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A Panel Data Analysis Model to Assess the Impact of Institutional Factors on Crop Diversification of Assam, India

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Abstract: ***The process of crop diversification is generally used in agriculture to mitigate both production and price risk. Crop diversification is a process through which farmers diversify his farm activities from one crop to different value added crops so that he minimizes the existing risk in his farm operation. Most of the studies in literature in context to crop diversification have identified different factors that influence crop diversification in their study area. However, very few studies have attempted to examine the impact of institutional factors on crop diversification at macro level by using district level panel data in Assam. Therefore, this study makes an attempt to examine the impact of institutional factors on crop diversification through panel analysis. To fulfill the objective of this paper secondary data have been collected from different issues of Statistical Hand Book of Assam, assamstate.com, RBI, etc. The overall results of this paper show that institutional factors like farm size have positive impact on crop diversification except institutional credit. Institutional credit has negative impact on crop diversification. This paper will definitely help to bring some policy changes in the macro level to optimize crop diversification in the region.***

Keywords: Institutional factors, crop diversification, climate change, risk mitigation

I. INTRODUCTION

A sustained economic growth, rising per capita income and growing urbanization are ostensibly causing a shift in the consumption patterns in favor of high-value food commodities like fruits, vegetables, diary ,poultry, meat and fish products from staple food such as rice, wheat and coarse cereals. The demand for and supply of these commodities have grown much faster than those of food grains [1, 2]. And this change is not confined to the higher income group of the Indian society only but is visible in the lower income or 'below poverty line' segment also. Such a shift in consumption patterns in

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favor of high-value food commodities even among the poorest strata of the India society depicts an on-going process of transformation that is leading towards a 'silent revolution' of agricultural diversification. This revolution or process of transformation is also reflected in the rising exports of high-value agricultural products [3].

Diversification of Agriculture is a process that has several dimensions. It can be viewed, narrowly, as a larger mix of activities within agriculture involving crop substitution. Diversification can also involve a shift of resources from one crop to a larger mix of crops keeping in view the varying nature of risks and expected returns from each crop/livestock activity, and adjusting in such a way that it leads to optimum portfolio of income [4].

Uncertainties and risk are two important parts in the discussions of agricultural economics. Therefore, risk and uncertainties play vital role in any kind of decision making process in agriculture. Every day farmers face with a significant amount of uncertainty. As a result agricultural producers are forced to make decisions based on imperfect information. Born out of this uncertainty is the possibility of injury or loss. Risk and uncertainty are ubiquitous and varied within agriculture and agricultural supply chains. This stems from a range of factors including the vagaries of weather, the unpredictable nature of biological processes, the pronounced seasonality of production and market cycles, the geographical separation of production and end users, and the unique and uncertain political economy of food and agriculture sectors, both domestic and international [5].

Different researchers have found that crop diversification is one of the prominent strategies of risk mitigation in agriculture. The broad rationale for crop diversification emanates from the opportunities it offers to reduce production and price risks, increasing yields, natural resource sustainability, maintaining ecological balance, increasing flexibility and sustain productivity and growth. It also creates opportunities for more employment and higher incomes through more efficient use of resources and exploitation of comparative advantage [6, 7, 8, 9, and 10]

Frequent change in the 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 agricultural sector of Assam becomes one of the key issues for the small and marginal farmers. The ex-ante coping mechanisms that may be available to farmers to tackle the production risk include crop insurance, contract farming and diversification. But then crop insurance and contract farming are in their nascent stage particularly in the states like Assam. So many a time farmers are seen taking recourse to crop diversification.

By keeping in view the implication of crop diversification in the agricultural sector of Assam, it becomes important to look at the status of crop diversification in Assam. Therefore, in this section of this paper an attempt is being made to examine the status of crop diversification in Assam from 2000- 2001 to 2010-11. The table I shows the trend of district wise extent of crop diversification in Assam. To measure crop diversification Simpson Index1 for diversification has been used. From the table I it has been observed that in the last decade the status of crop diversification in Assam more or less remains stagnant. According to Assam Agricultural Policy 2002, that the majority of the land in the state is owned by small and marginal farmers, practicing subsistence agriculture and at present they have little connection with the market. The farmers are also hampered by a low level of capital formation, coupled with very low availability of credit. The level of mechanization, fertilizer usage and irrigation in the state is very low, which is preventing the farmers from increasing the productivity of their land as well as improving the cropping intensity. This is the reason that although Assam has lately managed to become self-sufficient in rice production, there is still a significant shortfall in the production of wheat as well oil seeds and pulses, a gap which is showing an indicator of increasing rather than decreasing. The increase in diversification is prominent in the districts like of Goalpara, Dhuburi, Barpeta, Kamprup metro, and Bongaigaon. All these districts fall under lower Brahmaputra valley zone of Assam. The districts that showed less diversification in terms of area during the reference period are Sivasagar, Dibrugarh, Karimganj and Cachar. It may be noted here that the hill district of the state is an exception with a very high value of diversification index. This is obvious because the topography there supports variety of horticultural crops with short gestation period.

The status of crop diversification in a state or region is highly dependent on different factors. The domination of institutional factors in determining crop diversification is noteworthy. The association between institutional factors and crop diversification is appraised by different studies. Two significant institutional factors which augment crop diversification is size of land and institutional credit. However, in all cases this statement cannot be generalized. Because, effectiveness of these institutional factors on crop diversification also depends on some other factors like weather condition, infrastructural facilities in agriculture, agricultural marketing etc. Studies found that size of land (both small and large) has impact on crop diversification in both directions. Using state-level information on the percentage of landholdings belonging to smallholders, along with various indicators of diversification in agriculture a study made by Birthal and Joshi [4] found that diversification away from cereals into fruits and vegetables is significantly higher in states with a greater share of smallholders. However, in the study of Berhanu & Moti [11], found that diversification has decreased with decrease of average holdings in Haryana. Using linked census data for Upper-Austria from 1980, 1985 and 1990, Christoph Weiss [12] pointed out that smaller farms are more specialized and also tend to increase the degree of specialization over time more quickly than large farms. Thus, it can be said that both small and large farm diversify their agricultural activities subject to certain conditions. As like size of land, institutional credit also plays vital role in determining crop diversification. Most of the studies in literature found that institutional credit enhance crop diversification [2,4,9, 10].

Thus, literature proved that extent of these two institutional factors i.e. size of land and institutional credit enhance crop diversification to a large extent. Despite the significance of these interventions, very little is known regarding the outcomes, in particular, whether institutional factors have had the intended impact on crop diversification in Assam. In this context, this paper aims to understand the extent to which, institutional factors in agriculture support crop diversification in Assam. This study uses district level secondary data from 2000-01 to 2010-11 to examine one specific question: Do institutional factors influence crop diversification in Assam?

II. OBJECTIVE

The objective of this paper is to access the impact of institutional factors on crop diversification in Assam.

III. METHODOLOGY

The present study is completely based on secondary data. The data for this analysis were obtained from different sources like Land Utilization statistics, Assam, Directorate of Economics and Statistics, Assam, Data Bank, Reserve Bank of India.

The Simpson Index is calculated by using the following formula-

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

Where, SID is the Simpson Index of Diversity, and Pi is the proportionate area or value of i^{th} crop/livestock/fishery activity in the gross cropped area or total value of agricultural output. The index ranges between 0 and 1. If there exists complete specialization, the index moves towards 0.

To fulfill the objective of this study i.e. influence of institutional factors on crop diversification in Assam, a district level analysis was done using cross sectional time-series data or panel data covering the period 2001-02 to 2010-11. With 23 districts, a panel data of 230 observations (10 years * 23 districts) have been considered altogether for the analysis. Assam had 23 districts in 2001. A number of newer districts were created during the period 2001-02 to 2010-11. For the sake of data availability, consistency and to adopt a proper sequence of the data, four new districts namely Chirang, Baksa, Kamrup Metropolitan and Udalguri are aggregated with the original districts from where the newer districts have been carved out. The descriptions of the variables with their expected signs are depicted in table I.

The data being continuous in nature are tested for possible unit roots tests applying Levin-Lin-Su unit root test. Once the data are found to be stationary based on unit roots results, we run three regression models viz., pooled OLS, fixed effects and random effects models.

The basic specification of our model is as follows:

$DIVER_{it}=\alpha_i+\beta_1 FSIZE_{it}+\beta_2 IRRI_{it}+\beta_3 CREDIT_{it}+\varepsilon_i+u_{it}$

Where; i=1…………..n (23 districts of Assam);

t= year in number from 1 to 10 (10 years * 23 districts = 230 observations);

DIVER it= Crop diversification

FSIZE it= Average cultivable land holdings;

IRRI it= Irrigation Intensity;

CREDIT it= Institutional credit to agriculture;

εi= Cross – section or individual – specific error component;

uit=Combined time-series and cross-section error component.

The Simpson index of diversification has been used to measure the extent of Crop diversification and is taken as the dependent variable.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 logit transformation methods (Mandal, 2010; Goswamiet.al., 2013). Hence the following logistic function has been used as the basic model.

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

Where,

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

$Z=\alpha+\sum\beta_k X_K+\varepsilon$ ………………………………………………. (5.1)

Y stands for Simpson diversification index ($0\leq Y\leq 1$), 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 – ∞ to + ∞, 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,

$$Z=\alpha+\sum\beta_k X_k+\varepsilon$$

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

$$\log\left(\frac{1}{1-Y}\right)=\alpha+\sum\beta_k X_k+\varepsilon$$

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

$SI=\alpha+\sum\beta_k X_k+\varepsilon$ ………………………………………………….. (5.2)

Here, $\log\left(\frac{1}{1-Y}\right)$ is the modified form of the dependent variable, which is not necessarily bounded between 0 and 1.

When $Y\rightarrow 0$, $\log\left(\frac{1}{1-Y}\right)\rightarrow -\infty$ and $Y\rightarrow 1$, $\log\left(\frac{1}{1-Y}\right)\rightarrow\infty$.

We first run the pooled OLS where data are considered to have come from a single cross section. Our second model is the fixed effects model which examines differences in intercepts, assuming same slopes and constant variance across individuals. In other words, the fixed effects model assumes that the individual effect (heterogeneity) captured by the intercept is correlated with the independent variables. To distinguish between a pooled OLS regression and fixed effects regression, an F-test is carried out. Our third model is the random effects regression model. The random effects regression assumes that individual effect is not correlated with any regressors. The choice between fixed effect and random effects model is made on the basis of the Hausman test. On the other hand, Breusch-Pagan Lagrange multiplier test is carried out to choose between a pooled regression and random effects model.

IV. RESULTS AND DISCUSSIONS

Since the data are continuous in nature, it is possible that the data might contain unit roots which might lead to spurious relationships among the variables. Therefore, Levin-Lin-Su unit root test has been applied to check for any possible unit roots. The results of the test have been reported in table IV. The test confirms that all the data are stationary at level. Hence, we can safely run regressions on the data without fear of having any spurious relationships.

The result of our estimation is shown in table V. Although three different models viz., pooled OLS, fixed effect and random effect models were run, only results of the most appropriate one, that is, the random effect model have been reported. The results of the random effect model were decided to retain because the Hausman test suggests the use of it over the fixed effect whereas the LM test favours the use of it over the pooled OLS.

The results of regression show that out of the three independent variables, farm size and credit are found to have significant effect on agricultural diversification. Farm size has positive effect on agricultural diversification whereas credit is found to have been negatively affecting agricultural diversification. Specifically, for one percent increase in farm size, agricultural diversification is expected to increase by about 19 percent, holding all other variables constant. Similarly, ceteris paribus, for one unit increase in credit, agricultural diversification is expected to reduce by about 7 percent.

V. CONCLUSIONS AND POLICY IMPLICATIONS

Two broad implications of the panel regression model have been identified i.e. firstly, small and marginal farmers diversify less as compared to the medium or large farmers. As majority of the farmers in Assam are small and marginal, therefore, the trend of extent of crop diversification in table I is found to be stagnant over the decades. Less crop diversification implies that the farmers are concentrating more on food grain production compared to some other high value added commodities. The scenario of cropping pattern (in table-II) shows that 75.21 percent of total cultivable land are under food grain production in 2005-06 and in 2010-11 it is slightly increased to 76.40 percent. During this same period the extent of crop diversification also slightly fall down from .72 to .71. The overall implication of these findings is that though crop diversification is a prolific strategy to reduce risk in agricultural sector; but at the macro level the farmers are found to be more specialized in cereal production. The other significant variables i.e. institutional credit is found to have negative impact on crop diversification. This implies that the farmers of this region demands institutional credit for the cultivation of both summer and winter paddy only. Yes, availability of institutional credit reduce crop diversification in Assam, it means that institutional credit is not acting as a mediator of crop diversification. Therefore, it is necessary to channelize institutional credit towards crop diversification with proper extension facilities to the small and marginal farmers. Thus, one question may arise everyone's mind that how do the farmers of Assam reduce risk in agriculture in the vagaries of flood?

This paper deals with the issue of crop diversification only i.e. one sight of agricultural sector. The other sight of agriculture incorporates livestock and allied activities, poultry and fishery. Therefore, to mitigate risk in agriculture farmers in the state may also engage themselves in these sectors also. At last, it can be concluded that to study the association between risk and agriculture, study on both crop and non-crop sector needs to be motivated.

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Table- I: Extent of Crop Diversification among the Districts of Assam from 2000-01 to 2010-11

SL. No.	Districts	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
1	Cachar	0.39	0.41	0.37	0.39	0.55	0.59	0.51	0.59	0.55	0.52	0.47
2	Hailakandi	0.45	0.43	0.39	0.40	0.52	0.64	0.53	0.63	0.63	0.60	0.57
3	Karimganj	0.40	0.30	0.34	0.30	0.44	0.53	0.49	0.50	0.51	0.49	0.44
4	Goalpara	0.74	0.74	0.72	0.71	0.75	0.78	0.80	0.79	0.78	0.78	0.78
5	Dhubri	0.83	0.83	0.88	0.84	0.83	0.86	0.87	0.87	0.87	0.83	0.81
6	Kokrajhar	0.70	0.72	0.71	0.71	0.74	0.78	0.82	0.80	0.81	0.80	0.78
7	Bongaigao n	0.74	0.76	0.74	0.75	0.76	0.82	0.83	0.82	0.82	0.82	0.82
8	Kamrup(R)	0.73	0.76	0.78	0.74	0.70	0.72	0.82	0.77	0.78	0.76	0.76
9	Nalbari	0.63	0.65	0.59	0.61	0.68	0.72	0.66	0.64	0.63	0.55	0.65
10	Barpeta	0.77	0.78	0.76	0.77	0.83	0.82	0.85	0.85	0.83	0.83	0.82
11	Darrang	0.74	0.76	0.75	0.77	0.80	0.79	0.84	0.84	0.82	0.81	0.79
12	Sonitpur	0.63	0.69	0.63	0.64	0.66	0.70	0.79	0.72	0.73	0.70	0.68
13	Nagaon	0.74	0.77	0.76	0.72	0.76	0.72	0.80	0.73	0.66	0.75	0.70
14	Morigaon	0.72	0.73	0.87	0.73	0.72	0.79	0.77	0.75	0.76	0.78	0.75
15	Baksa	0.00	0.00	0.00	0.00	0.00	0.71	0.79	0.76	0.65	0.72	0.64
16	Chiraag	0.00	0.00	0.00	0.00	0.00	0.79	0.80	0.79	0.84	0.79	0.81
17	Kamrup(M	0.00	0.00	0.00	0.00	0.00	0.82	0.81	0.82	0.75	0.72	0.78
18	Udalguri	0.00	0.00	0.00	0.00	0.00	0.83	0.86	0.85	0.76	0.74	0.72
19	Jorhat	0.42	0.49	0.39	0.37	0.48	0.54	0.58	0.54	0.57	0.53	0.57
20	Golaghat	0.48	0.52	0.44	0.39	0.54	0.56	0.68	0.55	0.57	0.47	0.47
21	Sivasagar	0.14	0.15	0.12	0.11	0.17	0.26	0.28	0.30	0.26	0.19	0.24
22	Lakhimpur	0.61	0.63	0.61	0.63	0.64	0.68	0.68	0.72	0.72	0.65	0.65
23	Dhemaji	0.60	0.62	0.63	0.65	0.58	0.59	0.60	0.61	0.65	0.65	0.63
24	Dibrugarh	0.46	0.50	0.44	0.41	0.48	0.32	0.34	0.41	0.33	0.30	0.28
25	Tinsukia	0.46	0.50	0.45	0.45	0.56	0.60	0.63	0.63	0.62	0.52	0.59
26	K.Anglong	0.49	0.45	0.52	0.56	0.48	0.59	0.62	0.63	0.58	0.64	0.62
27	N.C.Hills	0.72	0.72	0.74	0.78	0.80	0.86	0.90	0.90	0.90	0.90	0.91
28	Assam	0.67	0.69	0.67	0.67	0.70	0.72	0.76	0.74	0.73	0.72	0.71

Source: Calculated from the data, published by Directorate of Economics &Statistics, Government of Assam in different issues

Table-II: Agro climatic Zone wise Cropping Pattern in Assam during 2005-06 and 2010-11 (in %)

Variables	Description of the variables	Expected signs
Farm Size(FSIZE)	Ratio of net sown area to number of farm families	+/-
Irrigation intensity (IRRI)	Gross irrigated area to total gross cropped area in percentage	+/-
Institutional Credit (CREDIT)	Institutional credit to agriculture	+/-

Source: Calculated from the data published by Directorate of Economics and Statistics, Assam in different issues.
Note: BV= Barak Valley HILL= Hill Zone LBV=Lower Brahmaputra Valley UBV=Upper Brahmaputra Valley CBV=Central Brahmaputra Valley NBV=North Bank Valley

Table III: Specification of variables and their expected signs with crop diversification

Crops/ Crop Groups	2005-06							2010-11						
	BV	HILL	LBV	UBV	CBV	NBV	Assam	BV	HILL	LBV	UBV	CBV	NBV	Assam
Autumn Paddy	7.18	7.54	15.7	2.31	9.02	15.16	11.5	7.01	7.36	10.87	2.18	5.53	11.87	8.67
Winter paddy	63.36	55.6	38.28	72.31	42.81	47.02	49.32	70.7	51.67	39.63	73.43	44.79	51.68	51.48
Summer Paddy	5.51	0.81	12.49	20.02	21.9	6.05	9.09	6.36	0.86	15.86	13.46	24.72	8.02	11.04
Cereals	76.13	70.14	69.55	77.45	75.51	70.13	72.12	84.21	65.59	69.05	77.46	77.66	73.02	73.27
Pulses	7.79	0.51	3.94	1.81	2.33	1.89	3.09	0.9	1.97	4	3.17	2.63	2.92	3.13
Food grains	83.92	70.65	73.49	79.26	77.84	72.02	75.21	85.11	67.56	73.05	80.63	80.29	75.94	76.4
Oilseeds	1.41	11.5	8.57	3.58	6.7	10.28	7.54	1.22	10.45	8.44	4.95	5.9	9.71	7.52
Jute	0.05	0.49	2.7	0.23	2.54	1.41	1.64	0.06	0.75	2.64	0.08	3.5	1.37	1.72
Sugarcane	0.31	2.91	0.17	0.72	1.8	0.48	0.68	0.23	4.5	0.2	0.58	2.04	0.58	0.82
Cotton	0.06	0.45	0.003	0.79	0.7	0.61	0.04	0	0	0	0	0	0	0
Spices	1.68	3.52	2.91	1.94	2.1	2.21	2.48	1.26	3.4	1.79	1.53	0.6	1.62	1.66
Fruits	4.34	5.64	2.75	4.58	2.72	2.7	3.42	3.29	5.47	2.23	2.51	1.17	1.56	2.04
Vegetables	8.23	4.84	9.41	8.9	5.6	10.29	8.99	8.83	7.87	11.65	9.72	6.5	9.22	9.84
Non-foodgrains	16.08	29.35	26.51	20.74	22.16	27.98	24.79	14.89	32.44	26.95	19.37	19.71	24.06	23.6

Table- IV: Results of panel unit root test

Variables	Levin-Lin-Su unit root test	
	Without trend	With tred
FARM SIZE	- 4.089**	- 5.001**
IRRIGATION	- 4.189**	-6.235**
CREDIT	-2.158*	-8.744**
DIVERSIFICATION	-4.409**	-9.602**

Note: '**' and '*' indicate significant at 1% and 5% respectively.

Table-V: Estimation results

VARIABLES	Random effects
FARM SIZE	0.187* (0.108)
IRRIGATION	0.009 (0.013)
CREDIT	-0.072*** (0.019)
Constant	1.667*** (0.197)
Observations Number of id	230 23
Hausman test (Prob. > Chi2)	4.37 (0.2244)
LM test (Prob. > Chibar2)	91.75 (0.0000)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1