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Determinants and extent of crop diversification among small holder farmers in Jalpaiguri district of West Bengal

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ABSTRACT

Sustained pressure on agricultural land coupled with rather stagnated agricultural performance (yield, profitability) adds to the vulnerability context and plight of the agrarian economy in Jalpaiguri district of West Bengal. Crop diversification is regarded as a risk management strategy and income augmenting proposition. The present study attempts to explore the extent and determinants of crop diversification in Jalpaiguri district – by utilizing both secondary data as well as primary data. Primary data, corresponding to agricultural year 2019-20, have been collected from 50 farming households of Dhupguri block following multi-stage random sampling technique. Magnitude of Simpson Diversification Index (0.79-0.80) indicates good level of crop diversification in Jalpaiguri district during 2000-01 to 2016-17 period; the same is observed to be 0.70 during 2019-20 when calculated from primary data. Allocation pattern of agricultural land is tilting towards crops like potato, maize, vegetables and spices with simultaneous decline in acreage under aus paddy, wheat, oilseeds, pulses, jute, etc. Factor analysis identifies significant positive determinants like training exposure ($p<5.0$), number of farm family adults ($p<5.0$), and negative factor like distance of crop field(s) from residence ($p<1.0$) to influence extent of crop diversification.Besides being focusing due attention towards these significant determinants, key infrastructures (like road, supply chain management mechanism, information communication, etc.) development and better institutional arrangement (exposure visits, access to farm credit, mechanization) are essential for promoting positive intent on crop diversification among farming folks.

Keywords: Crop diversification, Simpson index, entropy index, determinants, Jalpaiguri

Although Jalpaiguri district ($26^0152\ 473$ & $26^0592\ 343$ N Ø & $88^0232\ 23$ & $89^072\ 303$ E λ) is having a pre-dominantly agrarian economy, contribution of primary sector in its Net District Domestic Product (NDDP) is decreasing monotonically – from 41.94% during triennium ending year 2000-01 to 31.56% during triennium ending year 2013-14 (Statistical Abstract, Government of West Bengal, 2001, 2005, 2008, 2015). Sector-wise growth analysis (at 2004-05 constant price) suggests that the primary sector registered lowest growth rate (CAGR: 2.09% per annum) in comparison to either secondary sector or tertiary sector (Table 1) during 2004-05 to 2013-14 period. This is despite the fact that the total NDDP is increasing at about 6.28% per annum in the district. Within primary sector, fishery does relatively better (though, non-significant) than either agriculture or forestry.There may be several reasons for this 'backwardness'. In most of the crops, yield remains far below the national or state average except that of potato, not to speak of the respective 'frontier'(Statistical Abstract, Government of West Bengal, 2001, 2005, 2008, 2015). Corresponding time series analysis (Table 2) exhibits rather sluggish growth in this regard too; as for example, yield of summer (*boro*) paddy, which was 2.48 t ha^{-1} during triennium ending year 2000-01, reaches only to 2.55 t ha^{-1} during triennium ending year 2016-17 registering an annual growth (CAGR) of 1.62% per annum only. Indiscriminate use of inputs (especially, chemicals) and irrational/non-judicious choice of cropping mix may be some of the major reasons for this productivity stagnancy. Also, the given fact remains that the economy is having majority of marginal farm households (about 80% of total) with average land holding of 0.52 ha (= *3.90 bighas* in local unit) which gives little leverage for experimentation with/trialing new technology/innovation. Not only that, it (size of holding) is decreasing over the years. All these facts forced to think an alternate cropping strategy which may have role in pulling the agrarian economy out of trouble. Crop diversification, in this regard, is assumed to have a meaningful role.

Crop diversification seems to have started in West Bengal way back in 1983-84 (Dasgupta and Bhowmik, 2014), when the growth of cereals production in India started showing signs of stagnation. Dominance of cereal production slowly tilted towards allocation of crop

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acreage in favour of high value and non-cereal crops in the country (Mallik and Pattanayak, 2017; Joshi *et al*., 2003; Kumar and Gupta, 2015; Mithiya *et al*., 2018). This happens because of two main reasons: first, it has been observed that the benefits of the new technology or green revolution in cereals get exhausted after an 'optimum' level is reached (Dasgupta and Bhowmik, 2014), second, the small and the marginal farmer's desperate intent to lessen production risk by adopting a diversified crop portfolio (Vyas,1996). Crop diversification has a role in reducing poverty, enhancing nutritional intake, increasing employment and better management of renewable resources (Bhattacharya, 2008; Ligon and Sadoulet, 2018; Montalvo and Ravallion, 2009; Chen and Ravallion, 2007; Kumar *et al*., 2012; Sharma, 2011).The question comes, how is the present 'state' of crop diversification in Jalpaiguri district? The study by Mithiya *et al*., 2018 identified the district of Jalpaiguri under highly diversified (0.70 ≥ Simpson Index ≤ 1.0) category with jute, potato and seasonal vegetables as emerging crops. Similar kind of observation (on Jalpaiguri district) was made by Basu and Barman (2014). Major focus of this research study is to identify the determinants that influence farmer's decisions to diversify in crop production in Jalpaiguri district of North Bengal.

Table 1: Compound Annual Growth Rate (CAGR) of Net District Domestic Product in Jalpaiguri (at constant 2004-05 prices)

Major Sector	Sub-Sector	Growth Rate (CAGR)
Primary	-	2.09**
	Agriculture	2.08**
	Forestry	2.02^{NS}
	Fishery	2.22^{NS}
	Mining & quarrying	-0.30^{NS}
Secondary	-	5.55**
Tertiary	-	8.68**
Total NDDP	-	6.28**

Year :2004-05 to 2013-14

Source: Computed by using data available from Statistical Abstract (2005,2008, 2015), Bureau of Applied Economics and Statistics, Government ofWest Bengal.

Note: Growth rates have been calculated by fitting the function InY= a + bt.

*** Significant at 1% level; NS: Non-Significant.*

Table 2: Compound Annual Growth Rate (CAGR) of major crop yield in Jalpaiguri

Crop	Yield during TE 2000-01 (t ha^{-1})	Yield during TE 2016-17 (t ha^{-1})	CAGR (%)
Pre-kharif (*aus*) Paddy	1.47	2.39	3.53**
Kharif (*aman*) Paddy	1.30	2.47	3.59**
Summer (*boro*) paddy	2.48	2.55	1.62**
Wheat	1.78	2.08	1.29*
Maize	2.89	2.84	3.57**
Potato	20.72	30.70	3.02**
Jute	1.57	2.34	1.71**

(*Year:2000-01 to 2016-17*)

**CAGR significant at 5% level; ** CAGR significant at 1% level; TE: Triennium Ending Year.*

MATERIALS AND METHODS

The study uses both secondary and primary data - while the primary data have been collected from farming households secondary information have been culled from various government sources, websites, etc. Application of purposive and multi-stage random sampling method was followed for the present study. At the very first stage, the district of Jalpaiguri was being selected purposively because of the paramount importance of agriculture in livelihood sustaining in this district. The blocks, the villages constituted the second and third stage sampling units respectively. Block-wise general profile of newly formed Jalpaiguri district suggests that Dhupguri block was having (2nd) highest number of inhabited villages, households, population and total cropped area during triennium ending year 2018-19 and therefore, was selected as the representative block for conducting the study. Primary data, corresponding to agriculture year 2019-20 from randomly selected 50 respondent farming (distributed over 4 different villages in the block) households, were collected with the help of a pre-tested survey questionnaire. Face to face interview method was applied for collection of primary information.

Compound Annual Growth Rate (CAGR) for respective parameters were calculated by fitting exponential trend equation

$y = ae^{bt}$ [y= dependant variable *i.e*., area, productivity etc., a= intercept; b = regression coefficient; t = time variable) which is found to be 'best fit'. The idea and extent of crop diversification *i.e*., shifting from less profitable crop or enterprises to more profitable crop or enterprises (Saha, 2013), can be had by computing Diversification Index. In this study we had chosen Simpson Index and Entropy Index to measure the degree of crop diversification considering their wide applicability in research studies.

Simpson Index (SI)

Simpson Index is the most convenient index for measuring crop diversification in any specific geographic area. It is a measure of horizontal diversification which refers to the increase in the number of crops grown (given the economical rationality of this expansion). The formula of Simpson Index can be written as:

$$\text{Simpson Index (SI)} = 1 - \sum_{i=1}^{N} Pi^2$$

$$\text{Where, } P_i = A_i / \sum_{i=1}^{N} Ai$$

Where, Pi represents the area percentage of the i^{th} crop in total cropped area.

Ai = actual area under i^{th}crop.

ΣA_i = summation of area under all 'i' crops.

i = 1,2,3,……., N.

N = number of crops grown.

When the value of SI is almost zero it denotes that the area is close to specialization and when it is almost one it denotes that the area is fully diversified. The value of Simpson Index fluctuates between 0 and 1. As it is easy to calculate and explain, this method is broadly used for calculating diversification index.

Entropy Index (EI)

Entropy Index directly measures the crop diversification which has a logarithm character. The formula of Entropy Index can be written as-

$$\text{Entropy Index (EI)} = \sum_{i=1}^{N} Pi * \log\left(\frac{1}{Pi}\right)$$

$$\text{Where, Pi} = \text{Ai} / \sum_{i=1}^{N} Ai$$

Where, Pi represents the area percentage of the i^{th}crop in total cropped area.

Ai = actual area under i^{th}crop.

ΣAi = summation of area under all crops (Total Cropped Area).

i = 1,2,3,……., N.

N = number of crops grown.

The index increases with the increase in diversification and the upper value of index can surpass '1' when the number of total crops is higher than the value of logarithmic base *i.e.*, 10. When the value of Entropy Index is zero (0) it means there is complete specialization. The value of index fluctuates between zero (0) and one (1), when the number of crops is less than the value of logarithmic base.

Multiple Regression Model

Finally, to identify the determinants or the factors effecting crop diversification decision, Linear Multiple Regression Model has been applied as follows:

$$y = a + \sum_{1}^{n} b_i x_i + u$$

Where, y = the value of crop diversification index.

x_i = the magnitude of i^{th} explanatory variable for crop diversification in this study.

b_i = regression co-efficient for i^{th} explanatory variable

u = Error term.

After fitting the multiple regression model, it was checked for the existence of multicollinearity which may arise due to high correlation between two or more hypothesized independent variables. When there was presence of multicollinearity between the independent variables, we could not separate out the independent effect of each parameter estimate on the dependent variable (Sichoongwe, 2014). As a result, we may have little or no confidence in any policy prescriptions on these estimates. A measure of multicollinearity associated with the variance inflation factors (VIF) is defined as:

$$\text{VIF (Xj)} = \frac{1}{1 - R_j^2}$$

Where R_j^2 is the coefficient of determination when the variable X_j is regressed on the other independent variables (Gujarati, 1995). The variance inflation factor (VIF) was employed to detect the problem of multicollinearity for continuous variables. The value of VIF greater than 10 was taken as a sign for the existence of multicollinearity problem in the data.

RESULTS AND DISCUSSION

A close perusal of Table 3 indicates that predominance of cereals still prevailed in the district though the corresponding percentage share in total cropped area declined from about 57% in triennium ending year 2000-01 to about 50% in triennium ending year 2016-17. Tea remained a formidable pillar of this agrarian economy; with 167 tea gardens, the agro industry continued to share around 14.5% of total cropped area. Changes were seen in the continuous up-rise in allocation of acreage under horticultural crops; percentage of acreage share of this sector rose to 13% during triennium ending year 2016-17 from less than 11% during triennium ending year 2000-01. Potato (chief component of miscellaneous crops) was emerging as a major crop in the district. There was continuous decrease in jute (the principal fibre crop) which was in the mainstay of this agrarian economy.

Table 4 depicts about the extent of Diversification Indices in the district during different points of time *i.e.*, 2000-01, 2005-06, 2010-11, 2015-16 and 2018-19. As mentioned earlier, the Simpson Index (S.I) and Entropy Index (E.I) have been computed for the study. Almost

similar pattern in diversification indices was observed in both these two methods. The district, having cultivation practice of a number of crops (n = 25^{+}), showed a very good picture of diversification index (similar observations were made by Mithiya and Mandal, 2018; Basu and Barman, 2014). Over the years, though, little change in this extent has been noticed – S.I remained around 0.80-0.81 and E.I remained around 0.87.

Table 3: Change in % share of crop groups in total cropped area in Jalpaiguri district

Crop group	Triennium Ending yr 2000-01	Triennium Ending yr 2005-06	Triennium Ending yr 2010-11	Triennium Ending yr 2016-17
Cereals	57.04	55.49	51.94	50.51
Pulses	1.25	0.97	0.87	1.38
Oilseeds	2.36	2.70	3.41	3.00
Fibres	9.45	8.01	8.04	7.32
Vegetables	9.05	10.06	10.98	10.87
Fruits	1.87	1.98	1.92	2.03
Flowers	0.00	0.02	0.05	0.06
Tea	14.35	14.58	14.94	14.50
Other crops	4.63	6.19	7.86	10.33

Source: Computed by using data available from Statistical Abstract (2001, 2005, 2008, 2015) and District Statistical Handbook, Jalpaiguri (2017), District Statistical Handbook, Alipurduar (2017), Bureau of Applied Economics and Statistics, Government of West Bengal.

Table 4: Diversification Indices in Jalpaiguri district over the years

Year	Diversificat Indices	
	Simpson Index	Entropy Index
2000-01	0.7986	0.8786
2005-06	0.8163	0.9187
2010-11	0.8533	0.9035
2015-16	0.7952	0.8863
2018-19	0.7883	0.8723

We then move towards block-wise comparison of diversification indices which is depicted in table 5. The blocks (7 nos.) which was included in the newest form of Jalpaiguri district were considered for the study. The comparison was made in preceding 11 years *i.e*., 2008-09 to 2018-19 (as par availability of block-wise data). It is evidenced from Table 5 that Dhupguri block contributed the greatest shares (24.33%) of total cropped area during triennium ending year 2018-19. Traditionally, the southern blocks namely, Rajganj, Jalpaiguri, Maynaguri and Dhupguri covered more than 80% of total cropped area in Jalpaiguri (new) district; recently, though, share of northern blocks (*viz*., Metiali, Mal, Nagrakata) was on the rise. But changes occured

Table 5: Block-wise change in share (%) of crop groups in total cropped area in Jalpaiguri district

Crop group	Rajganj (% of TCA)		Jalpaiguri (% of TCA)		Maynaguri (% of TCA)		Dhupguri (% of TCA)		Malbazar (% of TCA)		Matiali (% of TCA)		Nagrakata (% of TCA)	
	TE 2010-11	TE 2018-19	TE 2010-11	TE 2018-19	TE 2010-11	TE 2018-19	TE 2010-11	TE 2018-19	TE 2010-11	TE 2018-19	TE 2010-11	TE 2018-19	TE 2010-11	TE 2018-19
Kharif (*aman*) paddy	48.88	49.59	54.59	51.85	52.25	47.09	51.42	38.83	63.97	62.04	75.71	60.10	65.99	63.37
Summer (*boro*) paddy	26.78	25.43	4.97	8.44	2.47	4.00	1.59	2.15	2.21	10.30	0.25	0.45	0.15	0.14
Wheat	2.32	0.87	4.77	4.63	5.01	4.18	5.52	4.59	4.37	1.50	3.13	3.04	3.96	1.84
Maize	0.10	1.52	0.07	1.71	0.07	2.78	0.16	1.57	1.09	3.35	2.93	10.76	11.17	14.96
Pulses	0.16	0.77	0.12	0.88	0.40	1.68	0.64	1.50	0.09	1.46	0.00	6.52	0.73	5.85
Oilseeds	1.76	3.40	2.45	3.29	2.63	4.34	3.17	2.03	1.96	1.80	4.01	5.33	3.51	2.98
Potato	4.55	7.96	10.08	13.58	9.17	9.87	16.63	28.39	9.56	11.26	5.27	6.47	6.26	4.44
Jute	10.94	9.87	18.79	12.97	19.62	20.87	13.19	12.29	7.10	5.65	5.61	4.18	4.98	3.11
Total cropped Area*	20.24	20.54	20.01	19.08	26.05	19.14	19.88	24.33	9.33	10.98	1.98	2.38	2.52	3.54

**Share of total cropped area in the block to the total cropped area in the district; TE: Triennium Ending Year*

**Source: District Statistical Handbook: Jalpaiguri, Government of West Bengal (2004, 2009, 2017); Office of the Deputy Director (Agriculture), Jalpaiguri, Government of West Bengal.*

Table 6: Block-wise Diversification Indices in Jalpaiguri district over the years

Block	Simpson Index		Entropy Index	
	2008	2018	2008	2018
Rajganj	0.6859(I)	0.6750(IV)	0.6252(III)	0.6233(IV)
Jalpaiguri	0.6435(IV)	0.6893(III)	0.6150(IV)	0.6890(II)
Maynaguri	0.6680(III)	0.6990(II)	0.6337(II)	0.6877(III)
Dhupguri	0.6852(II)	0.7308(I)	0.6600(I)	0.6958(I)
Malbazar	0.5438(V)	0.5869(VI)	0.5392(V)	0.5926(VI)
Matiali	0.3942(VII)	0.6049(V)	0.4133(VII)	0.6399(V)
Nagrakata	0.5247(VI)	0.5695(VII)	0.5309(VI)	0.5836(VII)

**Figures in parentheses indicate corresponding rank (R_i) among the blocks in respective year*

Table 7: Social and economic feature of farm families

Traits	Unit of expression	Value
Family adults	Nos.	4.22 (45.40)
Farming experience of far family head	Years	27.40
Education level of farm family head	Schooling years	7.62
Education level of farm families	Schooling years	8.10
Access to relevant institutes	Score	5.12
Training exposure	% family member	48.00
Farm family income	Lakh Rupees. /annum	2.21
Income from off-farm source	%	32.28
Total cultivable land	ha	1.35
Average distance of plot from residence	mts.	204.95

**Figure in parentheses indicates % of farm females in total adult family member*

in terms of acreage allocation pattern in between this two-time period *i.e*., 2008-09 and 2018-19.

During triennium ending year 2010-11, Maynaguri was sharing approximately 26% of total cropped area (the greatest among the blocks) in the district which came down to about 19% during triennium ending year 2018-19 paving neighboring block *i.e*., Dhupguri to share most in this regard. A huge change in acreage allocation had been noticed in Dhupguri block in between TE 2010-11 and TE 2018-19; acreage allocation towards foodgrains, which was 59.33% of total cropped area during TE 2010-11, came down to 48.64% during TE 2018-19. There was reduction in fibre crop's share (in corresponding TCA) too. It is despite the fact that there was simultaneous increase in total cropped area in the block (Dhupguri). That does mean that acreage allocation towards some commercial / high value crops was taking place and truly so.

We observed, 2.29 times jump in potato acreage from 6,516 ha (16.63% of TCA) in 2008-09 to 14,895 ha (28.39% of TCA) in 2018-19 in Dhupguri block. Acreage allocation towards maize was also on the rise with simultaneous decrease in *kharif* paddy acreage

Examination of acreage allocation pattern among crops (Table 5) does indicate about diversification indices in these blocks of Jalpaiguri district which is actually depicted in Table 6. A close perusal of this table corroborates the discussion made in the preceding paragraph - Dhupguri block shows the highest level of crop diversification indices. Again, the result is almost in equivalent pattern in both the methods applied. Dhupguri block has the value of Entropy Index 0.6958 and Simpson Index 0.7308 during 2018-19 which was 0.66 and 0.6852 respectively during 2008-09. That means an improvement in diversification context took place in this block during preceding 11 years. Not only that, we observed change in the ranking of these blocks (in accordance with their diversification indices) also. As for example, Rajganj block, with Simpson Index 0.3141 was top ranked during 2008-09; but within these 11 years span, the diversification picture in this block deteriorated (Simpson Index: 0.6750) and block slipped down to rank 4th. In contrast, Dhupguri block which was in 2nd position during 2008-09, rose to 1st position during 2018-19. We undertake the similar kind of exercise with the help of primary data (n=50) to validate the crop diversification indices and found a close

Table 8: Variable specification and expected sign towards crop diversification

Variables	Variable names	Variable description	Variable explanation	Expected sign of effect
X_1	F_Edn	Educational standard of farm family	Average schooling years of farm family members	+ve
X_2	F_income	Farm family income per annum	Rupees per annum	+ve
X_3	Training exposure	Training undertaken by any member of the family	Binary variable: yes = 1, no = 0.	+ve
X_4	F_adults	Nos. of adult male and female in the family	Number	+ve
X_5	Size_land holding	Size of cultivable land (both agricultural & horticultural)	Ha	+ve/-ve
X_6	Land_high	Percentage of high/medium-high land in cultivable land area	%	+ve
X_7	Irrig._land	Percentage of irrigated (partially or fully) cultivable land	%	+ve/-ve
X_8	Own_land	Tenancy status of farming households	% of own cultivable land	+ve
X_9	Distn_plot	Average distance of crop plots from residence	Kilometer per plot	-ve

proximity - overall Simpson Index and Entropy Index were 0.7041 and 0.6348 respectively. About 56% of the respondent farmers had crop diversification index (Simpson Index) 0.70 and above.This does indicate a wide variability among farming folks in terms of diversification indices. The question raises, 'why this variance'? We shall try to answer this question by identifying the possible determinants of agriculture diversification in the study site.

Before delving into 'determinants identification' we would like to have a brief sketch on social and economic profile of the farming households which is presented in Table 7. Understanding about social, economic, as well as demographic feature of a farm family may help in getting a clue about spatial variation in diversification nature of farm families. On an average, the farm families comprised of four (4) adults (about 45-50% were adult female) and the decision-making heads were having about 27 years of farming experience. Level of education of the family members play a crucial role in current decision-making context ('joint decision making' rather than 'individual decision making') of the economy. The cumulative schooling extent of these farm families was 8 years indicating a rather medium level of educational standard. They were low to medium in accessing relevant institutes (like office of the Assistant Director of Agriculture, Krishi Vigyan Kendra, Farmers Club, Commercial Banks *etc*.) or on participation (by self or any member of the family) in training programmes. The annual farm family income hovered around Rs. 2.21 lakhs, two-third of which came from crop farming and rest from other sources like business, service, wage earning etc.

We must keep it in mind that forces that drive agricultural diversification in a particular socio-economic set up may be different in another set up (Jha *et al*., 2009). Different authors/researchers have identified the drivers of crop diversification differently, like enhanced formal/informal education and extension service (Khan *et al.,* 2017), training on crop practices, extent of irrigated land (Basantaray and Nancharaiah*.,* 2017; Basavaraj *et al.,* 2016), size of land holding (Basavaraj *et al.,* 2016; Sichoongwe, 2014; Birthal *et al.,* 2006), etc. Some others also stressed on infrastructural development, enhanced market demand, changes in policy etc. to be instrumental in extent and magnitude of diversification (including crop diversification) in an economy (Bhattacharya, 2008; Singh and Sahoo, 2007; Dasgupta and Bhowmik, 2014).

Taking into consideration the works by the previous researchers and getting possible clues from the socio-demographic feature, we tried different combinations of explanatory variables to regress the dependent/ explained variable i.e., diversification index. As Simpson Crop Diversification Index has been extensively used in the foregoing sections, it was being used in the study as dependent variable. The selected independent variables were the standard of education

Table 9: Determinants of crop diversification in Jalpaiguri district

Explanatory variables	Regression coefficients	t value	Significance (Probability level)	Variance Inflation Factors
Intercept	0.611 (0.089)	6.88	<0.0001	-
F_Edn (X_1)	-0.000 (0.005)	0.14	0.89	1.075
F_income (X_2)	0.000 (0.00)	0.48	0.63	1.210
Training exposure (X_3)	0.048** (0.022)	2.17	0.036	1.276
F_adults (X_4)	0.022** (0.009)	2.51	0.016	1.279
Size_land holding (X_5)	-0.003 (0.019)	0.21	0.83	1.476
Land_high (X_6)	0.00 (0.00)	0.01	0.99	1.186
Irrig._land (X_7)	0.00 (0.00)	0.20	0.84	1.206
Own_land (X_8)	-0.00 (0.00)	0.24	0.81	1.779
Distn_plot (X_9)	-0.0001** (0.00004)	2.41	0.02	1.658
	R^2		**0.45**	
	F		**3.57**	
	No. of observations		***50**	

**Figures in parentheses indicate Standard Error of corresponding regression coefficient*
*** Significant at 5% level; *** Significant at 1% level.*

(proxy for knowledge and interest of entire farm family for improved agriculture), training exposure (by any of the family members so far – cumulative in sense), nos. of adults in the family (reflecting potential for labour supplying from within the family), income of farm family (a possible clue for investment potential), cultivable land holding, percentage of high to medium-high cultivable land, extent of irrigated land (fully or partially supplemented), tenancy status of cultivable land, distance of crop plots from decision pivots (residence, mostly) to the crop plots. Description of all these variables with their possible/expected sign of effect is depicted in Table 8.

The result of multiple regression analysis is presented in Table 9. Magnitude of R^2 and its significance test (with F-value) indicate that the model was 'good fit'. The values for variance inflation factors (VIF), being less than 10, indicate about absence of multicollinearity among the explanatory variables. The R^2 value of 0.45 shows that, about 45 percentage of variation in the Y_i (dependent variable, Simpson Diversification Index) is explained by the corresponding variation in the assumed explanatory variables (X_is).

A close perusal of this table (Table 9) postulates that training exposition of a farm family (X_3), total number of adults (male and female) in a farm family (X_4) and average distance of cultivable land (plots) from residence (X_9) were significant drivers of diversification in the study site. While for the first two variables (*i.e.*, X_3& X_4), the association was positive, for the third one (i.e., X_9), there was negative regression. In all these variables, the regression result matches/corroborates with the expected sign (Table 7) too.

The coefficient of training exposure was positive and statistically significant (p=3.60). That means those farming households which had greater exposure to agricultural training have a higher S.I in comparison to those farming households who did not have any agricultural training or lesser of it. Hence, an agriculturally trained farmer was more diversified than an untrained farmer which was also observed by Basantaray and Nancharaiah, 2017. Thus, it can be told that agricultural training leads to crop diversification and due attention are to be given on the matter.

Similarly, presence of more adult members in a farm family led to significant (p=1.6) rise in diversification.

Potential of more number of labours from within the family led to opt for favorable allocation among possible crops. A unit increase in farm adults may lead to 2.2 per cent increase in diversification index. Another significant (p=2.0) factor that had inverse relation with diversification index is the distance of crop plots from the residence. The nearer the situation of it (crop plot), greater is the ease of managing the cropping ventures – giving rise to leverage for taking up varied number of crop cultivation.

Besides these, we observe inverse relationship (though, non-significant and weak) between size of (land) holding (total cultivable land) and crop diversification and also between land ownership and diversification. This is quite opposite to the findings by Basavaraj *et al.,* 2016 who viewed that crop diversification increased with increase in land holding size. Though several studies (Birthal *et al.*, 2006; Basantaray and Nancharaiah, 2017; Basavaraj *et al.,* 2016; Bhattacharya, 2008 etc.) observed significant relationship with extent of irrigated land and diversification index (positive or negative), we did not find that particular relation in our study.

Agricultural diversification is believed to be a natural response to the surrounding economic and political environments inside and outside the sector. The study was undertaken to aptly grasp the 'nature & extent' of it in Jalpaiguri district. Our study validates the nature and extent of crop diversification in Jalpaiguri district (using secondary information) with sample observation from representative study site. It can be concluded that agriculture (crop cultivation) is moderately diversified in this pre-dominantly agrarian economy of Jalpaiguri district. Basically, it is 'horizontal diversification' and seems to be market driven rather than led due to consuming need of a farm family. Alongside this, desperate jeal for enhancement of farm income and risk reduction also seemed to interplay on the question of crop diversification decision. Over the years, acreage allocation pattern undergoes changes. But crop diversification is not out-rightly tilting towards horticultural crops as has been experienced in many other parts of the country. Alongside horticultural crops (mainly, seasonal vegetables), acreage allocation increasingly favoured commercial crops like potato, maize (rabi), chilli etc. which are potentially having better return aspect per rupee investment.

From income augmenting point of view too, role of crop diversification was proved to be highly favourable in this study. The annual farm family income rose from Rupees 1.81 lakhs (for relatively lower diversification farm families) to 2.72 lakhs for highly diversified farming folks exhibiting a great impact. Not only that, dependence on other source of income decreased with increase in extent of diversification too.

For promoting diversification, sustained training and awareness campaign/programme of feasible members (inclusive of farm female) of farm family may play crucial role. Decision making (farming or non-farming) is no more a unilateral process; rather, it is regarded as a collective effort (joint decision making) now a days. It may enrich the cumulative knowledge and information basket (of farm family) and facilitate better decision-making outcome. Necessary efforts and arrangements need to be supplemented. The extension agencies (government or private) need to give due 'thrust' on capacity building of other feasible family members (especially, the rural youths).

Proximity of crop field(s) is needed to be as close as possible to the residence of the farming households. It gives leverage/scope for better 'control' and 'supervision' of the crop management aspects/schedule leading to greater farm income. The key question here is effective 'monitoring' which needs to be ensured for better crop diversification picture. Again, more number of adults (may be male or female) gives the scope of not only family labour participation (especially, in farming) more but also, scope of frequent visit to the crop field(s).

Alongside, there needs simultaneous peripheral arrangement for getting a better crop diversification picture in an economy. Key infrastructures (like road, supply chain management mechanism, information communication, etc.) development and better institutional arrangement (exposure visits, access to farm credit, mechanization) are essential for promoting positive intent on crop diversification among farming folks.

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