

CROP DIVERSIFICATION AND FARM INCOME IN THE HILLS OF NORTH EAST INDIA: A CASE OF ARUNACHAL PRADESH

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ABSTRACT

North East India is primarily an agriculture based economy. Around three-fourth of the region is hilly and mountainous. The cultivable land is quite limited due to difficult terrains and large forest cover. Given these challenges, focussing on improving productivity and crop diversification towards high value crops seem to be suitable strategy to enhance farmers' income and promote rural development in the region. This paper examines the extent of crop diversification and its impact on farm income in Arunachal Pradesh. The study is based on the analysis of both primary and secondary data. Simpson Index of Diversification (SID) showed a high and growing degree of crop diversification in the State. The relationship between crop diversification and farm income was investigated with the multiple regression model. The result indicated positive and significant impact of crop diversification on farm income. This implied that crop diversification can be adopted as an effective strategy to improve well-being of farmers. However, there are certain challenges and issues such as, poor extension services, poor infrastructure, lack of cold storage, high cost of inputs, unorganised marketing, which need to be addressed to promote rural development in the State.

Keywords: *Crop Diversification, Farm Income, Rural Development*

INTRODUCTION

Crop diversification is regarded as an important strategy to mitigate risk and enhance income of farmers. The concept of crop diversification implies reallocation of resources in a large mix of diverse and complementary activities within agriculture. The process of crop diversification involves a shift of the resources particularly cultivated area from cereals and low value crops to high value crops like fruits and vegetables. Diversification of crops towards high value crops including fruits and vegetables, compatible with the comparative advantage of the region, is suggested as a viable solution to stabilise and raise farm income, increase employment opportunities for small and marginal farmers, boost exports and conserve and enhance natural resource base (Sharma, 2007). In this regard it is important to note that doubling income of farmers by the 2022 has been one of the main objectives of the Government of India (Chandrasekhar and Mehrotra, 2016). In fact, NITI Ayog has identified five issues; increasing agricultural productivity, remunerative prices for farmers, focus on land leasing and land titles, risk adaptation and mitigation, and a geographical focus on the eastern region, that need attention to improve the livelihood of the farmer households (Anonymous, 2015). Thus, crop diversification towards high value crops can be one of the effective strategies to realise the objectives of raising farm income.

Crop diversification and farm income are closely related to each other. Many studies have reported positive impact of crop diversification on farm income. Mandal and Bezbarua (2013) in their study of Assam found that crop diversification had been adopted by the farmers as a mechanism to cope with limits imposed by flood and crop diversification was found to have positive impact in enhancing farm income. Ibrahim *et al.*, (2009) applied the Simpson Index of Diversity to examine income and crop diversification in rural area of North Central Nigeria. The study reported high degree of income and crop diversification. Abro (2012) examined the impact of different forces on crop diversification in Pakistan for the period 1980-2011. The study showed that crop diversification towards high value crops could provide adequate income and employment to farmers. Bhattacharyya (2008) explored the farmers' cropping strategy and determinants of diversification in West Bengal. Crop diversification was found to be positively influenced by technological variables such as fertiliser use, infrastructure development

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(length of road) and prices of crops. De (2003) in a study in West Bengal found irrigation and chemical fertiliser as the important determinants of crop diversification.

North Eastern Region of India, which comprises of eight States, namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, is predominantly an agriculture based economy. The region accounts for around 8 per cent of the country's total geographical area. But almost two-third of the region is hilly and the rest is under plains. Agriculture is the mainstay of majority of the people in North East India.

In the hilly States cultivable land area is limited, being confined to the valleys and hill slopes. Agricultural productivity is low as the topography does not permit the intensive use of irrigation and modern inputs. In such a situation, crop diversification towards high value crops can significantly enhance farm income and livelihood of people in the region.

Arunachal Pradesh is the easternmost State of India and is located between $26^{\circ} 28' N$ and $29^{\circ} 33' N$ and $91^{\circ} 31' E$ and $97^{\circ} 30' E$. It is the largest State of North East India with geographical area of 83,743 Sq. Km. Agriculture is the dominant activity of vast majority of its people. A large proportion of its population depend on agriculture for their livelihood. The share of agriculture in Gross State Domestic Product (GSDP) has declined over the years from about 40 per cent in 1990-91 to 16.79 per cent in 2012-13 due to rapid growth of service sector.

However, still more than 60 per cent of the population depends of agriculture. As per 2011 census 58 per cent of its workforce was engaged in agriculture sector. The arable land is extremely limited owing to its hilly and mountainous topography. Operational area in the State was only 4.59 per cent of its geographical area in 2010-11. This is due to its difficult terrains and large forest cover; 80.50 per cent of geographical area (State of Forest Report 2013).

The State is having very low density of population (17 persons per 100 sq. km as per 2011 Census). But there has been increase in stress on land reflected by fall in average size of holding which declined from 6.19 hectares in 1970-71 to 3.51 hectares in 2010-11. At the same time, agricultural productivity is relatively low in the State. In such a situation, crop diversification towards high value crops can play a significant role in improving farm income and livelihood of people. The temperate climatic conditions of the State favour cultivation of off-season vegetables and temperate fruits. In this background, the present study attempted to explore the changes in cropping pattern and crop diversification in the State. It also examined the impact of crop diversification on rural farm income. The study is expected to have important policy implications for development of hill agriculture as well as promote rural development in the State.

Study Area

The study was conducted in two hilly districts of Arunachal Pradesh namely, West Kameng and Tawang districts. The entire area is hilly and mountainous as it falls in the eastern Himalayan ranges with its elevation ranging from 1800 metres to 7000 metres and above. West Kameng district is spread over an area of 7422 sq. km accounting for 8.86 per cent of the total geographical area of the State. Tawang district has an area of 2172 sq. km accounting for 2.59 per cent of the State's geographical areas. Both the districts together accounted for 11.45 per cent of the State's geographical area and 9.91 per cent of the State's total population (Census 2011). The topography of both the district is predominantly hilly and mountainous. In these districts, 80 per cent of the people live in rural area and agriculture is the mainstay of majority of the people.

Objectives

The objectives of the study were to examine extent of crop diversification and its impact of on farm income in the hilly districts of Arunachal Pradesh.

MATERIALS AND METHODS

The study was based on both primary and secondary data. But it mainly relied on farm level primary data generated through field survey to have more realistic picture of the agrarian scenario in the area. The secondary data were collected from various reports and statistics published by the government. The

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primary data were collected with the aid of well framed pre-tested questionnaire. The questionnaire was designed to collect information on socio-economic characteristics of farm household. It was designed to collect information relating to size of holdings, area put under different crops, inputs use, other miscellaneous expenditure and output of all crops cultivated both in value and quantitative terms. All these variables were measured in per unit area and time period for analysis was one crop year. The survey was based on multi-stage random sampling technique. In the first stage two districts were selected by purposive sampling.

In the second stage, from each district, two blocks were selected. In the third stage, from each block two villages were selected. In the final stage, households were selected at random from each village and required information was collected. The sample size was 150 farm households.

The villages were selected on the basis of distance from the district headquarter. In order to give proper representation of the sample, some villages located far away from the district headquarter were selected from and some located near the district were selected. The collected data were processed and analysed using various statistical techniques.

Analytical Techniques

Crop diversification refers to allocation of resources mainly, cultivable land and other resources at the disposal of farmers to different crops so as to mitigate risk and increase farm income. There are several methods to measure the degree of crop diversification. In this study, Simpson Index of Diversity (SID) has been applied to measure the extent of crop diversification in the study area. This method has been widely used to measure the biodiversity of an ecosystem. Joshi *et al.*, (2003) applied this method to compare crop diversification in South Asian countries. The SID can be computed using the following formula:

$$SID = 1 - \sum x_i^2$$

Where;

x_i = proportion of area under crop 'i'.

If only one crop is cultivated, $x_i = 1$ and SID = 0. As the number of crops increases, the share " x_i " declines as does the sum of the squared share, so that SID approaches 1. The closer the SID to one more the diversification and reverse implies the more specialisation.

The impact of crop diversification on farm income has been examined with the help of a multiple linear regression model of the form specified below:

$$FI_j = \beta_0 + \beta_1 Y_j + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \dots + \varepsilon_j \quad (3)$$

Where, FI = Gross farm income, Y_j = diversification index and X_i = other explanatory variables and ε_j = error term which is assumed to be normally distributed with zero mean and constant variance. The data were analysed using statistical software packages such as MS Excel, SPSS and Stata.

RESULTS AND DISCUSSION

Changes in Cropping Pattern

Cropping pattern may be defined as the proportion of area under different crops at a point of time in a region or a country. A change in cropping pattern over a period of time implies a change in proportion of area allocated to different crops.

The change in cropping pattern over time may be influenced many factors such as physical factor, environmental factor, institutional factor, social and economic factors, infrastructure factors and political system. It may be essential to mitigate risk and to improve livelihood of farming household. In this regard an attempt has been made to analyse the changes in cropping in the State. It was observed that in the State the area under food grains has been declining and the area under commercial crops has been increasing over the years. For instance, the share of area under food grains has declined significantly from 75.8 per cent in 1990-91 to 55.03 per cent in 2013-14.

On the other hand, the share of area under commercial crops has increased significantly from 24.2 per cent to 44.97 per cent during the same period (Table 1). This indicates that there is tendency of diversification towards high value crops in the State.

Research Article**Table 1: Changes in Cropping Pattern in Arunachal Pradesh (Area in Percentage)**

Crops	1990-91	2001-02	2007-08	2012-13	2013-14
Rice	49.1	40.2	39.97	36.46	33.88
Maize	15.1	13	13.77	13.73	12.07
Millet	8	6.7	7.19	6.56	5.84
Wheat	1.4	1.3	1.15	1.27	0.76
Pulses	2.2	2.3	2.74	3.06	2.48
Total Food Grains	75.8	63.5	64.83	61.08	55.03
Oilseeds	9.1	9.3	9.90	9.47	8.50
Potato	NA	NA	1.24	1.39	1.27
Spices	1.1	3.3	7.03	4.86	5.49
Sugarcane	0.1	0.3	0.40	0.44	0.40
Vegetables	6.5	8.1	6.61	7.11	6.46
Fruits	7.4	15.5	19.90	25.12	22.86
Total Non-Food	24.2	36.5	35.17	38.92	44.97

Source: Statistical Abstract of Arunachal Pradesh (Various years) (Computed)

The decline in the area under food grains was mainly on account of fall in area under rice, maize and millet. While the share of area under rice fell sharply from 49.19 per cent in 1990-91 to 33.8 per cent in 2013-14, the share of area under maize fell from 15.1 per cent to 12.07 per cent and the share of area under millet fell from 8 per cent to 5.84 per cent during the same period. The share of area under wheat also fell marginally from 1.4 per cent to 0.76 per cent during the same period. The increase in area under commercial crop was mainly contributed by sharp increase in area under fruits and spices. The share of area under fruits rose sharply from 7.4 per cent in 1990-91 to 22.86 per cent in 2013-14. At the same time, the share of area under spices rose from 1.1 per cent to 5.49 per cent during the same period. However, the area under oilseeds fell marginally from 9.1 per cent in 1990-91 to 8.50 per cent in 2013-14. The share of area under potato, vegetables and sugarcane remained more or less constant. The sharp increase in area under fruits and spices indicates crop diversification towards high value crops (HVCs). This can be attributed to favourable temperate climatic conditions for cultivation of fruits as well as efforts made by the State under National Horticulture Mission Scheme. The change in cropping pattern in the State shows a healthy trend in development of agriculture.

Extent of Crop Diversification

An examination of the extent of crop diversification in the State was carried out with the help of the Simpson index of diversification (SID). The SID value was computed to measure the extent of crop diversification. The value of SID was found to be high and increasing over the years. It was computed to be 0.71 in 1990-91 which rose to 0.83 in 2007-08. However, it declined to 0.79 in 2012-13 and again rose to 0.80 in 2013-14 (Table 2).

Table 2: Simpson Index of Diversification (SID) for Arunachal Pradesh

Year	SID value
1990-91	0.71
2001-02	0.78
2007-08	0.83
2012-13	0.79
2013-14	0.80

Source: Statistical Abstract of Arunachal Pradesh (Computed)

The SID value for the State indicates that crop diversification in the State is very high and has been increasing over the years. This implies that farmers in the State cultivate a large number of crops in their

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field to mitigate risk as well as to meet the requirement of their family. This is important to enhance their income and improve livelihood. An analysis of inter district variations in crop diversification revealed that in 2013-14 the SID value calculated to be the highest for West Kameng district (0.78) followed by Kurung Kumey district (0.77). Crop diversification was found to be the lowest in East Siang with SID value of 0.33 followed by West Siang district (0.42). The other districts with SID value of 0.70 and above were; Tirap, Longding, Tawang, Dibang Valley, Lohit, Upper Subansiri. The inter district variations in crop diversification is mainly due to difference in geographical and climatic conditions. The SID value was found to be high in relatively more hilly districts and low in relatively plain district. This indicates that relatively plain districts are more or less specialised in production of paddy while the hilly districts are diversified in production of various crops such as vegetables, fruits and spices owing to favourable climatic conditions.

Crop Diversification and Farm Income

Crop diversification is regarded as an important strategy to mitigate risk, secure livelihood and enhance farm income. Crop diversification particularly towards high value crops are considered to have positive contribution in raising farm income. The relationship between crop diversification and farm income was investigated with a multiple regression model. In order to examine the impact of crop diversification on farm income, net farm income (FI) generated per hectare (in thousand rupees) has been taken as dependent variable. Net farm income has been computed by deduction costs on inputs from gross farm income. In the explanatory variables, apart from crop diversification index (Y), farm size (FS) and machinery use which may have influenced farm income were added. However, a high and positive correlation was found between crop diversification index and machinery use indicating the problem of multi collinearity. Hence, the variable machinery use was removed and final regression was run with only two explanatory variables namely, crop diversification index and farm size. The descriptive statistics of the variables are presented in table 3.

Table 3: Descriptive Statistics of the Variables Included in Regression Analysis

Variables	Unit	Min	Max	Mean	Std. Deviation
Farm Income (FI)	Thousand Rupees	1.82	100	28.18	29.38
Crop Diversification (Y)	-	0.12	0.85	0.51	0.29
Farm Size (FS)	Hectare	0.38	6	1.58	0.90

Source: Field Survey, 2015

Net farm income of the sample farm households ranged from Rs. 1.82 thousand to Rs. 100 thousand with mean of Rs. 28.18 thousand and standard deviation of 29.38. A high standard deviation of farm income indicates wide variation in income generated from farm among the household. Crop diversification index varied from 0.12 to 0.85 with mean vale of 0.51. Farm size of the sample household ranged from 0.38 hectare to 6 hectares with mean of 1.58 hectares and standard deviation of 0.90. A low standard deviation of farm size indicates less inequality in land holding pattern among the farmers of hill agriculture. This may be attributed to community ownership and traditional rights over land in tribal areas.

Specification of Model

The regression model as applied in the study to investigate the impact of crop diversification on farm income is specified below.

$$FI_j = \beta_0 + \beta_1 Y_j + \beta_2 FS_j + \epsilon_j$$

This model has been widely used to investigate the relationship among variables. The above equation has been estimated by the Ordinary Least Square (OLS) method assuming that error terms are independently and normally distributed with zero mean. However, in cross-sectional data the presence of heteroscedasticity is common. It is advisable to run test for the presence of heteroscedasticity and make necessary correction because ignoring this problem would give inconsistent estimators. Since, the study is based on cross-sectional data, could not be ruled out. To test for presence of heteroscedasticity, Breusch-

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Pagan test was run. The result indicated the presence of strong heteroscedasticity. Therefore, the final estimates were obtained after affecting White's heteroscedasticity correction procedures. Durbin-Watson test for presence of autocorrelation was also run. The result indicated the absence of this problem. The result of the regression analysis on impact of crop diversification on farm income is presented in the Table 4.

Table 4: Results of Regression on Generation of Farm Income

Dependent Variable: Farm Income (FI) (per hectare)

Variables	Coefficient	Robust SE	t-Value	p - Value
Crop Diversification (Y)	82.06***	5.23	15.68	0.00
Farm Size (FS)	-3.61**	1.85	-1.95	0.05
Constant	-8.07**	3.77	-2.14	0.03
R-Square	0.64			
Adjusted R2	0.63			
F (2, 147)	124.17***			

Note: *** and ** indicate significant at 1 per cent and 5 per cent level respectively.

The coefficient of crop diversification (Y) was positive and significant at 0.01 level (Table 4). It indicated that greater is the crop diversification the higher is the farm income generation. It implies that diversified farmers are able to generate more income from farm than less diversified farmers. Hence, it can be suggested to promote crop diversification in the hill agriculture to enhance rural development and improve living standard of farmers. Farm size was found to have negative impact on farm income. Its coefficient was negative and significant at 0.05 level. This implies that small farms are able to generate more income per hectare of net sown area than the large farms. This is similar to the finding of Mandal and Bezbruh (2012). This indicates that small farmers in the hills are more diversified towards commercial crops and generate more income from small plot to meet family requirement. During the survey it was observed that small farmers were highly diversified towards commercial crops like potato, tomato and cabbage.

The values of R-square and adjusted R-square were found to be 0.64 and 0.63 respectively which are fairly high indicating good explanatory power of the variables included. At the same time, F-Statistic was highly significant. All this indicated good fit of the model.

The analysis revealed that cropping pattern in the State has witnessed significant change. The share food grain in total cropped area has declined significantly and the share of cash crops has increased significantly during the period 1990-91 to 2013-14. Crop diversification in the State was found to be high and increasing over the years. The crop diversification among the surveyed farm households was also high. The regression results on the impact of crop diversification on farm income indicated positive and significant impact which implies that farm income increased with crop diversification. The relationship between farm size and farm income per unit area was negative but not significant. However, number of challenges and problems were identified for agriculture development like limited arable land, poor irrigation, non-availability of inputs, poor transportation, lack of cold storage etc. Hence, there is a need to address those challenges to raise farm income and improve livelihoods of farmers in the rural areas of the State. These call for proper policy and support from the State agencies.

Policy Implications

The above findings and discussion lead to the following policy implications: there is a need to revitalise extension services to disseminate new technology in the rural areas. Emphasis should be laid on capacity building and skill upgradation of extension functionaries. Special emphasis should be given for introducing HYV seeds, improved planting material, and adoption of new technology for improving productivity. Irrigation facility should be strengthened. This will help to increase yield rate and also encourage multiple cropping. Cold storage facility should be set up in the area. This will help to reduce

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post-harvest losses and ensure better returns to the farmers. Agro-based industries should be set up in the area to reduce post-harvest wastage and produce value added products from crops like tomato, potato, chilli etc. This will generate income and employment for local youth.

Conclusion

It can be concluded from the results and discussion that cropping pattern in the State is changing in favour of cash crops. The crop diversification is observed to be growing with passage of time. The regression results showed that crop diversification had positive and significant impact on farm income. It can be inferred that farmers who are more diversified have more income than the others. Thus, crop diversification should be promoted in the State for improving the well-being of the farmers. However, there are numerous challenges like poor irrigation, inadequate availability of inputs, high cost of inputs, lack of cold storage facility, poor transportation etc. In this regard, the government must play a proactive role in introducing and disseminating new technology. It should strengthen extension services; provide finance, better inputs, support prices. In addition, the private sector should be given incentives to set up agricultural processing plants. The cold storage facilities should be set up, irrigation and transportation should be improved for the development of this sector. This will go a long way in promoting agriculture and rural development in the State.

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