Extent of Crop Diversification across different farm size groups in the North Bank Plains Zone of Assam

Abstract

~~The study was undertaken to find out the extent of crop diversification across different farm size groups in the North Bank Plains Zone (NBPZ) of Assam.~~ Crop Diversification is a strategy to optimize the use of land, water and other farm resources particularly for risk reduction, stabilization of farm income, augmenting farm employment and overall agricultural development in general. The study was undertaken to find out the extent of crop diversification across different farm size groups in the North Bank Plains Zone (NBPZ) of Assam. To find the extent of crop diversification of farmers across different farm size groups two districts *viz.* Lakhimpur and Sonitpur were selected randomly with a sample size of 160 farmers (80 belonging from Lakhimpur district and 80 belonging from Sonitpur district) administered with the Simpson Index of Diversity (Simpson, 1949). The statistical techniques employed were frequency (*f*), mean ($\bar{x}$), percentage (*%*). The findings suggested that in the pooled sample of farmers, majority of the respondents (64.37%) were in medium crop diversification category followed by 20.00 per cent in high and 15.63 per cent in low crop diversification category. Similarly, majority of the respondents were in medium crop diversification category in all the individual categories of farmer i.e., marginal, small and medium farmers respectively. This study will be useful to the extension functionaries, agriculture and allied departments to modify and quantify their ways and means to educate the farmers for adoption of diversification.

Keywords: Crop diversification, Poverty, Marginal farmer, Small farmer, Medium farmer.

1. Introduction

India has a population of more than one billion, where a vast majority of people depend on agriculture. Agriculture is the primary source of livelihood in the country especially in rural areas. Majority of the rural people live in abject poverty and even earning a subsistence type of livelihood is tough ask for them. Indian agriculture is characterized by small farm holdings and majority of them are dry lands and even irrigated areas suffered by the disparity of monsoon. The average size of operational land holding has declined to 1.16 ha in 2010-11 as compared to 1.23 in 2005-06. The average land holding of small and marginal farmers in India is too low (less than 1 ha) for which they cannot generate adequate employment and income for their livelihood and are forced to live below poverty line (Anon., 2012). India is facing the most complex challenge of decreasing land man ratio, growing problems of population and unemployment, changing food habits of consumers and rapid changing market due to globalization. As diversified farms are more resilient to market shift, provide protection against climate change and proved to be the most important sources for poverty reduction with increased income of the farmers, therefore agricultural diversification provides one way to overcome these overriding problems in a more competitive environment a strategy to ensure livelihood security through employment generation, poverty alleviation and conservation of natural resources.

In the agricultural context, diversification can be regarded as the re-allocation of farm's productive resources, such as land, capital, farm equipment and paid labours into new activities. These can be new crops, livestock products, value-adding activities, new enterprises etc. Vyas, (1996) defined agricultural diversification as shift from one crop to another crop, or from one

enterprise to another enterprise. According to Singh et al., (2009), Agricultural diversification refers to the process where producers allocate their productive resources to a wider range of economic activities. These activities may include the cultivation of number of crops which can be termed as crop diversification. Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a particular farm taking into account the different returns from value-added crops with complementary marketing opportunities (Khanam *et al.* 2018). Crop diversification is intended to give a wider choice in the production of a variety of crops in a given area so as to expand production related activities on various crops and also to lessen risk. Crop diversification in India is generally viewed as a shift from traditionally grown less remunerative crops to more remunerative crops (Hazra, C.R). With growing population, urbanization and industrialization, the area devoted to crop production has been declining. As a result new strategies were formulated and crop diversification is one of them. As a strategy crop diversification maximizes the use of land and optimizes farm productivity and income (Espino and Atienza). According to Gonzales (1989), the adoption of crop diversification schemes is dictated by both physical and economic factors. Physical factors include land capability, rainfall patterns, water quality, crop suitability and technology. Economic factors, on the other hand, include costs, prices, markets and economic viability of alternative cropping schemes (Adriano and Cabezon).

Crop diversification can be considered as an attempt to increase the diversity of crops through, e.g. crop rotation, multiple cropping or intercropping compared to specialized farming with the aim to improve the productivity, stability and delivery of ecosystem services (Kremen *et al.* 2012). Crop diversification practices can include higher crop diversity (Renard and Tilman 2019), more diverse crop rotations (Reckling *et al.*,2016), mixed cropping (Bedoussac *et al.*,

2015), cultivation of grain legumes in otherwise cereal dominated systems (Watson et al. 2017), perennial leys or grassland (Haughey *et al.*,2018) and regionally adapted varieties or variety mixtures (Yang *et al.* 2019; Vijaya *et al.*, 2019). In addition, diversification provides ecosystem check and balance mechanism for controlling pests (Gopallappa, 1996).

Therefore, keeping all in context the present study was undertaken to find out the extent of crop diversification across different farm size groups in The North Bank Plains Zone of Assam.

2. METHODOLOGY

The study was undertaken in the state of Assam, one of the states in North-Eastern region of India. The state of Assam is divided into 33 Administrative Districts. Out of these 33 districts, the study was conducted randomly in Lakhimpur and Sonitpur districts lying in the NBPZ of Assam. From both the districts, one sub-division, one ADO circles, two AEA *elekas* and two villages from each AEA *elekas* were selected randomly. A total of eight villages, four from each district, was selected viz. Phukan Doloni, Pukhuria, Rowdang and Gelahati Village from Lakhimpur district and Punioni, Napam, Goramari and Sopaguri village from Sonitpur district. From each of the selected villages, 20 respondents were selected randomly for the study. To carry out the study farmers were categorized following the landholding classification of Assam State Department of Agriculture. It is categorized as follows.

List 1 . Categorized

Categories	**Range**
Marginal farmers	Upto 1 ha
Small farmers	1.1-2 ha

Medium farmers	2.1- 4 ha
Big farmers	Above 4.1 ha

To find the extent of crop diversification, the Simpson Index of Diversity (Simpson, 1949) was used. It is a measure of diversity which takes into accounts both richness and evenness. The value of a diversity index increases both when the number of types increases and when evenness increases. For a given number of types, the value of a diversity index is maximized when all types are equally abundant. It has advantages of computational simplicity, robustness and wider applicability. The index ranges between 0 and 1. If ~~there~~ complete specialization exists, the index tends towards 0 and in cases of complete diversification, it tends towards 1. The Simpson Index of Diversification (SID) is calculated using the following equation:

$$SID = 1 - W_i^2 \qquad \text{where,} \qquad w_i = X_i / \sum X_i$$

Where, X_i = cropped area or income of the i^{th} crop or enterprise

W_i = proportionate area or income of i^{th} crop or enterprise in the total income or cropped area

i = 1,2……n (n = total number of crops or enterprise)

The following indicators were used to calculate the crop diversification of an individual farmer.

(i) Area under each crop: It implies the proportionate distribution of available farm land to different crops during a calendar year.

(ii) Income from each crop: It refers to the income received from different crops.

(iii) Number of enterprises: It refers to the total number of enterprises managed by an individual farmer recommended for study area**.**

(iv) Income from each enterprise: It refers to the income received from different enterprises *e.g.* crop production, animal husbandry, agro processing, retail trade etc.

List 2 .Based on SDI value obtained by the respondents, they were grouped into three categories by using mean and standard deviation.

Categories	Score Range
Low crop diversification	Up to ($\overline{X}$ -1SD)
Medium crop diversification	($\overline{X}$ - 1 SD) to ($\overline{X}$ + 1 SD)
High crop diversification	Above ($\overline{X}$ + 1 SD)

3. FINDINGS AND DISCUSSION

Before working out the crop diversification of different categories of farmers, the number of farmers adopting different crops was found out. Table 1 shows the frequency distribution of respondents according to different crops.

Table 1. Frequency distribution of respondents according to different crops

Sl. No.	Crops	Marginal farmers (n=37)	Small farmers (n=69)	Medium farmers (n=54)	Pooled sample (n=160)
1	Rice	37 (100)	67 (97.10)	54 (100)	158 (98.75)
2	Sugarcane	4 (10.81)	14 (20.28)	38 (55.07)	56 (35.00)
3	Potato	16	36	48	100

		(43.24)	(52.17)	(88.89)	(62.50)
4	Cauliflower	31 (83.78)	61 (88.40)	51 (94.44)	143 (89.37)
5	Cabbage	31 (83.78)	59 (85.51)	52 (96.29)	142 (88.75)
6	Ridge gourd	7 (18.91)	21 (30.43)	33 (61.11)	61 (38.13)
7	Cucumber	5 (13.51)	9 (13.04)	23 (42.59)	37 (23.13)
8	Sponge gourd	5 (13.51)	35 (50.72)	22 (40.74)	62 (38.75)
9	Mustard	7 (18.91)	17 (24.63)	44 (81.48)	68 (42.50)
10	Turmeric	2 (5.41)	15 (21.73)	8 (14.81)	25 (15.63)
11	Colacasia	0 (0.00)	7 (10.14)	17 (31.48)	24 (15.00)
12	Chilli	6 (16.21)	33 (47.82)	35 (64.81)	74 (46.25)
13	Capsicum	0 (0.00	3 (4.35)	10 (18.51)	13 (8.13)
14	Arecanut	6 (16.21	29 (42.03)	27 (50.00)	62 (38.75)
15	Pea	2 (5.41)	6 (8.70)	15 (27.78)	23 (14.37)
16	Pumpkin	2 (5.41)	10 (14.49)	8 (14.81)	20 (12.50)
17	Tomato	4 (10.81)	10 (14.49)	15 (14.81)	29 (18.13)
18	Blackgram	0 (0.00)	3 (4.35)	16 (29.63)	19 (11.88)
19	Coriander	2 (5.41)	11 (15.94)	8 (14.81)	21 (13.12)
20	Okra	1 (2.70)	11 (15.94)	30 (55.56)	42 (26.25)
21	Ginger	5 (13.51)	12 (17.39)	14 (25.92)	31 (19.38)
22	Lemon	9 (24.32)	32 (46.37)	14 (25.92)	55 (34.38)
23	Bottle gourd	1 (2.70)	7 (10.14)	27 (50.00)	35 (21.88)
24	Brinjal	3 (8.11)	18 (26.08)	18 (33.33)	39 (24.38)

* Figures within parenthesis indicate percentage

A perusal of the Table reveals that in case of marginal farmers, all of them (100.00%) were cultivating rice crop. An equal proportion of them (83.78) were cultivating cauliflower and

cabbage followed by 43.24 per cent of them cultivating potato. A sizeable proportion of them (24.32%) were cultivating lemon. The proportions of marginal farmers cultivating other crops were below 20.00 per cent. As regards small farmers, majority (97.10%) of them were cultivating rice crop followed by 88.51 per cent cultivating cabbage and 88.40 per cent of them cultivating cauliflower. More than half of them were found to cultivate potato (52.27%) and sponge gourd (50.27%). A sizeable proportion of them (47.82%) were cultivating chilli followed by 46.37 per cent cultivating lemon and 42.03 per cent were cultivating arecanut. Ridge gourd was cultivated by 30.43 per cent of the small farmers. The proportions of small farmers cultivating other crops were below 30.00 per cent. In case of medium farmers, all of them (100.00%) were cultivating rice crop. A large proportion of them (96.29%) were cultivating cabbage followed by 94.44 per cent cultivating cauliflower, 88.89 per cent cultivating potato and 81.48 per cent were cultivating mustard. Chilli was cultivated by 64.81 per cent of them followed by 61.11 per cent were cultivating ridge gourd. Okra was cultivated by 55.56 per cent of them followed by 55.07 per cent were cultivating sugarcane. Half of them (50.00%) were found to cultivate arecanut and bottle gourd. A sizeable proportion of them (42.59%) were cultivating cucumber followed by 40.74 per cent cultivating sponge gourd, 33.33 per cent cultivating brinjal and 31.48 per cent were cultivating colacasia. The proportions of medium farmers cultivating other crops were below 30.00 per cent.

Table 2 shows the distribution of respondents based on their crop diversification. Findings in Table 2 reveal that majority of the marginal farmer respondents (59.46%) were in medium crop diversification category followed by 27.03 per cent of them in low crop diversification and 13.51 per cent of them in high crop diversification category. The mean crop diversification index score (0.567) indicated low crop diversification. The value of coefficients

of variation (19.76%) indicated that the respondents were relatively homogeneous with respect to their extent of crop diversification.

Table 2. Distribution of respondents according to their crop diversification

Category	Range	Number of farmers			
		Marginal (n=37)	**Small (n=69)**	**Medium (n=54)**	**Total (n=160)**
Low	0.216-0.574	10 (27.03)	8 (11.59)	7 (12.97)	25 (15.63)
Medium	0.575-0.803	22 (59.46)	52 (75.37)	29 (53.70)	103 (64.37)
High	0.804-0.878	5 (13.51)	9 (13.04)	18 (33.33)	32 (20.00)
Mean score		0.567	0.688	0.775	0.689
S.D		0.112	0.079	0.074	0.115
C.V		19.76	11.50	9.57	16.72

* Figures within parenthesis indicate percentage

In case of small farmers, majority of the respondents (75.37%) were in medium crop diversification category followed by 13.04 per cent of them in high and 11.59 per cent of them in low crop diversification category. Their mean crop diversification index score (0.688) indicated medium crop diversification. The value of coefficients of variation (11.50%) indicated that the respondents were relatively homogeneous with respect to their extent of crop diversification. As regards medium farmers, majority of the respondents (53.70%) were in medium crop

diversification category followed by 33.33 per cent of them in high and 12.97 per cent of them in low crop diversification category. Their mean crop diversification index score (0.775) indicated medium crop diversification. The value of coefficients of variation (9.57%) indicated that the respondents were highly homogeneous with respect to their extent of crop diversification.

In the pooled sample of farmers, majority of the respondents (64.37%) were in medium crop diversification category followed by 20.00 per cent of them in high and 15.63 per cent were in low crop diversification category. Their mean crop diversification index score (0.689) indicated medium crop diversification. The value of coefficients of variation (16.72%) indicated that the respondents were relatively homogeneous with respect to their extent of crop diversification.

The highest mean crop diversification index score (0.775) was obtained for medium farmers and lowest (0.567) for marginal farmers. All the mean scores indicated medium level crop diversification However, an increase in crop diversification score was seen with increase in land holding size.

The values of coefficients of variation indicated that marginal farmers had more variability (19.76%) as compared to small (11.50%) and medium (9.57%) farmers with respect to their crop diversification.

4. CONCLUSION

Persistent low level of farmers' income can cause serious adverse effect on the future of agriculture in the country. To secure future of agriculture and to improve livelihood of half of India's population, adequate attention needs to be given to improve the welfare of farmers and raise agricultural income. Introduction, adaption and acceptance of new varieties as well as new

and upcoming production technologies can potentially strengthen farmers' cropping systems by increasing yields, improving draught resilience, boosting resistance to pests and diseases and also by capturing new market opportunities. There is a need to identify crops and varieties that may suit to a range of environments and farmers' preferences. Crop diversification provides better conditions for food security and enables farmers to grow surplus product for sale at market and thus help to obtain increased income to meet other needs related to household well-being. Crop diversification can enable farmers' to gain access to national and international market with new products, fruits and medicinal plants. Diversifying from the monoculture of traditional staples can have important nutritional benefits for farmers' in developing countries and can support a country for becoming self-reliant in terms of food production. Diversification can also manage price risk, on the assumption that not all products will suffer low market prices at the same time and increase the profitability of the farming community (Khanam *et al*, 2018).

If crop diversification is to be developed as a tool for improving cropping systems, developing novel value-chains and providing other socio-economic benefits, it is necessary to develop a shared conceptual understanding. Hence, it is recommended that there is need for concerted efforts by the concerned extension functionaries and development workers to increase the extent of agricultural/crop diversification by the farmers.

REFERENCES

Adriano, M.S and Cabezon, V.E. (1993). Economic policies affecting crop diversification in the Phillipines. Proc. National Workshop on Crop Diversification in the Phillipines, IIMI, Sri Lanka, 134-142.

Bedoussac, L., Journet, E. P., Hauggaard-Nielsen, H., Naudin, C., Corre- Hellou, G., Jensen, E. S., Prieur, L. and Justes, E. (2015). Ecological principles underlying the increase of productivity achieved by cereal-grain legume intercrops in organic farming. *A review. Agron Sustain Dev*. **35**(3):911–935. https://doi.org/10.1007/s13593-014-0277-7

Espino, R.F.C. and Atienza, C.S. (2000). "Crop diversification in the Phillipines". Expert consultation on "Crop Diversification in the Asia-Pacific Region", held in Bangkok, Thailand, 4-6 July, 2000.

Gonzales, L.A. (1989). The economics of diversifying into irrigated non-rice crops in the Phillipines. Proc. National workshop on Crop Diversification in the Phillipines, IIMI, Sri Lanka, 203-208.

Gopalappa D.V. (1996). Crop diversification and income level in Karimnagar District of Andhra Pradesh. *Indian Journal of Agricultural Economics*. **51**(3):381-388.

Haughey, E., Suter, M., Hofer, D., Hoekstra, N. J., McElwain, J. C., Lüscher, A. and Finn J. A. (2018). Higher species richness enhances yield stability in intensively managed grasslands with experimental disturbance. *Sci Rep*. **8**(1):15047.

Hazra, C.R. (2000). "Crop diversification in India". Expert consultation on "Crop Diversification in the Asia-Pacific Region", held in Bangkok, Thailand, 4-6 July, 2000

Khanam, R., Bhaduri, D. and Nyak. A.K. (2018). Crop diversification: an important way out for doublimg farmers' income. *Indian Farming.* 68(01): 31-32

Kremen, C., Iles, A. and Bacon, C. (2012). Diversified farming systems: an agroecological, systems based alternative to modern industrial agriculture. Ecol Soc. **17**(4).

Reckling M., Hecker J. M., Bergkvist G.,Watson C., Zander P., Stoddard F., Eory V., Topp K., Maire J. and Bachinger J. (2016). A cropping system assessment framework - evaluating effects of introducing legumes into crop rotations. *Eur J Agron*. 76:186–197.

Renard, D. and Tilman, D. (2019). National food production stabilized by crop diversity. Nature 571:257–260.

Simpson, E. H. (1949). Measurement of diversity. *Nature*.163-688

Singh, K. P. (2009). Study on sustainable rural livelihoods of semi developed districts of Bundelkhand area. *M.Sc. Thesis*. Jahawarlala Nehru Krishivishva Vidyalaya, Jabalpur

Watson, C., Reckling, M., Preissel, S., Bachinger, J., Bergkvist G, Kuhlman T, LindströmK, Nemecek T., Topp, C., Vanhatalo, A., Zander, Z., Murphy- Bokern D. and Stoddard, F. (2017). Grain legume production and use in European agricultural systems. *Adv Agron***.** **144**(1):235–303.

Yang L. N., Pan Z. C., Zhu W.,Wu E. J., He D. C., Yuan X., Qin Y. Y.,Wang Y., Chen R. S., Thrall P. H., Burdon J. J., Shang L. P., Sui Q. J. and Zhan J. (2019). Enhanced agricultural sustainability through within-species diversification**.** *Nat Sustain* **2**(1):46–52.