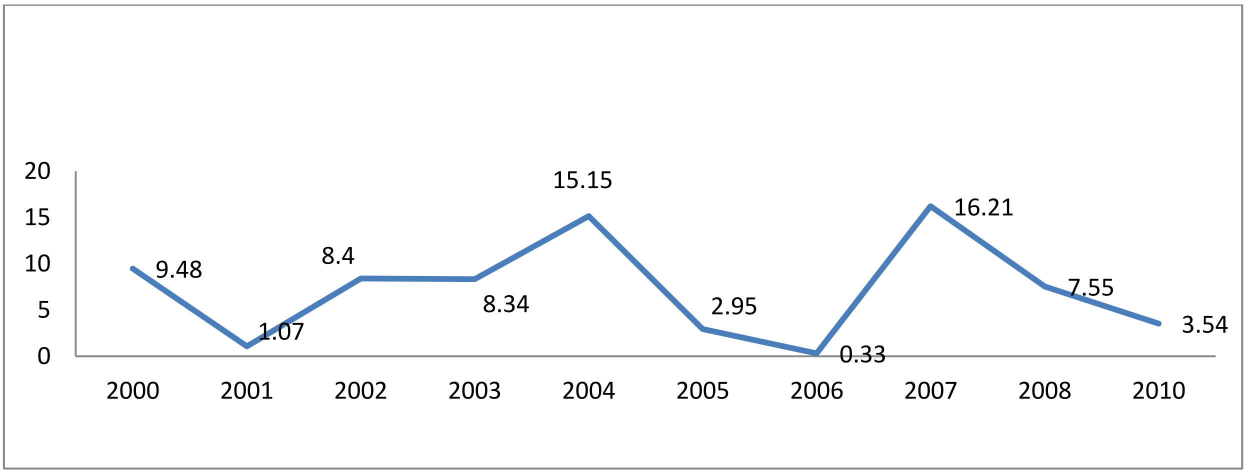
Figure 1.1. Crop Area Affected (% of Gross Cropped Area) by Floods in Assam during 2000 to 2010



Source: Different Issues of Assam Statistical Hand Book, Directorate of Economics and Statistics, Government of Assam.

Table I.Percentage Distribution of Sample Households having Livestock and Poultry Units in Flood Prone and Flood Free Areas

Flood Proneness	Cattle	Poultry	Pigs	Goats	Sheep
			Dhubri		
Flood Prone	22.5	25	0	15	12.5
Flood Free	25	30	0	17.5	17.5
Total	23.75	27.5	0	16.25	15
			Lakhimpur		
Flood Prone	20	27.5	0	12.5	0
Flood Free	22.5	7.5	0	22.5	0
Total	21.25	17.5	0	17.5	0
			Dibrugarh		
Flood Prone	42.5	52.5	35	27.5	12.5
Flood Free	40	20	20	32.5	8.5
Total	41.25	36.25	27.5	30	11
			Morigaon		
Flood Prone	37.5	57.5	0	27.5	0
Flood Free	32	50	0	30	0
Total	34.75	53.75	0	28.75	0

Brahmaputra Valley					
Flood Prone	30.63	40.63	8.75	20.63	6.25
Flood Free	29.89	26.88	5	25.63	6.5
Total	30.26	33.75	6.88	23.13	6.38
Source: Field Survey					

Table-II. Percentage Share of Crops and Non-Crops to total Gross Value of Agricultural output

Districts	Flood Proneness	Type of Farmers	Share of Crops	Share of Non-crops
Dibrugarh	Flood Prone	Marginal	94.48	5.52
		Small	82.40	17.60
		Semi Medium	94.12	5.88
		Medium	0	0
		Total	91.44	8.56
	Flood Free	Marginal	79.32	20.68
		Small	83.74	16.26
		Semi Medium	86.83	13.17
		Medium	85.80	14.20
		Total	83.94	16.06
Morigaon	Flood Prone	Marginal	85.72	14.28
		Small	32.55	67.45
		Semi Medium	88.32	11.68
		Medium	83.61	16.39
		Total	55.04	44.96
	Flood Free	Marginal	56.26	43.74
		Small	68.34	31.66
		Semi Medium	88.08	11.92
		Medium	97.78	2.22
		Total	70.95	29.05
Brahmapu tra Valley	Flood Prone	Marginal	74.39	25.61
		Small	55.79	44.21
		Semi Medium	91.26	8.74
		Medium	83.61	16.39
		Total	73.35	26.65
	Flood Free	Marginal	92.73	7.27
		Small	77.75	22.25
		Semi Medium	82.8	17.12
		Medium	82.59	17.41
		Total	74.39	25.61

Table III. Extent of Non-Crop Diversification in the Study Area

Districts	Simpson Index (Value)		Total	Modified Entropy Index (Value)		Total
	FP	FF		FP	FF	
Dhubri	0.55	0.33	0.44	0.61	0.41	0.51
Lakhimpur	0.41	0.2	0.31	0.58	0.39	0.49
Dibrugarh	0.41	0.33	0.37	0.56	0.43	0.5
Morigaon	0.24	0.19	0.22	0.43	0.31	0.37
Total	0.4	0.26	0.34	0.54	0.38	0.46
Source: Field Survey						

Note: FP= Flood Prone FF=Flood Free

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Table IV. Specification of variables and their expected signs for Non-Crop Diversification

Factors	Unit	Expected Sign
Farm Size (FS)	Size of farm in hectare	+/-
Road (R)	Distance in kilometers to the main roads	-
Market Density (MD)	Number of markets to total gross cropped area	+
Institutional Credit (IC)	1= Access of Credit 0=Otherwise	+/-
Extension Service (ES)	1= Access of Extension Services 0=Otherwise	+/-
Age	Age of the Farm Household Head	+/-
Household Size (HS)	Number of members in the household	+
Education Level (EDU)	Mean years of schooling of the farm household heads	+
F1	1= Flood Prone Area 0= Flood Free Area	+/-

Table V. Results of Regression Analysis for Non-Crop Diversification

Equation→	Equation 1.3
Results of Heteroscedasticity→	Breusch-Pagan test Chi2 [15] =70.41 Prob. = 0.0000 Result: presence of heteroscedasticity
Factors ↓	
Farm Size	-.2359*** -0.0452
Household size	.0478*** -0.0118
F1	.3350*** -0.0574
ES	.1285** -0.0623
Constant	1.094
R-squared	0.446
Adjusted R-squared	0.4288
F-test	30.70***
Durbin Watson Statistics	1.53
Prob>F	0
Degrees of freedom	-9,310

Note: Figures within ( ) are White robust standard error and degrees of freedom respectively.
***, ** and * indicate significant at 1, 5 and 10 per cent respectively.