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Crop Diversification and Farm Income in the Hills of North-East India: A Case Study of Arunachal Pradesh

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Department of Economics
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PREFACE

The Centre for Development Studies (CDS) was set up as a research adjunct at the Department of Economics, Rajiv Gandhi University (RGU), Itanagar, Arunachal Pradesh, with a generous grant from the Ministry of Finance (Department of Economic Affairs), Government of India. The objectives of the Centre include the creation of high-quality research infrastructure for students and researchers and faculty members, in addition to sponsoring and coordinating research on various developmental issues having policy implications both at the regional and national level. Publishing working/policy papers on the research outcome of the Centre, monographs and edited volumes areamong the key activities of the Centre. The present working paper by Dr. Maila Lama, titled, '***Crop Diversification and Farm Income in the Hills of the North-East India: A case Study of Arunachal Pradesh***', is the research outcome of a project funded by the CDS. It is the *second* in the series of working paper published by the Centre for Development Studies.

The working paper focuses on crop diversification and farm incomes in the hills of North East India. The 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. The present study explores the status and extent of crop diversification in the hilly areas of the State of Arunachal Pradesh. The analysis of the data reveals that productivity of different crops is lower in the State compared to the national average and that of the other States. Hence emphasis should be on improving productivity on the one hand and on the other hand, focus should be on all income-generating activities like cash crops, floriculture, horticulture, fish culture and pig-rearing, agro-processing etc. to enhance the income of the farmers. The results showed that crop diversification had a positive and significant impact on farm income. Hence there is a need to introduce new technology, strengthen extension services, provide cheap credit, new inputs, marketing infrastructure and support prices. The cold storage facilities, irrigation and transportation should be improved for the development of the agriculture sector.

This working paper, with its focus on crop diversification and farm income of the State, will be of interest and use to policy planners, academics, researchers and students. I congratulate the author for the excellent time bound work.

Date: July, 2019

Vandana Upadhyay
Coordinator, Centre for Development Studies
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SUMMARY

The 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. The diversification of crops towards 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). The promotion of crop diversification can be one of the best strategies to mitigate risk, increase agricultural productivity and raise income of farmers.

Arunachal Pradesh, with geographical area of 83,743 Sq. Km is the largest State of North-East India, but arable land is extremely limited owing to its hilly and mountainous topography. Agriculture is the largest employer but agricultural productivity is relatively low. In such a situation, crop diversification towards high value crops can play a significant role in improving livelihood of rural people in the State. In this background, the present study attempted to explore the status and extent of crop diversification in the State. The study has been carried out in two hilly districts of Arunachal Pradesh namely, West Kameng and Tawang districts. The study was based on both primary and secondary data. The sample size was 150 farm households. Simpson Index of Diversity (SID) was applied to measure the extent of crop diversification and multiple regression model was used examine the impact of crop diversification on farm income.

The study has been organised under six chapters. The ***first chapter*** consists of background, objectives of the study, hypotheses, overview of literature, data source and methodology and a brief description of the study area.

The ***second chapter*** deals with analysis of changes in land use pattern, cropping pattern and growth in production of crops in the State. The arable land is extremely limited owing to its hilly and mountainous topography. The operational area in the State was only 4.59 per cent of its geographical area in 2010-11. Cropping intensity in the State has increased from 121.82 per cent in 1995-96 to 130.50 per cent in 2010-11 but it is still lower than the national average which can be attributed to poor irrigation facilities.

The cropping pattern in the State has undergone significant changes. 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 while the area under commercial crops has increased significantly from 24.2 per cent to 44.97 per cent during the same period. This indicates that there is tendency of diversification towards high value crops. The

Simpson index of diversification (SID) indicated high extent of crop diversification. It was 0.71 in 1990-91 which rose to 0.80 in 2013-14.

The production of food grains in the State increased from 242.4 thousand tonnes in 2002-03 to 384.6 thousand tonnes in 2013-14 with compound annual rate of growth (CARG) of 4.19 per cent. The increase in production was mainly contributed by increase in production of paddy, pulses and maize.

The ***third chapter*** deals with the analysis of socio-economic profile of farmers. It was found that most of the respondents were in the age group of 30-50 years. The mean age of the respondents was estimated to be 48.26 years. Gender distribution of respondent farmers showed that most of them were male. Educational level of the surveyed farmers indicated that majority of them were illiterate. Most of the surveyed households showed had semi-medium size of land holdings followed by small size.

The ***fourth chapter*** evaluates level of inputs use, cost of production and returns from various crops cultivated by the surveyed farm households. It was found that quantity of inputs used as well as costs was relatively low in case of food crops than the cash crops. The level of use of fertiliser by the surveyed households was relatively low, particularly in case of food crops. Net income and cost ratio measures of farm efficiency showed farm efficiency to be better in production of chilli, pulses and potato.

The ***fifth chapter*** deals with analysis of cropping pattern of the surveyed farm households and impact of crop diversification on farm income. Crop diversification was quite high in all surveyed villages. The SID value was above 0.6 for all surveyed villages. Correlation between distance of village from district headquarters and the SID value was found to be negative. The analysis of impact of crop diversification and on farm income showed positive impact. But are numerous challenges and problems of agriculture development in the area like non-availability and high cost of inputs, poor irrigation and transport facility, lack of cold storage and credit facility, marketing problem.

The ***sixth chapter*** is a concluding chapter dealing with the summary of the important findings of the study, conclusions and policy implications. The following policy implications have been suggested: revitalise extension services to disseminate new technology in the rural areas, introduce HYV seeds, improved planting material, and adoption of new technology for improving productivity, strengthen irrigation facility, provide credit at reasonable rate, set up cold storage facility, improve transport, provide support price, set up agro-processing industries, implement national crop insurance scheme.

The discussion and findings of the study lead us to the following conclusions. The analysis of data revealed that productivity of different crops is lower in the State compared to national average and other States. The policy, therefore, should emphasis on improving productivity on the one hand and on the other hand, it should focus on all income-generating activities like cash crops, floriculture, fruit etc. culture, fish and pig-rearing, agro-processing etc. to enhance income of farmers. The results showed that crop diversification had positive and significant impact on farm income. So, crop diversification should be promoted in the State for improving the income of the farmers. There is a need to introduce new technology, strengthen extension services, cheap credit, new inputs, marketing infrastructure and support prices. The cold storage facilities, irrigation and transportation should be improved for the development of the agriculture sector.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

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. The 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). Doubling income of farmers by the 2022 has been one of the main objectives of the Government of India (Chandrasekhar and Mehrotra, 2016). NITI Ayoghas 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, promotion of crop diversification can be one of the best strategies to mitigate risk, increase agricultural productivity and raise income of farmers in the country in general and North Eastern Region in particular. This will help in promoting sustainable livelihood in rural areas.

North Eastern Region of India, which comprises of eight States, is one of most backward regions of the country. 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, with geographical area of 83,743 Sq. Km is the largest State of North-East India. Agriculture is the dominant activity of vast majority of its people. A large proportion of its population depends 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 morethan 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 land use statistics shows that the arable land is extremely limited owing to its hilly and mountainous topography. Only around 10 per cent of the total geographical area of the State consisting of foothills and river valley is suitable for cultivation. The State is having very low density of population (17 persons per 100 sq. km as per 2011 provisional 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 livelihood of rural people in the State. The hilly topography and temperate climatic conditions of the State favour cultivation of off-season vegetables and temperate fruits. Diversification towards high value crops can help farmers to generate higher income from a smaller plot of land. An analysis of secondary data revealed that in recent period cropping pattern in the State has been changing in favour of commercial crops. In this background, the present study attempted to explore the status and extent of crop diversification in the State. It also examined the impact of crop diversification on rural farm income. The study also explored issues and challenges of crop diversification in the hill agriculture and suggested measures based on ground realities to address those challenges. The study is expected to have important policy implications for development of hill agriculture as well as promote rural development in the State.

1.2 Overview of Literature

De (2003) examined changes in cropping pattern, productivity and determinants of crop diversification in West Bengal. The study reported that during the period 1970-73 to 1991-94 proportion of area under food grains in the State declined but at a diminishing rate from 89 per cent to 83 per cent. The fall in proportion of area under pulses was large as cereals continued to account for about 80 per cent of the gross cropped area. Among the non-food crops, proportion of area under oilseeds was reported to increase sharply during the period. Irrigation and chemical fertiliser were found to be the important determinants of crop diversification. The study measured crop diversification in terms of expansion of acreage under some crops which is not an appropriate measure.

Sharma (2007) explored the process of crop diversification in Himachal Pradesh. The study analysed the determinants, impacts and challenges of crop diversification in the State. The crop diversification in the State which started with introduction of apples in fifties and vegetables in eighties and gained momentum in seventies and eighties was found to have significant impact on income and employment of small and marginal farmers. The important determinants of crop diversification were found to be rural road length and access to rural credit. Inadequate infrastructure, lack of irrigation facilities, ageing apple plantation, changing climatic conditions, cheaper imports under liberalised regime were the main challenges of crop diversification.

Bhattacharyya (2008) examined the nature and magnitude of the extent of crop diversification in West Bengal in recent years and also explored the farmers' cropping strategy and determinants of diversification. Simpson index was applied to compute the extent of diversification. The extent of crop diversification in the State was found to be relatively low as compared to national level. Crop diversification in the State was found to be positively influenced by technological variables such as fertiliser use. Infrastructure development (length of road) and prices of crops were also found to have positive impact on crop diversification. Hence, the study suggested for providing institutional support to speed up diversification as diversification can reduce risk and augment the income of small farmers and also check environmental degradation to certain extent.

Chakrabarti and Kundu (2009) found that crop diversification towards high value crops had adverse impact on rural non-farm sector as this reduces the demand for products of RNF sector and encouraged the demand for modern industrial sector. The agricultural land conversion for industrialisation was also found to be seriously affecting the non-farm growth.

Abro (2012) examined the impact of different forces on crop diversification in Pakistan for the period 1980-2011. The study found that crop diversification towards high value crops could provide adequate income and employment to farmers. The significant determinants of crop diversification were found to be length of roads, per capita income, fertilizers and number of tube wells.

Ghosh (2013) examined changes in cropping pattern and nature of crop diversification in West Bengal in recent past. The study found that cropping pattern in the State was guided by food grain crops with more than 65 per cent of the gross cropped area. Based on Herfindal index to measure crop diversification, the study found crop diversification to be growing gradually with passage of time.

Mandal and Bezbaruah (2013) examined the determinants of crop diversification and its role in increasing farm income in flood affected agriculture in the plains of Assam by using farm level data collected from 342 households. They 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.

Ji-Kun*et. al.* (2014) attempted to examine whether farmers adapt to extreme weather events through crop diversification and factors influencing farmers' decision on crop diversification against extreme weather events in China. Their study was based on large scale household survey in nine provinces and sample size was 3306. They found that farmers' decision to diversify was mainly influenced by experience of extreme weather events in the previous year rather than in the current year.

Chand and Pavitra (2015) in a study to assess fertiliser use and imbalance estimated the actual and normative quantity of Nitrogen (N), Phosphorous (P) and Potassium (K) use for each State of India corresponding to the current cropping pattern. They found that 12 major States were using less than required level of N and observed large deficits in use of P and K in the country.

1.3 Objectives

The study has been conducted with the following objectives:

1. To examine the status and extent of crop diversification.
2. To assess the impact of crop diversification on farm income.
3. To identify constraints of crop diversification and suggest policy measures.

1.4 Hypotheses

The following hypotheses were tested:

1. The extent of crop diversification is expected to be high.
2. Crop diversification has positive impact on farm income.

1.5 The Study Area

The study has been carried out 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 4000 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. The topography of both the district is predominantly hilly and mountainous. Hence, they are considered good representative of hill agriculture.

The total population of West Kameng district is 87013 persons (6.30 per cent of the total population of the State) with a population density of only 12 persons per sq. km and total population of Tawang district is 49950 (3.61 per cent of total population of the State)with population density of 23 persons per sq. km (Provisional Census 2011). Both the districts together account for 11.45 per cent of the State's geographical area and 9.91 per cent of the State's total population. West Kameng district is inhabited by five major tribes namely, *the Monpas, the Sherdukpen, the Mijis, the Akas and the Buguns*. Tawang district is inhabited mainly by the *Monpa tribe*. In these districts, 80 per cent of the people live in rural area and agriculture is the mainstay of majority of the people.

The temperate climatic condition of the area favours luxuriant growth of temperate fruits and off-season vegetables. The hilly and mountainous topography has limited the arable land and acts as constraints to agriculture development. Responding to natural challenges farmers of these areas practise terrace cultivation which is the distinguish feature of hill agriculture. In this background, crop diversification towards high value crop can be adopted as an effective strategy to mitigate risk and farm income in the hill agriculture. An analysis of secondary data revealed a relatively significant extent of diversification particularly towards vegetable crops.Hence, the study is an attempt to explore the extent and impact of crop diversification on farm income in the area. It attempted to identify constraints and challenges of crop diversification in the hill agriculture of the State.

1.6 Data Source and Methodology

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 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 so 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.

Table 1.1: Village-wise Distribution of Sample Farm Households

District	Village	Distance from district headquarter	No. of sample household
West Kameng	Thembang	42	20
	Namshu	40	20
	Shergaon	35	20
	Rahung	20	20
Tawang	Lodung	75	25
	Mukto	59	15
	Lhou	20	15
	Seru	12	15
Total Sample	-	-	150

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

1.6.1 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:

$$SID = 1 - \sum x_i^2 \quad \text{..... (1)}$$

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.

1.6.2 Specification of Model

Many studies (Sharma, 2007, Abro, 2012, Mandal and Bezbaruah, 2013) have reported positive impact of crop diversification in raising farm income. The present study made an attempt to explore whether the same positive impact of crop diversification holds good in the hill agriculture. Netfarm income generated per unit area has been used as dependent variable to assess the impact of crop diversification on farm income. 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:

$$FI_j = \beta_0 + \beta_1 Y_j + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + ...+ \varepsilon_i \quad \text{..... (3)}$$

Where, FI = Gross farm income, Y_j = diversification index and X_i = other explanatory variables and ε_i = 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.

CHAPTER 2

LAND USE, CROPPING PATTERN AND TRENDS IN PRODUCTION OF CROPS

2.1 Introduction

Arunachal Pradesh is predominantly a hilly area as it is situated in the Eastern Himalayan ranges. The State with a geographical area of 83,747 Sq. km is the largest State in terms of area among the eight State of North East India. The total population of the State is 13,82,611 with a population density of only 17 persons per Sq. km which is one of the lowest in the country (Census 2011). This indicates that per capita availability of land is high in the State. The land-man ratio in the State is 6.06 hectares per person which is much higher than the national average of 0.27 hectare. However, a close scrutiny reveals that arable land is quite limited in the State. This is mainly due to its hilly and mountainous topography. The Statehas difficult terrains and mountain ridges. The hill ridges are situated in haphazard manner. As one ridge ends, the other starts which limits the availability of plain arable land. Between these ridges some narrow and wide valleys come into existence which is suitable for agricultural operation (Bhattacharjee, 2006). In the hilly slopes shifting cultivation in practised. Only some foot hills areas bordering Assam is plain where sedentary cultivation is practised. Because of ridges the surface is of the State is found varied almost everywhere which also results in numerous geographical isolations. Thus, the State has very limited arable land due to topographical constraint. A very high proportion of its area is under forest cover (80.5 per cent) and rugged terrain.

This chapter deals with land use pattern, cropping pattern and trends and growth in production of different crops in the State. It also highlights the relative performance of the State compared to other States of North East Region and country as a whole.

2.2 Land use pattern in Arunachal Pradesh

The total operational area in the State declined from 405878 in 1995-96 hectares to 384000 hectares in 2010-11 (Table A.2.1).As a percentage of geographical area, operational area in the State was only 4.85 per cent in 1995-96 which fell to 4.59 per cent in 2010-11 (Table 2.1). This can be attributed to conversion of agricultural into other uses due to population growth. The net sown area has also declined from 2.43 per cent in 1995-96 to 2.07 per cent of the total geographical in 2005-06. However, it

increased to 2.54 per cent of the total geographical area in 2010-11. The gross cropped area in the State has increased from 2.96 per cent in 1995-96 to 3.32 per cent of geographical area in 2010-11. This is shown in the table 2.1.

Table 2.1: Changes in Land Use Pattern in Arunachal Pradesh
(Per cent of geographical area)

Sl. No.	Category	1995-96	2000-01	2005-06	2010-11
1	Operational Area	4.85	4.70	4.32	4.59
2	Net area sown	2.43	2.39	2.07	2.54
3	Current fallow	0.34	0.27	0.44	0.48
4	Fallow land other than current fallow	0.72	0.76	0.62	0.84
5	Uncultivated land excluding fallow land	0.97	0.55	0.40	1.43
6	Culturable waste land	0.51	0.33	0.34	0.76
7	Land not available for cultivation	0.40	0.39	0.44	0.76
8	Gross cropped area	2.96	2.57	2.57	3.32
9	Cropping intensity (in %)	121.82	107.42	124	130.5
10	Net irrigated area (as % of Gross cropped area)	15.46	20.68	21.93	NA
11	Average size of holdings	3.83	3.69	3.33	3.51

Source: Statistical Abstract of Arunachal Pradesh (Various years)

Among the North Eastern States in 2010-11, net sown area as per cent of geographical area was the highest in Assam (35.85 per cent) followed by Tripura (26.69 per cent). This can be attributed to their plain land as these States are located in the Brahmaputra valley and Barak valley. Net sown area was the lowest in Arunachal Pradesh (2.53 per cent) followed by Nagaland (7.42 per cent). This can be attributed to their difficult and inhospitable mountainous terrains as well as large forest covers. Net sown area as per cent of geographical area for the region as a whole was 16.71 per cent which was lower than the national average of 43.07 per cent (Table A. 2.3). This is due to a very large area under forest cover. The region has a forest cover of 66.08 per cent of the total geographical area against the national average of 21.05 per cent. Among the North Eastern States the forest cover as per cent of geographical area was the highest in Mizoram (90.70 per cent) followed by

Arunachal Pradesh (80.50 per cent) and Nagaland (80.34 per cent).It was lowest in Assam (35.28 per cent) and Sikkim (47.32 per cent). It is interesting to note that all the North Eastern States have forest cover (as per cent of geographical area) above the national average.

2.2.1 Cropping Intensity

Cropping intensity reflects intensity of land use in a region. It is one of the indicators of agriculture development. Increase in cropping intensity is considered important for raising farm income per unit of land area. It may be influenced by factors such as, physical and climatic conditions, types of crops grown, size of population, infrastructure facilities. The analysis of cropping intensity in the State showed that it has increased from 121.82 per cent in 1995-96 to 130.50 per cent in 2010-11.

This indicates that there has been intensification of agriculture in the State. This is positive development and it is important for improving productivity given the limited and inelastic arable land. However, the cropping intensity in the State is found to be lower than the national average of 140.5 per cent (Agricultural Census 2010-11). The relatively low cropping intensity in the State can be attributed to poor irrigation facilities. For instance, net irrigated area as per cent of gross cropped area in the State was only 21.93 per cent in 2010-11 against the national average of 45.3 per cent. Among the North Eastern States in 2010-11, cropping intensity was found to be the highest in Sikkim (187.01 per cent) followed by Assam (145.36 per cent) and Mizoram (134.9). It was the lowest in Manipur and Nagaland(Agriculture Census 2010-11). Cropping intensity for the region as a whole was 137.17 per cent which was lower than the national average of 140.54 per cent (Table A.2.3).

2.2.2 Operational Holdings by Size Group

An analysis of operational holdings by size group in the State indicates that in 2005-06, there were 108 thousands numbers operational with area of 361 thousand hectares in the State. The semi-medium holdings accounted for the largest share of 27.78 per cent of the total number of holdings followed by medium (25 per cent) small holdings (23.15 per cent), marginal holdings (20.37 per cent) and large holdings (3.70 per cent). This is sown in the table 2.2.

Table 2.2: Number and Area of Operational Holdings by Size Group in Arunachal Pradesh

(Number in '000 & Area in '000 Ha.)

Size group	2005-06		2010-11	
	No.	Area	No.	Area
Marginal	22 (20.37)	11 (3.05)	21 (19.27)	12 (3.13)
Small	25 (23.15)	33 (9.14)	19 (17.43)	26 (6.77)
Semi-Medium	30 (27.78)	85 (23.55)	34 (31.19)	94 (24.48)
Medium	27 (25.0)	169 (46.81)	28 (25.69)	155 (40.36)
Large	04 (3.70)	63 (17.45)	07 (6.42)	97 (25.26)
Total	108 (100)	361 (100)	109 (100)	384 (100)

Note: Figures in the bracket indicate percentage of total.

Source: Agriculture Census 2010-11, Ministry of Agriculture

In case of area, it was found that medium holdings accounted for largest share of 46.81 per cent followed by semi-medium category (23.55 per cent). Large category of holdings accounted for 17.45 per cent. Marginal and small holdings accounted for only 3.05 per cent of 9.14 per cent of the area total operational area. The marginal and small holdings which together accounted for 43 per cent of total number of operational holding had a share of only 12 per cent of the total operational area. This indicates high inequality in distribution of land in the State.

In 2010-11 the number of operational holdings in the State has increased to 109 thousand hectares and total operational area has also increased to 384 thousand hectares. In case of number of operational holdings, the share of semi-medium holdings increased to 31.19 per cent and continued to account for the highest share. The share of medium category also increased marginally to 25.49 per cent. However, the share of marginal and categories fell to 19.27 per cent and 17.43 per cent. The share of large holdings increased significantly to 6.42 per cent.

In case of area, the medium holdings continued to account for the largest. However, its share fell to 40.36 per cent. The share of large holdings increased sharply to 25.26 per cent and come to occupy second position. The share of semi-medium holdings rose marginally to 24.48 per cent. The share of small holdings fell sharply to 6.77 per cent but the share of marginal holdings rose marginally to 3.13 per cent. In 2010-11, marginal and small holdings together accounted for around 37 per cent of the total number of operational holdings but accounted for only around 10 per cent of the total operational area. Large holdings which accounted for only 6.42 per cent of the

total number of operational holdings accounted for only around 25.26 per cent of the total operational area. This indicates high and growing inequality in land holdings in the State.

2.2.3 Average Size of Holdings

The average size of holding in the State is found to be higher than the national average. But it is observed that average size of holding has been declining over the years. The average size of holding in the State declined from 3.83 hectares in 1995-96 to 3.51 hectares in 2010-11 (Table 2.1). This is mainly on account of population pressure coupled with fall in operational area. The average size of holding at the national level fell from 1.57 hectare to 1.15 hectare during the same period.

An analysis of average size of holdings by size group in the State indicates that during the period 2005-06 and 2010-11, average size of holding in marginal and small categories increased marginally from 0.50 hectare and 1.32 hectares in 2005-06 to 0.57 hectare and 1.37 hectares in 2010-11. In case of semi-medium and medium categories, average size of holding declined from 2.83 hectares and 6.26 hectares in 2005-06 to 2.76 hectares and 5.54 hectares in 2010-11. In case of large category, average size of holdings declined from 15.75 hectares in 2005-06 to 13.86 hectares in 2010-11 (Table 2.3). This indicates a trend towards marginalisation of holdings in the State.In 2010-11, among the North Eastern States, average size of holding was found to be the highest in Nagaland (6.02 hectares) followed by Arunachal Pradesh (3.52 hectares). It was found to be lowest in Tripura (0.49 hectare) followed by Assam (1.10 hectares). In four States namely, Tripura, Assam, Manipur and Mizoram average size of holding was found to be lower than the national average of 1.15 hectare (Table A.2.5). This indicates huge pressure of population in these States of North Eastern Region.

Table 2.3 Average Size of Holdings by Size Group in Arunachal Pradesh(Area in Hectare)

Size group	2005-06	2010-11
Marginal	0.50	0.57
Small	1.32	1.37
Semi-Medium	2.83	2.76
Medium	6.26	5.54
Large	15.75	13.86
Total	3.34	3.52

Source: Agriculture Census 2010-11, Ministry of Agriculture

The land use statistics in the Region in general and Arunachal Pradesh in particular implies that agricultural transformation if any will be confined to very limited area of the State because of its low amount of operational area owing to large forest cover and hilly rugged terrain. The development of agriculture assumes important as 80 per cent of its population lives in rural areas. The people in the rural areas mainly depend on agriculture for their livelihood as the State is one of the least industrialised States of the country. As per 2011 Census, the total number of workers in the State was 587,657 out of which 51.51 per cent were cultivators and 6.16 per cent were agricultural labourers (Table A.2.6). Thus, in total about 58 per cent of the total workers were engaged in agriculture for their livelihood.

Therefore, the promotion of agriculture development in the State assumes important to improve the livelihood and living standard of its vast majority of people. Given the limitation posed by limited arable area, income of farmers can be enhanced only through improving productivity and crop diversification towards high value crops.

2.3 Changes in Cropping pattern in Arunachal Pradesh

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 Cropping pattern in an area may be determined by different factors such as geographical conditions and socio-economic factors. 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 (Bhowmick and Talukdar, 1998; Singh and Sadhu, 1991). In certain cases farmers adopt diversification to mitigate risk and to improve livelihood. A change in cropping pattern in favour of commercial crops is viewed as a sign of agricultural prosperity. In this regard an attempt has been made to analyse the changes in cropping in the State. It is 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 2.4). This indicates that there is tendency of diversification towards high value crops in the State.

Table 2.4: Cropping pattern in Arunachal Pradesh
(Area under major crops 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 (Table 2.4).

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 may be attributed to topography and climatic conditions of the State as well as development of education and infrastructure in the State over the passage of time.

2.4 Crop Diversification in Arunachal Pradesh

Diversification of crop is considered important to raise farm income and mitigate production risk. Many studies have reported positive relationship between crop diversification and farm income. Hence, the study made an attempt to examine the extent of crop diversification and its impact on farm income in the State. The Simpson index of diversification (SID) was computed to measure the extent of crop diversification.The value of SID was found to be high and increasing over the years. Itwas 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 2.5).

Table 2.5: Simpson Index of Crop 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 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 (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 are; Tirap, Longding, Tawang, Dibang Valley, Lohit, Upper Subansiri (Table A.2.7). 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.

2.5 Growth of Area, Production and Productivity of Food Crops

The growth of area, production and productivity of food grains in the State during the period 2002-03 to 2013-14 was analysed. It was found that during 2002-03 to 2013-14 food grains production in the State increased from 242.4 thousand tonnes to 384.6 thousand tonnes. The compound annual rate of growth (CARG) of food grains in the State during this period was computed to be 4.19 per cent. This was mainly on account of increase in productivity which increased from 12.26 quintals per hectare in 2002-03 to 17.9 quintals per hectare in 2013-14. The compound annual rate of growth in yield of food grains during this period was 4.08 per cent. However, the area under food grains increased marginally during this period. The area grew at CARG of only 0.10 per cent. This is shown in the table 2.6, 2.7 and 2.8.

The increase in food grains production during 2002-03 to 2013-14 was mainly contributed by increase in production of paddy, pulses and maize (2.8).

Table 2.6: Trend and Growth in Production of Food Crops in Arunachal Pradesh

(Production in MT)

Year	Paddy	Maize	Millet	Wheat	Pulses	Total Food grains
2002-03	152500	56441	19411	6250	7793	242395
2003-04	154589	54510	21326	6320	7719	244464
2004-05	134950	54985	21374	8652	7591	225561
2005-06	146191	57898	22376	6140	8285	240890
2006-07	216953	63524	21428	6301	8298	604153
2007-08	237219	57430	19425	5294	8618	327986
2008-09	246807	58830	18922	5169	9016	338744
2009-10	215842	60144	18391	4770	9656	308803
2010-11	233992	64714	20038	5872	9056	333672
2011-12	255000	68500	22000	6500	10500	362500
2012-13	263000	68192	23410	4401	10580	369583
2013-14	276171	68978	23825	4470	11143	384587
CARG	**6.61**	**2.12**	**0.80**	**-3.44**	**3.56**	**4.19**

Source: Statistical Abstract of Arunachal Pradesh (Various Years)

Table 2.7: Trend and Growth in Area under Food Crops in Arunachal Pradesh

(Area in Hectare)

Year	Paddy	Maize	Millet	Wheat	Pulses	Total Food grains
2002-03	124584	40548	21110	4114	7305	197661
2003-04	119205	38610	22279	4150	7129	191373
2004-05	121642	37800	22400	4278	7046	193166
2005-06	122267	41853	22802	3976	7720	198618
2006-07	123038	46281	21708	3979	7842	374736
2007-08	124029	42736	22308	3558	8512	201143
2008-09	126799	42897	22262	3278	8468	203704
2009-10	121468	43630	21373	3170	8818	198459
2010-11	121570	45061	21661	3699	8552	200543
2011-12	123496	46500	22000	3700	9500	205200
2012-13	126085	47486	22675	2937	9499	208682
2013-14	131989	47018	22744	2960	9672	214383
CARG	**0.40**	**1.80**	**0.20**	**-3.10**	**3.00**	**0.10**

Note: CARG – Compound annual rate of growth (Computed)

Source: Statistical Abstract of Arunachal Pradesh (Various Years)

Table 2.8 Trend and Growth in Yield Rates of Food Crops in Arunachal Pradesh

(Yield in Quintals/Hectare)

Year	Paddy	Maize	Millet	Wheat	Pulses	Total Food grains
2002-03	12.24	13.92	9.2	15.19	10.67	12.26
2003-04	12.97	14.12	9.57	15.23	10.83	12.77
2004-05	11.10	14.5	9.5	15.5	10.8	11.7
2005-06	11.96	13.83	9.81	15.44	10.73	12.13
2006-07	17.63	13.73	9.87	10	10.58	16.12
2007-08	19.13	13.44	8.71	14.88	10.12	16.31
2008-09	19.46	13.71	8.5	15.77	10.65	16.63
2009-10	17.80	13.8	8.6	15	11	15.6
2010-11	19.25	14.36	9.25	15.87	10.58	16.63
2011-12	20.6	14.7	10	17.6	11.1	17.7
2012-13	20.9	14.36	10.32	14.98	11.14	17.71
2013-14	20.9	14.7	10.5	15.1	11.5	17.9
CARG	**6.18**	**0.40**	**0.60**	**0.70**	**0.50**	**4.08**

Source: Statistical Abstract of Arunachal Pradesh (Various Years)

During the same period production of millet registered a CARG of 0.8 per cent and production of wheat registered a negative growth. During this period area under millet remained more or less stagnant and area under wheat declined. Thus, the fall in production of wheat was mainly due to decline in area. During this period the yield rates of millet, wheat and pulses grew marginally at CARG of 0.60 per cent, 0.70 per cent and 0.50 per cent respectively.

2.6 Growth of Area, Production and Productivity of Commercial Crops

Important commercial crops grown in the State are oilseeds, potato, ginger, turmeric, chillies, sugarcane and vegetables. The trend and growth of production of commercial crops is shown in the table 2.10.

The analysis of data on commercial crops revealed that during the period 2002-03 to 2013-14, production of oilseeds increased from 29.82 thousand tonnes to 31.64 thousand tonnes. The CARG of oilseeds production was found to be 1.51 per cent. The production of potato increased from 30.18 thousand tonnes in 2002-03 to 40.66 thousand tonnes in 2013-14 with CARG of 3.46 per cent.

Table 2.9 Trend and Growth in Production of Commercial Crops in Arunachal Pradesh

(Production in MT)

Year	Oilseed	Potato	Ginger	Turmeric	Chillies	Sugarcane
2002-03	29821	30183	32332	2020	2345	15284
2003-04	28478	29569	37177	1527	2430	15150
2004-05	26281	27538	32877	1794	2646	14132
2005-06	23695	29838	33326	1631	2646	16811
2006-07	29265	31689	42821	1965	2729	16843
2007-08	28568	29173	47407	2119	3634	21754
2008-09	31016	33405	50279	2375	3960	23439
2009-10	31118	36089	49663	2556	3499	27145
2010-11	29251	35832	52304	2719	3948	28974
2011-12	33000	40000	54000	2800	4300	30000
2012-13	31285	38872	56004	2893	4619	30151
2013-14	31635	40664	55073	3068	6747	30351
CARG	**1.51**	**3.46**	**5.76**	**6.08**	**8.65**	**8.44**

Source: Statistical Abstract of Arunachal Pradesh (Various Years)

During the same period the production of ginger increased from 32.33 thousand tonnes to 55.07 thousand tonnes. The CARG of ginger production was 5.76 per cent during 2002-03 to 013-14. During the same period the production of turmeric increased from 2.02 thousand tonnes to 3.07 thousand tonnes with CARG of 6.08 per cent. The production of chillies in the State increased at a faster rate. Its production rose from 2.34 thousand tonnes in 2002-03 to 6.75 thousand tonnes in 2013-14. During 2002-03 to 2013-14 the CARG of chillies production was 8.65 per cent which was the highest among the commercial crops. During same period the production sugarcane increased rapidly from 15.28 thousand tonnes to 30.35 thousand tonnes with CARG of 8.44 per cent (Table 2.10).

The increase in production of oilseeds, ginger and sugarcane in the State during 2002-03 to 2013-14 was achieved mainly on account of area expansion.

Table 2.10: Trend and Growth in Area under Commercial Crops in Arunachal Pradesh

(Area in Hectare)

Year	Oilseed	Potato	Ginger	Turmeric	Chillies	Sugarcane
2002-03	28494	4335	4448	514	1608	798
2003-04	28024	4022	4680	447	1657	738
2004-05	27139	3917	4451	505	1652	736
2005-06	27566	3963	4814	427	2168	878
2006-07	32160	3965	5832	532	1903	1030
2007-08	30729	3843	6305	599	2372	1233
2008-09	31785	4063	6717	612	2320	1370
2009-10	31740	4235	6401	626	2086	1476
2010-11	31854	4334	6601	611	2221	1508
2011-12	32500	4600	6800	625	2500	1550
2012-13	32767	4817	6847	699	2365	1530
2013-14	33107	4933	6861	654	2491	1561
CARG	**1.71**	**0.90**	**4.92**	**3.46**	**4.29**	**8.44**

Source: Statistical Abstract of Arunachal Pradesh (Various Years)

Table 2.11 Trend and Growth in Yield Rate of Commercial Crops in Arunachal Pradesh

(Yield in Quintals/Hectare)

Year	Oilseed	Potato	Ginger	Turmeric	Chillies	Sugarcane
2002-03	10.47	69.63	72.69	39.3	14.58	191.53
2003-04	10.16	73.52	79.44	34.16	14.67	205.28
2004-05	9.7	65.3	73.9	35.5	13.7	192
2005-06	8.6	75.29	69.23	38.2	12.2	191.47
2006-07	9.1	79.92	73.42	36.94	14.34	163.52
2007-08	9.3	75.91	75.19	35.38	15.32	176.43
2008-09	9.76	82.22	74.85	38.81	17.07	171.09
2009-10	9.8	86.1	77.6	40.8	16.8	183.9
2010-11	9.18	82.67	79.29	44.5	16.43	192.14
2011-12	10.15	86.95	79.41	44.8	17.2	193.55
2012-13	9.55	80.7	81.79	41.39	19.53	197.07
2013-14	9.6	82.4	80.3	46.9	27.1	195.7
CARG	**0.20**	**1.92**	**0.90**	**2.33**	**4.60**	**0.10**

Source: Statistical Abstract of Arunachal Pradesh (Various Years)

Thus, it was found that during the period 2002-03 to 2013-14 among the commercial crops the growth in production of chillies was the highest followed by sugarcane, turmeric and ginger. During the same period growth in area was the highest in sugarcane followed by chillies, ginger and turmeric. The growth in yield rate was the highest in chillies followed by turmeric and potato. The growth of area, production and yield of commercial crops indicates increasing trend of crop diversification and agricultural commercialisation in the State. Hence, there is a need design proper strategy and provide adequate support for smooth progress of agriculture development in the State.

The yield rates of some commercial crops are given in Table A.2.10. In 2010-11, Among the North Eastern States yield rate of oilseed was the highest in Mizoram (1203 kg per hectare) and lowest in Assam (576 kg per hectare).

CHAPTER 3

SOCIO-ECONOMIC PROFILE OF FARMERS

3.1 Introduction

This chapter deals with the analysis of socio-economic profile of the surveyed farmers. The study of socio-economic characteristics of the farmers is important to understand their social and economic status and level of well-being. In agricultural production analysis, the study of socio-economic profile is considered important. This is due to the fact that production decision of farming household relating to allocation of acreage to crops, amount of labour use etc.Chayanov (1920) in his model of farm household argued that demographic characteristic is an important factor determining the amount of labour to be committed to farm work by a peasant farm household. The demographic characteristic is captured by the consumer to worker (c/w) ratio. The amount of labour time devoted to farm work is directly related to c/w ratio. It implies that a farm household which consists of more number of dependent members will have to devote more time to farm work to produce sufficient for subsistence need of the family. Such household will have less leisure compared to the household with low c/w ratio. Mellor (1966) in his theory of agriculture development argued that farmers with small size of holdings will have to push labour use up to the point where its marginal productivity is equal to zero for their subsistence. But the farmers with large size of holdings have option to choose between farm work and leisure because of their higher incomes.

Thus, it shows that socio-economic characteristics of household play an important role in determination of production decision of the farm household. Hence, it was considered important of analyse the socio-economic profile of the surveyed farm household in relation to their production decision.

3.2 Classification of Respondents on the basis of Age

The examination of age distribution of farmers revealed that most of the farmers were in the middle age group of 30-50 years. Slightly more than half (53.33 per cent) of the surveyed farmers belonged to this age group followed by 42 per cent in the age group of 50 years and above. Relatively small percentage (4.67 per cent) of the surveyed farmers was in the younger age group of 18-30 years.

The distribution of surveyed farmers on age group is shown in the table 3.1.

Table 3.1: Distribution of respondents on the basis of age group

Age group	Number	Percentage
18-30	7	4.67
30-50	80	53.33
50 and above	63	42
Total	150	100

Source: Field Survey, 2015

The age of the respondents was found to vary from 25 years to 77 years with mean age of 48.26 years. The age distribution of the farmers indicates that agricultural activities in the hill agriculture are mainly performed by people in the middle age group and older age group. This may be due to that fact that with the spread of modern education, people in the younger age group spent more time in acquiring education and migrate to urban centres for white color jobs. So agriculture activities are left in the hands of middle and older aged people who do not have alternative source of employment. Low (1968) in his farm household model based on agrarian situation of countries bordering South Africa observed that due to higher opportunity cost the able members of the household migrates out leaving agriculture activities in the hands of less able members mostly female, old parents and children. He explained this as one of the causes of agriculture stagnation.

3.3 Classification of Respondents on the basis of Gender

Gender distribution of respondent farmers showed that most of them were male. Out of total respondents 54 per cent were male and the rest 46 per cent were female. The gender distribution of the surveyed respondents indicates that female work participation in agricultural operation is fairly good. It implies that female play a prominent role in agricultural production in the hill agriculture (table 3.2).

Table 3.2: Distribution of respondents on the basis of gender

Gender	Number	Percentage
Male	81	54
Female	69	46
Total	150	100

Source: Field Survey, 2015

3.4 Classification of Respondents on the basis of Education Level

An examination of education level of the surveyed respondents revealed high incidence of illiteracy among the farmers. Most of surveyed farmers were illiterate (73.3 per cent) followed by primary level education (18.7 per cent). Only 2.7 per cent of the surveyed farmers had education level of higher secondary and above. This implies that educated youths migrate to urban areas either for higher education or for better jobs in service sector. The education level of the respondents is given in the table (3.3).

Table 3.3: Distribution of respondents on the basis of education level

Education level	Number	Percentage
Illiterate	110	73.3
Primary Level	28	18.7
Secondary	8	5.3
Higher Secondary	3	2
Graduate & Above	1	0.7
Total	150	100

Source: Field Survey, 2015

The educational attainment of the farmers is an important determinant agriculture development. Education directly influences the adoption of new technology in agriculture. A farmer with good education may be more able to understand about new inputs and their utilization. It may also influence his ability to better market his products. Low level of technology adoption in the State can be attributed to low level of education of its farmers.

3.5 Classification of Surveyed Household on the basis Household Size

Household size of the farmers and its composition between working and non-working members is considered as an important determinant of level of agricultural activity of a farm household relating to labour and other inputs use in farm work. An analysis of household size of the surveyed farm household showed that most of the households (62 per cent) were having the size of 5-9 members followed by 35.3 per cent in the size of less than 5 members. Only 2.7 per cent of the surveyed households had household size of more than 9 members. This is shown in the table 3.4.

Table 3.4: Classification of the Surveyed Household on the basis of Household Size

Household Size	Number	Percentage
Less than 5	53	35.3
5 to 9	93	62
More than 9	4	2.7
Total	150	100

Source: Field Survey, 2015

The average size of household of the surveyed farmers was found to be 5.28 members with standard deviation of 1.86. This indicates that the farm households in the hill agriculture mostly are of medium size. This may be due to absence of the culture of joint family system among the tribes of the hills.

3.6 Classification of the Surveyed Households on the basis of Annual Household Income

The distribution of household on the basis of annual household income from all sources revealed that most of the farmers in the hill agriculture have low income. It was found that 58.7 per cent of the surveyed farm households belonged to income group of below one lakh rupees followed by 34 per cent in the income group of one to two lakh rupees. This is shown in the table 3.6.

Table 3.5: Classification of the Surveyed Households on the basis of Annual Income

Income group (in Rs.)	Number	Percentage
Below 10000	88	58.7
10000 to 200000	52	34.7
200000 to 300000	7	4.7
300000 and above	3	2
Total	150	100

Source: Field Survey, 2015

This implied that about 93.4 per cent of the surveyed farm households were living on annual household income of less than two lakh. Only 2 per cent of the surveyed households had income of three lakh and above.

The distribution of the surveyed households on the basis of annual household income revealed that well-being and living standard of the farmers in the hill agriculture in relatively poor. This may be due to low productivity, limited arable land. This calls for attention of policy makers to find out the ways and means to raise income of farmers.

3.7: Classification of Surveyed Households on the basis of Size of Land Holding

Size of land holding is an important indicator of economic status of a farm household. The classification of surveyed farm households on the basis of size of land holdings showed that most of the surveyed farmers had semi-medium size of land holdings followed by small size and medium size. Out of the total surveyed farmers 42 per cent had semi-medium size of land holding and 36.67 per cent had small size of land holding. Together these two categories accounted for 78.67 per cent of the surveyed farmers. While 18 per cent of the surveyed farmers had medium size holding only 1.33 per cent had large holdings. This is shown in the table 3.6.

Table 3.6: Classification of Surveyed Households on the basis of Size of Land Holdings

Category	Number	Percentage
Marginal	3	2.00
Small	55	36.67
Semi-medium	63	42.00
Medium	27	18.00
Large	2	1.33
Total	150	100

Source: Field Survey, 2015

The size of land holding varied from 0.5 hectare to 10 hectares. The average size of holding of the surveyed household was calculated to be 2.54 hectares with standard deviation of 1.68. The land holding pattern of the surveyed farmers is similar to the findings from the secondary data. The analysis of land holding pattern indicates that farmers in the hill agriculture operate on a relatively small plot of land and

distribution of land is observed to be relatively fair as indicated by the average size of holding and low standard deviation. This may be due to that fact that in the State there is a system of community ownership of land and indigenous customary laws ensure fair allocation of agriculture land.

3.8 Classification of Surveyed Households on the basis of Types of House

House type is also taken as an indicator of economic well-being of a household. An examination of house type of the surveyed household showed that most of the farm households had *kutch* house. Among the surveyed household, 67.3 per cent were living in *kutcha* house and only 32.7 per cent of them were having *pucca* house. This is shown in the table 3.7.

Table 3.7: Classification of Surveyed Households on the basis of Types of House

Type	Number	Percentage
Kutcha	101	67.3
Pucca	49	32.7
Total	150	100

Source: Field Survey, 2015

The analysis of house type of the surveyed household reflects that majority of the farm households in the area have low level of well-being. This calls for attention of the policy makers.

3.9 Classification of the Surveyed Households on the basis of Access to Drinking Water

Access to quality drinking water is very important for healthy and better quality of life. A healthy individual can perform well and hard in the fields as well as home. In other words, good health increases ability of a person to work more and earn more income and hence can have better level of living. Access of person to safe and good quality drinking water is one of the important determinants of his good health. Therefore, an attempt was made to examine the access of the surveyed household to safe drinking water. It was found that 87.3 per cent of the households had drinking water source (water tape) attached to their house and the rest of the households had to collect drinking water from the community water tape of their villages located at distance of few meters away from their households. This is given in the table 3.8.

Table 3.8: Distribution of Surveyed Households on the basis of Access to Drinking Water

Distance from household (in metre)	Number	Percentage
0	131	87.3
20	14	9.3
20 and above	5	3.4
Total	150	100

Source: Field Survey, 2015

The source of drinking water of the surveyed household was mainly tape water supplied by the State Public Health Engineering Department.The analysis indicated that access of the surveyed households was moderately good. But there is a scope for improvement.

3.10 Classification of the Surveyed Households on the basis of Access to Sanitary Toilets

Access to proper sanitary toilet is also an important determinant of health of family members. Lack of access to better sanitation can lead to spread of infectious diseases and degrades the health conditions of members of a household. A household having proper sanitary toilet can maintain better hygiene and ensure better health for its family members. The status of household sanitation was very poor in the State before the attainment of Statehood. Households in the villages were not having sanitary toilets and open defecation was widespread. However, with the passes of time, State intervention and increase in level of education, sanitation coverage has significantly improved. The analysis of access to sanitary toilets of the surveyed households showed that 71.33 per cent of them had sanitary toilet in their house and the rest 28.67 per cent had no sanitary toilet. This is shown in the table 3.9.

Table 3.9: Distribution of Surveyed Households on the basis of Access to Sanitary Toilet

Access	Number	Percentage
Yes	107	71.33
No	43	28.67
Total	150	100

Source: Field Survey, 2015

The analysis shows that among the surveyed households slightly more than one-fourth of the households practice open defecation. This implies that the 100 per cent coverage aim of the government has not been fulfilled. Hence, there is a need for further State intervention to achieve 100 per cent coverage so as to ensure better health of the rural households.

The analysis of socio-economic profile of the surveyed farm households revealed that most of the respondents were in the age group of 30-50 years. The mean age of the respondents was estimated to be 48.26 years. Gender distribution of respondent farmers showed that most of them were male. Educational level of the surveyed farmers indicated that majority of them were illiterate. A good number of them were having primary level education. Only few of them had education level of higher secondary and above. Household size of majority of the surveyed farmers was medium size. Majority of the farmers belonged to income group of below one lakh rupees. Land holdings pattern of the surveyed households showed that most of them had semi-medium size of land holdings followed by small size. Most of the farm households were found living in *kutch* house but majority of them has drinking water tape in their houses. At the same time a good number of households had access to sanitary toilets but there is a scope for improving coverage.

CHAPTER 4

LEVEL OF INPUTS USE, PRODUCTION COSTS AND RETURNS

4.1 Introduction

In agriculture, every farmer aims to increase output and minimize the cost. For this the farmers must use inputs efficiently. There is a need to identify inputs that are inefficiently used. If any input is found to be used inefficiently measures can be adopted to ensure efficient use of such input to increase output and also to reduce cost. There are various measures of farm efficiency like income ratios, cost ratios etc. which can be used to measure efficiency of farm in production of different crops. This chapter deals with the analysis of level of inputs used and cost of production of various crops among the surveyed farmers. It also measures the returns from various crops and farm efficiency in production of different crops.

4.2 Level of Inputs used in Production of different Crops

The level of output per unit area is significantly determined by the type and quantity of inputs used. A farmer using improved and good quantity of inputs can harvest more output than the other farmers. The difference is yield of a crop among the farmers can be explained by the differences in inputs used. The level and quantity of various inputs used by the surveyed farm households was examined to ascertain the kind and quantity of various inputs used in production of different crops. The important inputs used by the surveyed farmers were; seed, fertiliser, manure, chemical, machinery, bullock, labour etc.

Seed Use: The level and type of seed used for different crops are given in the table 4.2 and 4.3. It was found that in case of food crops the average quantity of seed used per bigha varied from 1.81 kg for pulses to 3 kg for maize. In case of commercial crops average quantity of seed used per bigha was 110 kg for potato and 2 kg for chilli. In case of tomato and cabbage, the average quantities of seed used per bigha were 2.8 sachets (140 grams) and 4.23 sachets (212 grams) respectively (Table 4.1).

Table 4.1: Quantity of Seed used in Production of different Crops by the Surveyed Households (In kg per bigha)

Crops	Min	Max	Mean
Paddy	1	3	2.67
Wheat	1.5	3	2.15
Maize	2	5	3.00
Millet	1.3	2.75	1.75
Pulses	1.67	2.5	1.81
Potato	80	250	110
Tomato (in sachet)	2	5	2.80
Chilli	1	3	2.00
Cabbage (in sachet)	2	6	4.23
Note: 1 sachet contains 50 grams			

Source: Survey Data, 2015-16

Regarding the type of seed used of different crops, it was found that in case of food crops 100 per cent of the surveyed farmers were using Non-HYV seed (local variety). However, the use of HYV seed was common in cash of commercial crops particularly, tomato and cabbage. In case of tomato and cabbage all the growers were found using HYV seed. In case of potato 66 per cent of the growers were using HYV seed and the rest 34 per cent used Non-HYV seed. The farmers informed that due to non-availability of HYV seed in their area they have to use local variety. But is case of chilli farmers were growing mainly local variety.

Fertiliser Use: Judicious use of fertiliser is important for improving the soil nutrients and to realize higher output per unit area. The farmers were found to use mainly urea and Di Amonia Phosphate (DAP) for improving soil nutrients. The level of use of fertiliser by the surveyed households on various crops showed relatively low level of its use, particularly in case of food crops. The level of use of fertiliser by the surveyed households is given in the table 4.2.

Table 4.2: Quantity of Fertiliser used in Production of Crops by Surveyed Households

(In kg per bigha)

Crops	Min	Max	Mean
Paddy	2	50	3.38
Wheat	1	3	1.15
Maize	0	25	4.10
Millet	0	10	1.25
Pulses	0	10	1.60
Potato	0	150	15.59
Tomato	0	175	38.80
Chilli	0	50	3.37
Cabbage	0	163	36.81

Source: Survey Data, 2015-16

The average quantity of fertiliser use per bigha for food crops varied from 1.15 kg for wheat to 4.10 kg for maize. The use of fertiliser was relatively high in case of cash crops. The average quantity of fertiliser use per bigha, except chilli, varied from 15.59 kg for potato to 38.80 kg for tomato. The minimum use of fertiliser was nil for most crops which indicated that there are farmers who did not use fertiliser and relied mainly on manure for improving soil nutrients.

Manure Use: Manure is also an important nutrient for improving soil quality and productivity. It is a highly desirable form of nutrient for its low cost as well as for being eco-friendly. It does not exert adverse effects on soil health, environment and human health. Hence, its use should be encouraged. However, the use of manure depends on its availability. The study use of manure by the surveyed households showed that farmers in the area were using mainly cow dung and farm yard manure and dry leave (locally called *sheu*). Cow dung was used mainly by the farmers having good number of cows. Other farmers were using mainly farm yard manure and dry leave (collected freely from community forests). The use of dry leave was common in two surveyed villages; Namshu and Thembang where farmers use dry leave in huge quantity in maize, millet and wheat field. The level of use of manure by the surveyed households is given in the table as 4.3.

Table 4.3: Quantity of Manure used in Production of Crops Surveyed Households

(In kg per bigha)

Crops	Min	Max	Mean
Paddy	0	100	3.23
Wheat	5	100	20.57
Maize	0	500	75.20
Millet	0	450	67.97
Pulses	3	140	17.98
Potato	0	450	56.59
Tomato	0	333	44.50
Chilli	0	500	99.26
Cabbage	0	50	15.5

Source: Survey Data, 2015-16

The table 4.3 shows wide variations in average quantity of manure used per bigha in different crops by the surveyed households. In case of food crops average quantity of manure used per bigha varied from 3.23 kg for paddy to 75.20 kg for maize. In case of cash crops, the average quantity of manure use per bigha varied from 15.5 kg for cabbage to 99.26 kg for chilli. The minimum use of manure in most crops is nil indicating that a good number of farmers did not use manure.

The analysis of fertiliser and manure use indicated that use of fertiliser is more in case of cash crops and use of manure is more in case of food crops.

Chemical Use: The use of chemical like fungicides, insecticides and pesticides are important to prevent crop damage due to diseases and pest attacks. This can reduce crop damage and give better yield. The study of chemical use showed that its use was crop specific. It was used mainly by tomato and cabbage growers as these crops are highly subjected to infections and diseases. To control fungal infection, the growers were found to use mainly Indofil M-45 and insecticides in small quantity. The level of use of chemical is given in the table 4.4.

Table: 4.4: Average Quantity of Chemical and Machinery used in different crops by Surveyed Households

Crops	Chemical (in kg/bigha)	Machinery (in rounds/bigha)
Tomato	4.22	8
Cabbage	2.43	6

Source: Survey Data, 2015-16

The table 4.4 shows that the average quantity of chemical use per bigha by the surveyed households was relatively more in case of tomato than cabbage. The average quantity used per bigha was 4.22 kg for tomato and 2.43 kg for cabbage. During the survey farmers reported that the quantity of use of chemical depends on weather conditions as such excessive rain increases the quantity use and lead to rise in production costs.

Machinery Use: The use of machinery is desirable in agricultural operations as it can reduce human efforts and ensure extensive cultivation. In the area the farmers were found to use mainly hand spray machine to sprinkle medicine on tomato and cabbage plants. The use of machinery like tractor for tilling soil was not observed. This may be due to hilly topography which is not suitable for its use. The use of hand spray machine was measured in terms of number of rounds. The average use of machine (hand spray) per bigha was found to be 8 rounds for tomato and 6 rounds for cabbage (Table 4.4).

Labour and Bullock Use: Agricultural activities are labour intensive in nature and require good number of labour. In the area, the use of labour (both family and hired in) in agriculture was found to be extensive. Members of farm households are observed to be engaged in agriculture for around 8 to 9 months in a crop year. Labour was used all activities like tilling of soil, sowing of seed, providing plant nutrients, medicines, weeding and harvesting etc. However, the households having bullocks used bullock power for tilling of soil. The use of bullock was limited as only 39 per cent of the surveyed farmers were using it and the rest 61 per cent did used it. It was found that farmers relied mainly on family labour for production of food crops and used hired labour in limited numbers. In case of cash crops use of hired in labour was fairly high. This is given in the table 4.5.

Table 4.5: Labour used in Production of different Crops by the Surveyed Households

(In days/bigha)

Crops	Family labour	Hired labour	Total
Paddy	10	5	15
Wheat	12	3	15
Maize	10	5	15
Millet	12	3	15
Pulses	12	3	15
Potato	24	6	30
Tomato	20	22	42
Chilli	14	6	20
Cabbage	24	16	40

Source: Survey Data, 2015-16

The table 4.5 shows that the use of labour is relatively low in case of food crops and high in case of cash crops. The average number of labour days required per bigha was more or less similar in case of food crops (15 labour days). But in case of cash crops the average number of labour days required per bigha varied from 20 days for chilli to 42 days for tomato. The proportion of hired in labour use was high in case of tomato and cabbage.

The analysis of labour use shows that production of cash crops like tomato, cabbage and potato are highly labour intensive and have huge potential to generate income and employment in rural areas. Hence, it can be suggested to promote extensive cultivation of these crops in the area.

4.3 Yield Rate of different Crops among the Surveyed Households

The yield rate of crop is an indicator of resource productivity and efficient use of available resources. The average yield rates of different crops among the surveyed households are given in the table 4.6.

Table 4.6: Yield Rate of different Crops among the Surveyed Households(In Kg/bigha)

Crops	Min	Max	Mean
Paddy	125	300	194
Wheat	125	200	162
Maize	150	600	242
Millet	150	300	136
Pulses	75	200	169
Potato	400	2667	1130
Tomato	267	5000	1335
Chilli	150	500	380
Cabbage	800	5250	1356

Source: Survey Data, 2015-16

The table 4.6 shows that there were wide variations in yield rates of different crops among the surveyed households as indicated by minimum and maximum yield. The variation was found to be more in case of cash crops than the food crops. For instance, in case of tomato yield rate varied from 267 kg per bigha to 5000 kg per bigha and for cabbage it varied from 800 per bigha to 5250 kg per bigha. This can be attributed to weather risk and diseases as these crops are highly affected by diseases and are highly perishable. During the survey, a good number of growers of these crops stated that they incurred huge losses due to crop damage.

The mean yield of cash crops was found to be much higher than that of the food crops. The mean yield of food crops varied from 136 kg per bigha for millet to 242 kg per bigha for maize. In case of cash crops, it varied from 380 kg per bigha for chilli to 1356 kg per bigha for cabbage. Thus, there is a need to focus on improving the yield of food crops to ensure food security of the farm households. At the same time, appropriate mechanism should be evolved to minimize damage of cash crops to increase income of the farmers.

4.4 Gross Value of Output of different Crops among the Surveyed Households

Gross value of output of different crops was computed by multiplying the output of each crop by the average price in local market. The gross value of output of the surveyed households is given in the table 4.7.

Table 4.7: Gross Value of Output of different Crops among the Surveyed Households

Crops	Gross Value Added (GVA) per Bigha (in Rs)		
	Min	Max	Mean
Paddy	2500	6000	3880
Wheat	2500	4000	3240
Maize	2250	9000	3630
Millet	3600	7200	3264
Pulses	4500	12000	10140
Potato	5200	34667	14690
Tomato	2933	55000	14681
Chilli	4950	16500	12540
Cabbage	7200	47250	12206

Source: Survey Data, 2015-16

The table 4.7 shows wide variations in the gross value of output per bigha among the surveyed households. In case of paddy gross value of output per bigha varied from minimum of Rs. 2500 to Rs. 6000 with mean of Rs. 3880. The variation was the highest in case of tomato and cabbage. In case of tomato it varied from Rs. 2933 per bigha to 55000 per bigha with mean of Rs. 14681 per bigha. This is due to the fact that these crops are exposed to high weather risk and are also affected by diseases. So the yield of these crops fluctuates widely. This was reported by the farmers during the survey. The mean gross value of output per bigha was found to be the lowest for wheat (Rs. 3240) and the highest for potato (Rs. 14690). This is mainly due to differences in yield rate.

4.5 Cost of Production of different Crops among the Surveyed Households

The Cost of various inputs used to production of different crops was also estimated to examine efficient use of inputs and also to compute net income (returns). To find out the cost of production of each crops, cost of different inputs used were computed. The cost of each input was computed by multiplying the quantity used by its average price. The total cost was obtained by adding the cost of different inputs. The average cost of production per bigha incurred by the surveyed household in different crops is given in the table 4.8.

Table 4.8: Costs incurred on inputs used in Production of Crops by Surveyed Households

(In Rs/Bigha)

Crops	Seed cost	Fertiliser cost	Chemical cost	Labour cost	Total Cost
Paddy	93	51	0	3000	3144
Wheat	43	17	0	3000	3060
Maize	45	62	0	3000	3107
Millet	26	19	0	3000	3045
Pulses	109	24	0	3000	3133
Potato	1430	527	0	6000	7957
Tomato	1470	1308	1688	8400	12866
Chilli	80	51	0	4000	4131
Cabbage	845	1251	972	8000	11068

Source: Survey Data, 2015-16

The table 4.8 shows that total cost of production per bigha on an average of different crops vary widely among the surveyed households. The cost of production was found to be less in case of food crops compared to cash crops. For instance, the total cost of production, in case of food crops, varied from Rs. 3045 per bigha for millet to Rs. 3144 per bigha for paddy. In case of cash crops, total cost of production varied from Rs. 4131 per bigha for chilli to Rs. 12866 per bigha for tomato. The high cost of production in case of tomato and cabbage can be attributed to high cost incurred on fertiliser, chemical and seed as the these inputs had to be purchased at market price. The farmers informed that did not get subsidized inputs from the government agencies. Due to high cost of production and high risk, these crops are grown by only few farmers. Hence, there is a need for providing subsidies on inputs like fertiliser, chemical and seed to encourage their production.

4.6 Farm Efficiency in Production of different Crops among the Surveyed Households

Efficiency is expressed as the ratio between some measures of returns and some measures of cost. There are various measures of farm efficiency in agriculture like the capital ratios, income ratios, cost ratios, cropping intensity index, crop yield

index, system index etc. In this study income and cost ratios have been computed to measure farm efficiency.

Income Ratios: The present study primarily used income ratios and cost ratios for measuring the efficiency of farm in production of different crops. Income ratio is measured in terms of net income per unit area. It is considered as one of the best measures of farm efficiency. Net income is obtained by deducting all expenditure incurred (actual as well as imputed) for farm production from the gross value of output. It is measured as:

Net Income per Bigha = Total Net Income divided by Area of the farm

Higher value of net income per unit area indicates better efficiency of the farm. The net income per bigha from different crops for the surveyed households is shown in the table 4.9.

Table 4.9: Net Income from different Crops accrued among Surveyed Household

(In Rs/Bigha)

Crops	Value of output	Total cost	Net Income	Cost ratio
Paddy	3880	3144	736	0.81
Wheat	3240	3060	180	0.94
Maize	3630	3107	523	0.86
Millet	3264	3045	219	0.93
Pulses	10140	3133	7007	**0.31**
Potato	14690	7957	6733	0.54
Tomato	14681	12866	1815	0.88
Chilli	12540	4131	**8409**	0.33
Cabbage	12206	11068	1138	0.91

Source: Survey Data, 2015-16

The table 4.9 shows that net income per bigha on an average among the surveyed households was the highest from pulses chilli (Rs. 8409) followed by pulses (Rs. 7007) and potato (Rs. 6733). It was negative in case of millet and low for other food crops. The net income was observed to be positively related to yield rates and prices of crops and negatively related to cost of production. For instance, gross value of

output was the highest in case of potato and tomato but due to high cost of production, net income from them were relatively low. Net income from cereal crops was found to be low due to low productivity.

Thus, it shows that as per net income measure, farm efficiency is the better in production of chilli, pulses and potato and inferior in production of wheat, millet and maize. Hence, on the basis of this measure farmers may be encouraged to concentrate on production high value cash crops to increase net income.

Cost Ratios: Another important measure of farm efficiency is the cost ratios. In this study gross cost ratio was used to measure the farm efficiency in production of various crops. Gross cost ratio is computed as:

Gross cost ratio = Total expenses divided by gross income

A higher gross cost ratio indicates lower efficiency. Gross cost ratio can be reduced by better allocation of resources. The gross cost ratio in production of various crops by the surveyed households is given in the table 4.9. The table shows that the gross cost ratio was the lowest in production of pulses (0.31) followed by chilli (0.33) and potato (0.54). It was found to be the highest in case of wheat (0.94), millet (0.93), cabbage (0.91) and tomato (0.88).It is found that as per cost ratio measure, farm efficiency was found to be better in production of pulses followed by chilli and potato. It was lower in case of wheat, millet, cabbage and tomato.

Thus, both the measures of farm efficiency lead to the same conclusion. Both the measures show farm efficiency to be better in case of chilli, pulses, potato. While the income ratio indicated farm efficiency to be better in case of chilli, the cost ratio indicated it to be better in case of pulses.

4.7 Revenue Generation from different Crops among the Surveyed Households

An attempt was also made to estimate the revenue generation from the sale of different crops. Average revenue generation per bigha for each crop was calculated by multiplying the quantity sold with the average price of the crop. The average revenue generation per bigha for different crops among the surveyed households is shown in the table 4.10.

Table 4.10: Revenue Generated from Sales of different Crops by Surveyed Households

(Quantity in Kg/Bigha)

Crops	Quantity sold (in kg)	Price (in Rs.)	Revenue (Rs)
Paddy	-	-	-
Wheat	-	-	-
Maize	39	15	582
Millet	-	-	-
Pulses	-	-	-
Potato	815	13	10807
Tomato	1330	11	**14138**
Chilli	200	33	6624
Cabbage	1159	9	10385

Source: Survey Data, 2015-16

The table 4.10 shows that revenue generation per bigha was the highest from tomato. It was Rs. 14,138 per bigha from tomato followed by potato (Rs. 10,807) and cabbage (Rs. 10,385). Revenue generation from chilli was Rs. 6,624 per bigha on an average among the surveyed farm households. The revenue generation per bigha was found to vary directly with the proportion of total output marketed.

Thus, the revenue generation from different crops indicates that in order to raise cash income of the farmers there is a need to encourage cultivation of high value cash crops like tomato, cabbage, potato and chilli in the area. But there is a need to reduce the cost of production particularly in the case of tomato and cabbage so as to increase net revenue.

The above analysis and discussion on level of inputs use, costs and returns revealed that use of fertiliser was very less in case of food crops but the use of manure was relatively more. In case of cash crops, except chilli, fertiliser use is fairly high. The use of chemical machinery (hand spray) was found mainly in production of tomato and cabbage. Both family and hired labour was found to be used in agricultural operations. Yield rates of food crops were found to be much lower than that of the cash crops. Gross value of output as well as cost of production on an average was

much higher in case of cash crops than the food crops. Farm efficiency measures indicated better efficiency in production crops, particularly chilli, pulses and potato. The prices received by the farmers for their products were much lower than the retail market prices which indicated poor marketing efficiency. Hence, there is a need to improve marketing system to ensure remunerative prices and provide formal source of credit to the farmers.

CHAPTER 5

CROP DIVERSIFICATION AND FARM INCOME

5.1 Introduction

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. Many studies have suggested positive impact of crop diversification on farm income. Sharma (2007) argued that crop diversification towards high value crops like fruits and vegetables made a significant income and employment of the small and marginal farmers in Himachal Pradesh. An analysis of secondary data on changes in cropping pattern and crop diversification in the Arunachal Pradesh showed that with the passes of time cropping pattern in the State is shifting away from food crops to high value crops like, fruits, spices and vegetables. The crop diversification as reflected by the Simpson Index of Diversification (SID) in the State is also found to be increasing over the years. Hence, it is considered important to examine the relationship between crop diversification and farm income in the hill agriculture of the State.

In this chapter, an attempt is made to see whether the same positive relationship between the two which is widely observed in the other State holds good or not and also to explore the challenges and constraints of crop diversification in the State. This chapter deals with cropping pattern of the surveyed farm households, crop diversification of the surveyed households and surveyed villages. Finally, it discusses the result of regression analysis of the impact of diversification and size of land on farm income.

5.2 Cropping Pattern of Surveyed Farm Households

An analysis of cropping pattern of the surveyed farm households showed that nearly half of the total cropped area was under food grains and slightly more than half under the non-food crops. While that share of area under food grains was 49.90 per cent, the share of area under non-food crops was 50.10 per cent. Among the food crops maize accounted for the largest share of 21.21 per cent followed by millet (19.09 per cent). The share of pulses was 1.67 per cent which was the lowest among the food crops (Table 5.1). This indicates that maize and millet are the principle crops which are extensively grown by the farmers in the study area.

Table 5.1: Cropping Pattern of the Surveyed Farm Households

Crops	Area (in per cent)
Paddy	3.78
Wheat	4.15
Millet	19.09
Maize	21.21
Pulses	1.67
Total Food grains	**49.90**
Potato	19.78
Tomato	8.51
Chilli	10.61
Cabbage	6.22
Soya bean	2.96
Peas	2.02
Total Non-Food grains	**50.10**

Source: Field Survey Data, 2015-16

Among the non-food crops, the share of area under potato was the highest (19.78 per cent). It was followed by chillies (10.61 per cent), tomato (8.51 per cent) and cabbage (6.22 per cent). This indicates that potato, chillies are the principle commercial crops grown in the study area. Recently tomato and cabbage are emerging as important commercial crops in the study area, particularly in West Kameng district. The farmers are observed to be increasing taking up cultivation of these crops by diverting land from food crops. The productivity of these two crops is found to be high compared to other crops. At the same time these crops are grown as off-season vegetables and find good demand from the neighbouring State, Assam. The farmers have found these crops highly remunerative and important source of income. However, the farmers have reported certain issues and problems relating to cultivation of these two crops. Firstly, these crops are highly perishable. So, due to lack of cold storage facilities in the area, farmers are bound to sell at low prices. Secondly, high fluctuations in prices of these crops result in low return. Thirdly, the harvesting period of these crops fall during monsoon season. Excessive monsoon rain not only damages these crops but also do not permit timely harvesting. Many farmers informed that they incurred huge losses due to damage of crops caused by excess rainfall and diseases. Fourthly, cost of production of these is observed to be very high as they require a lot of fertilizers and medicines to control diseases. These crops are mostly affected by blight. The medicines (Indofil-M45) and fertilizer (DAP)

are found to be costly as they are purchased from market and also from middleman. The farmers informed that inputs like fertilizer and medicines are not supplied to them at subsidised rate by the government. The farmers also informed that cost of production is increased due to excessive rainfall. Sudden rainfall washes away the medicine applied and again they have to use medicine to control diseases. Fifthly, for marketing of output the farmers have to rely on middleman as there is no marketing agency. So farmers are forced to take the price as fixed by the middleman. The prices received by the farmers are found to be much lower that the retail market prices.

5.3 Crop Diversification in the Surveyed Villages

An attempt was also made to explore the extent of crop diversification among the surveyed villages. It was found that in all surveyed villages crop diversification was quite high. The SID value was above 0.6 for all surveyed villages (Table 5.2). Among the surveyed villages, Rahung village of West Kameng district was found to be the most diversified village with SID value of 0.8. It was followed by Shergaon village of the same district with SID value of 0.79 and Seru village of Tawang district with SID value of 0.77. The SID value was found to be lowest in Namshu village (0.68) of West Kameng district. Thus, among the surveyed villages Rahung village was found to be the most diversified village in terms of crop production and Namshu village is found to be the least diversified village.

Table 5.2: Simpson Index of Diversification (SID) of the Surveyed Villages

Village	SID Value
Rahung	0.80
Shergaon	0.79
Seru	0.77
Mukto	0.76
Lhou	0.75
Lodung	0.74
Thembang	0.71
Namshu	0.68

Source: Computed from Field Survey Data, 2015-16

A correlation was run between distance of village from district headquarters and the SID value. The correlation coefficient was found to be negative. It was **-0.34** which implied that crop diversification is inversely related to distance. But it was not

significant. Therefore, it can be inferred that there are other factors like climatic conditions and topography which are more important determinants of crop diversification. For instance, during the field survey it was observed that commercial crops like, tomato and cabbage are suitably grown in villages located along the river valley having relatively warm climate. These crops were not found growing in the villages located in the hills.

5.4 Impact of Crop Diversification on Farm Income

Crop diversification is considered as an important strategy to enhance income generation in farm. Many studies (Sharma, 2007; Mandal and Bezbaruah, 2012) have reported positive contribution of crop diversification on farm income. Crop diversification especially towards high value crops (HVC) not only mitigate risk but may also be conducive to enhancement of income generation in farms. The study made an attempt to investigate the extent of crop diversification and its impact on farm income generation in hill agriculture. 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. A multiple linear regression model has been applied to assess the impact of crop diversification on 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 multicollinearity. 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 5.3 as below.

Table 5.3 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

Net Farm income of the sample farm household 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 and standard deviation of 0.29. 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.

The Model

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

$$FI_j = \beta_0 + \beta_1 Y_j + \beta_2 FS_j + \varepsilon_j \quad \text{..... (1)}$$

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-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 has been presented in the table 5.4 as below.

Table 5.4 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. 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 also 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 Bezbruah, 2012. This indicates that small farmers in the hills are more diversified towards commercial crops to 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 (0.64) and adjusted R-square (0.63)were found to be 0.64 and 0.63 respectively which is 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.

5.5 Challenges and Problems of Agriculture Development

The study also made an attempt to examine the challenges and problems of agriculture development in the area in particular and the State in general. The challenges and problems of agriculture development are identified as follows:

Limited availability of land: It is found to be one of important problem of agriculture development in the area. Most of the households were having semi-medium and small land holdings. The average size of holding was found to be small. Hence, there is limited scope for use of modern inputs to increase output.

Poor irrigation facility: Irrigation facility in the area was found to be very poor. Irrigation facility in the entire State is very poor. In 2010-11, only 22 per cent of the cropped area in the State was irrigated compared to national average of 45 per cent. So the farmers have to depend on rainfall for better harvest. Farmers reported that they get better harvest in the year when rainfall comes in time and poor harvest otherwise. It is important to note that 20.67 per cent of the surveyed households considered poor irrigation as main problem (Table 5.5).

Non-availability of inputs: It is also an important problem of agriculture development in the area. Production and yield of crops depend greatly on quality

and adequate quantity of inputs used. But it was found that farmers have limited access to quality inputs which resulted in low productivity. A high percentage of surveyed farmers (48.67) stated that non-availability of better inputs in adequate inputs as main cause of low productivity.

Lack of farm equipment: Farm equipment required for agricultural operation is found to be inadequate in the area. Lack of farm equipment was regarded as main problem by 20 per cent of the surveyed farmers (Table 5.5).

Poor transportation: Most of the villages are located in remote areas and are located far away from the markets. Though the villages are found to be connected by the PMGSY road, the transportation facility was found to be very poor. It was found that 7.33 per cent of the surveyed farmers regarded poor transportation as main problem (Table 5.5). So, farmers find it difficult to carry their products in the markets. Therefore, they have no option but to sell their products to middleman who comes with vehicles (Bolero Pick-up and Tata Mobiles) at low prices.

Lack of credit facility: Access to adequate and affordable credit to farmers is considered as an important input for increasing agriculture development in any region. However, the credit facility to farmers was found to be in extreme poor state as a result of which farmers relied mainly on self-finance and middleman. Out of the surveyed households, 2.67 per cent regarded lack of credit facility as main problem (Table 5.5).

Table 5.5: Responses of Surveyed Farmers on Main Problem of Agriculture Development

Main Problems	Number	Per cent
Non availability of inputs	73	48.67
Poor irrigation	31	20.67
Lack farm equipment	30	20.00
Lack of transport facility	11	7.33
Lack of credit facility	4	2.67
Any other	1	0.67
Total	150	100

Source: Survey Data, 2015-16

Marketing problem: Marketing of products is as important as quantity of output produced for improving income of farmers. A proper marketing is essential to ensure remunerative prices to the actual tillers. But in the area, marketing mechanism was found to be inefficient. Due to absence of organised marketing mechanism, farmers relied mainly on middleman for marketing of their products. Farmers were found to receive very low prices for their products from the middleman indicating low marketing efficiency.

Absence of Storage facility: The area produces off-season vegetables which are highly perishable. The crops are harvested during July to September (peak monsoon season). Due to absence of storage facility, farmers try to sell their output as early as possible to the middleman whatever be the price. The absence of storage facility is the one of the reasons of product damage and un-remunerative prices.

Climatic constraints: Climatic condition of the area is also found to impose huge challenges for agriculture development. The area is located in the Eastern Himalayan ranges. The climatic condition of the area is extreme type. Summer is mild warm and winter is extreme cold. The area receives huge monsoon rain which creates havoc like landslides, road blockades and crops damage. The area produces off-season vegetables (highly perishable) which are harvested during July to September. As there is no storage facility in the area, excess rainfall leads to huge losses and also creates problem in marketing of output. Extremely cold climatic condition during winter does not permit multiple cropping.

From the above analysis and discussion it was found that crop diversification was quite high among the surveyed villages. Cropping pattern of the surveyed farmers indicated high share of area under cash crops. 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, a good number of challenges and problems were identified for crop diversification and agriculture development in the area in particular and the State in general. 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.

CHAPTER 6

SUMMARY, CONCLUSION AND POLICY IMPLICATIONS

6.1 Introduction

This chapter deals with summary and conclusion of the important findings of the study. It also presents the important policy implications based on the findings for accelerating agricultural development in the State. The important findings of the study are summarised as follows:

6.2 Summary of the Findings

Arunachal Pradesh is predominantly a hilly area as it is situated in the Eastern Himalayan ranges. Agriculture occupies an important place as vast majority of people derive their livelihood from agriculture. Though the share of agriculture in GSDP has declined over the years from as high as 40 per cent in 1990-91 to 16.79 per cent in 2012-13 due to rapid growth of service sector, it still is the largest employer. Still more than 70 per cent of the population depends of agriculture. As per 2011 census 58 per cent of its total workforce was engaged in agriculture sector.

The land use statistics shows that the arable land is extremely limited owing to its hilly and mountainous topography. Only around 10 per cent of the total geographical area of the State consisting of foothills and river valley is suitable for cultivation. The State is having very low density of population (17 persons per 100 sq. km as per 2011 provisional census). 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. But average size of holdings in the State was found to be higher than the national average of 1.15 hectare and was the second highest among the North Eastern States. As a percentage of geographical area, operational area in the State was only 4.85 per cent in 1995-96 which fell to 4.59 per cent in 2010-11. The net sown area as per cent of geographical area which declined from 2.43 per cent in 1995-96 to 2.07 per cent in 2005-06 improved to 2.54 per cent in 2010-11. The gross cropped area in the State has increased from 2.96 per cent in 1995-96 to 3.32 per cent of geographical area in 2010-11. Cropping intensity in the State showed that it has increased from 121.82 per cent in 1995-96 to 130.50 per cent in 2010-11. But it is still lower than the national average. The relatively low cropping intensity in the State can be attributed to poor irrigation facilities.

As per 2010-11 census, most of the holdings in the State were found to be semi-medium holdings (31.19 per cent) followed by medium (25.49 per cent), small holdings (19.27 per cent), marginal holdings (17.43 per cent) and large holdings (6.42 per cent). In terms of area, the medium holdings accounted for the largest share (40.36 per cent) followed by large holdings (25.26 per cent), semi-medium holdings (24.48 per cent), small holdings (6.77 per cent) and marginal holdings (3.13 per cent). In 2010-11, marginal and small holdings together accounted for around 37 per cent of the total number of operational holdings but accounted for only around 10 per cent of the total operational area. Large holdings which accounted for only 6.42 per cent of the total number of operational holdings accounted for only around 25.26 per cent of the total operational area. This indicates high and growing inequality in land holdings in the State.

The study of changes in cropping pattern in the State showed that 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. This indicates that there is tendency of diversification towards high value crops in the State which is a positive sign of agriculture development in the State.

The study also made an attempt to examine the extent of crop diversification and its impact on farm income in the State. The Simpson index of diversification (SID) 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 0.79 in 2012-13 and again rose to 0.80 in 2013-14. 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 field to mitigate risk as well as to meet the requirement of their family. Among the various districts, West Kameng district was the most diversified district of Arunachal Pradesh.

The growth of area, production and productivity of food grains in the State during the period 2002-03 to 2013-14 showed that food grains production in the State increased from 242.4 thousand tonnes in 2002-03 to 384.6 thousand tonnes in 2013-14 with compound annual rate of growth (CARG) of 4.19 per cent. This was mainly on account of increase in productivity which increased from 12.26 quintals per hectare in 2002-03 to 17.9 quintals per hectare in 2013-14. The increase in food grains

production during 2002-03 to 2013-14 was mainly contributed by increase in production of paddy, pulses and maize.

Among the North Eastern States, Arunachal Pradesh accounts for less than 5 per cent of total food grains production in the region. For instance, in 2001-02, it accounted to 3.60 per cent of total food grains production in the region. Its share improved to 4.72 per cent in 2009-10. The low share of the State in food grains production can be attributed to its hilly topography and extreme climatic conditions which are not suitable for production of cereals particularly paddy and wheat. In 2010-11, yield rate of food grains in the State was 16.63 quintals per hectare which was lower than the national average of 19.30 quintals per hectare.

Important commercial crops grown in the State are oilseeds, potato, ginger, turmeric, chillies, sugarcane and vegetables. An analysis of data on commercial crops revealed that during the period 2002-03 to 2013-14, among the various crops production of chillies increased at a faster rate. Its production rose from 2.34 thousand tonnes in 2002-03 to 6.75 thousand tonnes in 2013-14 with CARG of 8.65 per cent which was the highest among the commercial crops. The production of sugarcane increased rapidly from 15.28 thousand tonnes to 30.35 thousand tonnes with CARG of 8.44 per cent. Production of oilseeds, potato, ginger, turmeric also increased during this period. While the increase in production of potato, turmeric and chillies was contributed by growth of both area and yield, increase in production of oilseeds, ginger and sugarcane in the State was achieved mainly on account of area expansion.

The analysis of socio-economic profile of the surveyed farm households indicated low level of well-being. It was found that most of the respondents were in the age group of 30-50 years. The mean age of the respondents was estimated to be 48.26 years. Gender distribution of respondent farmers showed that most of them were male. Educational level of the surveyed farmers indicated that majority of them were illiterate. A good number of them were having primary level education. Only few of them had education level of higher secondary and above. Household size of majority of the surveyed farmers was medium size. Income level of most of the surveyed households was below one lakh rupees. Most of the surveyed households showed had semi-medium size of land holdings followed by small size. Majority of them were found living in *kutch* house but a good number of them had drinking water tape in their houses. At the same time a good number of households had access to sanitary toilets.

The study of area sown under different crops by the surveyed households was found to be low. It was due to limited availability of cultivable land owing to hilly and

mountainous topography. This implies that there is a limited scope for improving the income of the farmers through area expansion. Hence, it is important to improve productivity of various crops to increase income of the farmers in the area.

The level of use of fertiliser by the surveyed households on various crops showed relatively low level of its use, particularly in case of food crops. But it was moderate in case of cash crops. The average quantity of fertiliser use per bigha for food crops varied from 1.15 kg for wheat to 4.10 kg for maize. In case of cash crops, average quantity of fertiliser use per bigha, except chilli, varied from 15.59 kg for potato to 38.80 kg for tomato. Use of chemical was crop specific. It was used mainly by tomato and cabbage growers as these crops are highly subjected to infections and diseases.

The use of manure among the surveyed households depended on its availability. The study use of manure by the surveyed households showed that farmers in the area were using mainly cow dung and farm yard manure and dry leave (locally called *sheu*). In case of food crops average quantity of manure used per bigha varied from 3.23 kg for paddy to 75.20 kg for maize. In case of cash crops, the average quantity of manure use per bigha varied from 15.5 kg for cabbage to 99.26 kg for chilli.

The farmers were found to use mainly hand spray machine to sprinkle medicine on tomato and cabbage plants. The use of machinery like tractor for tilling soil was not observed. This may be due to hilly topography which is not suitable for its use. The use of machinery was found to be more for tomato than cabbage.

The yield rates of different crops among the surveyed households were found to vary widely. The variation was found to be more in case of cash crops than the food crops. For instance, in case of tomato yield rate varied from 267 kg per bigha to 5000 kg per bigha and for cabbage it varied from 800 per bigha to 5250 kg per bigha. This can be attributed to weather risk and diseases as these crops are highly affected by diseases and are highly perishable. During the survey, a good number of growers of these crops stated that they incurred huge losses due to crop damage. But mean yield of cash crops was found to be much higher than that of the food crops.

Gross value of output per bigha was found to vary widely among the surveyed households. The variation was the highest in case of tomato and cabbage. In case of tomato it varied from Rs. 2933 per bigha to 55000 per bigha with mean of Rs. 14681 per bigha. This is due to the fact that these crops are exposed to high weather risk and are also affected by diseases. The cost of production was found to be less in case of food crops compared to cash crops. For instance, the total cost of production, in case of food crops, varied from Rs. 3045 per bigha for millet to Rs. 3144 per bigha for

paddy. In case of cash crops, total cost of production varied from Rs. 4131 per bigha for chilli to Rs. 12866 per bigha for tomato. The high cost of production in case of tomato and cabbage can be attributed to high cost incurred on fertiliser, chemical and seed.

Net income measure of farm efficiency showed efficiency to be better in production of chilli, pulses and potato and inferior in production of wheat, millet and maize. Hence, on the basis of this measure farmers may be encouraged to concentrate on production high value cash crops to increase net income. The cost ratio measure showed that farm efficiency to be better in production of pulses followed by chilli and potato. Hence, the farmers of the area may be encouraged to go for extensive cultivation of crops like, chilli, pulses and potato which are subjected to less risk.

Revenue generation per bigha was the highest from tomato. It was Rs. 14,138 per bigha from tomato followed by potato (Rs. 10,807) and cabbage (Rs. 10,385). It was Rs. 6,624 per bigha from chilli on an average among the surveyed farm households. Revenue generation from different crops was determined by the proportion of output sold, cost of production and price. It shows that in order to raise cash income of the farmers there is a need to encourage cultivation of high value cash crops like tomato, cabbage, potato and chilli in the area. However, there is a need to reduce cost of production which can be done by providing subsidised inputs and judicious use of inputs.

The regression results on impact of crop diversification and on farm income showed that coefficient of crop diversification (Y) was positive and significant at 0.01 level. Hence, the second hypothesis was also accepted. 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. Farm size was also 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.

However, the study found that there are numerous challenges and problems of agriculture development in the area like limited cultivable land, non-availability of inputs, high cost of inputs, poor irrigation facility, poor transport facility, lack of cold storage, lack of credit facility, marketing problem, climatic constraints etc. These challenges need to be addressed for development of agriculture and enhancing income of farmers in the area in particular and the State in general.

6.3 Policy Implications

On the basis of above discussion and findings, the following policy implications have been suggested:

- There is a need to revitalise extension services to disseminate new technology in the rural areas. Emphasis should be laid on capacity buildings 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.
- Adequate and timely supply of inputs such as seed, fertiliser, pesticides and implements should be provided by the Government. At the same time, judicious use of these inputs should be promoted to avoid harmful effects. Use of organic manure/compost should also be encouraged.
- Irrigation facility should be strengthened. This will help to increase yield rate and also encourage multiple cropping.
- Efforts should be made to provide credit at reasonable rate to farmers to enable them to undertake adequate investment in production of various crops.
- There is also a need to establish cold storage facility in the area. This will help to reduce post-harvest losses and ensure better returns to the farmers.
- The government should provide price support for various crops to the farmers and procure output through a notified agency. This will assure remunerative prices to farmers and encourage them to produce more output.
- Agro-based industries should be set up in the area for 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.
- Farmers are found to incur heavy losses due to damage of crops (tomato and cabbage) resulting from diseases and excess rainfall. The provisions of National Crop Insurance scheme may be implemented to protect the farmers from such losses in production.

6.4 Conclusion

The discussion and findings of the study lead us to the following conclusions. It was found that agriculture continues to be a significant contributor to the State's income. The contribution of agriculture is significantly high in providing employment to the

people as still more than half of its workforce is engaged in agriculture for their livelihood. So, increasing productivity in agriculture by using modern cultivation techniques, double cropping, and increased irrigation should be given top priority as there is limited scope to increase output through the expansion of area. The analysis of data revealed that productivity of different crops is lower in the State compared to national average and other States. This was mainly due to low level of use of fertiliser, manure and irrigation. The policy, therefore, should emphasis on improving productivity on the one hand and on the other hand, it should focus on all income-generating activities like cash crops, floriculture, fruit etc. culture, fish and pig-rearing, agro-processing etc. to enhance income of farmers.

It was found that yield rates as well as net income from cash crops were found higher than those from food crops. The regression results also showed that crop diversification had positive and significant impact on farm income. Hence, 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. In this regard, the government must play a proactive role in introducing and disseminating new technology such that it is adopted by the farmers. The Government must strengthen extension services and facilitate the change from the largely subsistence mode of production to the market mode by providing finance, better inputs, marketing infrastructure and support prices. Adequate quantity of inputs should be supplied to the farmers at reasonable 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. All this will go a long way in promoting agriculture and rural development in the State.

Appendix I

Table A.2.1: Changes in Land Use Pattern in Arunachal Pradesh

Sl. No.	Category	Unit	**1995-96**	**2000-2001**	**2005-2006**	**2010-11**
1	Operational holding	**No**	106000	106783	108635	109298
		Area ('000 hect.)	405.88	393.64	361.42	384
2	Net area sown	**Area ('000 hect.)**	203.63	200.21	173.47	213
3	Current fallow	**Area ('000 hect.)**	28.15	22.96	36.58	40
4	Fallow land other than current fallow	**Area ('000 hect.)**	59.92	64.04	52.1	70
5	Uncultivated land excluding fallow land	**Area ('000 hect.)**	81.08	46.22	33.68	120
6	Culturable waste land	**Area ('000 hect.)**	43.01	27.82	28.4	64
7	Land not available for cultivation	**Area ('000 hect.)**	33.14	32.39	37.2	64
8	Gross cropped area	**Area ('000 hect.)**	248.06	215.06	215.11	278
9	Net irrigated area	**Area ('000 hect.)**	38.36	44.48	47.18	NA
10	Cropping intensity	**(in Percentage)**	121.82	107.42	124	130.5
11	Net irrigated area (As % of Gross cropped area)	-	15.46	20.68	21.93	NA
12	Average size of holdings	**(inhect.)**	3.83	3.69	3.34	3.52

Source: Statistical Abstract of Arunachal Pradesh (Various years)

Table A.2.2: Land Utilisation Pattern of North Eastern Region (As per Agriculture Census 2010-11) (Area in '000 Hectares)

States	Geographical Area	Reporting area for land utilisation	Forests cover in 2011	Not Available for Cultivation	Other Uncultivated Land	Fallow Land	Net area sown	Area sown more than once	Total cropped area
Arunachal Pradesh	8374	5661	6741	64	120	110	212	64	276
Assam	7844	7850	2767	2626	433	129	2811	1289	4100
Manipur	2230	2010	1709	27	8	0	233	NA	233
Meghalaya	2243	2229	1728	231	556	213	283	53	336
Mizoram	2108	2101	1912	95	51	247	361	126	487
Nagaland	1658	1621	1332	89	150	160	123	NA	123
Sikkim	710	693	336	11	11	9	77	67	144
Tripura	1049	1049	798	134	28	2	280	29	309
NER Total	**26216**	**23214**	**17323**	**3277**	**1357**	**870**	**4380**	**1628**	**6008**
All India	**328726**	**305903**	**69203**	**43564**	**26165**	**24589**	**141579**	**57390**	**198969**
Source: Basic Statistics of North Eastern Region 2015 and State of Forest Report 2011									

Table A.2.3: Land Utilisation Pattern of North Eastern Region (As per Agriculture Census 2010-11)

(As Per Cent of Geographical Area)

States	Forest cover in 2011	Not Available for Cultivation	Other Uncultivated Land	Fallow Land	Net Sown Area	Area Sown more than once	Total Cropped Area	Cropping Intensity
Arunachal Pradesh	80.50	0.76	1.43	1.31	2.53	0.76	3.30	130.19
Assam	35.28	33.48	5.52	1.64	35.84	16.43	52.27	145.86
Manipur	76.64	1.21	0.36	0.00	10.45	NA	10.45	100.00
Meghalaya	77.04	10.30	24.79	9.50	12.62	2.36	14.98	118.73
Mizoram	90.70	4.51	2.42	11.72	17.13	5.98	23.10	134.90
Nagaland	80.34	5.37	9.05	9.65	7.42	NA	7.42	100.00
Sikkim	47.32	1.55	1.55	1.27	10.85	9.44	20.28	187.01
Tripura	76.07	12.77	2.67	0.19	26.69	2.76	29.46	110.36
NER Total	**66.08**	**12.50**	**5.18**	**3.32**	**16.71**	**6.21**	**22.92**	137.17
All India	**21.05**	**13.25**	**7.96**	**7.48**	**43.07**	**17.46**	**60.53**	140.54
Source: Basic Statistics of North Eastern Region 2015 and State of Forest Report 2011								

Table A.2.4: Status of Shifting Cultivation in North Eastern Region (in 2008)

States	Annual area under Shifting cultivation (Ha)	Fallow Period (Years)	Minimum area under Jhum at a given time ('000 Ha)	No. of Jhumia Families ('000)	Jhum land/Family
Arunachal Pradesh	70000 (0.01)	3 to 10	210	54	1.29
Assam	69600 (0.01)	2 to 10	139	58	1.2
Manipur	90000 (0.04)	4 to 7	360	70	1.29
Meghalaya	53000 (0.02)	5 to 7	265	52	1.01
Mizoram	63000 (0.03)	3 to 4	189	50	1.26
Nagaland	19000 (0.01)	5 to 8	191	116	0.16
Sikkim	NA	NA	NA	NA	NA
Tripura	22300 (0.02)	5 to 9	112	43	0.51

Note: Figures in the bracket indicate per cent of geographical area

Source: Basic Statistics of North Eastern Region 2015

Table A.2.5: Average size of holdings in North Eastern States of India (in hectares)

State	1990-91	1995-96	2000-01	2005-06	2010-11
Arunachal Pradesh	3.72		3.69	3.34	3.52
Assam	1.31			1.11	1.10
Manipur	1.24			1.14	1.14
Meghalaya	1.81			1.18	1.37
Mizoram	1.34			1.22	1.14
Nagaland	6.92			6.93	6.02
Sikkim	NA			1.48	1.42
Tripura	0.97			0.5	0.49
India	1.57	1.41	1.33	1.23	1.15

Source: Agriculture Census, Ministry of Agriculture

Table A.2.6: Percentage Distribution of Total Workers (Main & Marginal) by Category of Workers in Arunachal Pradesh (As Per 2011 Census)

District	Cultivators	Agriculture Labour	Worker in HH Industries	Other Workers
Tawang	26.72	5.54	0.40	67.35
West Kameng	34.07	4.01	1.89	60.04
East Kameng	68.86	3.35	0.86	26.93
Papum Pare	21.44	2.83	2.35	73.38
Upper Subansiri	65.00	5.53	1.44	28.03
West Siang	58.67	2.81	0.61	37.91
East Siang	50.18	8.86	1.23	39.73
Upper Siang	56.54	4.56	3.35	35.55
Changlang	63.10	6.68	0.79	29.43
Tirap	71.69	3.61	1.67	23.03
Lower Subansiri	45.22	6.52	1.44	46.83
KurungKumey	**72.07**	7.75	2.19	18.00
Ddibang Valley	36.29	2.98	1.91	58.82
Lower Dibang Valley	43.39	15.02	1.04	40.54
Lohit	49.08	12.78	1.29	36.85
Anjaw	60.15	1.72	0.80	37.33
Total Arunachal	**51.51**	**6.16**	**1.42**	**40.91**

Source: Statistical Abstract of Arunachal Pradesh 2014

Table A.2.7: District Wise Simpson Index of Crop Diversification (SID) in Arunachal Pradesh (2013-14)

District	SID value
West Kameng	**0.78**
KurungKumey	0.77
Tirap	0.75
Longding	0.75
Tawang	0.74
Dibang Valley	0.74
Lohit	0.73
Upper Subansiri	0.73
Lower Subansiri	0.69
Anjaw	0.67
Changlang	0.63
Lower Dibang Valley	0.63
Upper Siang	0.59
East Kameng	0.56
Papum Pare	0.50
West Siang	0.42
East Siang	**0.33**

Source: Computed using Data from Statistical Abstract of Arunachal Pradesh 2015

Table A.2.8: State-wise Yield for Food grains in NER, (2001-02 to2010-11) (in Kg/Hectare)

State	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Arunachal	1154	1226	1277	1178	1212	1216	1241	1255	1555	1663
Assam	1460	1417	1472	1405	1416	1286	1378	1551	1662	1763
Manipur	2306	2217	2355	2390	2241	2241	2297	2236	1796	2244
Meghalaya	1667	1686	1733	1674	1455	1800	1774	1783	1809	1803
Mizoram	1917	1866	1854	1888	1754	822	285	898	1047	1246
Nagaland	1380	1565	1561	1577	1615	1482	1567	1811	1256	1902
Sikkim	1289	1334	1395	1406	1354	1354	1378	1351	1496	1448
Tripura	2311	2289	2121	2179	2194	2399	2563	2526	2544	2587
India	1734	1535	1727	1652	1715	1756	1860	1909	1798	1930

Source: Basic Statistics of North Eastern Region 2015

Table A.2.9: Yield Rate of Principle Food Crops in North Eastern States

States	Rice		Wheat		Maize		Pulses		Gram		Tur (Arhar)		Total Food grains	
	2001-02	2010-11	2001-02	2010-11	2001-02	2010-11	2001-02	2010-11	2001-02	2010-11	2001-02	2010-11	2001-02	2010-11
Arunachal Pradesh	1126	1925	1394	1595	1360	1435	1044	1055	NA	NA	1000	833	1154	1663
Assam	1519	1843	1181	1179	700	722	558	555	500	500	714	718	1460	1763
Manipur	2382	2453	NA	NA	1980	1856	517	897	NA	NA	NA	NA	2306	2244
Meghalaya	1755	1912	1714	1791	1491	1499	745	849	600	500	750	750	1667	1803
Mizoram	1894	1160	NA	NA	2257	1508	1444	1534	NA	NA	1000	NA	1917	1246
Nagaland	1516	2102	2500	1712	1375	1958	849	1058	1000	714	714	840	1380	1902
Sikkim	1420	1727	1273	1023	1374	1648	862	899	NA	NA	NA	NA	1289	1448
Tripura	2381	2655	2083	2025	1000	1322	647	704	750	667	750	750	2311	2587
India	2079	2239	2762	2989	2000	2540	607	691	853	895	679	655	1734	1930

Source: Basic Statistics of North Eastern Region 2015

Table A.2.10: Yield Rate of Other Crops in North Eastern States

(Yield in Kg/hectare)

States	Oilseeds		Rapeseed & Mustard		Soya bean	
	2001-02	2010-11	2001-02	2010-11	2001-02	2010-11
Arunachal Pradesh	1076	921	1045	893	1448	1346
Assam	506	576	504	581	NA	NA
Manipur	400	744	333	779	NA	NA
Meghalaya	674	704	667	681	900	1091
Mizoram	654	1203	880	750	923	1929
Nagaland	1075	1040	1000	1000	1389	1246
Sikkim	690	832	603	792	810	881
Tripura	717	722	828	750	NA	NA
India	913	1193	1002	1185	940	1327

Source: Basic Statistics of North Eastern Region 2015

REFERENCES

Abro, Asif Ali (2012): 'Determinants of Crop Diversification towards High Value Crops in Pakistan', *Int. J Buss. Mgt. Eco. Res*., Vol. 3 (3), pp. 536-545.

Ahmed, J. U. (2010): *Development Vision of North East India, Concept Publishing Company*, New Delhi.

Anonymous (2015):'Raising Agricultural Productivity and Making Farming Remunerative for Farmers', Occasional Paper, NITI Ayog, Government of India.

Awasthi, I. C. (2012): *Livelihood Diversities in Mountain Economy: Constraints and Opportunities*, Concept Publishing Company, New Delhi.

Bhattacharyya, R. (2008): 'Crop Diversification: A Search for an Alternative Income of the farmers in the State of West Bengal in India,, Paper Presented at *International Conference on Applied Economics – ICOAE*.

Chand, R. and Pavitra, S. (2015): 'Fertiliser Use and Imbalance in India: Analysis of States', *Economic and Political Weekly*, Vol. L, No. 44, pp. 98-104.

Chandrasekhar, S and N. Mehrotra (2016):'Doubling Farmers' Incomes by 2022: What Would it Take'? *Economic and Political Weekly*, Vol. LI, No. 18, pp. 10-13.

De, U. K. (2003): *Economics of Crop Diversification*, Akansha Publishing House, New Delhi.

Deb, Bimal J. and B. Dutta Ray (2006): *Changing Agricultural Scenario in North East India*, Concept Publishing Company, New Delhi.

Ghosh, B. K. (2013): *The Dynamics of Crops Diversification: A Study of West Bengal*, lap lambert Academic Publishing, Deutschland, Germany.

Ibrahim, H. et. al. (2009): 'Income and Crop Diversification among Farming Households in a Rural Area of North Central Nigeria', *Journal of Tropical Agriculture, Food, Environment and Extension*, Vol. 8, No. 2, pp. 84-89.

Ji-kun, Huang (2014): 'Crop Diversification in Coping with Extreme Weather Events in China', *Journal of Integrative Agriculture*, Vol. 13, (4), pp. 677-686.

Joshi, P.K., Ashok Gulati, P.S. Birthal and LaxmiTiwari (2004): 'Agriculture Diversification in South Asia: Pattern, Determinants and Policy Implications', *Economic and Political Weekly*, Vol. XXXIX, No. 24, pp. 2457-67.

Karunakaran, N. (2015): *Crop Diversification for Sustainable Agriculture*, Pointer Publishers, Jaipur, India.

Lingareddy, T. (2015): 'Pulses: Need for Production Expansion', *Economic and Political Weekly*, Vol. L, No. 35, pp. 133-136.

Mandal, R. and M.P. Bezbaruah (2013): 'Diversification of Cropping Pattern: Its Determinants and Role in Flood Affected Agriculture of Assam Plains', *Indian Journal of Agricultural Economics*, Vol. 68, No. 2, pp. 169-181.

Panda, B. (1997): 'Changing Facets of Agriculture in Arunachal Pradesh', in Behera, M. C. and N. C. Roy (eds.), *Trends in Agrarian Structure in the Hills of North-East India*, Commonwealth Publishers, New Delhi, pp. 131-139.

Raane, A. A. and A. C. Deorukhkar (2012): *Economics of Agriculture*, Atlantic Publishers and Distributors, Pvt., Ltd., New Delhi.

Ray, Shovan (2009): *Handbook of Agriculture*, Oxford University Press, New Delhi.

Roy, N. C. (1997): 'Agricultural Productivity in Arunachal Pradesh', in Behera, M. C. and N. C. Roy (eds.), *Trends in Agrarian Structure in the Hills of North-East India*, Commonwealth Publishers, New Delhi, pp. 55-59.

Salam, M. A. (2006): *Agricultural Transformation in North-East India*, Mittal Publications, New Delhi.

Saumya, C. and Anirban Kundu (2009): 'Rural Non-Farm Economy: A Note on the Impact of Crop Diversification and Land Conversion in India', *Economic and Political Weekly*, Vol. XLIV, No. 2, pp. 69-75.

Sharma, H.R. (2007): 'Crop Diversification in Himachal Pradesh: Extent, Impact, Determinants and Challenges', *The Indian Journal of Labour Economics*, Vol. 50, No. 4, pp. 689-702.

Sharma, P., N. Ogale and S. Singh (2010): *Women in Hill Agriculture*, Concept Publishing Company, New Delhi.

Sidhu, K., V. Kumar and T. Singh (2009): 'Diversification through Vegetable Cultivation', *Journal of Life Science*, Vol. 1 (2), pp. 107-113).

Singha, K. and G. Patikar (2010): *Rural development in North East India*, Concept Publishing Company, New Delhi.

Soni, R. N. (2007): *Leading Issues in Agricultural Economics*, Vishal Publishing Co., Jalandhar, India.

Vaidyanathan, A. (2010): *Agricultural Growth in India: Role of Technology, Incentives and Institutions*, Oxford University Press, New Delhi.

Yadu, C. R. and Satheesha B (2016): 'Agrarian Question in India: Indications from NSSO's 70th Round', *Economic and Political Weekly*, Vol. LI, No. 18, pp. 20-23.

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The Centre for Development Studies (CDS) was set up in 2013 as a research adjunct at the Department of Economics, Rajiv Gandhi University (RGU),Itanagar, Arunachal Pradesh, with a generous grant from the Ministry of Finance (Department of Economic Affairs), Government of India. The objectives of the Centre include the creation of high quality research infrastructure for students, researchers and faculty members, in addition to sponsoring and coordinating research on various developmental issues having policy implications both at the regional and national level. Sponsoring national and international scholars for delivering lectures and other academic engagements and organizing national and international seminars, workshops, symposiums at periodic intervals on relevant topics and publishing working/policy papers on the research outcome of the Centre, monographs and edited volumes are other key activities of the Centre.

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