Agricultural Production in Assam in the Recent Decades: An Empirical Study of Select Crops in Two Districts of Western Assam

A Thesis Submitted for the Degree of Doctor of Philosophy in Economics in the Department of Humanities and Social Sciences, Indian Institute of Technology, Guwahati

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CERTIFICATE

This is to certify that the thesis entitled *Agricultural Production in Assam in the Recent Decades: An Empirical Study of Select Crops in Two Districts of Western Assam*, submitted by Mr. Hemanta Kumar Saud, Enrolment Number: 10614103, Assistant Professor, Department of Economics, Birjhora Mahavidyalaya, Bongaigaon, Assam, for the degree of Doctor of Philosophy in Economics in the Department of Humanities and Social Sciences (HSS), Indian Institute of Technology (IIT), Guwahati, embodies bonafide record of research work carried out under my personal supervision and guidance. The collection of materials from primary and secondary sources has been done Mr. Hemanta Kumar Saud himself.

The present thesis or any part thereof has not been submitted to any other Institute or University for award of degree or diploma.

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DECLARATION

I hereby declare that I have completed my thesis entitled *Agricultural Production in Assam in the Recent Decades: An Empirical Study of Select Crops in Two Districts of Western Assam*, under the supervision and guidance of Dr. Debarshi Das, Associate Professor (Economics), Department of Humanities and Social Sciences, Indian Institute of Technology (IIT), Guwahati. The thesis is the result of my own investigation, analysis and observation. Neither the thesis nor any part thereof has been submitted to any institute or University for any other degree or diploma.

In keeping with the general practice of reporting observations, due acknowledgement has been made wherever the work described is based on the findings of other investigations.

(Hemanta Kumar Saud)

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List of Abbreviations Used in the Chapters

AAU	Assam Agricultural University	JMDC	Jute Manufactures Development Council
ADO	Agriculture Development Officer	KCC	*Kisan* Credit Card
AIR	All India Radio	KVK	*Krishi Vigyan Kendras*
ATMA	Agricultural Technology Management Agencies	KWH	Kilo Watt Hour
AATS	All Assam Tribal Sangtha	LBV	Lower Brahmaputra Valley
ABSU	All Bodo Students' Union	LIS	Lift Irrigation System
ASSCA	Assam State Seed Certification Agency	MLE	Maximum Likelihood Estimate
CACP	Commission for Agricultural Cost and Pricing	MoP	Muriet of Potash
CAGR	Compound Annual Growth Rate	MSL	Mean Sea Level
CBV	Central Brahmaputra Valley	Mm	Millimeter
CCEA	Cabinet Committee on Economic Affairs	MNREGA	Mahatma Gandhi Rural Employment Guarantee Act
C-D	Credit-Deposit	MT	Metric Tone
CDB	Community Development Block	MV	Modern Variety
CGWB	Central Ground Water Board	NAIS	National Agricultural Insurance Scheme
CMIE	Centre for Monitoring Indian Economy	NBP	North Bank Plain
CSO	Central Statistical Organization	NCA	Net Cultivated Area
CWC	Central Water Commission	NEDFi	North Eastern Development Finance Institute
CWWG	Crop Weather Watch Group	NER	North Eastern Region
DTW	Deep Tube Well	NFSM	National Food Security Mission
DAP	Diammonium Phosphate	NGO	Non Government Organization
EGR	Exponential Growth Rate	NJB	National Jute Board
FAO	Food & Agriculture Organization	NPK	Nitrogen, Phosphorus and Potash
FCI	Food Corporation of India	NSSO	National Sample Survey Organization
FMCs	Field Management Committees	NR	Natural Rubber
GCA	Gross Cropped Area	NSA	Net Sown Area
GCF	Gross Capital Formation	OLS	Ordinary Least Square
GCFA	Gross Capital Formation in Agriculture	QE	Quick Estimation
GDP	Gross Domestic Product	RPD	Rubber Plantation Development
GIS	Global Information System	RPS	Rubber Producers' Societies

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GoI	Government of India	RBI	Reserve Bank of India
GS	*Gram Sevak*	RSS	Ribbed Smoked Sheets
GSDP	Gross State Domestic Product	SC	Scheduled Caste
HYV	High Yield varieties	SF	Stochastic Frontier
IASRI	Indian Agricultural Statistics Research Institute	SGDP	State Gross Domestic Product
ICAR	Indian Council of Agricultural Research	SRI	System of Rice Intensification
IIT	Indian Institute of Technology	SRR	Seed Replacement Rate
IJDP	Integrated Jute Development Programme	ST	Scheduled Tribe
IJIRA	Indian Jute Industries' Research Association, Kolkata	STW	Shallow Tube Wells
IJSG	International Jute Study Group	TCA	Total Cropped Area
ISEC	Institute for Social & Economic Changes	TPA	Total Paddy Area
IPCC	Intergovernmental Panel on Climate Change	TRA	Total Rice Area
IJDP	Integrated Jute Development Programme	TV	Traditional Variety
IJSG	International Jute Study Group	UBV	Upper Brahmaputra Valley
IRRI	International Rice Research Institute	VIF	Variance Inflation Factor
ISEC	Institute for Social & Economic Change	VLEW	Village Level Extension Worker
ICT	Information & Communication Technology		

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Abstract

Agriculture contributes substantially to the output and employment of a predominantly agricultural and over-populated country like India. Although, Indian agriculture provides food for a large section of World population and occupies first or second ranks in the production of different crops, productivity levels are much lower as compared to many countries. Use of modern inputs in Indian agriculture is comparatively lower than the developed countries and it is highly skewed among the regions in India. Compound annual growth rate of production of major crops decreased during the period 1990-91 to 2010-11 compared to its earlier two decades. Steadily declining size of agricultural holdings is a key fact about the evolution of Indian agriculture. Indian agriculture is dominated by the marginal and small farmers in terms of both numbers and operated area. The debates on inverse farm size-productivity relationship have been alive as well.

Agriculture forms the backbone of Assam's economy. Over 70 percent population of Assam gets their means of livelihood from the agriculture. Agriculture and allied sector contributed more than 20 percent to the State Domestic Product during 2014-15. But the productivity of agricultural crops is comparatively lower than the national average (except for a few crops). Growth of agricultural production and the indices of agriculture in the state are lower than the all India level.

The basic feature of the cropping pattern in the state is the predominance of food crops, mainly rice. Fragmentation of holdings into multiple plots acts as a major drag on the adoption of technological improvements in agricultural production and thereby impedes the growth of agricultural productivity. Although a large number of land reform measures have been introduced and land reform acts have been passed in Assam since 1948, the implementation of these acts has not been effective and the impact has been negligible.

Identifying the reasons of low productivity and finding out ways to achieve high production of crop output is the main research question of the thesis. To address this, both secondary and primary data have been used. The primary data have been collected by multistage sampling. The field study is confined among the farmers of two western districts of Assam. We focused on three important crops, viz., rice, jute and rubber.

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Rice is the staple food for the inhabitant of Assam. The share of rice in total cereals stood at 97.5 percent in 2011-12. Rice is grown in a wide range of agro-ecological situations of Assam in all the three seasons in a year. Yield rate of rice in Assam is lower than the all India average. The gap between state average and the national average has been rapidly increasing, which poses a serious policy challenge. Besides natural causes, rice production in the state has been hampered by input and service constraints. It is the overwhelming importance of rice in the state agriculture which made us choose the crop.

Jute is a field crop classified as a fiber crop with industrial value. Although, jute is one of the important cash crops in Assam, area under jute has drastically reduced and so the production been declined in the recent decades. As in rice, jute production in the state has also been hampered by input and service constraints. Jute is a declining crop. But historically Assam has been an important producer of crop. These considerations made us choose jute.

Rubber plantation has been rapid popularity in the state. The state, specially its western districts, has seen fast growth of rubber production. Natural rubber production of Assam as a share of Indian production has increased both in terms of area and output in recent years. Unlike declining popularity of autumn and winter rice, wheat, jute, etc., rubber is an emerging crop, which made us choose it.

The primary data were collected from 184 rice farmers, 115 jute farmers and 102 rubber farmers in two districts of western Assam, Goalpara and Bongaigaon. We chose two adjacent districts in order to ascertain if difference in district administration makes any difference to crop production, provided other factors remain more or less the same. Compared to Goalpara, more farmers in Bongaigaon have cultivated modern varieties of winter rice. Number of farmers having owned land is more in Goalpara. Average yield of total rice is higher in Goalpara than in Bongaigaon. Jute cultivation is declining. But when we estimated the profit per unit of land jute yielded higher value than rice. Number of growers having owned jute land is more in Goalpara than in Bongaigaon. Use of chemical fertilizers in jute cultivation is relatively higher in Goalpara than in Bongaigaon. Production as well as average yield of jute among growers in Goalpara is higher than in Bongaigaon. In rubber, yield as well as production among the growers in Goalpara is higher than the growers in Bongaigaon. Thus, Goalpara is better in yields of three selected crops, rice, jute and rubber.

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The production functions of the three crops have been estimated. The estimation has been done by both the standard OLS method and Stochastic Frontier method. In the latter case we can ascertain if there is any technical inefficiency in production. The analysis of the findings leads us to conclude the following. Most of the farmers are land poor. There is sub-optimal use of land input. A greater provision of land would add significantly to output. Capital, fertilizers, planting materials were found to be important for output increase. Public extension services were found to be critical in at least one case (winter rice, modern variety). An increase in the use of these inputs would help in enhancing the output level. We also found evidence of technical inefficiency in the production of a majority of crops. In the concluding chapter we forwarded suggestions and recommendations for improvement of agricultural production in the state.

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Chapter-I: Introduction and Review of Literature

This chapter discusses the theoretical framework and rationale for commencing an empirical study of the current agricultural production in Assam particularly in two districts of western Assam, Goalpara and Bongaigaon. During the course of our research, we studied the scenario of Indian agriculture and some agriculturally developed states of the country to compare the agriculture scenario in Assam. We reviewed literature right from the growth of agriculture to the mode of agricultural production, operational holding, input use, crop diversification and changes in cropping pattern, etc. With the backdrop of literature reviewed, we framed the research problem; objectives of the study, methodology adopted, sources of data, selection of crops and field area, etc. are designed. This chapter concludes by offering a road map of the chapters that are discussed in this thesis.

1.1: The Background of the Study:

Agriculture continues to remain as one of the most important sectors in the global economy. It is one of the earliest economic activities and a considerably large number of the World population has continued to depend on agriculture for their livelihood. All ancient civilizations of the World were mainly agricultural in character. Majority of the population in the developing countries lives in the rural areas and they are connected to agriculture as a way of life (Ray, 2007). Agriculture as a subsistence or a commercial activity has gained importance over time in a developing economy. However with time, farm practices have been improved to meet the growing demand and to enhance quality of the agricultural products. Agricultural practices are transformed from subsistence stage to commerce and trade; natural inputs are being increasingly replaced by purchased inputs (Lekhi and Singh, 2004).

Agricultural sector plays a strategic role in the process of economic development of a country. It has already made a significant contribution to the economic prosperity of the developed countries. In England, Agricultural Revolution preceded the Industrial Revolution. In the U.S.A. and Japan, also agricultural development has helped to a great extent in the process of their industrialization (Lekhi and Singh, 2004). It is seen that increased agricultural output and productivity tend to contribute substantially to an overall economic development of a predominantly agricultural and over-populated

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country. It generates income, supply food and fodder, labour force, expands industrial market, foreign trade and thereby increases the tempo of economic growth. A dynamic agricultural sector has the inherent capacity of generating marketed surplus, which subsequently raises rural income. The importance of agriculture is best summarized in a famous Chinese proverb saying that "economic life is just like a tree whose roots are presented by agriculture, stem by industry and branches and leaves by trade and commerce" (Shandilya et al., 2003).

The classical economists such as Adam Smith, David Ricardo, Thomas Robert Malthus have analyzed agricultural development in terms of its relationship to the growth of the overall economy. Early theoretical literature on the place of agriculture in economics can be traced to as far back as the eighteenth century in the writings of the Physiocrats. They believed in science of natural laws and emphasized the significance of agriculture to make a country wealthy (Lekhi, 2000). They viewed agriculture as the engine of economic growth, and that agriculture is the only activity capable of generating a surplus large enough to stimulate growth in other sectors of the economy. According to Physiocrats, only agriculture turned out a "net product" over and above its cost of production (Ray, 2010). Simultaneous development between agriculture and industry is pre-requisite for initiating a balanced and smooth economic growth, and they form an integrated part of the economy. Lewis has very aptly remarked, "If agriculture stagnates, the capitalist sector cannot grow, capitalist profit remains a small part of the national income and savings and investments are correspondingly small" (Lekhi and Singh, 2004). Rostow (1971) has opined that the take-off stage of development has to be preceded by an agricultural revolution. Schultz (1944) treated agriculture as a source of economic growth. To make agriculture a powerful engine of growth, it is pre-requisite to invest in this sector which in turn will generate incentives to guide the farmers. Thus, the main emphasis rests on the view that, "once there are investment opportunities and efficient incentives, farmers will turn sand into gold" (Lekhi, 2000).

1.2: Linkage between Agriculture and Industry and Other Sectors:

There are diverse links between agriculture and other sectors of an economy. Agriculture and industry are the *two wheels* of an economy where development of one sector relies on the development of the other sectors. They are not alternatives but are complementary and are mutually supporting with respect to both inputs and outputs. In a closed

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economy, one of the most important pre-conditions of industrial expansion is the achievement of the rate of increase in agriculture productivity. Rising agriculture productivity supports and sustains industrial development by meeting the increased food needs of the non-agriculture sector, provide raw materials to argo-based industries, supplying surplus labour to the industrial sector and raising rural purchasing power for industrial products. Similarly, in open economy, with access to international trade, contribution of agriculture productivity may diminish for the time being. But industrialization provides a wider range of consumption goods, raising their level of wants, encouraging greater productive efforts and better agricultural production through input supplement from industrial sector. Empirical tests show that a unit increase in agricultural output would have a positive effect on both industrial production and national income. Rangarajan (1982) estimated that "a one percent increase in agricultural output tends to raise industrial production by 0.5 percent and augment national income by 0.7 percent." It is widely accepted that throughout the post-independence years, weak agricultural growth put a brake on industrial growth. The experience in the eighties and nineties also lends support to this. During the eighties, the growth rate of 3.2 percent in agricultural production appeared to have had contributed to accelerated growth in industrial production (around 6%). The decelerated growth rate in agricultural production seems to have an impact on growth of industrial production in the nineties **(**Kapila, 2005). Byres (1995) emphasizes on the role that the transition to capitalism in agriculture would play in industrial development, but he further discusses the Lewis model (1954) and the Indian planning debate that annual agricultural growth rate of 5 percent was necessary for the creation of surplus that could be siphoned off and invested in industrial development (Lerche, 2013). But Indian agriculture could not even reach 4 percent growth rate since independence. Bernstein (1996) suggests an important perspective that the agrarian question of capital has been bypassed, and does not figure in the Indian debate. The classical version of the agrarian question, that a dynamic capitalist agrarian sector was expected to provide the capital needed for industrial growth and provide a market for non-agricultural produce did not happen in India. "The economic regime that developed in India from the mid 1980s was one of significantly weakened linkages between growth in agriculture and industry" (Lerche, 2013). In the last decade the growth in the industry sector accelerated to the unprecedented rate of 8.2 percent, but the agriculture sector growth rate decelerated and hovered around 3 percent. Mehta (2015) stated that the experience of the past two decades reveals a weakening of the inter-

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sectoral relationship. By Globalization, circulation of capital and commodities are no longer national but are mediated by international capital and World market. In the post-liberalization period the growth rate in the non-agriculture sector picked up, but the agricultural sector decelerated. He estimated that per unit dependence of agriculture on services has increased from 0.016 in 1968-69 to 0.023 in 2007-08.

Besides industry, agriculture sector has an intimate linkage with rural development and poverty reduction. The agriculture productivity growth is considered as an important strategy for rural poverty reduction in the developing countries (World Bank, 2008). Inclusive market oriented agricultural growth can contribute to higher income for farming families, creation of rural non-farm employment, higher wages and thereby reduced poverty and inequality. An interesting result from the cross section data of districts in India was that agricultural productivity is very powerful in reducing rural poverty. A 1 percent increase in land productivity reduces poverty by as much as 0.65 percent. The effect of dependence of workers on agriculture was reverse. A 1 percent reduction of labour force in agriculture resulted in 0.49 percent decline in rural poverty and on the other hand, a 1 percent increase in pressure of workforce on agriculture land resulted in 0.57 percent increase in rural poverty. Lerche (2013), said "the overall economic balance between agriculture and other sectors is difficult to gauge. First, state support to agriculture has been cut back, whereas the terms of trade between agriculture, industry and service sectors have improved from the point of view of agriculture. Second, it is fiercely debated whether state support resulted in a net transfer of value to agriculture or, on the contrary, surplus was siphoned off from agriculture." The overall tendency is a weakening of the links between agriculture and the rest of the economy.

1.3: Agriculture Production in India:

Agriculture is not only the backbone of our food, livelihood and ecological security system, but also the very soul of our sovereignty. Indian agriculture provides food for 17.5 percent of the World population with its 4.2 percent of World's water resources and 2.4 percent global land area. 51 percent of India's land is arable (Indian Council for Agricultural Research, 2009; Population Census in India, 2011). Recognizing the predominance of agriculture in the national economy and the dependence of a large proportion of the working population on agriculture, policy makers in independent India

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have given top priority to agricultural development (Bhalla and Singh, 2000). In the tenth five year plan approach paper it is mentioned that agricultural development is central to economic development of the country. All the three basic objectives of economic development of the country, namely, output growth, prices stability and poverty alleviation are best served by growth of agriculture sector. Any change in this sector, positive or negative, has a multiplier effect on the entire economy. The agriculture sector occupies centre stage in Indian economy embodying three thrust areas as-(i) to promote inclusive growth, (ii) to enhance rural income and (iii) to sustain food security (Economic Survey, 2014-15).

Agriculture, as the single largest private sector occupation in India of over 100 million farmers, is the lifeline of the economy. Agriculture provides the basic ingredients to mankind and other creatures (produces 51 major crops) and raw material for industrialization and support for economic growth and social transformation of the country. India is the first in the World in the production of milk, pulses, tea, jute and jute like fibers, second in rice, wheat, sugarcane, groundnut, vegetables, fruits and cotton production, and is a leading producer of spices and plantation crops as well as livestock, fisheries and poultry. However, in case of productivity levels Indian agriculture is much lower as compared with other countries including some non-agriculturist countries. With only 100 million hectares of agricultural land, China is producing 400 million tons of grains while India with its 146 million hectares of agricultural land produces on an average 185 million tons of food (*The Assam Tribune*, 1999). The average yields of wheat in the Netherlands (7716kg/ha) and Ireland are more than three times India's yield rates (2117kg/ha). The average production of rice per hectare in India is around 1756 kg compared to 5470 kg of North Korea. Similar conclusions hold for most of the other crops (Mahadevan, 2003). India happens to be one of the largest growers of many of agricultural crops but ranks very low in terms of yield. For instance, India is first in area and second in production of rice and wheat in the World but, in terms of productivity, ranks are only 52nd in rice and 38th in wheat in the World (Misra and Puri, 2010).

The agriculture sector (including allied activities) in India accounted for 13.9 percent of the GDP at 2004-05 prices in 2011-12. As per new series of national income released by the Central Statistics Office (CSO), at 2011-12 prices the share of agriculture in total GDP is 18 percent in 2013-14 (Economic Survey, 2011-12) (see appendix Table I.1). Exports of agriculture and allied products during 2013-14 accounted for 14.05

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percent of India's total exports against 9.7 percent in 2010-11; however, it declined to 11 percent in 2014-15 (CSO). As per the World Trade Organization's Trade Statistics, the shares of India's agricultural exports and imports in World trade in 2013-14 were 2.69 percent and 1.31 percent respectively. Notwithstanding the declining trend in agriculture's share in the GDP, it is critical from the income distribution perspective as it accounted for about 48.9 percent employment in the country in 2011 (Economic Survey, 2014-15). The average per capita income from agriculture and allied sectors was Rs.6608 in TE 2013-14, which grew 1.62 times the level in TE 2003-04 from Rs.4068 (Mehta, 2015). There has been a consistent decline in growth of the agriculture sector since 1990 onwards as compared to the 1980s. It was 4 percent per annum during the 1980s on an average, which came down to about 2 percent during 1997-2002 (Mathur et al., 2007). The compound annual growth rate (CAGR) in the entire period from 1962-65 to 2003-06, agricultural output increased at 2.36 percent (Bhalla and Singh, 2009). The Eleventh Plan (2007-12) period witnessed an average annual growth of 3.3 percent in the GDP from agriculture and allied sector, which was higher than Ninth and Tenth plans (Economic Survey, 2012-13). As against a growth target of 4 percent for agriculture and allied sectors in the 12th plan, the growth registered in the first year was 1.2 percent and in 2014-15 it was 1.1 percent at 2011-12 prices (Economic Survey, 2014-15). The Approach Paper to the Twelfth Five Year Plan mentioned that achieving minimum agricultural growth (i.e., 4.0%) is a pre-requisite for inclusive growth, reduction of poverty levels, and development of the rural economy and enhancing of farm income. In comparison to agriculture, growth rate of industry and service sectors were 8.2 percent and 7.7 percent respectively during 2010-11(Economic Survey, 2011-12). There is a synchronous decline in the national income derived from agricultural sector and workforce engage in agriculture and allied activities. Decline in the latter is slow, from 69 percent in 1981 (Census of India) to 48.9 percent in 2011 (Economic Survey, 2014-15). While the share of value added Gross Domestic Product coming from agriculture at current prices has declined sharply from around 39 percent in 1980 to about 17.9 percent in 2011-12, the share of the total labour force engaged in agricultural activities has displayed a much slower decline from 68 percent to 49 percent during the same period (Appraisal Document of 12th Five Year Plan, 2012-17). The continued reliance of a large majority of the population on agriculture which adds an ever declining share to GDP, clearly underlines the failure of any meaningful structural transformation of the Indian economy over the last six decades (Basole and Basu, 2009).

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In summary, it can be stated that though Indian economy is basically agrarian, and agriculture has a pivotal role in the economy, in terms of different parameters of agricultural development, agricultural performance is poor in India in comparison to developed countries. Agriculture remains the focal point of Indian policy making. The low levels of productivity in Indian agriculture, points to the possibilities of increasing productivity by adopting appropriate strategies and policies. With the introduction of economic planning in 1950-51 and with the special emphasis on agricultural development, particularly after 1962, the previous phase of stagnation in agriculture was reversed as-(i) a steady rise in yield per hectare, (ii) a steady rise in area under cultivation and (iii) due to increase in area as well as yield per hectare, total production of all crops recorded a rising trend (Bhalla and Singh, 2000). Table 1.1 reveals the growth rate of Indian economy with sectoral comparison during different time periods.

Table-1.1: Average GDP growth rates of agriculture and other sectors in India at 1999-2000 prices (in %)

Period	Total Economy	Agriculture & Allied	Agriculture	Non-Agriculture
1951-52 to 1967-68 (Pre-Green Revolution Period)	3.7	2.5	1.97	4.9
1968-69 to 1980-81 (Green Revolution Period)	3.5	2.4	2.63	4.6
1981-82 to 1990-91 (Wider Technology Dissemination Period)	5.2	3.9	3.58	6.4
1991-92 to 1996-97 (Early Reforms Period)	5.2	3.7	2.04	6.6
1997-98 to 2001-02 (Ninth Plan)	6.6	2.5	2.55	10.7
2002 to 2007 (Tenth Plan)	7.5	2.4	-	12.7
2007 to 2012 (Eleventh Plan)	8.1	4.1	4	12.6
2012-13 to 2016-17 (Twelfth Plan)*	6.3	1.6	-	8.3

*Advance Estimates as on 08.02.2016 (at constant 2011-12 prices) during first 4 years of the 12th plan.

Source: (i) Economic Survey, 2007-08; (ii) 11th and 12th Five Year Plan Document (iii) Institute for Social & Economic Change (ISEC).

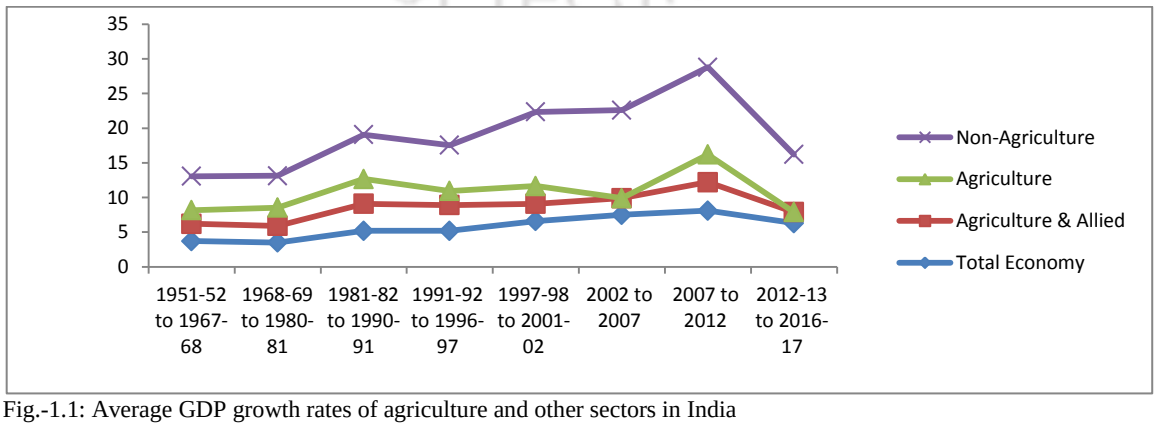

Fig.-1.1: Average GDP growth rates of agriculture and other sectors in India

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The growth in the agricultural sector all through the period of planning remained less than the overall growth in the economy. The matter of concern is the fact that, while in the post-liberalization period the growth rate in the non-agriculture sector gained momentum, the agricultural sector decelerated. The increasing gap between the agriculture and non-agriculture sectors was most prominent during the tenth and eleventh plans. It was perhaps because of the impact of economic reforms initiated in early nineties. While the overall GDP increased at the rate of 7.8 percent per annum, the agriculture sector registered a rate of growth of only 2.8 percent per annum in 2007-08 at 1999-2000 prices (Economic Survey, 2007-08). The impact of liberalization in India implied a positive increase in growth in industrial and service sectors but not in agriculture. However, the average annual agricultural growth rate during the Eleventh Plan at 4.1 percent, the highest achieved in any plan period. Table 1.2 refers the trends of growth of crops in India since the inception of Indian planning to eleventh plan period.

Table-1.2: Trends in crop-wise agricultural growth in India from 1951 to 2012 (% per annum average)

Crops/period	1951-67	1968-80	1981-90	1991-96	1997-2002	2002-07	2007-12
Cereals	4.19	3.43	3.42	2.36	1.49	1.28	2.24
Pulses & Oilseeds	2.98	0.97	5.41	2.92	-1.43	4.29	1.17
Fruits & Vegetables	2.67	4.82	2.84	6.07	4.11	2.97	-
Other Crops	2.42	2.98	1.71	2.18	3.82	3.58	-
All Crops	3.07	3.05	3.34	3.38	2.00	3.03	3.3

Source: (i) Agriculture for Inclusive Growth, 2011, (ii) CSO, Press Note May, 31st 2012.

From table 1.2, we see the growth rate of cereals gradually declined from more than 4 percent during 1951 to 1967 to less than 2 percent during 2002 to 2007. There was a high fluctuation in the growth rate of pulses and oilseeds during 1951-1967 to 2007-12. Among the crops, commercial crops have registered a growth rate of more than 3 percent. The combined growth of pulses and oilseeds was more than 5 percent during 1980s. Growth of fruits & vegetables was also impressive during 1990s. During 9th and 10th plan, no impressive growth showed in other crops category.

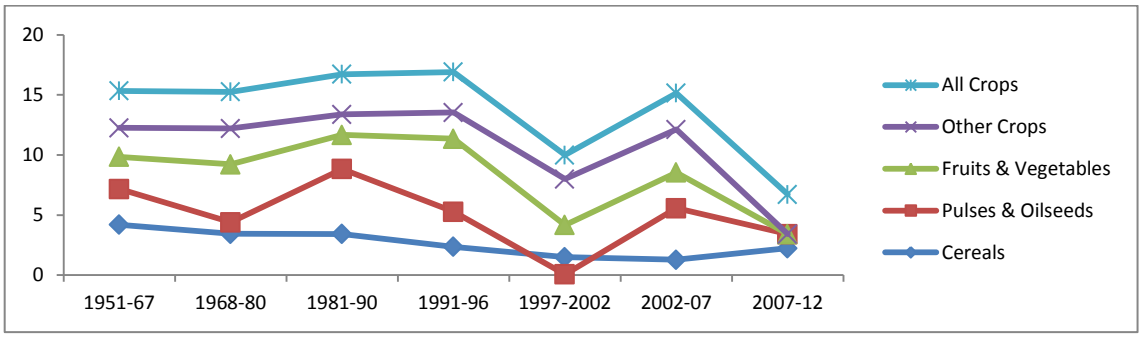

Fig. 1.2: Trends in crop-wise agricultural growth in India from 1951 to 2012.

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Agricultural production has two components-foodgrains [1] and non-foodgrains. [2] Agricultural policies' focus in India across decades has been on self-sufficiency and self-reliance in foodgrains production and a considerable progress has been made on this front. India has experienced an unprecedented growth in agricultural production after the advent of Green Revolution and become self-reliant in foodgrains production (Patnaik, 2001; Anant, 2002). However, the CAGR of foodgrains production decreased from 2.46 percent during the period 1970-71 to 1990-91 to 1.85 percent during 1990-91 to 2010-11. The CAGR of all the crops except cotton declined during 1990-91to 2010-11 from the period of 1970-71 to 1990-91.

In case of non-foodgrains, production of oilseeds and cotton show a progress from 1990-91 onwards with fluctuations while jute production shows slow and halting progress.

Table-1.3: Trends in agricultural production of major crops from 1970-71 to 2012-13: (MMT/bales)

Crops	1970-71	1980-81	1990-91	2000-01	2006-07	2007-08	2008-09	2010-11	2011-12	2012-13^	CAGR*	CAGR**
Rice	42.2	53.6	74.3	85.0	93.4	96.7	99.2	96.0	104.3	90.7	2.87	1.63
Wheat	23.8	36.3	55.1	69.7	75.8	78.6	80.7	86.9	93.9	-	4.29	2.57
Total Cereals	96.6	119.0	162.1	185.7	203.1	216.0	219.9	226.3	242.23	232.57	2.62	1.93
Pulses	11.8	10.6	14.3	11.1	14.2	14.8	14.6	18.2	17.09	17.58	0.97	0.85
Total Foodgrains	108.4	129.6	176.4	196.8	217.3	230.8	234.4	244.8	259.32	250.14	2.46	1.85
Oilseed	9.6	9.4	18.6	18.4	24.29	29.8	27.7	32.5	29.8	29.5	3.36	2.27
Cotton	4.8	7.0	9.8	9.5	22.63	25.9	22.3	33.0	35.2	33.8	3.63	6.28
Jute	4.9	6.5	7.9	9.3	10.32	10.2	9.6	10.0	10.7	10.6	2.42	1.46
Tea	0.4	0.6	0.7	0.8	1.0	0.9	0.9	1.0	1.0	-	2.84	1.71
Rubber	0.1	0.2	0.3	0.6	0.9	0.8	0.9	0.8	0.8	-	5.65	4.78

Note: 1. Data in the table are in terms of million tons excepting for cotton and jute. For cotton data are in terms of million bales where one bale=170 kg. For jute, data are in terms of million bales where one bale =180 kg.
2. Data for oilseeds includes nine major oilseeds, viz., groundnut, rapeseed and mustard, sesamum, linseed, castorseed, nigerseed, safflower, sunflower and soyabeen

^: Fourth Advanced Estimate; * CAGR 1970-71 to 1990-91 in %; ** CAGR 1990-91 to 2012-13 in %.

Source: Economic Survey, 1988-89, 1992-93, 1998-99, 2007-08, 2009-10 and 2012-13

As an emerging cash crop, rubber production in the country increased from 0.1 million MT in 1970-71 to 0.9 million MT in 2008-09. Table 1.4 shows the trend of area under different crops in India from 1970-71 to 2013-14.

[1] Foodgrains includes cereals (rice, wheat, jowar, bajra, maize, ragi, barley and small millets) and pulses (gram, tur and other pulses) (Agriculture Statistics, National Statistical Commission)

[2] Non-Foodgrains includes oilseeds, fibers, plantation crops, condiments and spices, fruits & vegetables and other crops (Agriculture Statistics, National Statistical Commission)

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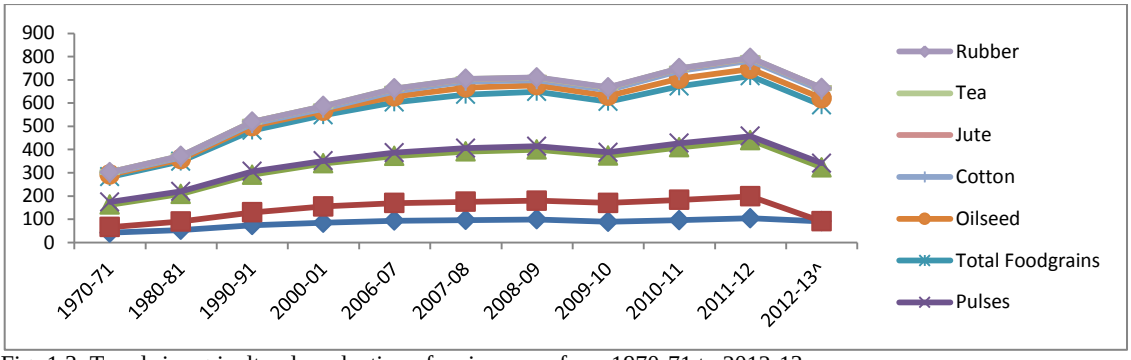

Fig.-1.3: Trends in agricultural production of major crops from 1970-71 to 2012-13

Table-1.4: Trends of gross area under major crops in India from 1970-71 to 2013-14: (in million hectares)

Crops	1970-71	1980-81	1990-91	2000-01	2005-06	2007-08	2008-09	2010-11	2011-12^	2013-14^	CAGR*	CAGR**
Rice	37.6	40.1	42.7	44.7	43.7	43.9	45.5	42.9	44.0	43.9	0.64	0.02
Wheat	18.2	22.3	24.2	25.7	26.5	28.0	27.8	29.1	29.9	31.2	1.43	0.93
Maize	5.8	6.0	5.9	6.6	7.6	8.1	8.2	8.6	8.7	9.4	0.09	1.90
Total Cereals	101.8	104.2	103.2	100.7	99.2	100.4	100.7	100.3	100.2	98.2	0.07	-0.14
Pulses	22.6	22.5	24.7	20.3	22.4	23.6	22.1	26.4	24.8	25.2	0.45	0.33
Total Foodgrains	124.3	126.7	127.8	121.0	121.6	124.1	122.8	126.7	125.0	126.0	0.14	-0.04
Oilseeds	16.6	17.6	24.1	22.8	27.9	26.7	27.5	27.2	26.4	28.5	1.88	0.61
Sugarcane	2.6	2.7	3.7	4.3	4.2	5.1	4.4	4.9	5.1	5.0	1.78	1.41
Cotton	7.6	7.8	7.4	8.6	8.7	9.4	9.4	11.2	12.2	11.7	-0.13	2.09
Jute	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	-	0.00	0.00
Tea	0.4	0.4	0.4	0.5	0.6	0.6	0.6	0.6	0.6	-	0.00	2.05
Rubber	0.2	0.3	0.5	0.6	0.4	0.6	0.7	0.7	0.7	-	4.69	1.70

Note: AE: Fourth Advance Estimate; * CAGR 1970-71 to 1990-91 in %; ** CAGR 1990-91 to 2010-11 in %.
Source: Economic Survey, 1988-89, 1992-93, 1998-99, 2007-08, 2009-10 and 2012-13

Table 1.4 shows that since 1970-71 area under rice in India has increased marginally while area under wheat has increased significantly. The area under foodgrains has declined in the last two decades; some restoration started from 2010-11. Area under oilseeds has also increased. Area under jute remained almost same while area under tea has marginally increased from 2000-01 and thereafter remains same. Area under rubber plantation in the country has gradually increased from 0.2 million hectare in 1970-71 to 0.7 million hectare in 2011-12. Except maize, cotton and tea the CAGRs of area of major crops in India have declined during the period from 1970-71 to 2010-11.

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Although the productivity level in Indian agriculture is very low in comparison to the other countries, there has been a slow and steady rise in productivity of most of the crops during 1970-71 to 2011-12. Table 1.5 shows the increasing trend in yield per hectare of major crops in India.

Table-1.5: Trend of yield per hectare of major crops in India: (Kg/hectare)

Crop	1970-71	1980-81	1990-91	2000-01	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12[a]	2013-14[a]	CAGR*	CAGR**
Rice	1123	1336	1740	1901	2102	2131	2202	2178	2125	2239	2372	2424	2.21	1.27
Wheat	1307	1630	2281	2708	2619	2708	2802	2907	2839	2989	3140	3075	2.82	1.36
Maize	1279	1159	1518	1822	1938	1912	2335	2414	2024	2540	2476	-	0.86	2.61
Cereals	949	1142	1571	1844	1968	2020	2151	2183	2075	2256	2396	2023	2.55	1.83
Pulses	524	473	578	544	598	612	625	659	630	691	694	764	0.49	0.90
Total Food grains	872	1023	1380	1626	1715	1756	1860	1909	1798	1930	2059	2101	2.32	1.69
Oilseeds[b]	579	532	771	810	1004	916	1115	1007	958	1193	1135	1153	1.44	2.21
Sugarcane[c]	48	58	65	69	67	69	69	65	70	70	70	70	1.53	0.37
Cotton	106	152	225	190	362	421	467	403	403	499	491	532	3.84	4.06
Jute	1186	1245	1833	2026	2362	2342	2260	2207	2492	2344	2422	-	2.20	1.24
Tea	1201	1478	1794	1673	1713	1667	1705	1695	1695	1695	1695	-	2.03	-0.28
Rubber	653	788	1076	1576	2000	1800	1299	1306	1211	1211	1211	-	2.53	0.59

a: Fourth Advance Estimates;
b: includes groundnut, rapeseed & mustard, sesamum, linseed, castorseed, nigerseed, safflower, sunflower and soyabeen;
c: ton/hectare;
* CAGR 1970-71 to 1990-91 in %; ** CAGR 1990-91 to 2010-11 in %,
Source: Economic Survey, 2010-11, 2012-13

Over the period from 1970-71 to 2011-12, yield per hectare of all foodgrains has increased by more than two times from 872kg to 2059kg. Most significant increase has been recorded in wheat with its yield increasing from 1307kg per hectare to 3140kg per hectare. Most disappointing has been the performance of pulses output, its productivity per hectare rose from 524kg in 1970-71 to only 694kg in 2011-12 with some

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fluctuations. Yield of non-foodgrains has also been increased more than two folds over the period 1970-71 to 2011-12. Oilseeds yield has gradually increased from 579kg to 1135kg and jute productivity increased more than two fold from 1186kg to 2422kg per hectare. CAGRs of yield of major crops except maize, pulses, oilseeds and cotton have also declined during 1990-91 to 2010-11 to 1970-71 to 1990-91.

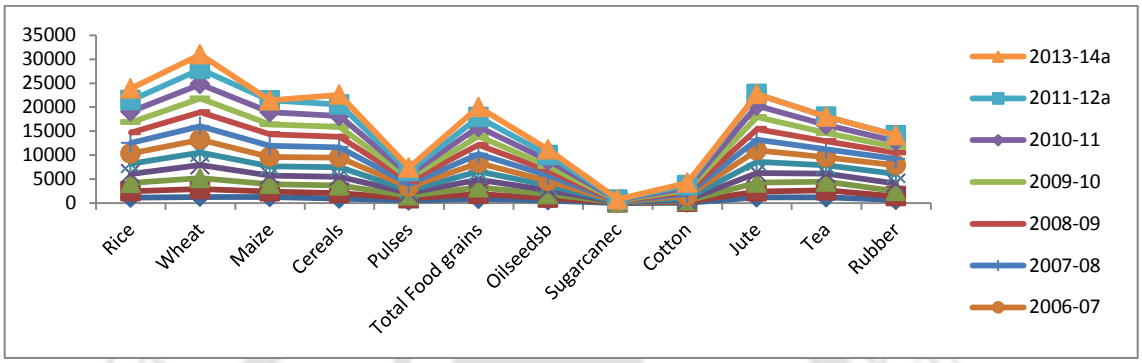

Fig. 1.4: Trend of yield per hectare of major crops in India.

1.3.1: Agricultural Land Holding in India:

One of the key facts about the changes in cultivation in India over the last five decades is the steadily decline in the size of agricultural land holdings. While the average size of ownership holding was 22.21 acres, 7.11 acres and 6.02 acres for large, middle and small categories of peasant households respectively in 1962, the corresponding figures in 2003 were 18.12 acres, 6.65 acres and 3.44 acres. The per household average area of land owned in the rural sector became 0.592 hectare in 2013, about 13 percent less than the corresponding figure (0.725ha) in 2003. Farmers are mostly small and marginal landholdings which pose a challenge in terms of adoption of farm mechanization as well as generating productive income from farm operation. The share of marginal holdings (area less than or equal to 1 hectare) in the rural areas was 75.41 percent in the year 2013 compared to 69.63 percent in 2003. The share of area of marginal holdings was 29.75 percent in the year 2013 compared to 23.01 percent in 2003 (NSS 70th Round Report, 2013). However, the average size of area owned by the marginal peasant households has increased slightly from 1.22 acres in 1962 to 1.61 acres in 2003.[3] Average number of parcels per operational holding has declined steadily from 5.7 in 1962 to 2.3 in 2003 (Basole and Basu, 2011). Three factors seem to lie behind the declining average size of

[3] There is a predominance of landless, marginal and smallholders in rural households in India. In 2013, they together accounted for about 93 percent of the total rural households. The ratio of their share in institutional credit and households has increased from 0.72 in 2003 to 0.84 in 2013 (NSSO, New Delhi).

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ownership holdings in India: land reforms, transfer of land through sale and growing demographic pressures. The average size of operational holding in India declined from 2.3 hectares in 1970-71 to 1.15 hectares in Agricultural Census, 2010-11. The decline in landholding without any alternative income augmenting opportunity is resulting into a fall in farm income, causing an agrarian distress (Goswami, 2014).

Table-1.6: Change in percentage distribution of operated area by category of operational holdings in all India:

Category of Holdings	Percentage of Operated Area							
	1970-71	1981-82	1991-92	2002-03 (*Kharif*)	2002-03 (*Rabi*)	2005-06 (AC)	2010-11 (AC)	2012-13
Marginal (<1ha)	9.0	11.5	15.6	22.6	21.7	20.23	22.24	27.71
Small (1-2ha)	14.8	16.6	18.7	20.9	20.3	20.91	22.07	23.44
Semi-medium (2-4ha)	22.6	23.6	24.1	22.5	22.3	23.94	23.59	23.50
Medium (4-10ha)	30.5	30.2	26.4	22.2	23.1	23.11	21.18	19.33
Large (>10ha)	23.0	18.2	15.2	11.8	12.5	11.81	10.92	6.02
All Categories	100	100	100	100	100	100	100	100

Note: AC Agriculture Census; Data for the year 2005-06 for Jharkhand not included.

Source: (i) Agricultural Situation in India, October, 1981 and August, 1985; (ii) Estimates from 70th Rounds of NSSO (2013); (iii) Agriculture Census 2010-11, Agriculture Census Division, Department of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India.

From the NSS data it is seen that in the rural area of India percentage distribution of operated area has increased in the categories of marginal and small land holdings while it has decreased in the categories of medium and large. Agriculture census shows that there are more than 117 million out of 138 million farm holdings are small and marginal with less than 2 hectares land in India. The number of small farm holdings has risen to 85 percent in 2010-11 compared with 83.2 percent in 2005-06 (Reddy, 2014). Thus, Indian agriculture is dominated by the marginal and small farmers in terms of both numbers and operated area. No wonder, two-third of MNREGA workers are actually land owners, an indication that small farmers are unable to survive solely on agriculture (The Hindu Survey of Indian Agriculture, 2014). Moreover, high fragmentation of land holdings and its localization in different places have made impossible to use modern technology and become less suitable for efficient cultivation. It leads to wastage of labour, time and other farm inputs and also leads to low yield rate.

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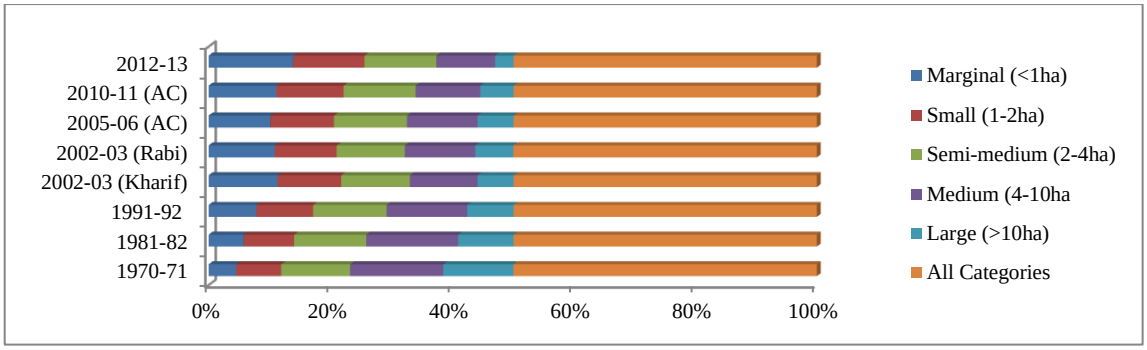

Fig.-1.5: Change in percentage distribution of operated area by category of operational holdings in all India

In conclusion, even though agriculture is the primary sector and backbone of the country where about half of the workforce of our country is engaged, growth rate of this sector has been lower than the non-agricultural sectors. Productivity level of different crops is much lower than other developed countries. Of course, Green Revolution initiated in the country since mid1960's bought unprecedented growth in the production of agriculture but it was mostly confined to wheat and rice. Although foodgrains dominates the crop sector in Indian agriculture, indices of area and production of non-foodgrains are increasing over foodgrains (see appendix Tables I.2 and I.3). Annual compound growth rates of area, production and yield of most of the major crops during the period 1990-91 to 2010-11 is lower than the period of 1970-71 to 1990-91.

Inadequate land availability, declining size of land holding, increasing risk involved in cultivation, ever rising input cost, problem in marketing, lack of storage facilities, lack of credit facilities, labour shortage, etc. made farming a less attractive enterprises in India (Sirajudeen, 2013). Low net income from the agricultural sector has been cited as the primary reason forcing the farmers to abandon agriculture (Mehta, 2015). Thus, the discussion can be concluded with the comment of Datt and Mahajan (2014) that India is now in a dangerous position. On the one hand, 'India is shining' that is, manufacturing and service sectors are growing and financial markets are booming. On the other hand, there is a suffering India and deepening gloom in the agricultural sector.

1.4: Agriculture Production in Assam:

Like the national economy, the economy of Assam is also predominantly agrarian. Agriculture and its allied activities played an important role in the socio-economic development of the state as this sector is the major contributor to the state economy and providing livelihood to a significant proportion of the population. This sector continues

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to support more than 70 percent population of the state directly or indirectly providing employment of more than 53 percent of the workforce (Govt. of Assam, 2011). The contribution of agriculture and allied sector to the State Domestic Product was more than 20 percent during 2014-15 at constant 2004-05 prices (Economic Survey, Assam, 2014-15). As per agricultural census, 1990-91, total gross cropped area (GCA) (excluding tea plantation) in the state was 39.62 lakh hectares which has increased to 41.74 lakh hectares (53.02% of the total geographical area) in 2011-12 (Economic Survey, Assam, 2014-15). The net sown area (NSA) had increased from 27.81 lakh hectares in 1990-91 to 28.11 lakh hectares in 2011-12 which is 71.71 percent of the GCA in the state. The per capita availability of net sown area comes to around 0.1 hectare in 2010-11. The average size of operational holding is 1.10 hectares and more than 83 percent of the farmer family is small and marginal farmers (Agricultural Census, 2010-11). According to NSS 70th Round Report (2013), average area owned per household excluding landless household in Assam was 0.682 hectare compared to 0.639 hectare in India in 2013. Agricultural production in Assam is about 2 percent of national production. Share in value of crop production in agriculture and allied sector in Assam was 73.4 percent compared to 63.4 percent in all India in 2010-11(Viswanathan, 2015). Rice is the major food crop grown in Assam. Other important crops grown in this state are wheat, maize, rape seed, mustard, *rabi* pulses, potato, sugarcane, jute, etc. Horticultural crops like pineapple, banana, papaya, etc. are also grown. Tea, coffee and rubber plantation are also undertaken in the state. The percentages of land area and production of foodgrains of Assam compared to all-India figures was 1.92 and 1.41 respectively during 2006-07 (Agricultural Statistics at a Glance, 2012). Cropping intensity is estimated at about 149 percent in 2013-14 (Economic Survey, Assam, 2014-15).

In spite of its immense importance in the state economy and its high potentiality of development; it has been observed that the rate of growth of the state agriculture was not encouraging during the last few decades. The productivity of agricultural crops is comparatively lower than the national average with some exceptions. Production of total foodgrains in Assam increased by 20.7 percent during the period 2001-02 to 2011-12 or 1.88 percent per year while in all India it increased by 2.32 percent per year during 2000-01 to 2011-12. The yield of foodgrains in Assam declined from 1416kg to 1286kg per hectare while in all India it increased from 1715kg to 1756kg per hectare during the period (Agricultural Statistics at a Glance, 2012). According to Statistical Abstract, India, 2012, average yield of total foodgrains in Assam was 1704kg/ha in 2011-12

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compared to 2078kg/ha in India. The estimated sectoral growth of agriculture in GSDP in 2010-11(A) at constant (2004-05) prices was 6.6 percent (Economic Survey, Assam, 2010-11) while in all India it was 7.0 percent (Economic Survey, 2011-12). The index of agricultural production (base triennium ending 1981-82=100) for the state was constantly lower than all India index from 2003-04 to 2009-10. (In 2009-10, production index in Assam was 186 as against 194 in all India for all commodities). The index of agricultural production of all commodities (base triennium ending 2007-08=100) in 2013-14 was 141.56 (Economic Survey, 2014-15). The index of yield of all commodities in Assam was 136.55 in 2009-10 compared to 179.4 in all India (Economic Survey, Assam, 2010-11 and Economic Survey, 2011-12). As in other regions of the country, growth rate of agriculture production in Assam has been going down in the recent years. The CAGR of agricultural output in the state declined from 2.38 percent during 1962-65 to 1980-83 to 0.67 percent during 1990-93 to 2003-06. The CAGR of crop yield declined from 1.48 percent during1980-83 to 1990-93 to 0.90 percent during 1990-93 to 2003-06 while CAGR of cropped area become negative (-0.23%) during 1990-93 to 2003-06 (Bhalla and Singh, 2009).

Although the issue of agricultural downfall of mainland India is discussed at length, there is a need to analyze the situation in Assam. Broadly it can be argued that the lack of adequate agricultural infrastructure, topographical conditions, less uses of agricultural inputs, inaccessible markets, lack of information and motivation, government policy, etc. are some of the basic factors hindering the growth of agricultural production in Assam. With more than two-thirds of the population engaged in agriculture and related activities, it is important to study the constraints faced by the farmers. The proposed research work will try to study the trend of agricultural growth rate in Assam over the decades and the causes associated with Assam's lagging behind the national average. There will be special emphasis on some selected crops. Different authors have already mentioned that a number of factors are responsible for lower growth of agricultural production in the state. Taking a cue the study focus on three input constraints viz., poor irrigation facilities, lack of credit facilities and poor extension services for agricultural development in the state in general and for the growth of three crops namely, rice, jute and rubber in particular. Justifications for selection of these factors and choice the select crops will be discussed in the latter part of this chapter and in chapter II. The part of this chapter is organized as follows:

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First, we review the existing literature on the various aspects of Indian and Assam agriculture. The discussion will be supported with secondary data. In the second section, we discuss selected crops namely, rice, jute and rubber. And finally, we discuss research problem, objectives, justification and the methodology to be followed in the study.

1.5: Detailed Review of Literature: **Indian Agriculture:**

Past experience and knowledge strengthens the base of any research. Therefore, review of literature is a prerequisite for any scientific study. In this section, keeping in mind the objectives of the study, a review of the available literature has been made to examine the nature and behaviour of agricultural production first of India and then of Assam. The factors which cause poor performance in Assam and Indian agriculture are also briefly examined, taking into consideration the past studies made by different authors. The following section contains some issues of agriculture and the broad results of different studies.

1.5.1 Growth Rate of Agriculture and Crop Output in India:

Indian agriculture has witnessed wide variations in growth performance during a span of seven decades after independence. This performance has been discussed by classifying it in different phases. Chand and Parappurathu (2011) of National Centre for Agricultural Economics and Policy Research, New Delhi identified five distinct phases of growth of Indian agriculture and outlined below as:

Phase-I: Pre-green revolution period (1950-51 to 1967-68)

Phase-II: Early green revolution period (1968-69 to 1985-86)

Phase-III: Period of wider technology dissemination (1986-87 to 1996-97)

Phase-IV: Post-reform period (1997-98 to 2005-06) and

Phase-V: Period of recovery (2006-07 to 2009-10)

The pre-green revolution period was characterized by steep decline in growth in GDP agriculture, with decadal growth rates found to plummet sharply from 2.78 percent to 1.06 percent. The overall agricultural growth rate in the Nehruvian period was impressive, but by mid-sixties agricultural sector was jolted by repeated droughts and food shortage. The early green revolution period observed a visible reversal of growth in

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GDP agriculture. The decadal growth rate reached near 3 percent by the decade ending with 1985-86. The period of wider dissemination of technology was characterized by sustained growth in the sector for over a decade peaking at the year 1996-97. The deceleration of growth was started from 1997-98 onwards and a clear indication of slumping of the agricultural sector was visible till the year 2005-06. This slump is widely perceived as an outcome of substantial diversion of resources away from agriculture to other sectors of the economy. However, a significant recovery of growth is observed in the last few years that has pushed the decadal growth rate of agriculture above 3 percent.[4] The target of 4 percent growth in agriculture and allied sector was surpassed during the Eleventh Plan, the highest achieved in any plan period. But the average growth rate of first four years of the 12th Plan has fallen to 1.6 percent.

Bhalla and Singh (2009) did a similar periodization with a shorter time span. The economic planning in India after 1951 and the new agricultural technology introduced during the mid1960s led to significant growth in yield and output levels of some crops and of aggregate crop output in India. In the initial period, the new technology was confined to wheat in the irrigated north-western region of India, its benefits mostly accrued to areas growing wheat. But over time, new technology spread to rice and some other crops and its geographical coverage extended to many other parts of the country. By 2003-06, despite considerable inter-state variation, most states in India were able to share the gains of the new technology. The deepening and extension of new technology led to significant growth of agricultural output (Bhalla and Singh, 2009). Table 1.7 shows the growth of annual average value of output and annual compound growth rate of states of India grouped into four regions, viz. North-Western, Central, Southern and Eastern and compared this growth in Assam with the regions and all India level.

Table-1.7: Region-wise levels and growth of value output during 1962-65, 1970-73, 1980-83, 1990-93 and 2003-06: (Value of 44 crops at 1990-93 constant prices)

Region	Annual Average Value of Output (in Rs. Million)					CAGR of Output (in %)*			
	1962-65	1970-73	1980-83	1990-93	2003-06	(A)	(B)	(C)	(D)
North-Western	136926	181727	249331	353444	433389	3.39	3.55	1.58	2.85
Central	157469	166909	227231	313613	469240	2.06	3.27	3.15	2.70
Southern	155230	187691	214796	300455	319549	1.82	3.41	0.48	1.78

[4] Chand, R. & S. Parappurathu. Historical and Spatial Trends in Agriculture: Growth Analysis at National and State level in India, National Centre for Agricultural Economics and Policy Research, New Delhi.

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Eastern	111298	126032	140488	200274	227919	1.30	3.61	1.00	1.76
Assam	15,039	17419	22964	29154	31798	2.38	2.42	0.67	1.84
All-India	565643	666706	843474	1174471	1469719	2.24	3.37	1.74	2.36
CV (%)						54.19	51.07	118.59	43.95

Note: North-West region includes states of Haryana, Himachal Pradesh, J & K, Punjab and U.P.
Central region includes states of Gujrat, M.P., Maharashtra and Rajasthan
Southern region includes states of Andhra Pradesh, Karnataka, Kerala and T.N.
Eastern Region includes states of Assam, Bihar Orissa and W.B.
*per cent Annual Compound Growth Rate: (A) =1980-83/1962-65; (B) = 1990-93/1980-83; (C) =2003-06/1990-93 and (D) =2003-06/1962-65: CV: Coefficient of Variation
Source: Bhalla and Singh, 2009.

During the entire period from 1962-65 to 2003-06, total agricultural output (value of 44 crops) in India at constant 1990-93 prices increased at a CAGR of 2.36 percent. During this period, the highest output growth rate of 2.85 percent per annum was recorded by the north-western region of India, followed by the central region (2.70%) and southern region (1.78%). The lowest growth rate of 1.76 percent was registered by the eastern region where the CAGR of Assam was 1.84 percent (better than eastern region CAGR) during the entire period. The new technology was mainly beneficial for wheat which is the main crop of north western states of India while it had modest impact on rice, the main foodgrain crops of eastern region. During the initial period of Green Revolution (1962-65 to 1980-83), all states in the north-western region registered high growth rates of agricultural output. Assam recorded highest CAGR (2.38%) in the eastern region during this period.

As noted by Bhalla and Singh (2009), the period from 1980-83 to 1990-93 (maturing of Green Revolution) makes a turning point in India's agricultural development. At the all-India level, the growth rate of crop output accelerated from 2.24 percent per annum in initial period to 3.37 percent per annum in the maturing period. Table1.7 shows that during the period of 1980s agricultural growth spread throughout all regions in India. During this maturing period agricultural growth rate in eastern India as well as in Assam was highest in the entire period from 1962-65 to 2003-06.

Agricultural growth during 1990-93 to 2003-06 (post-liberalization period) reflects the impact of economic reforms on agricultural performance. As it is clear from table 1.7, the period marks by sharp deceleration in agricultural growth rate at the all India level and in all regions. At the all-India level, the output growth decelerated from 3.37 percent per annum during 1980-83 to 1990-93 (pre-reform era) to only 1.74 percent

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per annum during 1990-93 to 2003-06 (post-reform era) which reflects the negative impact of economic reforms on agricultural performance in India. During the period, the growth rate of agricultural output of Assam decelerated to 0.67 percent per annum which was lower than the eastern region's growth rate. Thus, regional inequalities were accentuated during this period. The main reason for the deceleration of growth during the post-reform period was decline in investment in irrigation and other rural infrastructure (Bhalla and Singh, 2009).

Sen (2011) said, "by taking the long time series data of Indian agriculture output or GDP from agriculture, it is difficult to find a positive growth continuously for more than four years. Now, it is more than eight years since we had negative growth. The overall GDP is growing at over 9 percent per annum while agriculture is growing at about 3 to 3.5 percent and the farmers are obviously falling behind." The main component of growth of value output is growth of yield, since there is not much scope to expand the sown area. Productivity per acre has fluctuated much more than sown area, and output has grown mainly through increase in productivity per acre. Fluctuations in productivity are measured by the co-efficient of variation and they were found to be highest during 1990-93 to 2003-06, the post-reform period.

1.5.2: Changes of Crop Yields:

Prior to Green Revolution in India, the average yield was quit low, area expansion was the major source of growth of output. For example, during 1949-50 to 1964-65, the contribution of area growth to output was 50.16 percent, while that of yield growth was only 38.41 percent. The introduction of new technology during the mid 1960s resulted in raising the yield level of major crops, particularly wheat and rice thereby making the yield growth the dominant source of growth of output (Bhalla and Singh, 2009). Vaidyanathan (2010) said that the trend rates of yield growth, while consistently greater than that of output, but follow roughly the same pattern as in output growth. Table 1.8 gives the nature of changes that have taken place in the levels and growth of aggregate crop yields during 1962-65 to 2003-06.

Table-1.8: Region wise level and growth of crop yield during 1962-65, 1970-73, 1980-83, 1990-93 and 2003-06: (at 1990-93 constant prices)

Regions	Annual Average Value of Output (Rs/ha. of GCA)					CAGR of Yield (%)*			
	1962-65	1970-73	1980-83	1990-93	2003-06	(A)	(B)	(C)	(D)

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North-western	4093	5025	6423	9244	10958	2.53	3.71	1.32	2.43
Central	2654	2763	3464	4551	6367	1.49	2.77	2.62	2.16
Southern	4873	5873	6848	9178	10244	1.91	2.97	0.85	1.83
Eastern	4338	4671	4944	6894	8314	0.73	3.38	1.45	1.60
Assam	5728	6241	6907	7998	8989	1.05	1.48	0.90	1.11
All-India	3738	4257	5090	6957	8460	1.73	3.17	1.52	2.01
CV (%)	50.13	50.19	42.75	42.59	36.98	57.93	49.87	78.28	35.41

Note: *per cent annual compound growth rate: (A) 1980-83/1962-65; (B) 1990-93/1980-83; (C) 2003-06/1990-93 and (D) 2003-06/1962-65,

Source: As in earlier table

Table 1.8 shows that during 1962-65 to 2003-06, at the all-India level while the value of output grew at a CAGR of 2.36 percent per annum, land yield registered a growth rate of about 2.01 percent per annum, accounting for as much as 85.17 percent of growth of output, while the contribution of area growth was only 14.83 percent. Not surprisingly, the pattern of CAGR of yield is similar to that of output. Increase in yield was recorded by all the four regions in India, the highest increase having been registered by the north-western region followed by the southern, eastern and central regions, in that order during 2003-06. As far as average value of yield is concerned, Assam fared better than all-India level and that of other states of eastern region. During 1962-65 to 1980-83, north-western states registered significant increase in the yield levels and growth. As compared with the yield growth rate of 1.73 percent per annum at the all-India level, the north-western region recorded growth rate of 2.53 percent per annum while it was only 1.05 percent per annum in Assam. In maturing of Green Revolution period, the growth rate of yield accelerated not only at the all-India level, but in most states and regions. Eastern region recorded a very high yield growth rate of 3.38 percent per annum where Assam registered only 1.48 percent. The growth rate of yield was lower in the post-reform era than in the pre-reform era. During the post-liberalization period, the growth rates of both agricultural output and yield slowed down. All regions recorded a deceleration in their yield growth rates. The major reason of this deceleration was the decline in public investment in irrigation and water management, scientific research and non-availability of yield-raising cost-reducing new technology (Bhalla and Singh, 2009).

1.5.3: Limitation in Cropped Area:

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Area under cultivation for different crops in India has gradually exhausted. In 1980s, there has been a remarkable performance of agriculture in India and the growth rate of production of all crops was 3.21 percent per annum. While the earlier period 1949-50 to 1964-65 also had a relatively high growth rate (3.13% per annum), a major part of it was contributed by area expansion. In contrast, the growth of agriculture during 1980-81 to 1991-92 was almost entirely due to yield improvement. In this regard, Alagh and Bhalla (1979) have pointed out that "the task of accelerating growth rates in agriculture is becoming more difficult, given the fact that the total cultivable area in the country is virtually exhausted and it is consequently no longer possible to increase output substantially by increasing area alone". Vaidyanathan (2010) also said, area growth at the national level was decelerating in all three sub-periods i.e., between 1950 and 1971, during 1971-87 and since 1987.

Net area sown has registered a rapid deceleration in its growth over time in India due to increase in rural habitations, forestation, urbanization and industrialization (Bhalla and Singh, 2000). During 1962-65 to 1980-83, net area sown rose at a rate of 0.15 percent per annum at the all-India level. This growth rate decelerated to -0.05 percent per annum during 1990-93 to 2003-06. All the regions except the central region recorded a deceleration in their net sown area during this period (Bhalla and Singh, 2009).

Table-1.9: Region wise level and growth of Net Sown Area during 1962-65, 1970-73, 1980-83, 1990-93 and 2003-06: (44 crops)

Regions	Annual Average Net Sown Area (in'000ha)					Annual Compound Growth Rate (in %)*			
	1962-65	1970-73	1980-83	1990-93	2003-06	(A)	(B)	(C)	(D)
North Western	25860	26031	26356	26306	26516	0.11	-0.02	0.06	0.06
Central	58139	60150	61918	63149	63978	0.35	0.20	0.10	0.23
Southern	30021	29958	28877	29423	27851	-0.22	0.19	-0.42	-0.18
Eastern	22041	21687	22287	21935	21262	0.065	-0.16	-0.24	-0.09
All-India	136981	139044	140716	142289	141279	0.15	0.11	-0.05	0.08

Note: *per cent annual compound Growth Rate: (A) 1980-83/1962-65; (B) 1990-93/1980-83; (C) 2003-06/1990-93 and (D) 2003-06/1962-65

Source: As in earlier table

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As replicated in the table, the CAGR of net area sown has declined in all the regions in India from the period of 1962-65 to 2003-06 even negative in some regions.

1.5.4: Total Cropped Area (TCA):

Notwithstanding the fact that yield growth has become the dominant contributor to growth of output after the advent of Green Revolution, growth of GCA continues to be an important source of growth of output in some states and regions of India. Table 1.10 shows the annual growth of TCA in different regions of India.

Table-1.10: Region-wise Level and Growth of GCA during 1962-65, 1970-73, 1980-83, 1990-93 and 2003-06: (44 crops)

Regions	Annual Average Area(in'000ha)					Annual Compound Growth Rate (%)*			
	1962-65	1970-73	1980-83	1990-93	2003-06	(A)	(B)	(C)	(D)
North-western	33455	36168	38821	38236	39549	0.83	-0.15	0.26	0.41
Central	59338	60406	65596	68911	73697	0.56	0.49	0.52	0.53
Southern	31852	31960	31366	32736	31193	-0.09	0.43	-0.37	-0.05
Eastern	25655	26980	28416	29050	27413	0.57	0.22	-0.45	0.16
Assam	2625	2791	3325	3645	3538	1.32	0.92	-0.23	0.73
All-India	151315	156622	165698	168817	173718	0.51	0.19	0.22	0.34

Note: *percent Annual Compound Growth Rate: (A) 1980-83/1962-65; (B) 1990-93/1980-83; (C) 2003-06/1990-93 and (D) 2003-06/1962-65

Source: As in earlier table

During 1962-65 to 1980-83, cropped area recorded a growth of 0.51 percent per annum at the all-India level. Whereas, its growth rate was 0.83 percent per annum in the northern region, and 0.57 percent and 0.56 percent per annum respectively in the eastern and central regions, the growth rate of cropped area was negative in the southern region. In this period, growth of cropped area in Assam was 1.32 percent, much higher to the all-India average. In the period of 1990-93 to 2003-06, GCA recorded a paltry growth rate of 0.22 percent in all-India level, while growth rate in Assam was negative (-0.23%).

Growth in the agricultural sector has consistently fallen short of targets despite some technological progress. The pace of area expansion has been slowing down progressively and an increasing proportion of output growth has come from increasing production per unit of crop area or rising intensity of cultivation. Initially, area growth and yield increases contributed equally to output growth, but towards the end of the period, the latter accounted for over three-fourth of the output growth. However, the picture is more complex when we consider growth trajectories in different sub-periods. Thus,

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1) output grew at nearly steady rate of 2.4 percent per annum during 1950-70; the trend growth rate between 1970 and 1987 was somewhat higher at 2.7 percent pa, but dropped slightly since then.

2) yields show a fluctuated growth rates in each periods; the rate of growth during 1970-1987 period being significantly higher than during 1950-70; the trend rate has since come down a bit.

3) crop area growth trends in different periods show a similar pattern: deceleration within each of the three sub-periods (i.e.,1950-70, 1970-87 and 1987 to 2004) (Bhalla and Singh, 2009).

Growth and development of agriculture in an economy is also largely influenced by managerial and technical aspects besides natural components. In the following sections we have dealt with particular dimensions of agricultural production, such as farm size, mode of production, input use, investment and credit, etc.

1.5.5: Farm Size and Agricultural Productivity:

Researchers have mentioned that small and fragmented size of land holding is one of the reasons for low agricultural production in Assam. The debates on inverse farm size-productivity relationship which started with the publication of Sen's (1962) paper in 'The Economic Weekly' continue to attract the attention of scholars. Sen (1962) found the results valid in Indian agriculture that "by and large, productivity per acre decreases with the size of holding". Taking the pooled data he found inverse relationship between increasing farm size and productivity (Shrivastava, 1996). Some have favoured small farm size for attaining high yield while others said that in the present liberalized and globalized economy small farm size could not face the competition (Despande, 1998).

Mazumdar (1963) wrote, "The data presented by the Farm Management Survey in India have added another example to a phenomenon observed in many parts of the underdeveloped World, viz. that in peasant agriculture, as the size of farms decreases the output per acre increases". In the study of Farm Management in India (1966), it was found that in some of the regions like Punjab, UP, Maharashtra, Madras, Andhra Pradesh and Orissa, output per hectare decreases with increases in farm size. The study also observed that in almost all regions the intensity of cropping as well as percentage of irrigated area decrease as farm size increases.

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Khusro (1973) similarly argued as farm size expands gross output per acre declines. He has written, "as farm size expands the proportion of bad and indifferent land to total land increases, this in turn accounting for the decrease in per acre output and farm income." He said all the regression lines fitted to the data of gross output per acre and acreage are downward sloping, the sign for the regression co-efficient being invariably negative.

Todaro (1981) observed, "Evidence on a wide range of third World countries…..clearly demonstrates that small farmers are more efficient producers of most agricultural commodities". Thus, when the debate on the relationship concluded in the mid-seventies, there was a near consensus among scholars that small farms are more productive as compared to their large counterparts (Sharma and Sharma, 2000).

Of course there are a few others who argued that inverse relationship could not be considered universally valid (Bhardwaj, 1974; Rudra, 1982). The second phase debate on the farm size-productivity commenced around the eighties when the scholars increasingly started questioning the validity of inverse relationship. The basic argument of these studies is that with the spread of new agricultural technology, the inverse relationship has either weakened or even has got reversed. A study of Chadha (1978), using disaggregated data for 61 villages from different parts of Punjab concluded that in the central and south districts, the inverse relationship had disappeared.

Contrary to the inverse relation, Chand (1999) observed strong association between farm size and value of farm assets and their composition is the result of many factors. One, higher the operated area more is the requirement for capital assets. Two, due to scale effects it is economically more attractive for larger sized holdings to make investments in farm machinery like tractors, pump sets, sprayer, etc. Three, smaller the size of holding, lower is the income from crop production and thus higher is the dependence on other activities.

In a study Chand found that medium sized farms obtained highest productivity per unit of land. Output per unit area increased with farm size upto medium size holding and declined thereafter. It is inferred from the results that the relationship between farm size and productivity is of inverted "U" type. Again Lerche (2013) said, small farm size hampers the development of productive agriculture and hence an obstacle to a proper agrarian transition. A commitment to the maintenance of a public distribution system for

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certain essential commodities like foodgrains, the existence of large holding is recognized as enabling a steady and regular flow to marketable surplus.

While most of the pre-green revolution period studies like Raj Krishna (1962), Sen (1962), and Hopper (1965) confirmed inverse relationship between size of farm and productivity, some of the post-green revolution studies like Rao (1975) and Parthasarathy (1987) show that inverse relationship under traditional technology does not seem to hold true when new technologies are introduced. In a highly advanced agriculture large farm size can avail benefits of large scale production and thus productivity per acre will be more. In agriculturally backward states like Assam relation of large farm size-productivity could be negative.

From the foregoing discussions, we have arrived at an ambivalent conclusion. While some scholars found inverse relationship to be true, some other observed a positive on relationship between farm size and yield. Thus, it is a matter of debate and raise the question of validity of small farm size is a cause for low productivity. We could not resolve the debate. No resolution of the disput was made in this thesis. Without doubt the role of institutional factors in this debate has to be emphasised.

1.5.6: Agrarian structure, modes of production and land reforms in Indian agriculture:

The term 'Agrarian Structure' in a broader sense, denotes all of the existing and lasting production and living conditions found in a rural region and covers all the structural conditions for production in agriculture. It comprises of social, technological and economic elements and determines the achievable productivity, income and its distribution. It also includes the system of land tenure and the system of land management (Kuhnen, 1995). Agrarian structure should cover two aspects: one relating to the distribution pattern of land owned and operated and the second relating to the agrarian relationships. The agrarian relationships are largely determined by the structure of land ownership, but they also reflect several historical, political and social factors (Dantwala, 1986). The system of land tenure (social agrarian structure) and land management (technical and economic agrarian structure) determine agrarian relations (Kuhnen, 1995). The agrarian structure prevailing in an economy at a point of time has a close bearing on its agricultural production and development (Grewal and Rangi, 1989).

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Organization of production in Indian agriculture was debated during 1960s and 1970s in the mode of production debate - was it capitalist or semi-feudal? Even though the modes of production debate took place in the 1970s, its influence is still considerable (Lerche, 2013). There have been proponents of capitalism, pre-capitalism, semi-feudalism, colonial and post-colonial modes, and recently, a dual mode. Thorner (1982) in her survey of the modes of production debate stated that while it was generally agreed 'that capitalism today dominates Indian agriculture', the more disputed question was how to characterize the kind of capitalist development taking place.

Rudra (1969) takes up the subject of classes among the peasantry and marks three categories of farmers: small peasants, middle peasants and big farmers. He sets forth certain criteria for identifying capitalist and expected that the "capitalist of Punjab would: (a) tend to cultivate his land himself rather than to gave it out on lease; (b) tend to use hired labour in a much greater proportion than family labour; (c) tend to use farm machinery; (d) market an important share of his produce; and (e) so organize his production as to yield a high rate of return on his investments." Rudra did not find capitalist farmers by using these criteria. Rudra (1975) further argued that today there exist two classes in Indian Agriculture-'a class of big landlords, and 'a class of agricultural labourers'. The latter include landless labourers, landed labourers and poor tenants.

On the other hand, Patnaik (1981) demolishes Rudra's arguments. She believes, "ex-colonial countries like India are characterized precisely by a limited and distorted development of capitalism which does not revolutionize the mode of production". The colonial period saw a growing commercialization of agriculture with increasing regional specialization but this was not capitalist production (Thorner, 1982). Patnaik initially argued that the most rapidly developing regions of India in the 1970s, the Punjab, experienced the development of 'peasant capitalism'. However, she later specified that this peasant capitalism took place within a capitalist path dominated by landlord capitalism (Lerche, 2013).

Rudra (1975) uses Patnaik's argument that concentration should be measured not in acres but in the value of land held. Basole and Basu (2011) also said, "The same size of holdings can go with very different ways of organizing production, i. e., capitalist or

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semi-feudal, depending on the availability of water, power, fertilizers, draught animals, other tools and implements, etc."

Chattopadhyay (1972b) wrote that the existence of a sophisticated instrument of production is not necessary for identifying a capitalist. Given the capitalist mode of production, the existence of 'modern equipment' would only indicate a higher level of capitalism. Bhaduri (1973), on the contrary, stated that the "dominant character of existing production relations" could best be described as semi-feudal in that they "have more in common with classic feudalism of the master-serf type than with industrial capitalism". He listed four prominent features of these semi-feudal relations: share-cropping; perpetual indebtedness of the small tenants; concentration of two modes of exploitation, namely usury and land ownership in the hands of the some economic class; and lack of accessibility to the market for the small tenant. He said "semi feudal production relations operate as a barrier to the introduction of improved technology" (Thorner, 1982).

Chandra (1974), another supporter of the semi-feudal thesis believes that it would be more useful to characterize agrarian production relations in India as 'semi-feudal' rather than 'lumpen-bourgeois' or 'rickety capitalist'. Land ownership being highly skewed tenancy arrangements were predominantly of a traditional kind. Some features of semi-feudal relations as mentioned by Bhaduri and Chandra are still relevant in Indian agriculture and still operates as a barrier to the introduction of improved technology in different states in India and influences the productive capacity.

According to Marxist social scientists in India, the existence of feudal or semi-feudal relations was the real cause of backwardness and poverty in the Indian rural communities (Sengupta Commission Reports, NCEUS, 2007 and 2009). But it is possible to see agricultural productivity as purely a technological phenomenon and it can be raised by the application of superior agricultural methods. Thus, whereas the key to higher productivity lies in technological changes according to one school, it lies in institutional reform according to the other. However, land reforms and technological changes are not mutually exclusive but are complementary in the process of agricultural development (Bhatt, 2014). Land reforms policy in India was conceptualized either from a social justice perspective or from productivity perspectives.

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Rawal (2008) has shown through NSSO data that inequality in land ownership increased from 1992 to 2003-04. The Gini co-efficient of ownership of land increased from 0.73 in 1992 to 0.76 in 2003-04, landlessness (except for homesteads) stood at 42 percent, an increase of 6 percent since 1992. In 2003, according to the NSSO data, 63 percent of all landowners fell into the category of 'marginal farmers'. Landlessness had increased dramatically since the inception of reforms (NCEUS, 2008 and Lerche, 2013). It can be concluded that the agrarian system is skewed against the poorer cultivators.

Feudal Relations of Production:

At the time of independence, three types of land tenure system were prevalent in India- the *Zamindari* (or Landlord Tenure or Permanent Settlement), the *Ryotwari* (or the Joint Village Tenure) and the *Mahalwari*. Approximately 57 percent area of the country was under the *Zamindari* system where *Zamindars* were the proprietors of land. They indulged in sub-letting and rack renting rather than showing any interest in agricultural development. On the other hand, the tenants did not have incentive to supply sufficient efforts in agriculture. *Ryotwari* system (38% area in terms of coverage) was considered to be a relatively better arrangement under which the cultivator was the owner of land and he was responsible for the payment of revenue. The peasants under this system could not be ejected so long as they paid the fixed rent to the Government. However, with the passage of time the *Ryotwari* system also deteriorated and became very repressive as rent to be paid by the tenants was revised upward many times (Goswami, 2014). *Ryots* in the *Ryotwari* system also leased out their land to tenants for cultivation and these tenants were also subjected to the same type of exploitation as prevalent under the *Zamindari* system. Major part of the Brahmaputra valley was under the *Ryotwari* system. Under *Mahalwari* system (5% area in terms of coverage) the entire village was made responsible for the contribution of revenue (Misra and Puri, 2010; Bhatt, 2014). All land tenure systems of colonial time were characterized by the exploitation of the tenants. Investment made by the landlords for agricultural development was negligible.

After independence, the state governments enacted laws to abolish the intermediaries. However, these were entirely inadequate to have any drastic impact on the agrarian structure. However, detailed discussions on the history of land reform in India are kept outside the scope of this study due to limitation of space.

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1.5.7: Declining Importance of Tenancy in Indian Agriculture:

Tenancy as an institution of cultivation has a deep rooted historical background (Cheung, 1969). Tenancy and its terms and conditions reflect the demand and supply position of land in agriculture. In general, tenancy in its modern form appears to grow only with commercialization of agriculture, and so in the earlier stages of commercialization leasing in is often very limited (Smith, 1959).

Sharecropping tenant cultivation has been historically identified as one of the most important semi-feudal forms of surplus extraction in rural India particularly in Punjab, Haryana and Orissa (Patnaik, 1976). It is for this reason that the extent of its prevalence today can be used as an important indicator of the continued strength of feudal and semi-feudal modes of surplus extraction. However, aggregate level data suggests that tenant cultivation has witnessed a steady decline in rural India over the last four decades. Tenancy is relatively less prevalent today and has steadily declined over the decades, but sharecropping continues to be the predominant form of the tenancy contact (Basole and Basu, 2011). The share of marginal and small ownership holdings shows a high extent of tenancy which comes to about 84 percent. On the other hand, the share of marginal holdings in total leased out area is much smaller and shows a declining trend. According to NSSO data, the percentage of households leasing[5] in land has declined from 25 percent in 1971-72 to 12 percent in 2003 and area declined from 12 percent to 7 percent during the period; the percentage of area leased out to total area owned has also decreased from 6 percent in1971-72 to 3 percent in 2003 (Government of India, 2006c & Saikia, 2014). The percentage of tenant holdings has been continuously declining from over 20 percent in 1960-61 to 11 percent or less in all the size categories of holdings (except the large holdings) in 2003. Among the large holdings the percentage is still as high as 14 percent. The sharp decline in tenancy is also observed for operational holdings. Whereas the percentage of operational holdings with partly or wholly owned land has practically remained unchanged at around 95 percent, the percentage of operational holdings with partly or wholly leased in land has fallen drastically from around 24 percent in 1960-61 to 10 percent in 2003. In terms of the total area operated, the percentage share of area leased in has declined from 10.7 percent in

[5] Generally all tenurial contracts excluding those made for 30 years or more, whether made verbally or formally, were treated as land lease.

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1960-61 to 6.5 percent in 2002-03. At the aggregate level, the gradual shift from tenant cultivation to self-cultivation seems to be a persistent and unmistakable trend in the Indian agriculture economy (Basole and Basu, 2011).

1.5.8: Use of Modern Inputs:

With the introduction of new technology, productivity of agriculture largely depends on the use of modern inputs. Use of high yielding varieties, chemical fertilizers, insecticides, pesticides, irrigation facilities, industrial equipments, etc. have become essential for enhancing agricultural production. "Three indicators-uses of chemical fertilizers, use of mechanical power and use of co-operative credit have been selected as indicators of the adoption of modern technology in agriculture" (Nath, 1969). W. A. Lewis said, "The secret of rapid agricultural progress in the underdeveloped countries is to be found much more in agricultural extension, in fertilizers, in new seeds, in pesticides and water supplies than in altering the size of the farm, in introducing machinery, or in getting rid of middlemen in the marketing process". Bhattarai and Narayanamoorthy (2003) have empirically shown that improvement in irrigation and rural literacy are the two most important factors for agricultural growth in India. Some empirical studies like Odhiambo and Nzuma (2004) for Kenya; Lezin and WEI Long-bao (2005) in the context of China and Velazeo (2006) for Peru have examined agricultural growth and explained important determinants that contribute to factor productivity growth in agriculture. It has been suggested that labour, capital, land, technological improvements are the major positive contributors for agricultural growth in China. For Peru, public investment, favourable expected prices, weather conditions are pre-requisites for private investment and agricultural growth. It is the government expenditure in the form of expenditure on research and extension, etc. that is the key factor behind growth in total factor productivity in Kenya (Mathur et al., 2007). Bhati (1976), Asaduzzaman (1979), Dasgupta (1979), Hansan (1980) and Palmer (1996), highlighted that there is a positive association between the farm size and the adoption of HYV technology. India's Green Revolution is a dramatic example of how the input of greater knowledge in the form of improved production technologies can rapidly increase the productivity of scarce land resources (Planning Commission's Report of the Committee on India Vision 2020 and Vision Documents of soma states). Bhalla and Singh (2000) found that there was a large

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concentration in the use of modern inputs in the high productivity districts in India. All the high productivity states like Punjab, Haryana, Kerala, Tamil Nadu, Andhra Pradesh, Gujarat and West Bengal had been using large doses of modern inputs. The role of inputs in raising yields is confirmed by the fairly high correlation between quantum and intensity of inputs used and yield levels across states. For instance, during 2003-06, the "Pearson's coefficient of correlation (r)" between state level yields and use of fertilizer, pump sets and irrigation turn out to be 0.70, 0.69 and 0.50, respectively (Ray, 2010). The correlation between yield levels and pumpsets improved from 0.32 during 1962-65 to 0.69 during 2003-06, that tractor from 0.14 to 0.40 and for irrigation from 0.31 to 0.50, over the same period (Bhalla and Singh, 2009). However, it is worthwhile to mention that India is not using its agricultural inputs to the optimum level. There is a greater need for public investment in agriculture, irrigation, credit availability, better marketing of agricultural products, research and development that would help revive agricultural growth (Mathur et al., 2007).

Fertilizer Consumption in Indian Agriculture:

Maintaining of soil fertility is an important step in creating a sustainable agriculture sector. Fertilizers raise yields, but the intensity of its use and magnitude of its impact depends crucially on soil moisture conditions and management, as well as seed varieties and other elements of biochemical technology. It was found that a 1 percent increase/decrease in fertilizer use results in 0.32 percent increase/decrease in per hectare productivity (Chand et al., 2009). The new agricultural strategy was based on increased use of fertilizers. In India, the per hectare consumption of fertilizers in nutrients terms increased from 105.5kg/ha in 2005-06 to 128.34 kg/ha in 2012-13 (Economic Survey, 2013-14). The consumption of fertilizer in India is far below to some developed countries of the World such as, South Korea (400 kg/ha), Japan (340 kg/ha), Netherland (275 kg/ha), Belgium (225 kg/ha), etc. (Datta and Mahajan, 2014). Again a great deal of variability has been observed in fertilizer consumption among the states in India. For example, fertilizer consumption in Assam is less than half of Punjab, Haryana and even too low to national average. The studies find that the adoption of fertilizer use is somewhat lower among small farmers than large farmers, owing mainly to credit constrains. But those small farmers who do adopt tend to use higher doses of fertilizers

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than the larger farmers (Kapila, 2005). Table 1.11 presents the use of modern inputs in four regions of the country along with Assam.

Table-1.11: Region-wise Use of Various Inputs:

Regions	Tractors (Nos./'000ha)			Pump sets (Nos./'000ha)			Fertilizer consumption(Kg./ha)			% of Total Cropped Area Irrigated			Cropping Intensity (%)		
	1982	1992	2003	1982	1992	2003	1980	1990	2003	1980-83	1990-93	2003-06	1980-83	1990-93	2003-06
North-West	118	274	451	77	133	175	93	160	245	56	67	75	147	156	161
Central	21	55	128	32	57	88	21	55	86	16	22	27	114	118	126
Southern	20	44	73	78	106	137	54	116	149	29	33	34	114	119	121
Eastern	8	11	62	27	46	76	26	74	123	27	30	39	134	146	149
Assam	1	3	5	1	2	0	5	16	89	17	15	5	128	142	139
All-India	37	86	167	49	79	111	44	91	136	29	36	41	124	130	135
CV (%)	544	636	152	259	128	62	347	143	118	175	111	88	15	18	19

Source: Bhalla & Singh, 2009.

Table 1.11 reveals that the uses of tractors pump sets and consumption of fertilizer has increased in all the regions and in all India level at a rapid rate during the period from 1980 to 2003. Assam has also shown a quantum jump in fertilizer consumption, but due to poor base of consumption the state is in a lesser fertilizer consuming state.

The successful application of fertilizers requires plentiful drainage. Where irrigation facilities enjoy a limited spread, the use of fertilizers is also thin (Ray, 2007). In case of use of pump sets Assam is in a deplorable state. However, excessive and beyond permissible level of fertilizer application may have harmful effect on the soil quality and reduce productivity of land, deplete the ground water level and create health hazard problems. Residual effects of chemical fertilizers and pesticides on human and animal health have become a health concern (Vyas, 2011). Excessive use of fertilizers cause micronutrient imbalance. For example, excessive use of fertilizer in Punjab and Haryana has caused deficiency of the micronutrient zinc in the soil, which is affecting productivity of the soil (Sidhu and Dhillon, 1997).

Thus, balanced use of chemical fertilizer is important not only for increasing the agricultural productivity but also for sustaining soil fertility. The optimum desirable NPK ratio is 4:2:1(Bhattacharjee, 2003). During 2008-09, the consumption of NPK ratio was 4.6: 2.0: 1.0 which has changed alarmingly to 8.2: 3.2: 1 during 2012-13 (Govt. of India, Ministry of Chemicals & Fertilizers, 2013).

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Irrigation Facility:

The availability of assured irrigation continues to be the essential precondition for the adoption of new seed-fertilizer technology in most crops. The Planning Commission of India has estimated the productivity of irrigated land to be almost double compared to that of unirrigated land (Vyas, 1978). Irrigation helps replacing low-valued crops by high-valued ones which ultimately results in enhancement of the value of agricultural production. The role of irrigation in the field of agriculture is two-fold: one-it promotes growth in agricultural productivity and two-it contributes towards stabilization of agricultural production. As Dhawan (1996) points out, irrigation increases crop output through a rise in (a) proportion of net sown area of a holding and (b) gross cropped area and cropping intensity. Bhalla and Singh (2000) said that the new technology in Indian agriculture was primarily based on irrigation. Hence, initially it was the irrigated area in Punjab, Haryana and western UP that had adopted the new technology large scale, which recorded significant acceleration in their crop output. Irrigation moderates the impact of irregular, uneven and inadequate rainfall with fluctuations from year to year. Effect of rainfall variation on per hectare productivity of crop sector turned out to be stronger than the effect of net irrigated area. While 1 percent variation in rainfall causes 0.104 percent variation in productivity in the same direction the effect of 1 percent variation in net irrigated area was 0.067 percent variation in productivity (Chand et al., 2009). The total irrigation potential in the country has increased from 81.1 million hectares in 1991-92 to 102.77 million hectares by March 2007, i.e. about 53 percent of gross cropped area in the country (Economic Survey, 2009-10). The gross irrigated area in India has gone up from 62 million hectares (34% of sown area) in 1990-91 to 87 million hectares (45.3% of sown area) in 2009-10, an increase by over 40 percent in two decades whereas net irrigated area has increased from 48 million hectares to 63.3 million hectares that is an increase by over 30 percent during the period (Agricultural Statistics at a Glance, 2012). The coverage of foodgrains area under irrigation had increased from 24.1 percent in 1970-71 to 48.6 percent in 2010-11. However, Indian agriculture is still heavily rainfall dependent with just 35 percent of total arable area being irrigated and distribution of irrigation across states is highly skewed (Economic Survey, 2014-15). Even in areas having irrigation facilities, potential is not wholly utilized because of defective management (Kapila, 2005). That is why Indian agriculture is ‘a gamble with the monsoons’.

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Investment in irrigation infrastructure is the single largest expenditure in agriculture. However, irrigation systems worldwide suffer from inefficiency, deteriorating equipment and infrastructure and mis-allocation. Inefficient overuse of water in the fields results in water logging and salinization. Efficient management of the existing irrigation systems is a must for better utilization of the potential created.

Table 1.11 shows that the irrigated cropped area has increased in each region in India during 1980-83 to 2003-06. At all India level, it has increased from 29 percent to 41 percent. Contrary to national trend as well as trends of different regions including eastern region, irrigated cropped area in Assam has been sharply decreasing from 17 percent to 5 percent over the period.

In case of the use of various modern inputs of agriculture production, Assam is far behind the all-India average and other regions, even other states of the eastern region which is evident from table 1.11. However, the cropping intensity in Assam is higher than national average and some regions in India but lower than states of north-west and eastern India.

1.5.9: Investment in Agriculture:

An increase in production of agriculture is possible by expansion of irrigation, spread of new technology and additions to rural infrastructure and by change in the institutional structure. To achieve these changes adequate investment, investment from both private and public sectors are required. Before the country entered into the era of development planning, Indian agriculture could be described as a land-labour-bullock economy. According to an available estimate, investment in agriculture on implements, bullocks, irrigation and land on the eve of First Five Year plan was of the order of Rs. 2300 crores, 73.7 percent of which was spent on bullocks alone (Ghosh, 2005). From 1961 to 1999, gross capital formation in agriculture (GCFA) grew at about 3 percent per annum. After the mid sixties public investment in agriculture was stepped up significantly. The new technology raised the profitability of investment for the farmers. Besides, in agriculture, there was a high complementary between public and private investment (Kapila, 2005). As the Mid-Term Appraisal of the Ninth Five Year plan points out, "there is a strong complementarities between public and private investments, and inadequate public

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investment could lead to a 25 percent lower private investment than desired" (Rao, 2001). Similarly, Gulati and Bathla (2001) observed that there has been an increasing role played by private sector investment while there is a decline in public sector capital formation in the sector. Public investment in agriculture in real terms has witnessed steady decline from the Sixth Five Year Plan (Rs.64,012 crore or 5.8% in total investment) to the beginning of Tenth Plan (Rs.42,226 crore or 4.9% in total investment). After the economic reforms started, the Government's expenditure and investment in the agricultural sector have been drastically reduced. The Government expenditure in rural development including agriculture, irrigation, flood control, village industry, energy and transport declined from an average of 14.5 percent in 1986-1990 to 6 percent in 1995-2000. Chand (2001) argues the Central Government's expenditure on per hectare of net sown area declined from Rs.63 in Fifth Plan to Rs.10 per hectare in 1990's. Private investment also declined during 1990's, particularly in the states like Punjab, Haryana, Orissa, Bihar, Assam which is ranging between Rs.21 and Rs.38 per hectare in 1996-97 from Rs.40 to Rs.51 in 1981-82. Compared to the all India average of Rs.126 per hectare, private investment in Assam was Rs.38 (Roy and Das, 2003). Reddy (2012) said, there was continuous decline in public outlays and investment in agriculture sector for over two decades. However, this trend was reversed in the Tenth Plan (2002-2007) and public investment in agriculture stood at Rs.67,260 crore (Economic Survey, 2009-10). The rate of growth of GCF accelerated to 9.7 percent in the Eleventh Plan compared to a growth of 2.7 percent during the Tenth Plan (Economic Survey 2012-13). Pal et al., (2011) stated, "During the current decade, while public investment rose sharply (15.80%), private investment grew at 4.8 percent, thereby registering an impressive growth of 7.1 percent in the total investment". As per the National Account Statistics, CSO (2004-05 series), "the total investment in agriculture & allied sector increased at an impressive rate of 11.6 percent on an average during 11th plan mainly on account of private investment growing at 15.0 percent. As a percentage of agricultural GDP, public investments in agriculture stood at 2.8 percent in the 10th plan which increased to 3.1 percent in the 11th plan and remained at the same level in 2012-13. In the same period, the private investment increased from 15.9 percent of agricultural GDP in 11th plan to 18.1 percent in 2012-13)". Table 1.12 and 1.13 presents the public and private investment in agriculture and allied sectors and growth rates of investment in agriculture in India.

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Table-1.12: Public and private investment in agriculture and allied sectors and its percentage share to GDP of agriculture and allied sectors: (at 1999-2000 & 2004-05 prices)

Year	Investment in Agriculture & Allied sectors (in Rs. Crore) and % share in investment in brackets			Investment in Agriculture as % of Total Investment	% Share of GCF to GDP of Agriculture and Allied Sectors (at 2004-05 prices)		
	Public	Private	Total		Public	Private	Total
1990-91*	7882 (22.16)	27691 (77.84)	35573	-	-	-	-
1999-2000*	8670 (17.3)	41481 (82.7)	50151	10.2	-	-	-
2000-01*	8084 (17.8)	37396 (82.2)	45480	9.7	-	-	-
2001-02*	9712 (17.0)	47267 (83.0)	56979	11.7	-	-	-
2002-03*	8734 (15.7)	46934 (84.3)	55668	10.3	-	-	-
2003-04*	10804 (20.2)	42737 (79.8)	53541	8.8	-	-	-
2004-05	16183 (20.5)	62665 (79.5)	78848	7.7	2.9	11.2	14.1
2005-06	19909 (21.4)	73211 (78.6)	93121	7.3	3.4	12.4	15.8
2006-07	22978 (24.3)	71422 (75.7)	94400	7.2	3.8	11.7	15.4
2007-08	23039 (20.9)	86967 (79.1)	110006	6.7	3.6	13.6	17.2
2008-09	24452 (17.6)	114145 (82.4)	138597	7.1	3.8	17.5	21.3
2009-10	23635 (18)	109742 (82)	133377	-	-	-	20.1
2010-11	21500 (15)	120754 (85)	142254	-	-	-	18.4
2012-13	-	-	-	11.6	6.2	15.0	21.2

Note: *GCF in agriculture at 1999-2000 prices

Source: (i) Computed from Annual Report 2009-10 on Agriculture; (ii) Economic Survey, 2006-07, 2009-10, 2011-12 & 2014-15; (iii) Agricultural Statistics at a Glance, 2011and (iv) Central Statistical Organization, Govt. of India, New Delhi.

From table 1.12 it is noticed that investment in Agriculture & Allied sectors increased to Rs.56979 crore in 2001-02 from Rs.35573 crore in 1990-91 at 1999-2000 prices. But the share of public investment declined from 22.16 percent to 17.0 percent during the period. In terms of 2004-05 prices, amount of investment in agriculture has also increased by about two fold during 2004-05 to 2010-11 but the share of public sector investment in agriculture declined from 20.5 percent to 15 percent during the period implying that the share of private sector investment was as high as 85 percent.

The Gross Capital Formation in Agriculture has been declining from 11.7 percent in 2001-02 to 7.1 percent in 2008-09. In comparison, GCF in industrial sector increased from 37.0 percent in 2000-01 to 50.1 percent in 2007-08. GCF in service sector also declined from 53.3 percent in 2000-01 to 43.2 percent in 2007-08. The share in capital

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formation in agriculture continued to be the lowest among all sectors (Reddy, 2012). This poor investment in agriculture is one of the main causes of slow growth in agriculture in recent years. Gulati and Bathla (2002) have estimated that a 10 percent decrease in public investment leads to 2.4 percent annual reduction in agricultural GDP growth.

However, this trend has since been arrested and the share of capital formation of the agriculture and allied sectors in GDP has increased from 14.1 percent in 2004-05 to 21.2 percent in 2012-13(at 2004-05 prices) (Economic Survey, 2012-13, 2014-15).

Table-1.13: Investment Growth Rates in Agriculture in India at 2004-05 prices : (in percent per annum)

Year/GR	2001-02	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Growth Rate	6.9	6.6	13.9	5.9	15.9	21.4	8.2	8.4

Source: Economic Survey, 2011-12

The annual growth rate of investment in Indian agriculture observed high fluctuation from 2001-02 to 2010-11. Investment growth rate in agriculture increased surprisingly to 21.4 percent in 2008-09 but fell in succeeding years.

We conclude that the capital formation in the farm sector in India is not upto the mark as of its importance in Indian economy. There is a widespread belief that inadequate and declining quantum of investment expenditures in agriculture is a major reason for the sluggish and decelerating growth in this sector (Vaidyanathan, 2010).

1.5.10: Credit Availability:

Credit is an instrument that enables farmers to acquire commands over the use of working capital, fixed capital and consumption goods. Employing modern agricultural technology is possible when farmers are provided easy and cheap credit for purchasing modern inputs. Farmers who got credit facility were found to be more responsive to the adoption of improved agricultural technology. Most of the World's farmers have to borrow at some time, many of them heavily to raise agricultural production. It is, thus in the interest of agriculture and essential to agriculture and general progress that credit be

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available to farmers in adequate amount and at appropriate costs (Sadhu and Singh, 1975).[6]

"The lesson of universal agrarian history from Rome to Scotland is that an essential of agriculture is credit. Neither the condition of the country nor the nature of the country nor the nature of the land tenures, nor the positions of the agriculture, affect the one great fact that agriculturist must borrow".[7]

The emergence of Green Revolution and introduction of new technology in agriculture has led the increasing demand for disbursing credit to most of the farmers. Agriculture credit, in a practical sense, is a nucleus of the system of farm operation. In poor a state like Assam, agricultural credit assumes even greater importance (Dey and Rakshit, 2003). Traditionally, farmers depended for their credit needs on local moneylenders, friends and relatives, local merchants and commission agents. Increasing dependency on informal sources of credit by rural households from 1991 onwards is a cause of concern (Tripathy, 2015). NSSO estimated that about 52 percent of the agricultural households in the country were estimated to be indebted, of which 61 percent had operational holdings below one hectare, 57.7 percent of the outstanding amount was sourced from institutional channels and rest 42.3 percent from money lenders, traders, relatives and friends. The average amount of outstanding loan per agricultural household was Rs. 47000 (approx.) (NSS 70th Round, 2013). Studies conducted by the RBI and NABARD indicate that the crop loans are not reaching intended beneficiaries and there are no systems and procedures in place at several bank branches to monitor the end-use of funds. Although overall credit flow to the agriculture sector has increased over the years, the share of long-term credit in agriculture declined from 55 percent in 2006-07 to 39 percent in 2011-12. According to NSSO 70th Round Report, as much as 40 percent of the finances of farmers still come from informal sources, despite an increase in the flow of institutional credit to agriculture in recent years. The share of institutional credit in the total credit availed by the farm households increased significantly over time from 31.7 percent in 1971 to 61.1 percent in 2002 (Subbarao, 2012). But in the race between the supply of formal credit and the demand for capital on farms, the former lagged behind, leaving a big gap to be filled by high-cost

[6] Sengupta and Roy (2003), p.193

[7] Nicholson, F. A., Report regarding the possibility of introducing land and agricultural bank in the Madras Presidency, Vol. I, p. 46.

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alternatives such as private money lenders, dealers, microfinance institutions, etc. (Satyasai, 2012). Usurious money lenders account for a 26 percent share of total agricultural credit (Economic Survey, 2014-15). Marginal land holding households suffered the most with only 15 percent of their credit being sourced from institutional sources (NSSO, 2006). The latest All India Debt and Investment Survey have shown that non-institutional financial agencies accounted for as much as 44 percent of the outstanding credit in 2012-13 (Hoda and Tewary, 2015).

Direct agriculture credit has significant positive impact on agriculture output. In particular, change in per capita agriculture direct credit by one percent will lead to increase in per capita agriculture output by 0.11 percent (Das et al., 2009). Direct finance to cultivators has increased from 72.6 percent in 1975-76 to 82.4 percent in 2011-12 (Tripathy, 2015) (see appendix Tables I.4, I.5).

With the recommendation of the Narasimham Committee on the liberalization of financial system, banks were to be permitted to close rural branches, in the name of rationalization of branch networks. As a result, growth in credit to agriculture declined from 6.8 percent in the 1980s to only 2.6 percent in the 1990s. However, Rangarajan (2009) said since 1991-92 there has been fairly rapid expansion of credit to agriculture. Between 2002 and 2011, agricultural credit grew by 17.6 percent per annum, but there is little evidence to argue that the major beneficiaries of the revival in agricultural credit in the 2000s have been the small and marginal farmers (Ramakumar, 2014). In the whole process small and marginal farmers are usually left out of the purview of formal credit (Satyasai, 2012) or they are often not accessible due to lack of required collateral. There is a wide gap between the loan accounts and credit disbursal to small and marginal farmers and big farmers during 1985-86 to 2011-12. During 2011-12, 77.8 percent of loan accounts of small and marginal farmer received 63.5 percent of total disbursed credit whereas 22.2 percent of loan accounts belonging to the large farmer obtained 36.5 percent of total loan amount disbursed (Tripathy, 2015). The small and marginal farmers who have borrowed from money lenders, normally at the rate of 36 percent per annum, are committing suicide in large numbers all over the country (Datt and Mahajan, 2013). In post reform era, there has been indifference in extending credit to agriculture. It is very clear that during the period commencing from 1993, the loaning to agriculture sector has been neglected (Vaidyanathan, 2010). Table 1.14 shows the proportion of operational holdings of different size groups availing institutional credit.

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Table-1.14: Proportion of operational holdings availing institutional credit, farm-size-wise at all India level from 1981-82 to 2006-07:

Operational holdings size-group	Proportion of operational holdings availing institutional credit (in %)						Increment in 2006-07 over 2001-02 (in %)
	1981-82	1986-87	1991-92	1996-97	2001-02	2006-07	
Marginal	17.53	14.78	15.68	9.50	14.02	19.6	4.6
Small	27.42	24.12	17.90	17.63	27.74	32.8	5.0
Semi-medium	31.03	29.27	21.53	19.90	31.57	34.5	3.0
Medium	33.24	30.16	22.45	23.10	33.13	39.4	6.3
Large	33.19	29.40	22.49	23.04	29.38	40.1	10.6
Overall	23.09	20.10	17.53	13.41	20.24	25.0	4.75

Source: Satyasai, (2012). *Access to Rural Credit and Input Use: An Empirical Study,* Agricultural Economic Research Review, Vol.25 (Conference Number) pp. 461- 471.

Institutional credit to overall operational holdings has decreased from 23.1 percent in 1981-82 to 13.4 percent in 1996-97 while gradually improvement is seen and after a decade it reached to 25 percent. Proportion of marginal land holdings availing institutional credit is all along lower than other size of land holdings from 1981-82 to 2006-07.

Innovative credit products were introduced during post-liberalization period with a view to improving the reach of institutional credit. The self-help groups (SHGs)-bank linkage programme launched in 1993-94 for providing micro-finance to the rural poor, the *Kisan* Credit Card (KCC) scheme are introduced as a step towards simplifying the procedure for timely and adequate short term institutional credit to farmers. Number of KCCs issue increased from 24.31 million in 2010 to 39.9 million in 2014. And the loan amount disbursed from 1240.1 billion at the end of March, 2010 to 3684.5 billion at the end of March 2014 (RBI, Annual Report, 2013-14).

It is also observed that the credit absorbing capacity of the farmers is increasing due to modernization and commercialization of agriculture, which necessitates constant assessment and balancing of demand in relation to productivity, costs, prices and margins. However, credit worthiness of the purpose, the actual production needs, the incremental income and repaying capacity of the farmers may play an important role in determining to whom and how credit should be given.

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1.5.11: Extension Services:

With the change in farming technology and diversification of agriculture in favour of more competitive and high value quality products to enhance remunerativeness of farming, role of extension services become important. Rapid technological advances in agriculture have occurred since World War-II. These advances have induced great changes in agricultural production and also highlighted the importance of a rapid and efficient transfer of advanced knowledge to the farmer. When farmers become aware of the availability of new technology, they may have an accurate perception of the related costs and benefits of cultivating different crops. Better management, information and utilization are equally important as increased investment in inputs (Steitieh, 1971). However, information on improved agricultural technology is often a public good because the provider of the information cannot exclude other potential users from free access to information provided to one user, and the value of the information is not directly affected by the number of users. The crucial role of extension services in diffusing new innovations among the farmers has also been emphasized in several studies like Chouhan (1980), Vadapalli (1997), Bezbaruah and Roy (2002), etc. With increase in level of access to extension services farmers become more aware of the recent techniques and practices of cultivation. This may be conducive to crop diversification (Mandal, 2011). Sharma (2005) observed, extension activities played the major role in bringing Green Revolution into the country. Research and extension played a major role in the success of the first Green Revolution (CACP, 2011).

The strategy, which was based on high yielding varieties and increased application of fertilizers, needed institutions to implement it at the ground level. Indian Council of Agricultural Research (ICAR), along with the state agricultural universities developed and replicated the high yielding seeds and went forward to demonstrate it on farmer's fields. The Food Corporation of India (FCI) and the Agricultural Price Commission were established to ensure a remunerative price to the farmers. FCI also procured foodgrains for public distribution. So, right from the production to the distribution there were institutions to support the technology (Vyas, 2011).

Effective agricultural extension can bridge the gap between discoveries in the laboratory and changes in the individual farmer's fields. In addition to information about cropping techniques, optimal input use, high yielding varieties and prices, extension

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agents can inform farmers about improved record keeping and aid in the development of their management skills. The country is experiencing change in key climate variables, namely temperature, precipitation and humidity which has already started affecting its agriculture and farmers need support in applying adaptive measure to cope with these changes. Addressing many of these complex issues requires solutions which are beyond the decision-making capacities of individual farmers. Agricultural extension work, if properly organized, can meet all these needs nationally and locally in an effective manner. Hayami (1971) pointed out that agricultural development basically involved increasing the productivity of land and the productivity of labour. They emphasized farmers required with high level of knowledge and entrepreneurial orientation that can achieve through the spread of education (Alexander, 2002).

Extension needs research support in several areas including district level planning, manpower planning and human resource management, ICT (Information & Communication Technology) enabled extension, marketing extension, public-private partnerships, evaluation of promising approaches, monitoring and learning and impact assessment. After several years of neglect, public sector extension has been witnessing renewed interest and policy attention during the last few years. Enhanced funding for district level Agricultural Technology Management Agencies (ATMA) and *Krishi Vigyan Kendras* (KVKs) (Agriculture Science Centres) and other central sector agricultural and rural livelihoods programmes clearly reveals this (Sulaiman, 2014). KVKs are the institutions providing institutional training to farmers.[8] To support State Extension Programmes, Extension Reforms Scheme was launched in 2005-06 aiming at making the extension system farmer driven as well as accountable to farmers. The ATMA has active participation of farmers/farmer groups, non-government organizations and other stakeholders operating at district level and below. Farmers can now also avail information regarding the weather conditions and decide their farm operations. The use of GIS (Global Information System) is also being promoted in a big way (Economic Survey, 2014-15). Whether these initiatives remain mere paperwork or are implemented remains to be seen.

The number and diversity of organizations involved in extension and farm advisory provision also increased over the past two decades. Private sector (input

[8] V. S. Vyas and Pradip Bhargava (edn.), Policies for Agricultural Development, 1997.

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companies and agri-business firms), NGOs, producer organizations, consultants, media and mobile service providers do provide several useful information and services to farmers. However, farmers quite often do not receive adequate information and advisory support even under this increasingly pluralistic extension system (Sulaiman, 2014). About 60 percent small and marginal farm holdings depended on shopkeepers for extension services (Reddy, 2014). Certain other schemes which support agriculture sector are mass media support to agriculture focusing on *Doordarshan* telecast and *All India Radio* broadcasting agriculture related information; *Kisan Call Centres* to provide agricultural information to the farming community through toll free telephone lines; agro-clinic and agri-business centres on payment basis, etc. Further, extension education institutions at Nilokher (Haryana), Rajendra Nagar (Andhra Pradesh), Anand (Gujarat), and Jorhat (Assam) are operating to improve the skill and professional competence of extension field functionaries.

Like research, extension is presently supply driven and not demand driven. Farmers participation and their feedback is lacking in the extension programme. Mass media is not being sufficiently used, or used in an ad-hoc manner. Other supportive institutions like credit and marketing are not linked with the extension system. The NSSO 70th round survey indicates that about 59 percent of farmers do not get much technical assistance and know-how from government funded farm research institutes or extension services. Presently, the ratio of one extension worker is for every 800 to 1000 farmers. So, farmers have to rely on progressive farmers, media and private commercial agents for technical information. Effectiveness of the lab-to-farm programme can be improved by leveraging information technology and e-(electronic) and m-(mobile) applications, participation of professional NGOs, etc. (Economic Survey, 2014-15).

As mentioned in the Report of Agriculture Development of Assam (2001-02 and 2002-03), the urgent need is of modern information communication system for transfer of technology from laboratory to land and to create awareness among the farming community to adopt scientific method of agriculture, publicity through various media, viz., *Doordarshan*, AIR, leaflets, booklets, newsletters, etc. video and film shows, sensitization and exhibition, *kisan mela*, etc. have been utmost necessary.

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1.5.12: Change in Cropping Pattern and Crop Diversification:

A major change which has taken place in the recent years is in the cropping pattern and crop composition. The proportion of area under different crops at a particular period of time is called cropping pattern. Crop composition, on the other hand, refers to the different amounts of crop-wise production that composes the total crop production at a particular time. Given the yield rate, addition to the area of a particular crop through a change introduced in the cropping pattern will raise the share of that particular produce in the existing crop-composition (Daimari, 2008). Agriculture diversification meant transforming agriculture from major cereal (rice/wheat) dominated cropping systems to more diversified systems, especially by promoting secondary crop [9] production. Agricultural diversification is driven by rising income levels and expanding urbanization process. It has emerged as an important alternative to attain the objectives of output growth, poverty alleviation, reduced risk of crop failure, employment generation and natural resources' sustainability. The recent experience in Asia, particularly South East Asia, Middle East and North Africa indicates that policy makers and planners are increasingly focusing on agricultural diversification to promote agricultural development (Chand, 1999). Mandal (2011) said diversification of crops, particularly into high value crops may prove to be a third alternative (other two are area expansion and productivity), at least in the short-run source of growth in agriculture.

The cropping pattern in a particular region is subject to changes depending on a number of factors like soil type, climate, pattern of rainfall, topography and elevation from sea level, sizes of operational holding and location of the holding, agricultural technology, availability of irrigation facilities, relative price and profitability of various crops and so on. Malya (1963) shows that the proximity to an urban centre, better transport and efficient marketing facilities have more important influence on the cropping pattern. Gupta and Tewari (1985) have found in a study of Allahabad farms that large farms and wealthier farms are relatively less diversified. Tenancy discourages diversification (Ray, 2010). Bhardwaj et al., (1991) conclude in a case study in Haryana that the element of risk (yield and price) has a significant impact on cropping pattern and resource allocation of farmers under study. Vyas (1996) considered market as the most

[9] The term "secondary crops" is usually used to indicate crops which are cultivated after rice harvested in the same fields (Sugino, 2006)

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important factor determining the pattern of crop diversification. Singh et al., (1997) found that irrigation has substantial impact on acreage growth of different crops in West Bengal and other states. The decline in the profitability of traditional crops and an increase of the same in case of non-traditional high value crops, especially in the 1990s has been reported by Barghouti et al., (2004) as the most important economic factor influencing crop diversification. In a study in the Brahmaputra valley of Assam, Dutta et al., (2005) found that the farmers have been able to diversify their cropping pattern after getting access to irrigation facilities, especially through privately owned shallow tube wells (STWs). New technology and improvement of infrastructure can also help change the cropping pattern (De, 2003; Bhalla and Singh, 2009).

In the second half of Green Revolution there was a change in cropping pattern. Farmers preferred non-food crops to food crops due to gradual commercialization of Indian agriculture. With the globalization, agriculture is playing an important part in exports; incentive for raising commercial crops has also improved. Sawant and Achuthan (1995) calculated that CAGR of non-foodgrains output was 4.3 percent which exceeded significantly that of foodgrains, namely, 2.92 percent during 1981-92. The reason was, non-foodgrains benefited from significant expansion in both the components of production, i. e., area and yield. With fairly rapid expansion in productivity of non-foodgrains, growth in agricultural income too accelerated in majority of the states in the 1980s. The share of foodgrains in GCA declined from 67.3 percent in 1990-93 to 63.75 percent by 2003-06. The ratio of foodgrains to non-foodgrains declined from 74:26 in 1970-71to 66:34 in 2010-11.

However, some of the authors have noted adverse impact of crop diversification. The extent of the advantages in cropping pattern change is conditioned by the number of farmers attempting to secure them. If a considerably large number of farmers make similar changes, the price advantage of the particular product would quickly disappear as a result of an increased supply of that product. But this argument may not be valid in all circumstances because the extent of diversification depends not only on price but also on other factors like topography and soil content, irrigation, access to market, socio-economic characteristics of the farmers etc. (Mandal, 2011). Output growth of non-foodgrains is crucial in determining aggregate performance of agriculture, depending upon their relative share in crop pattern. To the extent that the demand for non-foodgrains is more income elastic and they enjoy relatively higher price advantage over

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the foodgrains (Sawant and Achuthan, 1995). However, a noticeable point is that the extension of non-foodgrains production at the cost of foodgrains production may hamper the availability of foodgrains and food security of the nation in the long run. Cheaper but essential foodgrains production may be hampered by crop diversification intended by high income.

1.6: Agriculture in Assam:

Assam is an agrarian economy in the sense that agriculture and allied sector continues to support about three fourth population of the state and providing employment to about 50 percent of the total workforce (out of total 8687123 main workers, 36.13% are cultivators and 10.4% were agricultural labourers in 2011) (Economic Survey, Assam, 2014-15). More than 85 percent of the farmer family is small and marginal farmers (Agricultural Census, 2010-11(P)) with average land holding of only 0.63 hectare in a scattered manner. The contribution of agriculture and allied sector to the Gross State Domestic Product at constant (2004-05) prices was more than 20 percent during 2014-15 which recorded a gradual fall since 2005-06 (Economic Survey, Assam, 2014-15). The trend of growth of the agricultural and allied sector (GSDP at constant (2004-05) prices) was erratic during the period 2005-06 to 2011-12 and finally pegged at 3.53 percent in 2014-15 compared to 7.37 percent growth in industry and 7.08 percent growth in service sectors respectively (Economic Survey, Assam, 2014-15). The average growth rate of GSDP in agriculture and allied sector in Assam during 2005-06 to 2013-14 at constant (2004-05) price was 3.65 percent compared to 3.97 percent in India; and only in agriculture sector, this average growth rate was 3.47 percent and 4.1 percent respectively. Saikia, (2014) mentioned that while growth of industry and service sector recorded an encouraging picture with annual average growth of 8.58 percent and 7.33 percent respectively, agriculture and allied sector has achieved annual average growth of 1.24 percent only during the 10^{th} five year plan. However, total foodgrains output share of Assam in all India increased from 1.9 percent in 1999-2000 to 2.05 percent in 2009-10. Almost all other neighboring hilly NER states depend on Assam for foodgrains and other agricultural products. But in spite of its overwhelming importance, the progress of agriculture in the state is far from satisfactory. The small farmer oriented agriculture is stuck with low productivity and stunted growth. Agricultural productivity in the state is

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one of the lowest in the country. In 2011-12, foodgrain yield in Assam was 1704kg per hectare against its national average of 2078kg per hectare. To Swaminathan (2001a), Assam is one of the 'sleeping agricultural giants' in eastern India. Following tables will give an empirical evidence of some dimensions of Assam agriculture.

Table-1.15: Sectoral Contribution to Gross State Domestic Product (at constant 1980-81 prices, 1993-94 prices & 2004-05 prices*) (in %)

Year/Sector	Agriculture and allied	Industry	Service
1980-81	47.5	12.6	39.9
1981-82	46.8	13.1	40.1
1982-83	47.6	12.3	40.0
1983-84	47.4	12.4	39.9
1984-85	44.6	14.2	41.2
1985-86	45.0	12.9	42.1
1986-87	44.6	12.2	43.2
1987-88	44.5	13.2	42.3
1988-89	43.9	13.5	42.6
1989-90	44.0	13.2	42.8
1990-91	42.6	13.2	44.7
1993-94	40.3	12.6	47.1
1996-97	37.5	13.3	49.2
1997-98	38.4	13.4	48.3
1998-99	36.9	13.0	50.1
1999-00	36.4	14.7	48.8
2000-01 (QE)	35.7	14.3	50.0
2001-02 (Adv.)	34.7	14.7	50.6
2003-04	31.2	-	-
2004-05*	25.5	27.54	46.9
2005-06	25	26	49
2006-07	25	24	51
2007-08	24	24	52
2008-09	23	24	53
2009-10	23	24	53
2010-11	22	22	56

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2011-12(Q)	22	22	56
2012-13(P)	17.5	23.2	59.3
2013-14	21.3	21.27	57.5
2014-15	20.2	23.0	56.8

Note: QE quick estimate, Adv. Advanced Estimate, P provisional estimate, *Figure for 1994-95 onwards till 2003-04 are based on 1993-94 prices and thereafter based on 2004-05 prices.

Source: Economic Survey, Assam (various issues), Directorate of Economics and Statistics, Govt. of Assam.

It is evident from the above table that over the years the share of agriculture and allied sector in the GSDP has declined from 47.5 percent in 1980-81 to 20.2 percent in 2014-15. The industry sector has also shown a gloomy picture of fluctuation from 12.6 percent in 1980-81 to 23 percent in 2014-15. However, the share of service sector has progressed from 40 percent in 1980-81 to 57 percent in 2014-15.

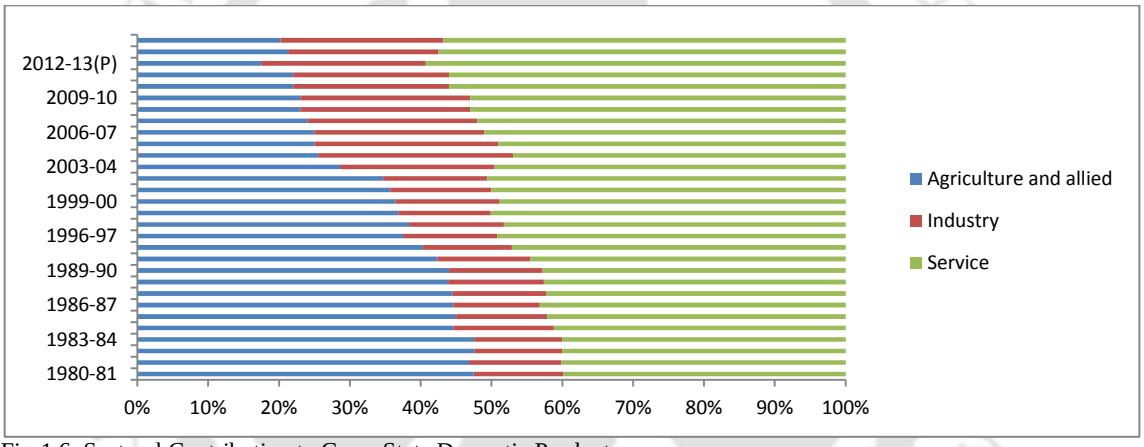

Fig-1.6: Sectoral Contribution to Gross State Domestic Product.

Table-1.16: Estimated CAGRs of production of foodgrains, non-foodgrains and all crops in Assam and India during 2001-02 to 2010-11 (in %)

Crops	CAGR in Assam	CAGR in India
Foodgrains	1.90	1.95
Non-foodgrains	1.30	2.90
All Crops	1.60	2.43

Source: (i) Goswami (2014); (ii) Author's calculation

Table 1.16 implies that the contribution of the foodgrains to the growth of the overall agricultural production in the state has been more relevant to that of the non-foodgrains during the last decade. Bezbaruah (1994) observed a contrasting feature of agricultural growth in Assam from that of the whole of India is the relatively better performance of

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non-foodgrains than foodgrains in Assam during the 1970s and early 1980s. Table 1.17 referred the acreage share of Assam in all India of major crops.

Table-1.17: Assam's share of major crops in all-India in terms of acreage (in %)

Year	Rice	Wheat	Total Cereals	Total Pulses	Total Foodgrains	Rapeseed & Mustard	Total Oilseeds	Jute & Mesta	Tea	Sugarcane
1980-81 to 1984-85*	5.7	0.5	2.3	0.5	2.0	6.5	1.5	10.9	53.4	1.64
1985-86 to 1989-90*	5.8	0.4	2.4	0.6	2.1	7.2	1.7	10.7	54.9	1.38
1990-91	5.8	0.3	2.5	0.5	2.1	5.1	1.3	10.1	56.0	0.97
1991-92	5.9	0.3	2.7	0.5	2.3	4.6	1.3	9.8	55.6	0.98
1992-93	6.0	0.3	2.6	0.5	2.2	4.7	1.2	10.6	55.8	1.12
1993-94	5.9	0.3	2.6	0.5	2.2	4.4	1.1	9.3	56.3	1.05
1994-95	5.7	0.3	2.5	0.5	2.2	4.6	1.2	10.4	53.3	0.92
1990-91 to 1994-95*	5.9	0.3	2.6	0.5	2.2	4.7	1.2	10.0	55.4	1.01
1995-96	5.8	0.3	2.7	0.5	2.3	4.3	1.2	10.2	52.7	0.9
1996-97	5.7	0.3	2.6	0.5	2.2	4.2	1.2	9.0	52.6	0.9
2000-01	5.68	0.28	2.73	0.58	2.28	-	1.31	9.85	52.8	0.63
2005-06	5.54	0.19	2.50	0.45	2.14	2.90	0.84	6.89	55.0	0.55
2006-07	5.00	0.21	2.26	0.46	1.93	3.5	0.98	7	55.5	0.52
2007-08	5.29	0.2	2.4	0.48	2.03	4.05	0.96	6.5	53.7	0.51
2008-09	5.46	0.18	2.54	0.52	2.18	3.59	0.89	7.22	55.6	0.66
2009-10	6.04	0.21	2.67	0.51	2.25	4.45	1.03	7.22	46.5	0.64
2010-11	6.04	0.15	2.69	0.48	2.20	-	0.99	7.75	46.8	0.61
2011-12	5.79	0.13	2.61	0.53	2.19	-	1.09	8.25	53	0.55

Note: * Average value of the years

Source: (a) Data are from Area and Production of Principal Crops, Govt. of India, Fertilizer Statistics and Tea Board of India. (b) Goyari, 2007; (c) Calculation by the author

Area share of Assam in all India acreage in different crops shows that share of rice remained almost same, share of wheat declined from 0.5 percent to 0.13 percent, and the share of total pulses about 0.5 percent during last three decades from 1980-81 to 2011-12. Area share under oilseeds in Assam gradually declined from 1.7 percent in 1985-86 to 1 percent in 2011-12. Assam is occupying a leading area share in all India acreage in two important cash crops, viz. tea and jute. More than half of the area of tea of the country is shared by Assam while area share of jute has slightly declined in recent years.

By partition of the state into Meghalaya and Arunachal Pradesh, total area under different crops in absolute terms has declined significantly. Historically, the performance of agriculture in Assam has been indifferent till the early 1980s. Dhar (2001) said the cultivation of jute is gradually becoming unpopular in Assam. But later the production growth improved and variability has also declined (Pandey and Pal, 2000). It has been observed that in spite of the dismal performance, the recent years experienced some

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positive changes in some crops like in paddy, pulses, natural rubber, etc. Table 1.18 shows the trends of production of major crops in Assam since 1980-81.

Table-1.18: The trend of production of Food and Non-food crops in Assam: (in'000 tons)

Crops/ Years	1980-81	1990-91	1999-00	2000-01	2001-02	2002-03	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	CAGR @
Autumn Rice	502	522	514	558	488	445	398	336	348	374	335	356	338	-2.05
Winter Rice	1978	2565	2693	2760	2713	2671	2594	1950	2239	2866	3214	3649	3298	1.20
Summer Rice	43	183	654	681	653	622	561	630	732	768	860	1028	1080	8.82
Total Rice	2523	3270	3861	3999	3854	3738	3553	2916	3319	4009	4409	5033	4716	1.76
Maize	13.7	14	14	15	14	14	14	14	13	13	14	14	17	0.93
Wheat	118	105	98	86	85	78	54	67	71	55	65	56	49	-3.56
Total Cereals	2658	3393	3978	4105	3957	3834	3621	3001	3407	4079	4492	5106	4784	1.65
Total Pulses	47	49	64	62	66	60	56	59	61	62	66	72	73	1.92
Total Food grains	2706	3442	4042	4167	4023	3894	3680	3060	3468	4142	4557	5178	4857	1.65
Total Oilseeds*	112	169	143	155	151	144	110	129	135	137	143	155	152	-0.50
Sugarcane	-	1522	1155	988	1011	916	871	856	1055	980	1062	1076	1053	-1.74
Cotton#	-	-	1	1	1	1	1	1	1	1	1	1	1	0.00
Jute	912	866	657	668	675	691	680	579	559	657	647	626	608	-1.67
Tea[a]	305130	392392	451236	453587	433327	434759	435649	487487	502041	511885	487497	499887	480286	0.97
Rubber[b]	-	110	-	2580	2700	2750	3050	4750	6395	5097	9832	10213	10950	24.49
Total non-foodgrain	-	-	3781	3646	3626	3474	2988	3396	3430	3587	3779	3858	3967	0.23

Note: *excluding Coconut, a: in '000 Kg, b: in MT, # '000bales of each 170 kg. @ CAGR in 2011-12/1990-91 in %.

Source: Directorate of Economics and Statistics, Assam and Directorate of Agriculture, Assam

Rice production in the state increased from 2523 thousand MT in 1980-81 to 5033 thousand MT in 2010-11 with some fluctuations. Trend of autumn rice production gradually declined contrary to increase in summer rice production which was due to both increase in area and yield. While production of wheat decreased from 118 thousand MT in 1980-81 to 49 thousand MT in 2011-12, production of total pulses gradually increased

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from 2006-07 and it reached to 73 thousand MT in 2011-12. Production of total foodgrains gradually declined from 4,167 thousand MT in 2000-01 to 3,060 thousand MT in 2006-07 and then started rising. Production of oilseeds in the state also decreased from 169 thousand MT in 1990-91 to 155 thousand MT in 2010-2011, while the production of jute decreased from 912 thousand bales in 1980-81 to 640 thousand bales in 2011-12. A significant improvement took place in the production of rubber in the state as in national average where production reached in 10950 MT in 2011-12. Rubber is a crop which we shall study in detail. The CAGR of production of autumn rice, wheat, oilseeds, sugarcane and jute in Assam becomes negative during the period from 1990-91 to 2011-12 while summer rice and rubber production growth rate was significant during the period. One of the basic causes for slow growth of agricultural production in the state is the low rate of yield compare to all India. Table 1.19 reveals comparison of yield rates of different crops in Assam and all India.

Table-1.19: Yield Rate of certain crops in Assam and India: (in kg/ha)

Years	State/ Crops	Total rice	Wheat	Maize	Total Cereals	Total pulses	Total Foodgrains	Oil seeds	Jute[a]	Tea	Rubber
1970-71	A	1033	583	547	-	-	988	413	1305	1202	-
	I	1123	1307	1279	949	524	872	579	1186	1201	653
1980-81	A	1109	1158	593	1128	416	1073	480	1463	1501	-
	I	1336	1630	1159	1142	473	1023	532	1245	1478	788
1990-91	A	1310	1284	626	1067	428	1266	530	1632	1693	-
	I	1740	2281	1518	1571	578	1380	771	1833	1794	1076
2000-01	A	1568	1279	722	1394	540	1073	515	1730	1685	1580
	I	1901	2708	1822	1844	544	1626	810	2026	1673	1576
2004-05	A	1408	1066	724	1271	571	-	529	1830	1603	-
	I	1984	2602	1907	1903	577	1652	885	2186	1713	1750
2005-06	A	1446	1074	721	1282	537	1430	465	1836	1603	1854
	I	2102	2619	1938	1968	598	1715	1004	2362	1713	2000
2006-07	A	1412	1132	778	1251	557	1285	495	1744	1622	1848
	I	2131	2708	1912	2020	612	1756	916	2342	1667	1800
2007-08	A	1549	1268	722	1354	558	1501	523	1976	1610	1431
	I	2202	2802	2335	2151	625	1860	1115	2260	1705	1299

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2008-09	A	1635	1090	724	1616	567	1570	542	1939	1593	1449
	I	2178	2907	2414	2183	659	1909	1007	2207	1695	1306
2009-10	A	1765	1087	726	1738	560	1686	530	1967	1513	1511
	I	2125	2839	2024	2075	630	1798	958	2492	1695	1211
2010-11	A	1983	1179	722	1957	555	1894	582	1808	1782	1329
	I	2239	2989	2540	2256	691	1930	1193	2344	1695	1211
2011-12[b]	A	1874	1135	684	1933	560	1792	564	1669	1709	1272
	I	2372	3140	2476	2396	694	2059	1135	2422	1695	1211

Note: A: Assam; I: All India Average; Yield rate of rubber is calculated as production in kg divided by tapping area

[a] lakh bales

[b] 4th Advance Estimates

Source: Economic Survey, 1980-81, 2000-01, 2010-11, 2011-12 & 2012-13; Agricultural Statistics At A Glance 2012, Statistical Hand Book of Assam 1992, 2002, 2010; Economic Survey, Assam, 2012-13,

It is evident from the table 1.19 that yield rates of all major crops in Assam are considerably lower compared to national average. More distressing is the fact that the gap in yield levels between Assam and the national average has widened for all the crops reported till 2008-09. Barring one or two crops, rubber being one, the yield per hectare of crops in Assam has been much lower than the all India (Saikia, 2014). Table 1.20 shows the CAGR of agricultural area, production and yield under major crops in Assam and all India during 1990-91 to 2011-12.

Table-1.20: CAGRs of Area, Production and Yield of major crops in Assam and all India during 1990-91 to 2011-12:

Crops	Growth rate of area (in %)		Growth rate of production (in %)		Growth rate of yield (in %)	
	Assam	India	Assam	India	Assam	India
Autumn Rice	-3.69	-	-2.05	-	1.69	-
Winter Rice	0.19	-	1.20	-	1.01	-
Summer Rice	5.95	-	8.82	-	2.16	-
Total Rice	0.04	0.14	1.76	1.63	1.72	1.49
Maize	0.04	1.87	0.98	4.26	0.42	1.53
Wheat	-3.47	1.01	-3.56	2.57	-0.59	2.36
Total Cereals	-0.06	-0.14	1.65	1.93	2.93	2.03
Total Pulses	0.74	0.20	1.92	0.85	1.29	0.87
Total Foodgrains	-0.02	-0.11	1.65	1.85	1.67	1.92

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Total Oilseeds	-0.52	0.44	-0.50	2.27	0.30	1.86
Sugarcane*	-0.29	1.54	-1.74	1.90	-0.65	0.35
Cotton	-5.61	2.41	0.00	6.28	-	3.79
Jute	-1.77	0.00	-1.43	1.46	0.11	1.34
Tea	0.92	1.95	0.97	1.71	0.04	-0.23
Rubber*	4.78	1.62	14.04	4.78	-5.24	0.80

Note: * CAGR calculated during 2004-05 to 2011-12

Source: Calculated by the author from data on agricultural production, Statistical Handbook of Assam various issues and Economic Survey India, various issues.

Compound annual growth rate of area under most of the major crops except pulses and rubber in Assam during the period 1990-91 to 2011-12 are lower than national level. It is also lower in production compared to all India, while exception was seen in case of rice, pulse and rubber. Though the area growth rate of rice in Assam was lower than the national average, CAGRs of total rice production and yield in Assam were higher (1.76% and 1.72% respectively) than the national level (1.63% and 1.49%) due to good performance of summer rice. However, CAGRs of area and production of wheat, oilseeds, sugarcane and jute in Assam were negative. In case of pulses, growth rate of area, production and yield in Assam were higher than the national average. In case of total foodgrains, like national average area growth in Assam was also negative but growth rate of production and productivity in Assam were lower than all India average. Although the growth rate of productivity of jute is positive but it is very low in comparison to all India. Unlike this, the CAGR of rubber production during the period 2004-05 to 2011-12 in Assam was remarkably high, 14.04 percent compared to 4.78 percent at national level.

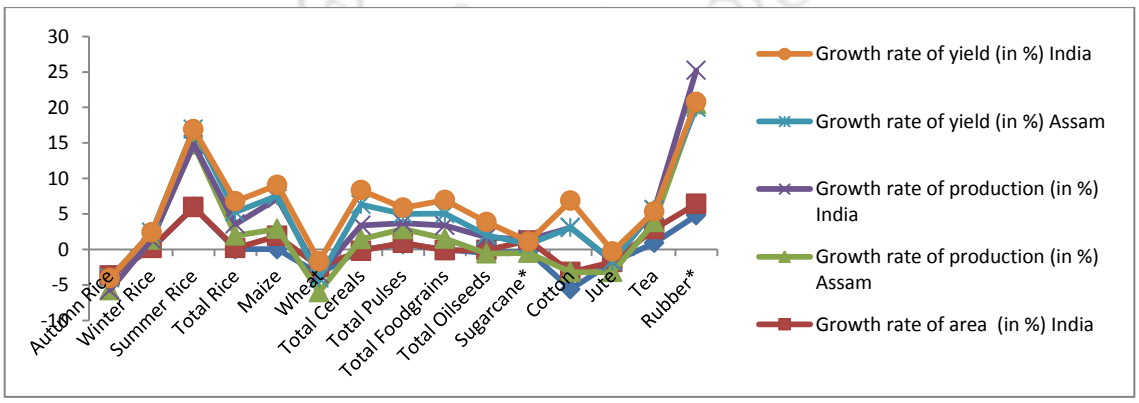

Fig.1.7: CAGRs of Area, Production and Yield of major crops in Assam and all India.

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The state level time series of indices of area, production and productivity for all crops, food crops and non-food crops are the most appropriate data series for assessing the overall growth performance of crop sector (Dholakia and Dholakia, 1993). The two tables 1.21 and 1.22 show the index of production, area and yield of foodgrains and non-foodgrains of Assam and India. The index of all commodities scaled the level of 126 in Assam while it was 192 in India in 2011-2012, although in 1980 Assam was much ahead of India (125 compared to 102).

Table-1.21: Index of Agricultural Production in Assam and India from 1980-81 to 2011-12:
(Base: Triennium ending 1981-82=100 & Base: T.E. 2007-08=100.)

Year	Assam			India		
	Foodgrains	Non-foodgrains	All Commodities	Foodgrains	Non-foodgrains	All Commodities
1980-81	123	132	125	105	97	102
1990-91	144	131	138	144	156	148
1991-92	142	143	142	138	159	146
1992-93	144	142	143	144	164	152
1993-94	148	149	148	150	170	157
1994-95	146	154	150	156	181	165
1995-96	150	157	153	146	185	161
1996-97	148	157	153	161	201	176
1997-98	149	161	155	156	183	165
1998-99	143	158	151	165	198	177
2000-01	174	162	168	158	178	166
2001-02	169	160	164	172	190	179
2002-03	164	166	165	140	166	150
2003-04	170	162	166	172	201	183
2004-05	152	154	153	160	206	177
2005-06	155	148	153	169	230	192
2006-07	128	156	142	176	241	200
2007-08	145	161	153	187	247	207
2008-09	174	167	170	190	221	193
2009-10*	131	107	121	159	144	160
2010-11*	149	106	130	179	170	185

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2011-12*	141	109	126	188	175	192

N. B. The Agricultural Indices for Assam are constructed only on the crops covered by the Crop Forecast. Figure rounded to nearest zero. *Base: T.E. 2007-08=100.

Source: (i) Economic Survey, Assam, 1996-97, 2000-01, 2007-08, 2010-11, 2011-12 & 2012-13, Govt. of Assam
(ii) Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India

Table-1.22: Index number of Area and Productivity for foodgrains, non-foodgrains and all commodities in Assam and India from 1980-81 to 2011-12: (Base: Triennium ending 1981-82=100 & Base: T.E. 2007-08=100)

Year	Index of Area						Index of Productivity					
	Assam			India			Assam			India		
	Food grains	Non-food grains	All commodities	Food grains	Non-food grains	All commodities	Food grains	Non-food grains	All commodities	Food grains	Non-food grains	All commodities
1980-81	120.8	124.9	121.8	99.8	99.4	99.7	124.9	113.4	114.9	105.1	99.2	102.9
1990-91	111.6	121.0	113.7	100.7	120.0	105.2	121.7	105.0	112.7	137.8	128.0	133.8
2000-01	114.7	119.7	115.8	95.4	127.0	102.7	151.4	135.5	145.0	152.8	133.2	144.4
2001-02	110.5	119.4	112.5	96.7	127.0	103.9	141.7	110.7	138.5	164.1	139.1	153.3
2002-03	110.3	116.8	111.8	89.7	116.1	95.8	136.5	113.8	134.2	143.2	124.7	135.0
2006-07	95.6	111.6	99.2	97.5	143.0	108.0	122.6	114.2	118.0	180.4	169.9	185.8
2007-08	101.0	116.4	110.1	97.7	144.7	108.6	130.7	106.2	115.9	191.1	170.9	190.6
2008-09	107.1	117.2	115.3	96.8	147.8	108.6	146.9	101.1	126.1	196.1	149.4	177.6
2009-10	109.7	122.1	118.6	95.6	144.3	106.9	158.3	112.0	136.6	184.7	142.9	168.3
2010-11*	110.9	121.4	119.4	104.4	113.8	109.0	176.4	114.23	139.8	197.4	170.7	194.1
2011-12*	108.7	111.9	107.6	104.3	115.5	109.8	128.9	97.8	117.6	114.0	112.2	113.0

Note: * Base Triennium Ending 2007-08=100

Source: (i) Statistical Hand Book Assam 2010; (ii) Economic Survey, 2012-13

Index of agricultural productivity in Assam in 2012 (base triennium ending 2007-08=100) was 117.56 while in all India it was 113. The index number of area of rice in Assam (triennium ending 1981-82=100) was higher than national index. But the production and productivity indices of rice in Assam was lower than the all India. In case of jute, though Assam has a prominent place in jute production, indices of area, production and productivity of jute in the state was quite low compared to all India indices (see appendix Table I.6).

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1.6.1: Agrarian Structure in Assam:

There are two types of agricultural farming prevailing in Assam viz., peasant agriculture and capitalist (tea and partly rubber plantation) agriculture. However, Assam has no extreme mode of production, i.e., neither pure capitalist (landlord capitalism) nor poor peasantry. The peasant agriculture is more important from the point of its contribution to workforce engaged. Lerche (2013) said "All types of peasant agriculture are becoming uneconomical under the corporate food regime and land reforms have made this aspect worse." Compared to capitalist farming, the peasant agriculture in Assam is handicapped by all sorts of constraints - natural, technological and socio-economic. The mode of production in pre-colonial Assam is described as semi-tribal, semi-feudal (Guha, 1991). In Assam due to prevalence of *ryotwari* system of tenancy in most part of the state except Goalpara and a small portion of Cachar district there was no competition for land in the last century, and hence the concentration of land ownership in a few hands did not develop as seen in other parts of the country. The problem of exploitation of cultivators by the landlords is therefore, not acute in Assam as in other parts of the country (Deka, 1984).

In the colonial rule, the agrarian property structures in Assam were multiform and varied. There were two broad groups of landholders - (i) those who were settled for special cultivation, i.e., the tea planters (mostly British-owned corporate bodies) and (ii) those who were settled for ordinary cultivation. Though capitals flowing into tea plantation have been immensely profitable for the planters, this had a limited impact on the larger peasant economy of Assam. However, land alienation, commercialization and indebtedness process have started with infusion of merchant capital and immigration of peasants from East Bengal. In the colonial state, in search of new means of revenue collection merchant capital had penetrated the peasant economy. The interests of the merchants have given birth to a novel complex of surplus exaction. Thus, agrarian economy of the state became more market-driven and it was characterized by high indebtedness, rising incidence of landlessness and tenancy. The vestiges of tribalism were wearing off and it was transformed into a semi-feudal mode of surplus production (Das and Saikia, 2011). The average size of owned holdings per household was small in the peasant sector estimated at about five to five-and-a-half acres. The incidence of land revenue fell heavy on the peasants, since its demand was hardly met by them out of a

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real surplus. It was at the time of paying the land revenue and in lean months that the cultivators borrowed from the traders, landlords and rich peasants.

Sharecropping tenant cultivation has been historically as one of the most important semi-feudal forms of surplus extraction in rural Assam. A sizable portion of the state rural farm population is still engaged in share tenancy.

Moreover, agrarian structure in Assam is characterized by inequality in the distribution of landholding-owned and operated. The increasing trend in the number of ownership and operational holdings, marginalization in the size of operation holdings, sub-division and fragmentation of land holdings, decreasing trend in the proportion of holdings with partly or wholly leased-in land, etc. are reported to be the main features of the existing agrarian structure. These have serious impact on the agricultural production and productivity of the state (Saikia, 2014). Agricultural production is affected not only by the monsoon and other natural calamities like flood, drought, etc., but also by the technological and socio-economic factors. Low level uses of modern inputs in agricultural operations, low investment in agriculture, lack of credit facilities, lack of irrigation facilities, inadequacy of ground water harvesting infrastructure, poor rural road connectivity, lack of post-harvest processing, shortage of cold storages, inadequate marketing system, poor extension services, etc. are said to be the main factors plaguing the agricultural situation of the state. Goyari, (2005) states “So far as irrigation system is concerned, reportedly there are 2095 numbers of big and small irrigation plants in the state, but interestingly only 75 numbers are in running condition. As regard the use of fertilizers, though it has grown over time, our farmers applied only 74.40kg per hectare against Indian average of 137kg per hectares. On the other hand the cold storages in the state bring about setback in agricultural production, as there are only 22 cold storages which also cannot be run smoothly due to disruption of power." Irrigation Minister, Govt. of Assam stated in the state assembly on 11th Feb, 2014 that a total of 204 minor irrigation projects have been lying defunct and are beyond repair in the state. In addition, 182 minor irrigation projects and a medium irrigation project are non-functional, but can be repaired (The Assam Tribune, February, 2014). Consumption of electricity for agricultural purposes in Assam was only 32.00 million KWH or 0.98 percent of total electricity consumption in 2009-10. But it was 40.29 percent in Haryana, 39.42 percent in Rajasthan, 33.46 percent in Punjab, 34.21 percent in Karnataka and in all India level it was 20.98 percent during the period (Agricultural Statistics at a Glance, 2011-12 and

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Central Electricity Authority, New Delhi). Only about half of the paddy cultivation in Assam is using HYV seeds, with very little change observed over the last two decades.

Contrary to peasant agriculture, capitalist agriculture is found in tea estates which were mostly owned by Kolkata based planters or corporate leaders of the country who were alleged to exercise exploitation for appropriation of surplus value. In rubber plantation of Assam some sort of capitalist mode of production and some society formed cultivation is developing which is yet to evaluate its performance. Thus, notwithstanding such factors, it may be worthwhile to examine whether the existing agrarian structure and relations in the state is conducive to agricultural development through the utilization of potentiality of agricultural land in terms of crop productivity (Saikia, 2014).

In the literature review section we discussed different research work and secondary data pertaining to Indian and Assam agriculture to compare the status of Assam agriculture with rest of India. This would help to frame the basis of present research work.

1.7: Research Problem and Objectives:

1.7.1: Research Gap:

From the review of existing literature it is observed that there is a need to analyze different aspects of agricultural production in Assam in recent decades. At national level agriculture analysts and economists like Vyas (1978, 2001, 2011), Hanumantha Rao (2001), Kapila (1997, 2005), Bhalla and Singh (2000, 2009), Basole and Basu (2009, 2011), Chand (1999, 2009), Ray (2007, 2010), Vaidyanathan (2010), Reddy (2012, 2014), Sen (2006, 2011), Tripathy (2015), etc. have discussed the recent trends of Indian agriculture with a special focus on major agriculture producing states of the country. In case of Assam not much analysis has been seen on the recent deceleration of agricultural production. Policies adopted in different aspects of agriculture followed in the mainland India may not be fit for the state for its distinctive geophysical features and historical isolation from rest part of the country. Moreover, there is a dearth of field level study on one recently popularized public sponsored crop, rubber plantation in the state. Against this backdrop, a research has been undertaken to study the agricultural production in the state in recent decades and it has been induced by the necessity to fill the gap. For limitation of time we shall focus on some select crops.

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Growth rate of agricultural production in Assam has been going down in the last couple of decades like the rest of the country. Productivity in many crops in the state is less than agriculturally advanced states as well as national average. Input use in Assam agriculture is much less than in many other agriculturally advanced states as well as national average. Although many factors might be responsible for poor growth of output over these years it is not feasible to analyze the causes of the decline which happened years ago from the field data collected at present. From the data collected from our primary survey we can analyze the relation between the agricultural productivity and the various underlying factors. This may give us hints as to why the growth rate of agricultural production has been low in the recent decades. Thus, the question boils down to - "what factors are responsible for the low yield of agricultural production in Assam?" If we can identify the reasons of low productivity at present then those reasons can be addressed to get high growth of agricultural yield and output.

Among the factors responsible for agricultural backwardness we emphasized on the role of irrigation facilities, credit facilities, and extension services in agricultural production in Assam with special reference to three select crops namely, rice, jute and rubber. These factors whenever applicable will be given special emphasis, aside for other special factors for specific crops. Inadequate supply of irrigation, credit and extension services might have an adverse impact on yield of the crop. From the review of existing literature, it is identified that these three facilities are not adequate for the farmers and could not support much on agricultural production in the state.

It is observed that in agriculturally developed states, Indian farmers mostly invest in irrigation; share of expenditure on irrigation to total expenditure is more. The new agriculture technology is mainly dependent upon quality of irrigation. Bhattarai and Narayanamoorthy (2003) have empirically shown that improvement in irrigation and rural literacy are the two most important factors for agricultural growth in India. Assam has a long non-rainy dry season. So assured irrigation during non-rainy dry *rabi* season is very much essential for cultivation. There is an ample scope for extension of summer rice cultivation in the state, but for that irrigation facilities should be available. Secondly, credit is required in agriculture because input needs to be bought. Credit is treated as one of the indicators of the adoption of modern technology in agriculture (Nath, 1969). The adoption of fertilizer use is somewhat lower among small farmers than among large farmers owing mainly to credit constraints. Inadequate formal credit is one of the

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constraints in the state which caused low agricultural production in Assam (Goyari, 2007). Thirdly, extension services is something which can't be bought, it is a public good. Government expenditure on research and extension is the key factor behind growth in total factor productivity in Kenya (Mathur et al., 2007). With the introduction of new technology, new farming practices and development of information technology with its wide application in farming, extension services become important in agriculture sector. In Assam large-scale agricultural extension services were inadequate. Rao (2005a) analyzed agricultural growth in India from the first decade of the plan period and suggested the continued need for provision of irrigation facility, strengthening of extension services, adequate supply of institutional credit to raise farm productivity and profitability. These three factors responsible for low agricultural development in the state are significant from the point of that these are economic and technical factors rather than nature dependent. On natural factors we have less control, but we have the capacity to improve the facilities of irrigation, credit and extension services to raise production in the state.

1.7.2: Objectives and Research Questions:

The objective of the research is to decipher the factors behind the low productivity of agriculture in Assam in general for three important crops of the state viz., rice, jute and rubber. We shall examine the performance of the agrarian economy of Assam in the context of the all India agricultural trends keeping in mind the changes that have been taking place both at regional and at national level. We hope to arrive at some policy prescriptions for the immediate and long run agricultural development after having finished the exercise. While analyzing the field data from the state we can statistically estimate the underlying production function for the crops. This can be done either assuming a simple OLS (ordinary least square) production function, or by the stochastic frontier model where one allows for the possibility of technical inefficiency at the farm level. These exercises will give us a clue as to what factors have been responsible for low productivity. Finally, the thesis intends to spell out policy prescriptions.

Thus, the objectives and corresponding research questions of the study are pin pointed as follows:

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1. To analyze the performance of agriculture in Assam compared to the national average and other agriculturally developed states in India. The focus is on the three select crops, viz., rice, jute and rubber. Secondary data and the existing literature will be used.
   [Research Question: What has been the performance of agriculture in Assam compared to the national average and other agriculturally developed states, especially in regard to the three select crops?]

2. To collect primary field data on the three crops in order to estimate the underlying production functions.
   [Research Question: What is the nature of the underlying productions functions of these three crops?]

3. To estimate the production functions of crops, allowing for stochastic technical inefficiency.
   [RQ: What are the estimates of production functions if technical inefficiency is accounted for? Does technical inefficiency exist?]

4. To spell out policy implications for the immediate and long run agricultural development.
   [Research question: What could be some policy prescriptions for the three crops?]

1.8: Crop Selection and Brief Description:

The research work has confined itself within the study of production of three important crops in Assam, viz., rice (the most important, traditional food crop), jute (declining but important fiber cash crop) and rubber (non-traditional, ascending plantation crop). Rice and jute are the main economic crops in Assam. The select three crops have great significance in the state agriculture and bear a special position in western Assam which is our study area.

Why these Crops?

Rice: Rice is the staple crop of Assam. Share of rice in total cereals consumed in rural Assam is 95 percent and in urban area it is 89 percent (Govt. of India, 2006d). It

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occupies the largest share of total cropped area. The soil, topography, rainfall and climate of the state in general are suitable for cultivation of paddy crops which occupied 91.46 percent of the NCA and 61.8 percent of the GCA in the state during the year 2010-11. The average area covered for normal paddy cultivation during the year was 25.46 lakh hectares or about 92.82 percent of the total area under foodgrains in the state in 2011-12 (Economic Survey, Assam, 2012-13). Rice is grown extensively in all the districts of the state throughout the year. However, the average productivity of rice in the state is lower than national average; Assam produces only1874kg per hectare compared to 2372kg per hectare in India. The yield differences show fluctuations from year to year. But underlying such year to year fluctuation, a tendency of widening of the yield gap over the years is visible (Saikia, 2014). Moreover, there has been a gradual decline in respect of area cultivated under autumn rice.

Jute: Jute is an important fiber cash crop grown in Assam occupying about 1.5 percent of total cropped area in 2010-11 (Economic Survey, Assam, 2012-13). Among the states of India producing jute, Assam is the third largest producer accounting for 7.87 percent of its total area and 6.68 percent of its total production in the country (Raja, 2012) with the yield of 16.69 quintals compare to 24.22 quintal per hectare in India.

Assam has favourable agro-climatic condition for the cultivation of jute. Dhubri, Kokrajhar, Bongaigaon, Goalpara, Barpeta, Nalbari, Kamrup and Nawgaon districts contribute about three-fourth of the state's production. Cachar, Darrang, Sibasagar and Lakhimpur districts are other important producers. However, area under jute in the state has gradually declined from 1.05 lakh hectares in 1980-81 to 66 thousand hectares in 2011-12. The share of the state's jute producing land in all India declined from 10.9 percent in 1980-81 to 7.22 percent in 2009-10. Similarly, production of jute in the state also declined from 912 thousand MT in 1980-81 to 640 thousand MT in 2011-12. State's share of jute production in all India has also declined from 11.11 percent to 6.63 percent during the period 2000-01 to 2008-09. It becomes significant to investigate in depth the decline of jute cultivation in Assam.

Rubber: An important and recently popularized plantation crop in Assam is rubber. Although rubber is a non-traditional crop in Assam, its plantation is getting momentum in the state as we have seen above. Particularly in western part of Assam rubber

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plantation has been taken as an occupation by unemployed youths. Assam has a large potential area of 2,00,000 hectares out of which 32 thousand hectares were planted in 2011-12 (The Rubber Board, 2012). During 2008-09, percentage share of Assam in all India of rubber plantation area was 3.58 percent and production share was 0.74 percent. The prospective areas for rubber plantation in the state are Goalpara, Kamrup, Dhubri, Kokrajhar, Baksa, Chirang, Bongaigaon, Nagaon, Karbi Anglong, Darrang, Cachar and Karimganj districts and selected pockets of Lakhimpur, Sivasagar, Jorhat and Dibrugarh districts. It is pertinent to study rubber cultivation in the state as it is converting uncultivated land to farm land and adding to the total cropped area and crop production in the state.

Unlike declining popularity of wheat, autumn rice and jute, rubber cultivation is gaining its popularity in the state due to congenial argo-climatic condition and its remunerative eco - friendly activity. However, the demand for the natural rubber grown in the state is basically derived from outside of the state. So the question arises at this moment whether the growers of this non-food crop are protected enough with assured market for their produce in future.

In a nutshell, rice is the main crop in the state though low in yield; jute was once popular but now declining, though still an important crop for the state while rubber is an emerging crop with high growth.

Fig.1.8: Map of Assam demarcating six agro-climatic zones.

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1.9: Data Sources and Methodology:

For the secondary data the period of study is approximately confined to the last three and a half decades from 1980s to 2016. Data related to the various aspects of the study have been collected from different sources. In the collection of secondary data following variables were the primary consideration-

-growth rates and indices of agricultural production, area and yield,

-use of agricultural inputs,

-agricultural land use and land holding pattern,

-cropping pattern,

-policies, extensions, reforms, etc.

Secondary data related to pattern of land utilization, land holding and its distribution in different crops, production and productivity of crops, input uses, institutional support and extensions in different crops, indices of area, production and yield of crops, etc. at the national and state levels have been collected. Books, thesis, reports, journals and periodicals and research articles formed the preliminary source of data, which can help to build theoretical background of the study. Various official reports, records and publications of World agencies like FAO, World Development Report, World Bank, Asian Development Bank, IRRI; national agencies like the Census of India, the Agriculture Census, Government of India Economic Survey, NSSO, CSO, ISAE, CACP, Department of Agriculture and Co-operation, Ministry of Food and Agriculture, Planning Commission, RBI, ICAR, IASRI, The Rubber Board of India, University Libraries and state agencies like Directorate of Economics and Statistics, Govt. of Assam, Directorate of Agriculture, Assam, Department of Planning & Development, Govt. of Assam, Regional Agricultural Research Stations, etc. forms the main source of data. District level data on area, production and yield of different crops have been obtained from the Director of Statistics & Economics, Govt. of Assam and hosts of cross sectional and time series data on variety of items. To review literature and collect study materials I have visited different data sources like Ratan Tata Library, Delhi University; CACP Library, Shastri Bhawan, New Delhi; Library of IIT, Guwahati;

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Krishna Kanta Handrique Library of Gauhati University, Guwahati; Directorate of Extension Education, AAU, Jorhat and Library of NEDFi, Guwahati; Regional Rubber Research Institute, Guwahati; Directorate of Land, Requisition, Acquisition and Reforms, Govt. of Assam, Guwahati; Library of Assam Secretariat, etc. Data on Jute production in Assam are collected from FAO; Director of Statistics & Economics, Govt. of Assam; Jute Corporation of India; publications of NEDFi, Guwahati. Relevant data on rubber cultivation are obtained from the Rubber Board of India; Rubber Grower's Companions; Regional Offices of Rubber Board, Agia, Goalpara and Kajalgaon, Chirang; Rubber Growers' Societies; successful rubber planters, etc.

The primary data have been collected from the farm households of two districts of Lower Brahmaputra Valley Agro-climatic Zone, viz., Goalpara and Bongaigaon by a pre tested questionnaire to fulfill the objectives and address the research questions.

1.9.1: Field Study Area and Justification:

Primary data of the sample agricultural households and their agricultural activities have been collected from two districts of western Assam viz. Bongaigaon and Goalpara.[10] These two districts are selected for field study because both districts are included in the same Agro-climatic Zone of Assam that is in Lower Brahmaputra Valley. Lower Brahmpaputra Valley zone was selected because it is the only zone where all three crops are cultivated in large number. Besides it is the largest producer of rice and rubber in the state. The climate, topography, socio-economic and agricultural practices of the districts are almost similar. In these districts the three select crops are cultivated. Both the districts are included in the heavy rainfall belt of Assam (Taher and Ahmed, 2005) which is favourable for cultivation of these crops. During the season Lower Brahmaputra Valley Zone receive 1000-3100mm of rainfall (Ahmed et al., 2011). In spite of these similarities, a significant difference in yields of the crops between the districts has been observed. While in productivity of rice, Goalpara district is considerably higher than the state average, but Bongaigaon district is in below the Goalpara and slightly above to the state average. Productivity of rice in Goalpara is 16 percent greater than Bongaigaon in

[10] A district is the basic planning and administrative unit in India. Mahanta (2003) by an econometric analysis of regional disparities in agricultural development in Assam classified Goalpara and Bongaigaon districts as developing along with other four districts in Assam. He classified agricultural regions as very developed, developed, developing and backward.

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2013-14. However, in productivity of jute and rubber, Bongaigaon district is in better position than state average and Goalpara district as well. Although Goalpara has been cultivating jute and rubber extensively since long ago its yield is lower than state average. The study intended to enquire the causes of these differences in yield. Whether differences in input use are sufficient to explain the difference? Or did administrative efficiency between the districts cause variation in the yields? This is the reason we selected two adjoining districts so that "other factors remain the same" – other than the fact that administrations are different, and yet one gets different agricultural performance. So, one purpose was also to check if district administrations do matter in improving performance. There is a rich literature of such work where neighbouring states or regions are compared, including Banerjee et al., (2002), Gupta et al., (2014).

1.9.2: Methodology:

The study is based on both primary and secondary data. Secondary data give an idea about some characteristics of agricultural production in Assam and India. Sometimes these data might not be sufficient to fulfill the objectives of the study. Hence, primary data have been collected to fulfill the stated objectives. Appropriate statistical tools are used to understand the trends and patterns of agricultural production and those trends and patterns are empirically and analytically studied. The results are represented with the help of tables and graphs. The relationship between the use of modern inputs and productivity levels is studied in a quantitative manner and examining the association between the two through regression analysis.

The primary data were collected by carrying out the field study by sample survey method. Before going to the final field study, we have been undertaken a pilot survey. Simple random sampling and purposive sampling method were adopted during the selection of sample. The samples of the growers at the village level have been selected by using a simple random sampling. The sample size for winter rice, jute and rubber are 184, 115 and 102 respectively. Detailed discussion on methods adopted in field study and selection of sample is cited in Chapter VI. Two separate questionnaires have been framed to collect data from growers as well as from district agriculture office. The data are collected on *Kharif* season of 2015 and 2016. After collection of data and compilation and tabulation necessary statistical tools and statistical software STATA

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version 8.2 are employed for finding results and for analysis of data. Individual farm household in the field study was a unit of observation.

1.10: Structure of the Thesis:

The thesis is organized into eight chapters including the introduction. The first chapter of the thesis contains a general background of the topic of the research. This chapter also includes a detailed review of relevant literatures; relevant secondary data of all India and Assam. The objectives and research problem of the study, data sources and methodology adopted in the study are presented in this chapter. Chapter two discuss in detail, agricultural production conditions in Assam, land use pattern, land reforms and tenants' rights, input use and cropping pattern in Assam. Chapter three, four and five concentrate on different aspects of production of three select crops viz., rice, jute and rubber. Chapter six discuss district profiles and the field data gathered during field survey. Chapter seven discuss the estimation of production functions of three crops select. Finally, Chapter eight discuss on major findings, recommendations and conclusions. Bibliography and appendix and annexure are enlisted at the end of the thesis.

Table-1.23: Chapterization of the Thesis:

Chapters	Title of the Chapters	Contents
I	Introduction and Review of Literature	Motivation of the study, review of literature, analysis of secondary data pertaining to Indian and Assam agriculture, research problem, objectives, justifications, data sources and methodology, etc.
II	Agricultural Production in Assam: An Overview	General description of Assam Agriculture, land use pattern, land holding, input use, land reform, cropping pattern, etc.
III	Rice Production in Assam	Production of rice and its different aspects
IV	Jute Production in Assam	Production of jute and its different aspects
V	Rubber Production in Assam	Production of rubber and its different aspects
VI	District Profiles and Field Data	District Socio-economic Profiles and performance of District Agriculture in Goalpara and Bongaigaon; analysis of the Field Data
VII	Estimation of Production Functions and Technical Inefficiency	Farm size productivity relation, Production Function-CD production function-OLS and Stochastic Frontier Model Estimation
VIII	Summary of the Findings, Policy Prescriptions and Conclusion	Summary of major findings, policy recommendations, limitation and conclusion
References and Bibliography Appendix Annexure		

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Chapter-II: Agricultural Production in Assam: An Overview

This chapter would like to offer a brief overview of the state and current agricultural production condition of Assam. As an agriculture dependent economy, it is necessary to discuss natural, physical, institutional, economical and technological aspects of agricultural condition of the state.

2.1: General Description:

The economy of Assam is primarily a rural-based one where more than 85 percent of the population lives in the rural areas and their main occupation is agriculture. Despite undergoing a sectoral transformation, over 70 percent population of the state gets their means of livelihood from agricultural sector and provides employment to more than 53 percent of the work force in Assam (Govt. of Assam, 2011). According to Economic Survey, Assam, 2014-15, share of employment in agriculture sector in Assam in 2009-10 was 63 percent compared to 52 percent in India. Agriculture and allied sector contribute more than 20 percent to the State Domestic Product in 2014-15 (Economic Survey, Assam, 2014-15). The Total Cropped Area (TCA)[11] in the state has increased marginally from 39.26 lakh hectares in 1991-92 to 41.74 lakh hectares in 2011-12. The Net Cultivated Area (NCA)[12] was 28.11 lakh hectares (or 35.80% of total geographical area and 67.56% of total cropped area) in 2011-12. The area sown more than once (within the year) recorded 13.63 lakh hectares in 2011-12 and the percentage of area sown more than once to net area sown in the state increased from 41.2 percent in 1991-92 to 48.51 percent in 2011-12 (Economic Survey, Assam, 2014-15). The average size of operational holding in the state is 1.10 hectares and more than 83 percent of the farmers are small and marginal farmers (Agricultural Census, 2010-11). However, cropping intensity has increased from 141.17 percent in 1991-92 to 145.8 percent in 2009-10 (Economic Survey, Assam, 2014-15). Land under still water and water logged area jointly constitute 1.78 lakh hectares or 2.27 percent of total geographical area of the state. About 23 percent of the net sown area of the state is either flood or drought prone. Area covered by

[11] Gross cropped area is net area sown plus area sown more than once.

[12] Net area sown is net operational area. It is not necessarily the area available for cultivation which can be greater as it will include area available but not used.

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horticultural crops in Assam was 5.40 lakh hectares (13.6% of Gross Cropped Area, GCA) during 2004-05. The percentage of area under irrigation is only about 15 percent of the GCA and 20.7 percent of NCA (Directorate of Economics & Statistics, GoI, 2004). On the other hand, area of foodgrains under irrigation in Assam was only 4.6 percent in 2010-11 compared to 47.8 percent in India. The soil, topography, rainfall and climate in Assam are quite suitable for cultivation of rice which occupies about 25.46 lakh hectares or nearly 62 percent of the TCA and more than 93 percent of the total area under foodgrains in the state during 2011-12. In terms of output in the North Eastern Region, more than 70 percent of rice, about 70 percent of foodgrains, 83 to 89 percent of sugarcane, about 80 percent of rapeseed and mustard, 55 to 65 percent of potato and more than 90 percent of jute output are from Assam (Goyari, 2005).

Even though the state is richly endowed in natural resources, growth of agriculture production in Assam has been slow over the decades. The growth in gross cropped acreage and cropping intensity, however, has not translated into rapid growth in output. The all crop index of agricultural production in Assam has grown by less than one percent per annum (average over 1992-93 to 1998-99), in comparison with an average growth of about 2.7 percent per annum at the all India level over the same period.[13] Consequently in comparison to other states of India, Assam is not able to produce adequate agricultural commodities to cope with its domestic requirements. Until the early years of planning (till the nineteen sixties), Assam was a food surplus state, but due to excessive growth of population and, the slow rate of growth in agricultural production, Assam is now categorized as a food deficit state (Das, 2012)

2.2: Geographical Location, Climatic Pattern and Seasonal Characteristics of Assam:

Assam is located in North-Eastern part of India between $24^0 08' 10'' N$ and $27^0 58' 15'' N$ latitudes and $89^0 42' 05'' E$ and $96^0 01' 14'' E$ longitudes (approx.). It is bounded by two foreign countries, Bangladesh and Kingdom of Bhutan (about 532 kilometers of international boundary) and seven north eastern states of India. Assam occupies a strategically important position. The state is connected to the rest of the country by a small strip of land in its western border (Bardoloi et al., 1986). The total geographical area of the state is 78438.00 sq. km (i.e., about 2.4% of country's total geographical area)

[13] Agriculture and Allied Sectors: Constraints and Policy Options, Department of Agriculture, Assam.

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of which 77667.99 sq km is rural area and 770.01sq km is urban area and population of the state is 31,169,272 (i.e., about 2.2% of country's population). The rural population of the state is 86 percent of the total population which is much higher than that for India (69%) (Population Census of India, 2011). The state comprises twenty seven administrative districts, twenty five in the plains and two in the hills. There are 56 Sub-Divisions, 184 Revenue Circles, 219 Community Development Blocks, 2202 *Gaon Panchayats*, 26395 Revenue Villages and 214 Towns in the state (Population Census of India, 2011). Few more districts and sub-divisions were recently constituted by the Government of Assam.

The climate of Assam is subtropical characterized by the relative coolness, extreme humidity, and heavy summer rainfall and winter drought. The climate of the Brahmaputra and Barak valley are characterized by hot and wet summer and mild to moderately cold dry winter. Due to its large variation of physiography, the state has a wide variation of climate. In summer, maximum mean temperature goes up to 40^0C, while in winter, mean minimum falls down to 7^0C. Temperature generally varies between 25^0 and 40^0 Celsius, (Dutta, 2011). On an average, the relative humidity is more than 80 percent in almost all the locations of Assam throughout the year (Ahmed et al., 2011). There is both spatial and seasonal variation in the amount of relative humidity in the state (State of Environment Assam, 2004). The state receives 4 hours sunshine/day during *kharif* and 6 hours in *rabi*. Average solar radiation indicates that the radiation interception is only 36-38 percent of the sunshine hours during June to August due to overcast sky while during November to February it is 70-74 percent. During winter months too, the radiation interception is low due to foggy weather (Ahmed et al., 2011). The average rainfall (all seasons) received by the state was 1735.8mm during 2009-10 (Economic Survey Assam, 2010-11) compared to 1212.3 mm average rainfall in India in 2010-11 (Agricultural Statistics at a Glance, 2012). About 70 percent of the total annual rainfall is confined to the months of June, July and August, whereas December, January and February are almost rainless. There is, however, regional variation in the rainfall pattern. As a result, two distinct types of crops can be grown in the state-(1) *Kharif* in the summer months and (2) *Rabi* in the winter months (Das, 2012). This cycle of climatic season has a great bearing on the agricultural cycle of the state.

Considering the variation of temperature, humidity and rainfall, weather condition, etc., the year in Assam is divided into four seasons, viz., (1) Pre-Monsoon, (2)

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Monsoon, (3) Retreating or Post-Monsoon and (4) Dry Winter. The pre-monsoon starts by early March along with the gradual rise in temperature coupled with occasional thunder showers and this season remains up to May. It is a transitional one between the dry winter and wet summer. The occasional rains (20-23% of annual rainfall) of this season are favourable for the cultivation of jute, summer rice and tea. The monsoon season receives maximum amount of rainfall (62-65% of annual rainfall). The South-West Monsoon normally operates for a longer spell in Assam compared to the rest of the country. It starts in Assam by the middle of June and continues up to September. The Monsoon season is the most important period for agricultural activities of the Assamese peasants, since winter rice ('*Sali*' rice) and jute are grown during this period. By the middle of September, South-West Post-Monsoon starts to retreat and is followed progressively by fair weather and morning fogs (6-8% of annual rainfall) towards the end of November. The season is favourable for sowing of *rabi* crops, wheat and pulses. The dry winter season begins at the end of November and continues up to the end of February. The main characteristics of this season are the absence of rainfall (2-3% of annual rainfall), cool weather with low temperature and frequent morning fogs. Irrigation is required for success of *rabi* crops (Das, 2012).

2.3: Physiographic Frame of Assam:

The state has three distinct physiographic divisions - (a) the plains, the Brahmaputra Valley, (b) the plateaus, the Barak or Cachar Valley and (c) the hills, the Hills Region.
The Brahmaputra Valley is an alluvial plain, about 725 km long and about 80 km broad on the average and consists of an area of 56,339 km representing 72 percent of the total area of the state (Das, 2012) with about 85 percent of the state population. The Brahmaputra River flows from the east (Sadiya) to west (Dhubri) with 40 major tributaries while Barak River flows from east to west through undulating plains with 7 major tributaries. The Brahmaputra valley constitutes 22 administrative districts occupying about 5.6 million hectare while the Barak valley is constituted by 3 administrative districts with about 9 percent geographical area or about 0.7 million hectare and 12 percent population of the state. The two hill districts viz. Karbi Anglong and Dima Hasao lying in the middle of the state separates the two valleys. The region covers 19 percent of geographical area or about 1.5 million hectares and only 3 percent of state's total population (Govt. of Assam, 2010; Ahmed et al., 2011). Based on

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topography, climate: rainfall & temperature, soil characteristics and the land use pattern, the whole state has been broadly divided into six Agro-Climatic Zones whereas Brahmaputra valley is sub-divided into four main divisions:

Table-2.1: Agro-climatic zones of Assam and their some basic characters:

Agro-Climatic Zones	Districts included	Geographical Area (Sq.km.)*	NSA (ha) in 2003-04**	Average annual rainfall (normal in mm in 2006)	Population (in %)	Main Agricultural Products
North Bank Plain (NBP)	Dhemaji, Lakhimpur, Sonitpur, Darrang and Udalguri	14421 (18.4)	525933 (36.73)	2400.23	16.7	Rice, rape and mustard, sugarcane and tea. Suitable for *Bao* rice (low land rice)
Upper Brahmaputra Valley (UBV)	Tinsukia, Dibrugarh, Sibsagar, Jorhat, and Golaghat	16013 (20.4)	608571 (37.58)	2304.76	22.21	Rice, rape and mustard, sugarcane, tea.
Central Brahmaputra Valley (CBV)	Nagaon and Morigaon	5561 (7.1)	325880 (58.88)	1884.8	11.5	Rice, jute, rape, pulses and mustard.
Lower Brahmaputra Valley (LBV)	Kamrup, Goalpara, Dhubri, Kokrajhar, Bongaigaon, Barpeta, Nalbari, Baska and Chirang	20222 (25.8)	907598 (45.05)	2483.51	34.7	Rice, jute, rape and mustard, potato, wheat, pulses and rubber.
Barak Valley (BV):	Cachar, Hailakandi, and Karimganj.	6962 (8.9)	229811 (33.20)	3336.26	11.7	Rice, sugarcane, potato, jute and rubber.
Hills (H)	Karbi Anglong and Dima Hasao	15222 (19.4)	154808 (10.10)	1122.2	3.2	Rice, potato, maize, sugarcane and rubber.

Note: *Fig. in parenthesis represent % share of different zones in total geographical area of the state; ** Fig. in parenthesis represent NSA as % of total geographical area;

Source: (i) Ahmed et al., 2011; (ii) Statistical Hand Book Assam; (iii) Author.

The agro-climatic zones are highly diverse and hence the pattern of adaptation of crop production system differs across the zones. Highly diverse topographical situations within zones demand wide ranging technological options and thus call for appropriate policy interventions.

2.4: Cropping Season in Assam:

Cropping season in the state can be divided into-

a) Cold weather crops (November and December) consisting of *Aman* rice [14] and sugarcane.

b) Rabi crops are harvested in early summer (February and March). It includes summer rice[15], pulse, wheat, mustard, oil seeds, tobacco, vegetables, etc.,

[14] Winter paddy: Grown during the rainy season of summer and harvested in winter

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c) *Kharif* crops are those which are grown during the rainy season, and are dominated by rice, jute and tea.

2.5: Land Use Pattern and Area under different Crops in Assam:

A study of land use pattern is highly essential in order to quantify the availability of land to be used for production. Since land is a scarce factor, efficient, rational and scientific utilization of it in conjunction with the other inputs, like labour, capital and technology are preconditions for raising agricultural production and productivity in a country or region of a country (Das, 1984; Barman, 1985).

Land use pattern in Assam may be classified into urban land use pattern and rural land use pattern. The later is again sub-divided into nine categories, in line with the recommendation of the Standing Advisory Committee on Statistics, F.A.O. and Mamoria (1972)[16]. The category-wise availability of land is indicated in the table 2.2 below:

Table-2.2: Trend of Land-Use Pattern in Assam (Area in hectares)

Category of Use	1981-82	1991-92	1998-99 (P)	2002-03	2004-05	2007-08	2008-09	2009-10	2011-12
Total Geographical Area according to Surveyor General of India	78.52 lakh	78.44 lakh	7843800	7843800	7843800	7843800	78.44 lakh	7850005	7850005
Total Reporting Area according to Village Papers	78.52 lakh	78.52 lakh	7850005	7850005	7850005	7850005	78.50 lakh	7850005	7850005
Forest Area	19.84 lakh (25.27)	19.84 lakh (25.3)	1930289 (24.6)	1932718 (24.64)	1954012 (24.89)	1853260 (23.61)	1853260 (23.61)	1853260 (23.61)	1853260 (23.61)
Not Available for Cultivation (Total)*	24.53 lakh (31.24)	24.73 lakh (31.5)	2510221 (32)	2533382 (32.27)	2511977 (32)	2434578 (31.2)	26.26 lakh (33.45)	2625545 (33.45)	2620445 (33.38)
(i) Land put to non-agricultural uses	9.12 lakh (11.61)	10.13 lakh (12.9)	1051381	1080570	1064700	1026536	10.30 lakh (13.12)	1026536	1021050 (13.01)

[15] Summer rice: Sown during the winter season and usually it is cultivated on irrigated land. It is less exposed to production risk. As a result, the yield of summer rice is relatively more (Goswami, 2014).

[16] (i) forests, (ii) barren and uncultivable lands. (iii) lands put to non-agricultural uses, (iv) cultivable waste lands, (v) permanent pastures and grazing lands, (vi) lands under miscellaneous tree crops and groves, (vii) fallow lands other than current fallows, (viii) current fallows, and (ix) net area sown. The urban land use, on the other hand, includes the area under municipalities, town committees and other urban areas. This falls under the category of area not available for cultivation (Gopalakrishnan, 2000).

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			(13.4)	(13.78)	(13.56)	(13.1)		(13.08)	
(ii) Barren and uncultivable land	15.41 lakh (19.63)	14.60 lakh (18.6)	14588 40 (18.9)	14528 12 (18.5)	14472 77 (18.44)	14080 42 (17.94)	14.25 lakh (18.15)	14080 42 (17.94)	1408380 (17.94)
Other Uncultivated Land Excluding Fallow Land (Total)	5.36 lakh (6.83)	4.72 lakh (6.02)	48296 0 (6.15)	44525 5 (5.67)	44525 5 (5.67)	40377 1 (5.14)	4.32lakh (5.5)	43243 9 (5.51)	433539 (5.52)
(i) Cultivable waste lands	1.04 lakh (1.32)	1.04 lakh (1.3)	80194 (1.02)	76631 (0.98)	76631 (0.98)	74319 (0.95)	0.77 lakh (0.98)	76631 (0.98)	78031 (0.99)
(ii) Permanent pastures and other grazing lands	1.84 lakh (2.34)	1.65 lakh (2.1)	16696 8 (2.13)	15996 8 (2.04)	15996 8 (2.04)	15643 6 (1.99)	1.58 lakh (2.01)	15996 8 (2.04)	159668 (2.04)
(iii) Lands under miscellaneous trees and groves	2.47 lakh (3.15)	2.3 lakh (2.93)	23579 8 (3)	20865 6 (2.66)	20865 6 (2.66)	17301 6 (2.2)	2.09 lakh (2.66)	19584 0 (2.49)	195840 (2.49)
Total Fallow Land	1.72 lakh (2.2)	1.72 lakh (2.2)	22548 2 (2.87)	18565 6 (2.37)	18578 2 (2.37)	16959 7 (2.16)	1.57 lakh (2.00)	12816 4 (1.63)	132164 (1.68)
(i) Fallow lands other than current fallows,	0.84 lakh (1.07)	0.80 lakh (1.02)	81710 (1.04)	62293 (0.79)	59394 (0.76)	52191 (0.66)	49557 (0.63)	49582 (0.63)	51582 (0.66)
(ii) Current fallows land	0.88 lakh (1.12)	0.82 lakh (1.05)	14377 2 (1.83)	12336 3 (1.57)	12638 8 (1.61)	11740 6 (1.5)	1.28 lakh (1.63)	78582 (1.00)	80582 (1.03)
Land Under Cultivation	-	29.82 lakh (38.0)	-	27.74 lakh (35.33)	-	-	-	-	-
Uncultivated area	-	48.70 lakh(62.0)	-	50.76 lakh (64.7)	-	-	-	-	-
Net Area Sown (NAS)	27.06 lakh (35.1)	27.81 lakh (35.4)	27010 53 (34.41)	27529 94 (35.07)	27529 79 (35.07)	27529 79 (35.07)	28.10 lakh (35.8)	28105 97 (35.8)	2810597 (35.80)
Total Cropped Area (excluding tea)	34.60 lakh (44.07)	39.26 (50.0)	39406 49 (50.2)	39580 65 (50.42)	38963 51 (49.64)	38387 32 (48.90)	39.99 lakh (50.94)	41050 93 (52.3)	4174023 (53.17)
Area sown more than once within the year(% of NAS)	7.54 lakh (27.86)	11.45 lakh (41.1)	12395 96 (45.89)	12050 71 (43.77)	11433 72 (41.53)	10857 53 (39.44)	11.9 lakh (42.35)	12944 96 (46.06)	1363426 (48.51)

Note:*Area under non-agricultural uses

(i) Figure under bracket in percent to Total Geographical Area and in case of area sown more than once it is from NAS

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(ii) Net area sown is net operational area. It is not necessarily the area available for cultivation which can be greater as it will include area available but not used.
(iii) Gross cropped area is net area sown plus area sown more than once.

Source: (i) Statistical Hand Book Assam (2002, 2014), (ii) Economic Survey, Assam (2010-11), (iii) Dhar (2007) (iv) NEDFi DATA BANK (2003) and (v) Percentages calculated by author

The table 2.2 reveals that total geographical area of Assam is estimated at 78.50 lakh hectares. Total area under forest has declined from 19.84 lakh hectares (25.3%) in 1991-92 to 18.53 lakh hectares (23.61%) in 2011-12 while land not available for cultivation has increased from 24.73 lakh hectares (31.53%) to 26.20 lakh hectares (33.38%) during this period due to increase of land in non-agricultural uses. It is seen that there is considerable area under barren and uncultivable land, 14.08 lakh hectares (17.94%) in the state in 2011-12. This land is mainly swamps and hills. Moreover, other uncultivated land excluding fallow land decreased from 6.83 percent in 1981-82 to 5.52 percent in 2011-12. Current fallows and other fallows decreased from 2.2 percent in 1981-82 to 1.68 percent in 2011-12 of the total area in the state. Assam has about 80000 hectares cultivable waste land.

Total land area under cultivation in Assam has decreased from 38.0 percent to 35.33 percent during 1991-2003. And it is declining due to encroachment of human habitation, road and railway network, canals, industries and urban centres and also due to degradation caused by soil erosion and water logging. Net sown area in the state (71.71% of the GCA) has remained almost same while total cropped area of the state has increased little from 50.0 percent in 1991-92 to 53.17 percent in 2011-12.

Since the forest land in the state has already been reduced and it remains below the minimum 33.3 percent of total geographical area of the state, there is no scope for further extension of arable land into the forest land. Most of the barren and uncultivable lands exist in Karbi Anglong and Dima Hasao districts of Assam. In order to render this category of land cultivable, huge cost is necessary. Thus, the scope for extension of area under cultivation in the state is limited and the urgent need is to increase the efficiency of existing resources in the state (Gopalakrishnan, 2000).

From the above analysis, it is amply clear that scope for the physical expansion of land in Assam is limited; the main emphasis, therefore, should be laid on intensification

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of agriculture to increase the productivity per hectare on the existing cultivable area in coming decades (Das, 2012).

2.6: District-wise Variation of Land Utilization in Assam:

The inter-regional and inter-temporal variation in agricultural performances has been a matter of concern in Assam. Table 2.3 offers a list of the districts of Assam having highest and lowest area under different categories.

Table-2.3: District-wise distribution of Land Use Pattern in Assam in 2010-11.

Land-Use Patterns	Districts with highest areas	Districts with lowest areas
Area under forest	Kokrajhar (51.52), Golaghat (44.3), Cachar (36.65), Tinsukia (34.72), Karbi Anglong (30.9), Sonitpur (27.8)[districts having more than 1 lakh ha of forest area]	Nalbari (0), Bongaigaon (0.03), Darrang (0.15), Barpeta (0.25) [districts having less than 1 thousand ha of forest area]
Area not available for cultivation	Dima Hasao (80.47), Karbi Anglong (56.87), Dibrugarh (42.06), Dhemaji (42.3), Jorhat (38.8), Sonitpur (34.54), Tinsukia (30.3) [districts have more than 1 lakh ha]	Hailakandi (10.85), Chirang (16.88), Udalguri (18.18), Morigaon (19.97), Nalbari (26.2),
Other uncultivated land excluding fallow lands	Dhemaji (16.06), Sibsagar (11.22), Goalpara (9.8), Kamrup (9), Dibrugarh (8.91)	Nalbari (3), Lakhimpur (3.12), Chirang (3.18), Dhubri (3.35), Hailakandi (3.7)
Total fallow lands	Darrang (9.83), Bongaigaon (6.1), Dhubri (6), Jorhat (4.3),	Chirang (0.002), Karimganj (0.04), Hailakandi (0.42), Udalguri (0.07)
Net area sown	Barpeta (60.23), Darrang (57.46), Kamrup (57.4), Nagaon (57.33),	Dima Hasao (5.76), Dhemaji (20.8)
Total cropped area	Udalguri (95.2), Lakhimpur (87.86), Darrang (85.3), Goalpara (71.53), Nagaon (70.36),	Dima Hasao (11.5),
Area sown more than once (% of NAS)	Chirang (91.8), Dhemaji (78.1), Nalbari (68.2), Barpeta (66.2),	Kamrup (2.1), Sibsagar (7.2), Dibrugarh (15.4),
Area under multiple crops	Kamrup	Karbi Anglong , Dima Hasao
Water logged Land	Karimganj (4.1), Cachar (3.7), Jorhat (2.5),	Tinsukia (0.003), Hailakandi (0.03), Chirang (0.04)

Note: Figures under parenthesis are the % of total geographical area; % of NAS.

Source: (i) Statistical Hand Book Assam, 2012, (ii) Das (2012)

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2.7: Agricultural Land Use:

Agricultural land use is governed by a number of factors. Initially, there are technical factors which include the natural endowments associated with land in a region. These technical agro-climatic factors determine the production possibility frontiers within which there are several socio-economic, historical factors that guide and govern the actual land use. One important feature revealed by Agricultural Census of the state is that over the successive censuses the total area of operational holdings has been declining (Tamuli, 2014). Agricultural land use in Assam is characterized by a low percentage of cultivable land, extraordinarily high percentage of rice hectareage in the total area sown, low crop intensity and low yields of crops per unit area (Das, 2012).

There has been a very slow increase in area under different crops in Assam over the past three and a half decades. The chief characteristic of the pattern of peasant agriculture in Assam is that foodgrains crops occupy an overwhelming proportion of the total cropped area. About 66 percent (2767000 ha) of the total gross cropped area of the state is occupied by the foodgrains while 34 percent (1392977 ha) by the non-foodgrains during 2010-11. The predominance of foodgrain crops in the state's agricultural fields indicates little commercialization of agriculture in Assam. In recent years some area of the state have been using for cultivation of recently popularized non-food crops like small tea gardens, rubber plantation, floriculture, medicinal and aromatic plants, etc.

Table-2.4: Net sown area and its unirrigated and irrigated components as percentage of operated area for Assam & all India, 2002-03: (Rural)

State	*Kharif* percentage of operated area			*Rabi* percentage of operated area		
	U	I	N	U	I	N
Assam	81	6	87	40	11	51
India	51	36	87	19	38	57

Note: U Unirrigated cropped area; I irrigated cropped area; N Net sown area

Source: NSS Report No. 492

Percentage of unirrigated cropped area both in *kharif* and *rabi* season in Assam was considerably high compared to all India although net sown area was almost similar in 2002-03.

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2.8: Description of Some Major Crops:

Among the agricultural crops of the state, rice occupies a major position accounting for nearly 61.2 percent of GCA and 90.6 percent of NCA in 2011-12. Rice is grown almost entirely on rainfed condition (Bhowmick at el., 2005). It is grown extensively in every districts of the state and its cultivation follows mainly the traditional farming practices. Assam is one of the very few states in India where the peasants are dependent largely on rice cultivation for their livelihood (Das, 2012). Rice production in the state has increased from 1641 thousand MT during 1960-61 to 3270 thousand MT in 1990-91. Further, it increased up to 5033 thousand MT in 2010-11. Thus, there has been almost 3 fold increase in the production of rice over five decades. However, output of total rice recorded an annual growth of only 2.4 percent against the national rate at 3 percent (Goyari, 2007).

Besides rice, wheat and maize are the two other cereal crops grown in the state. But the area under these crops is very small. Wheat is cultivated mainly in undivided Kamrup and Goalpara districts while maize is important in the two hill districts. After the introduction of high yielding varieties of wheat, emphasis was laid on cultivation of this *rabi* crops, but wheat hectareage in the state is very meager. The average wheat hectareage during 2001-02 to 2009-10 represents only 1.6 percent of the TCA. The production of wheat declined from the maximum amount of 118 thousand MT in 1980-81 to just 49 thousand MT in 2011-12. The production of other coarse cereals in the state has not shown much improvement over the last four decades.

Pulses are also important food crops in Assam grown mainly in the districts of undivided Goalpara, Kamrup, Darrang and Nogaon as a winter crop. The areas under all pulses have increased from 1.13 lakh hectares in 1990-91 to 1.32 lakh hectares in 2011-12. Total production of pulses gradually declined from 74 thousand MT during 1998-99 to 73 thousand MT in 2011-12. The total production of foodgrains in the state has shown an increase of 145.83 percent in 2003-04 over 1960-61, whereas at all India level, it has increased by about 214 percent in 2011-12 over 1960-61.

The cash crops grown in the state, each of which occupies more than 1 percent of the total hectareage under all principal crops, are oilseeds, jute, sugarcane, and tea. Production of oilseeds is concentrated mainly in undivided Goalpara, Kamrup, Darrang and Nogaon districts. However, it is declined from 169 thousand MT in 1990-91 to 152

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thousand MT in 2011-12 (Economic Survey, Assam, 2012-13). Jute is the most important fiber cash crop in respect of its contribution to the agricultural economy of Assam. Jute occupied about 1.91 percent of total cropped area (0.66 lakh ha) in 2011-12. The total production of jute, which was 912 thousand bales (1 bale =180kg) in 1980-81 has gradually declined and became 608 thousand bales in 2011-12 (Economic Survey, 2012-13). Cultivation of this crop is concentrated in Nogaon, Morigaon, Kamrup, Goalpara, Dhubri, Kokrajhar, Bongaigaon, Barpeta, Cachar, Lakhimpur and Darrang districts. Due to problem of retting, processing, marketing and rise of alternative crops the area under jute in Assam is declining (Hazarika, 2006; Saikia, 2013). Besides jute, cotton and mesta are the two other fiber crops grown in this state. But their hectareages are not significant.

Sugarcane is grown more or less in all the districts of the state. It is, however, significantly concentrated in the district of Sibsagar, Cachar and Karbi Anglong. The total area under sugarcane cultivation has declined from 1.2 percent of the TCA under the principal crops in 1980-81 to 0.67 percent in 2011-12 and production has decreased from 1522 thousand MT in 1990-91 to 1053 thousand MT in 2011-12. Assam is well known for tea. The Brahmaputra valley is the single largest tea growing area in the World. The total area under tea cultivation is accounting for more than half of the country's total tea area and the tea industry of Assam provides average daily employment to more than six lakh persons. The state has recorded a total production of 480.29 million kg in 2011-12 (Directorate of Economics and Statistics, Assam). In addition to existing big and large tea gardens owned by reputed companies both Indian and multinational the profession of the tea plantation in the state has been taken up by common man as business venture of late (Economic Survey Assam, 2010-11). According to the State Government reports, there are about 70,000 small tea holdings covering approximately 1, 17,000 acres of land in 14 districts in Assam.

Rubber is another important and recently popularized plantation crop in Assam. Percentage share of Assam in all India of rubber plantation area was 5.18 percent and production share was 1.14 percent in 2011-12(P). Besides, other cash crops, viz., tobacco, chilies, ginger, turmeric, condiment and spices, varieties of vegetables and fruits and horticultural crops are also grown in the state.

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2.9: Production Condition:

State agriculture is characterized by small size of landholding and the application of low level of farming technology. The rapid growth of population, its high degree of concentration in the rural areas and their over dependency on agriculture leads to the further fragmentation of landholding and the reduction of per capita availability of agricultural land. According to Basole and Basu (2011), fragmentation of holdings into multiple plots acts as a major drag on the adoption of technological improvements in agricultural production and thereby impedes the growth of agricultural productivity, both of labour and of land. Barooah (2013) focused that in the near future, agricultural system in Assam will also be increasingly challenged by water scarcity and climate change. The gradual development of the other sectors of the economy increases the area under non-agricultural uses, constantly, while growth of NSA as well as GCA remains almost constant or of negligible growth.

Although agriculture is the backbone of the economy of Assam, the production system has been predominantly a rainfed system. Nearly 80 percent of TCA was rainfed signifying that dependency of agriculture on vagaries of nature and vulnerability to risk (Goswami, 1989). The degradation of agricultural land due to soil erosion through surface run off and flood during the rainy season is a very serious and recurrent problem and excessive deposition of silt during the flood on the agricultural field is a common problem in the state. The *Rashtriya Barh Ayoh* has identified 31.05 lakh hectares of flood prone area in the state of which Water Resource Department through implementation of various projects has protected 16.50 lakh hectares of flood affected land (Economic Survey, Assam, 2010-11). Flood is a major cause of instability of agricultural production in the state (Mandal, 2011). In 2008-09, chronically flood prone area and chronically drought prone area in Assam were 475060 hectares (17.58% of the NSA) and 93,817 hectares (3.47% of the NSA) respectively.

Low agricultural income of the farmers of the state is another characteristic of state agriculture. Low net income as the primary reason forcing the farmers to abandon agriculture that has been cited by cultivators of Bongaigaon district during pilot survey. Mehta (2015) stated that "from 1983-84 to 2011-12 the cost of agricultural production increased at a higher rate when the labour cost was included in it. The wage bill for hired workers comprised 26 percent of total cost in 1983-84 and it rose to 36 percent by 2011-12". Barah (2001) estimated that the per capita agricultural income in Assam was Rs.

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1741(at current price). Due to small farm size most of the farmers could not maintain a minimum income unit of land [17] . However, cultivators in Assam are earning comparatively better income from agriculture than the all India average. According to NSSO, 70th Round (2013), average monthly net receipt from cultivation in Assam was Rs. 4211 which was higher than all India average of Rs.3081 but lower than the other high agriculture states, like Punjab (Rs.10862), Haryana (Rs.7867), Karnataka (Rs.4930), and even lower than Arunachal Pradesh (Rs.6647), Meghalaya (Rs.6472). The average value of gross cropped area per hectare in Assam was Rs.3765 as compared to that of Rs.2229 for all India.

Agricultural production is plagued by decline of agricultural land, scattered and fragmented land holding, non-implementation of land reform measures, slow spread of modern technology and use of modern farm inputs like low use of fertilizer, shortage of irrigation facilities, low adoption of HYV seeds, pest attacks[18], shortage of cold storages, inadequate marketing system, recurrent floods and drought conditions, low investment in agriculture, poor infrastructural facilities, ineffective institutional support, less involvement of educated youths, etc. (Goyari, 2005). These constraints lead to high risk and uncertainty, ultimately hindering adoption of high input technology. Agricultural research and development is found to be in a state of neglect in the state.

Sarma (2002) mentioned that the state agriculture is facing multifarious problems both bio-physical and socio-economic. Most of the problems can mainly be attributed to the unique physiography, soil and climatic conditions. Higher rainfall resulting in water logging and floods, low sunshine (or bright) hours, and over cast sky which reduces the photosynthetic efficiency of the HYV and high incidence of diseases and insect-pests, occasional droughts, acidic reaction of soil and water, low soil nutrient status, non-availability of quality seeds of improved varieties in time, etc. are the basic problems during *kharif* crop season in Assam.

The management of vast fallow areas in *rabi* season has been a major policy challenge in Assam. Because, over 80 percent of cultivable areas is kept fallow in *rabi* season. This adversely affects the resource use efficiency in agriculture and thereby the

[17] Khusro, A. M. arrived at some estimates of farm-size of below which a farm is palpably inefficient and uneconomical so long as techniques of production remain at what they are at present. Minimum income units of land represent a size of farm below which its output is too small to maintain the family at a reasonable standard of living.

[18] pest endemic area was 2.23 lakh hectares in 2002-03.

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cropping intensity, land productivity and deteriorates rural livelihood. In the hill districts of Assam, the traditional practice of shifting (*jhum*) cultivation is still the predominant mode of farming. The practice of shifting cultivation is believed to be one major reason for lower agricultural productivity in these districts (Goswami, 2014).

2.10: Cultivation Pattern:

The three important aspects of agricultural land use in Assam are related to extensive cultivation, intensive cultivation and underutilization of cultivable lands. During the period 1961-62 to 1997-98, extensive cultivation had played a minor role in raising agricultural production. Intensive cultivation depends upon the availability of irrigation. But the growth of Gross Area Irrigated (GAI) during the period was negative in all the regions of Assam. This indicates continued negligence in making proper use of cultivable land in the state (Goswami, 2002). Lack of irrigational facilities is the main reason for which multiple cropped areas could not be increased in Assam.

The policy approach recommended by Goswami (2002) is that in order to increase agricultural production, extensive cultivation through land shifts from outside the agricultural sector is neither feasible nor possible. Rather land not available for cultivation has increased from 24.53 lakh hectares in 1981-82 to 26.26 lakh hectares in 2010-11.Thus, increase in agricultural production can be best done through (1) bringing most of the area cultivated under irrigation, and (2) bringing all fallow lands under cultivation of region-specific remunerative crops. The underutilized land have shown negative growth in the state, cultivable waste land has also decreased from 1.04 lakh hectares in 1991-92 to 0.76 lakh hectares in 2010-11. For bringing cultivable waste into cultivated land, heavy investments would be required on its reclamation. Thus, it would be wiser to ensure optimal utilization of fallow lands and reap the benefit of increased production. But the total fallow lands in the state have also been decreasing from 1.72 lakh hectares in 1991-92 to 1.28 lakh hectares in 2010-11.

2.11: Intensity of Cropping:

There are only two ways to satisfy the increasing food and other agricultural demands of the state's rising population: either expanding the net area under cultivation or intensifying cropping over the existing area. Out of the two ways for achieving larger volume of agricultural production, more emphasis should be laid on the latter in Assam

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as the former is not a matter of significance at present because most of the area available for cultivation has already been brought under plough leaving only 0.98 percent of the total area as cultivable waste (Statistical Hand Book, Assam, 2012). The introduction of short duration crops resulted in substantial increases in the intensity of cultivation and hence, increases in GCA in north western states of the country (Bhalla and Singh, 2009). Cropping intensity refers to rising of a number of crops from the same field during one agriculture year. It can be expressed as Cropping Intensity = Gross Cropped Area/Net Area Sown x100.

The total area as a percentage of the net area sown gives a measure of land use efficiency or intensity of cropping. Cropping intensity is 100 if the land has been cropped for only once in a year. The areas where the intensity of cropping is under 130 percent may be called agriculturally weaker areas (Das. 2012). Higher cropping intensity means that a portion of the net area is being cropped more than once during one agricultural year. Cropping intensity is expected to be higher for smaller farms as smaller farms can be expected to use their limited land resource more intensively. With little scope for horizontal expansion of the cultivated area, and the disappearance of fallow land from the agricultural landscape in the state, it would seem imperative that the peasants of Assam should raise more than one crop from the same plot of land to meet the need of increases population. Das, (2012) mentioned that "the small peasants are forced to grow more than one crop in order to get subsistence from their meager plot of land whereas the medium and big peasants in a subsistence farm economy do not feel the necessity of using the land more intensively."

Intensity of cropping is more in those districts where the density of population is higher and the average size of operational holdings is smaller. Das (2012) has attempted to find out quantitatively if there was any significant association between the degree of population pressure and intensity of cropping. The study proved that there exists a significant correlation between population pressure and cropping intensity as increase in rural population leads to the decrease in per capita net sown area and this loss was sought to be countervailed by raising more than one crop from the same parcel of land. Of course the possibility of other physic-economic factors that might be responsible for increasing the intensity of cropping should not be excluded. Das (2012) concludes that, "there will be a real development in agriculture if the intensification is achieved not by the force of population pressure, but by a choice of scientific farming."

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The cropping intensity has direct correlation with assured irrigation which enables farmers to go for multiple cropping and use higher dose of fertilizers and HYV seeds. Besides irrigation, fertilizers, early maturing high yielding variety of seeds, selective mechanization, plant protection measures through the use of insecticides, pesticides, etc. do have a role in affecting the intensity of cropping (Raj, 1962). Duration of crops in the field is also considered as a measure to determine cropping intensity (Dayal, 1978).

The intensity of cropping index of the state as a whole was only 115.57 percent in 1970-71. It has gradually increased and in 2013-14 it becomes 149 percent compared to 141 percent in all India during the period. Table-2.5 shows the trends of cropping intensity of Assam and India since 1970-71.

Table-2.5: Cropping Intensity in Assam and all India:

Years	Index (in percent) in Assam	Index (in percent) in India
1970-71	115.57	118.2
1980-81	128.0	123.3
1981-82	127.6	124.5
1982-83	131.9	123.2
1983-84	132.7	125.7
1984-85	137.9	125.2
1985-86	137.1	126.7
1986-87	134.7	126.4
1987-88	136.7	127.3
1988-89	135.0	128.5
1989-90	138.7	128.1
1990-91	140.3	130.0
1991-92	141.2	130.1
1992-93	141.8	130.1
1993-94	141.1	131.0
1994-95	137.7	131.5
1995-96	141.7	131.2
1996-97	140.8	132.6
1998-99	145.89	134.3
1999-2000	145.9	133.6

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2000-01	146.48	131.1
2001-02	143.62	133.8
2002-03	143.77	131.8#
2003-04	142.83	134.8
2004-05	141.53	135.9
2005-06	-	136.6*
2006-07	139.1	137.6*
2007-08	139.44	138.0*
2008-09	142.3	137.6*
2009-10	145.8	137.2
2010-11	146.06	137.0
2013-14	149.0	141.0

Note: * provisional; # in 2002-03 there was significant decline to gross area sown and net area sown due to decline in net area sown in the state of Andhra Pradesh, Kerala, M.P., Maharashtra, Odisha, Rajasthan, T. N., W. B. and Haryana.

Source: (i) The indices are calculated from the land use data collected from the Department of Agriculture, Govt. of Assam (ii) Agricultural Statistics at a Glance, 2001, Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India, (iii) Fertilizer Statistics, 2011-12, The Fertilizer Association of India, New Delhi. (iv)The Assam Tribune, Nov. 13, 2014

It is an important observation that the index of cropping intensity in Assam is relatively high compared to all India average over the years. However, it is remarkably low in relation to the agriculturally developed states in India. Among the states of India, Delhi has the highest cropping intensity with 209 percent followed by Chandigarh (200%), Punjab (190%), Sikkim (187%), West Bengal (181.3%), Haryana (179%) and UP (143%) in 2009-10 (Statistical Hand Book, Assam, 2012; Statistical Abstract, Punjab, 2011). Cropping intensity in Assam is lower than these states due to vast fallow area in *rabi* season. About half the farmers in the state cultivate and harvest their field only once a year (Govt. of Assam, 2003). In Assam, there is a significant spatial variation in the pattern of cropping intensity at the district level. Except, Dhubri, Bongaigaon, Barpeta, Nalbari, Kamrup and Darrang all the districts of Assam are 'weaker areas' in respect of agricultural economy. Bhowmick et al., (2005) found that within the limits of *kharif* dominated cropping pattern, the cropping intensity was relatively higher in Nagaon than in Golaghat, as land type in Nagaon was suitable for cultivation of more crops such as jute, pulses and other oilseeds than in Golaghat. The crop diversification and expansion of summer rice area seem to improve the cropping intensity to some extent in recent years.

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2.12: Pattern and Distribution of Operational Holdings:

Agricultural production of a region depends largely on the structure of operational holdings[19]. Landholdings per family and the nature of these holdings may affect the economic efficiency of farming (Phukan, 1990). An operational holding may be wholly owned and self operated or wholly leased in or partly owned or partly leased in. But the leased out land must be excluded from the purview of the concept of operational holding. The definition of operational holding by the Food and Agriculture Organization (FAO) of the United Nations includes all land operated irrespective of its location. This means that the entire holding might be in the same village or might be spread over more than one village[20]. Size of land holdings are categorized as follows:

Category of Land Holdings	Size Group (ha)
Land less	<=0.002
Sub-Marginal Holdings	0-0.5
Marginal Holdings	0.5-1.0
Small Holding	1.0-2.0
Semi-medium	2.0-4.0
Medium	4.0-10.0
Large Holding	10.0 & Above

Inequality of landholdings:

According to the Agricultural Census (2010-11), there were 27.2 lakh operational holdings in Assam covering an operated area of 29.99 lakh hectares compared to 27.5 lakh operational holdings with 30.5 lakh hectares operated area in 2005-06. According to NSSO, 70th Round (2013), estimated number of agricultural households in Assam was 34,23,000 which was 65.2 percent of agricultural households as percentage of rural households compared to 57.8 percent in all India. The average size of operational holding in Assam declined from 1.47 hectares in 1970-71 to 1.10 hectares in 2010-11, in spite of increase in operated area from 28.82 lakh hectares to 29.99 lakh hectares during the period. As per the Agricultural Census, 2010-11, the marginal holdings accounted for

[19] An operational holding is defined as the land which is used wholly or partly for agricultural production and is operated as a single technical unit by one person, alone or with others, without regard to title, legal form and size (World Agricultural Census, 1971).
[20] All India Report on Agricultural Census, 1970-71, Govt. of India, Ministry of Agriculture and Irrigation.

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67.32 percent of the total holdings and 25.84 percent of the total operated area. The small holding shared 18.27 percent of the total holdings and 22.91 percent of the total operational area. Semi-medium and medium size holdings shared 14.26 percent of total operational holdings covering 41.85 percent of total operational area. On the other hand, the large holdings constituted only 0.15 percent of the total number of holdings and 9.4 percent of the total operated area in the state in 2010-11(Economic Survey, Assam, 2014-15). Following two tables show the trend of operated holdings and area in the state.

Table-2.6: Trend of change in agricultural holdings, operated area and average size of holding in Assam with all India average since 1970-71: (As per Agricultural Censuses)

Agricultural Census Year	Number of Holdings	Total Operated Area (in'000 ha)	Average Size of Holdings in Assam (in ha.)	Average Size of Holdings in India (in ha.)
1970-71	1964376	2882	1.47	2.28
1976-77	2253654	3079	1.37	2.00
1980-81	2297588	3121	1.36	1.82
1985-86	2419156	3161	1.31	1.69
1990-91	2523379	3205	1.27	1.57
1995-96	2682997	3138	1.17	1.49
2000-01	2712137	3114	1.15	1.32
2005-06	2750114	3049	1.11	1.23
2008-09	2747826	3160	1.15	-
2010-11	2720223	2999	1.10	1.16

Note: Total may not be equaled due to rounding off to nearest zero.

Source: (i) Economic Survey, 2012-13; (ii) CMIE, Report on Agriculture, November 1997, (iii) Agriculture Census, 2010-11,Agriculture Census Division, Ministry of Agriculture and Co-operation, Govt. of India, New Delhi.

There is a gap in the average size of operational holdings between Assam and all India in all the NSS Rounds. The table shows a decreasing trend in the state as well as in all India but the average size in Assam is lower than all India level. Average size of operational holdings in Assam was 0.83 hectare in NSS 26th Round that declined to 0.69 hectare in NSS 59th Round. On the contrary, average size of operational holding declined from 1.25 hectares to 1.06 hectares at all India level in the corresponding periods (see appendix Table II.1). The percentage decrease in the average size of operational holding in the state was 16.87 compared to 15.2 in all India level during NSS 26th to 59th rounds.

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Table-2.7: Category-wise distribution of number of operational holdings and area operated in Assam based on Agricultural Censuses:

Year	Number of operational holdings (in lakh)						Area operated (in lakh ha.)					
	Marginal	Small	SM	Medium	Large	all Size	Marginal	Small	SM	Medium	Large	all Size
1970-71	11.20 (57.03)	4.70 (23.9)	2.74 (13.95)	0.90 (4.58)	0.10 (0.51)	19.64 (100)	5.09 (17.66)	6.61 (22.9)	7.57 (26.27)	5.21 (18.08)	4.34 (15.06)	28.82 (100)
1976-77	13.43 (59.66)	5.09 (22.6)	2.96 (13.15)	0.96 (4.26)	0.07 (0.31)	22.51 (100)	5.93 (19.27)	7.18 (23.3)	8.08 (26.25)	5.28 (17.15)	4.31 (14.00)	30.78 (100)
1980-81	13.63 (59.4)	5.22 (22.8)	3.13 (13.64)	0.92 (4.01)	0.05 (0.22)	22.95 (100)	5.83 (18.7)	7.48 (23.9)	8.59 (27.54)	4.87 (15.6)	4.42 (14.17	31.19 (100)
1985-86	14.51 (59.98)	5.46 (22.6)	3.22 (13.3)	0.92 (3.8)	0.08 (0.33)	24.19 (100)	5.83 (18.44)	7.81 (24.7)	8.68 (27.46)	4.87 (15.41)	4.42 (13.98)	31.61 (100)
1990-91	15.5 (61.43)	5.78 (22.9)	3.0 (11.89)	0.91 (3.61)	0.04 (0.16)	25.23 (100)	6.07 (18.94)	7.84 (24.5)	9.18 (28.64)	4.92 (15.35)	4.04 (12.61)	32.05 (100)
1995-96	16.69 (62.21)	5.62 (20.9)	3.51 (13.08)	0.96 (3.58)	0.05 (0.19)	26.83 (100)	6.21 (19.79)	7.7 (24.5)	9.24 (29.44)	4.95 (15.77)	3.28 (10.45)	31.38 (100)
2000-01	16.99 (62.62)	5.61 (20.7)	3.52 (12.97)	0.96 (3.54)	0.05 (.18)	27.13 (100)	6.63 (21.3)	7.3 (23.2)	9.58 (30.76)	4.89 (15.70)	2.74 (8.8)	31.14 (100)
2005-06	17.53 (63.7)	5.91(21.48)	3.2 (11.63)	0.83 (3.02)	0.05 (0.18)	27.52 (100)	7.60 (24.93)	7.18 (23.6)	8.46 (27.75)	4.27 (14.00)	2.98 (9.77)	30.49 (100)
2010-11	18.31 (67.29)	4.97 (18.3)	3.03 (11.17)	0.85 (3.12)	0.04 (0.15)	27.20 (100)	7.75 (25.84)	6.87 (22.9)	8.18 (27.27)	4.37 (14.57)	2.82 (9.4)	29.99 (100)
%increase /decrease*	(+) 63.48	(+) 5.74	(+) 10.95	(-) 5.6	(-) 60	(+) 38.5	(+) 52.26	(+) 3.93	(+) 8.06	(-) 16.12	(-) 35.02	(+) 4.06

Note: S M: Semi Medium; Figures are rounded up; Figure in bracket indicates percentage of household and area per household; * % increase/decrease in 2010-11 over 1970-71.

Source: Directorate of Economics and Statistics, Govt. of Assam.

From the table 2.7 it is seen that both the number of holdings and operated area of marginal and small size class increased from 1970-71 to 2010-11; number of holdings and area operated under semi-medium has also increased till 2000-01 and thereafter decelerated. Area operated under medium holdings decreased from 5.21 lakh hectares in 1970-71 to 4.37 lakh hectares in 2010-11. Numbers of holding and area operated under large holdings also decreased during the period. The distribution of operational holdings in the state is uneven. Holdings are also highly fragmented and situated in different

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places making difficult to use modern technology, wastage of labour, time and other inputs and hence less suitable for efficient cultivation.

Table-2.8: Comparison in percentage distribution of Operational Households and Operated Area by size categories in Assam with all-India from 1970-71 to 2010-11 (Rural)

Size Class	State	Operational Holdings						Operated Area					
		1970-71	1980-81	1990-91	2000-01*	2005-06*	2010-11	1970-71	1980-81	1990-91	2000-01*	2005-06*	2010-11
Marginal	A	57.03	59.39	61.43	62.65	63.74	67.31	17.66	18.69	18.94	21.29	24.93	25.83
	I	51.0	56.4	59.4	62.9	64.8	67.0	9.0	12.1	15.0	18.7	22.2	22.2
Small	A	23.94	22.75	22.91	20.7	21.49	18.28	22.93	23.98	24.46	23.45	23.55	22.91
	I	18.9	18.1	18.8	18.9	18.6	17.9	11.9	14.1	17.4	20.1	20.9	22.1
Semi-Medium	A	13.95	13.64	11.89	12.96	11.57	11.17	26.27	27.54	28.64	30.76	27.75	27.27
	I	15.0	14.0	13.1	11.7	10.9	10.1	18.5	21.2	23.2	24.0	23.9	23.6
Medium	A	4.58	4.00	3.61	3.52	2.98	3.08	18.09	15.62	15.35	15.71	13.95	14.58
	I	11.2	9.1	7.1	5.5	4.9	4.3	29.7	29.6	27.1	24.0	23.1	21.2
Large	A	0.1	0.05	0.04	0.05	0.06	0.04	15.05	14.17	12.61	8.79	9.77	9.40
	I	3.9	2.4	1.6	1.0	0.8	0.7	30.9	23.0	17.3	13.2	11.9	10.9

Note: * Excluding Jharkhand; A: Assam, I: India

Sources: (i) Author calculated from table nos. 2.6 and 2.7; (ii) Agriculture Census 2010-11, Agriculture Census Division, Department of Agriculture & Co-operation, Ministry of Agriculture, Govt. of India.

Table 2.8 gives a comparative statement of the percentage distributions of operational households and operated area owned by five broad size-classes in Assam and all-India from 1970-71 to 2010-11 as obtained from Directorate of Economics and Statistics, Assam, Agriculture Censuses and NSSO Land Holding Surveys. In Assam, the large and medium holdings, at the top 4.68 percent bracket, owned 33.14 percent of the total land in rural area in 1970-71, their share declined to 3.04 percent and 23.72 percent respectively in 2005-06. But in 2010-11, medium and large holdings increased to 3.12 percent and their land area also increased to 23.98 percent. On the other hand, considering the country as a whole, the large and medium holdings, at the top 15.1 percent bracket, owned 60.6 percent of the total land (rural) in 1970-71, their share declined to 5 percent and 32.1 percent respectively in 2010-11. At the bottom, the proportion of marginal holdings increased from 57 percent to 67 percent and operated area increased from 17.66 percent to 25.83 percent from 1970-71 to 2010-11 in Assam (Economic Survey, Assam, 2014-15) while in all-India; marginal holdings increased from 51 percent to 67 percent and operated area from 9 percent to 22 percent respectively during the period. Thus, percentage of marginal holding in Assam is almost same with India but operational area under marginal holding in Assam is more than all India level.

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The process of marginalization of holdings has been witnessed by all the states in the country though the extent of marginalization varies from state to state. Inequality of land ownership in Assam can be understood by studying the evolution of the average size of holdings by ownership size-classes which are shown in table 2.9.

Table-2.9: Class-wise average size of operational holdings (area owned per household) in Assam and all India: (in ha.)

Size-Classes	State	Average Size of Operational Holdings								
		1970-71	1976-77	1980-81	1985-86	1990-91	1995-96	2000-01*	2005-06*	2010-11
Marginal	A	0.45	0.44	0.43	0.40	0.39	0.37	0.39	0.43	0.42
	I	0.40	-	0.39	-	0.39	0.40	0.40	0.38	0.38
Small	A	1.41	1.41	1.43	1.43	1.36	1.37	1.30	1.22	1.38
	I	1.44	-	1.44	-	1.43	1.42	1.42	1.38	1.42
Semi-Medium	A	2.76	2.73	2.74	2.69	3.06	2.63	2.73	2.66	2.69
	I	2.81	-	2.78	-	2.76	2.73	2.72	2.68	2.71
Medium	A	5.78	5.5	5.29	5.29	5.41	5.15	5.22	5.13	5.15
	I	6.08	-	6.02	-	5.90	5.84	5.81	5.74	5.76
Large	A	43.4	61.57	88.4	55.25	101	65.6	53.02	60.92	65.69
	I	18.10	-	17.41	-	17.33	17.20	17.12	17.08	17.37
All size classes	A	1.47	1.37	1.36	1.31	1.27	1.17	1.15	1.11	1.10
	I	2.28	-	1.84	-	1.55	1.41	1.33	1.23	1.16

Note: * Excluding Jharkhand; A: Assam; I: India

Source: (i) Calculated by the author from the table nos. 2.7 and 2.8; (ii) Agriculture Census, Census division, Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India.

Table 2.9 shows that the area per household in the marginal class has gradually declined from 0.45 hectare in 1970-71 to 0.37 hectare in 1995-96 and it increased by a little. The average size of marginal land holdings in Assam is bigger than that of in all India. The average size of large operational holdings in Assam has increased from 43.4 hectares in 1970-71 to 65.69 hectares in 2010-11 whereas in all India it has decreased.

The pattern of land holding in Assam varied from place to place especially in between the plain and the hill areas. While some districts such as Cachar, Dibrugarh, Sibsagar and Lakhimpur have bigger size of land holding. The average size of land holding in Karbi Anglong and Dima Hasao has been relatively larger. This was mainly

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due to the terrain conditions, low density of population and the prevalence of *jhum* cultivation (Gopalakrishnan, 2000).

The values of Gini's co-efficient (a measure of skewed distribution of land) cited in table 2.10 indicate the changes in the degree of concentration in the distribution of operational holdings in Assam and all India over the decades. There was a falling tendency of Gini's co-efficient of concentration of operational holdings in Assam and the all India since 1970-71 and in Assam the co-efficient was lower than all India average. In Assam, the co-efficient decreased from 0.5321 in 1970-71 to 0.4094 in 2010-11 whereas in all India it has decreased from 0.6205 to 0.5399.

Table-2.10: Gini's co-efficient of operational holdings of Assam and India based on different agricultural censuses:

Agricultural Censuses	Assam	All India
1970-71	0.5321	0.6205
1976-77	0.5298	0.6141
1980-81	0.5676	0.6052
1985-86	0.5341	0.5925
1990-91	0.5442	0.5805
1995-96	0.4563	0.5610
2000-01	0.5128	0.5513
2005-06	0.5149	0.5489
2010-11	0.4094	0.5399

Source: Calculated by the author

It is seen that the distribution of operational holdings is relatively less skewed than distribution of ownership holdings. Lorenz curve for the ownership holdings distribution has also more or less remained unchanged between 1961-62 and 2003. High incidence of landlessness and marginalization of landholdings pose a threat to livelihood security of rural poor households. About 79.6 percent households at the bottom own only 23.0 percent of the total area, while 3.6 percent households have land above 4 hectares own 34.7 percent of the total area.

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Landlessness and the Land Acts:

Landlessness among farmers is another characteristic of Indian agriculture. The NSSO (2006a) defines landless households as only those households which own less than 0.002 hectare or less than 0.05 acre or less than 0.15 *bigha* of land. Owning less than 1 acre as 'effective landless'. According to 59th Round of National Sample Survey (NSSO, 2006b), nearly 6.6 percent of the rural households in India don't own any land, while about 3.4 percent households own on average 0.002 hectare only. These two categories of rural households are generally categorized as landless. Table 2.11 reveals the changes in proportion of landless households in rural Assam and India as estimated by the survey of NSSO.

Table-2.11: Changes in proportion of landless households in Assam and all-India (Rural)

State/Year	Percentage of landless households					
	1961-62	1971-72	1982	1992	2003	2013
Assam	-	25.0	7.5	13.4	8.1	7.42
All-India	11.7	9.6	11.3	11.3	10.00	7.41

Source: NSS 59th Rounds (2003) and (2013).

Surprisingly landless families in rural Assam significantly declined after 1970s.[21] The percentage of landless households in Assam has decreased from 25.0 to 7.42 as decreased in all India percentage from 9.6 to 7.41 during the period from 1971-72 to 2013. However, average area owned per household in rural Assam was 0.551 hectare, if landless households are excluded, it was 0.599 hectare while in rural India these figures were 0.725 hectare and 0.806 hectare respectively in 2003 (NSSO). The Assam Fixation of Ceiling of Land Holding Act, 1956 was vigorously enforced in entire plain districts of Assam and land ceiling was fixed at 50 *bighas* (16.6 acres or 6.7 ha) per family in 1970. Surplus land acquired under Ceiling Act was distributed for various purposes and some lands were also distributed to the people and as a result landless families in Assam were decreased significantly (Brahma, 2013). Moreover, the decision to grant ownership under the Rights of Tenant's Act, 1971 entitled the Bengali refugees of the early 1950s, who

[21] In view of the 1970 land policy the government of Assam in collaboration with the *Panchayat* (a village level administrative body) undertook a survey of landless persons during early 1970s and it reveals 622295 landless persons in Kamrup in 1969 included in three different categories. First, persons having no land numbered 228833; next, persons having 1.65 acres numbered 285984; and lastly, persons having 1.65 to 2.64 acres numbered 107568 (Baruah, S. N., Rural Economy of Assam (art.), The Assam Tribune, March 8, 1972).

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had been mere *bargadars*, to become land owners in the 1970s. So the numbers of landless households in the state decreased after 1970s. Another important factor that contributed to decline of landless families in Assam was the impact of the Assam *Bhoodan* Act, 1965 which provided the basis for regulation, distribution and settlement of *bhoodan* land. In pursuance of this Act, nearly 12000 acres of land were donated of which 928.85 acres could be distributed among 856 landless families (Directorate of Land Requisition, Acquisition and Reforms, Assam).The Government Land Policy 1968 and 1989 encouraged *Gramdan* and *Bhoodan* movement in the state. Besides, the implementation of Minimum Need Programme and Rural House Sites Scheme from 1974-75 for rural landless agricultural workers also reduced landless families in the state.

Tenancy in Assam:

An unequal situation of the rural poor in accessing land through ownership may be partly improved if they are able to lease in land from large and medium farmers. The NSSO (2013) show that about 14 percent rural households in India lease in land which accounts for nearly 12 percent of the total area owned. Out of total leased in area, 74.2 percent are operated by marginal, small and semi-medium farmers. The large farmers share only 11.2 percent of the total leased in area (Haque, 2005).

Tenancy is an important agrarian institution in Assam and a sizeable portion of the state rural farm population is engaged in share tenancy. The historical pervasiveness and the persistence of tenancy have widely been noticed in the state. The evolution of the institution of tenancy can be traced back to the land revenue system in Assam (Goswami, 1962). Share tenancy is more prominent among small and medium size group of farmers in Assam. The main factors influencing share tenancy, from the point of view of the tenants are insufficient land to meet the farm family need and surplus labour. More than sufficient land, labour shortage and managerial problems are the reasons for leasing[22] out the land by the big land owners. Moreover, indivisible and non-tradable inputs, nature of crops grown, area under irrigation, absenteeism of land owners, inferior quality of land, land not suitably located, etc. also determine the magnitude of tenancy (Barman and Das, 2005). The existing share cropping arrangement is still a major factor influencing the

[22] Land Lease: Granting of the right to use a piece of land to others, either on rent or free, by the owner without transferring the title. In the land holding surveys of NSSO, hereditary tenancy and long-term lease for 30 years or more are not treated as land lease---they are treated as land ownership. On an average, a tenant holding included about 0.7 hectare of leased-in land during 2002-03.

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economic performance of the share tenants. In many cases the tenants discriminate between their owned plots and share cropped plots. The share tenants mainly prefer output sharing ratios on a 40:60 and 25:75 basis. In Assam plains, sharecropping in the form of half share of the produce was the principal form of tenancy. This system is known as *Adhi* and the share croppers are known as *Adhiars*. Table 2.12 shows the share tenant holdings and share of area leased in from 1961-62 to 2002-03 in Assam with comparison to all India.

Table-2.12: Percentage of tenant holdings and operated area leased-in for Assam and India: (Rural)

State	Percentage Share of Tenant Holdings						Percentage Share of Area Leased in					
	1961-62	1971-72	1981-82	1991-92	2002-03	2013	1961-62	1971-72	1981-82	1991-92	2002-03	2013
Assam	-	-	12.9	10.1	8.9	7.04	-	-	6.4	8.9	5.3	4.5
All India	23.5	25.7	15.2	11.0	9.9	13.65	10.7	10.6	7.2	8.3	6.5	11.62

Note: (i) Tenant holding stands for an operational holding with wholly or partly leased in area; (ii) Data for 2002-03 relate to the *Kharif season*

Source: Report No.492, NSS 59th Round, 2003; NSS 70th Round, 2013.

The results of the 59th round reveals that both percentage of tenant holdings and percentage of operated area leased in for rural Assam and India are declining during the period of 1971-72 to 2002-03. According to NSSO data, in 2002-03, only 9.9 percent tenant holdings with 6.5 percent of operated area in all India and 8.9 percent tenant holdings with 5.3 percent operated area in Assam was under tenancy. Tenancy holding and share of leased in area in India have increased to 13.65 percent and 11.62 percent respectively in 2013 but in Assam both the share of tenant holdings and leased in area decreased. Percentage of households reporting leased out land is also less in Assam (1.78%) compared to all India (3.26%) in 2013 (NSS 70th Round Report, 2013).

The NSSO landholding surveys classify tenancy contracts relating to leased in land into the following categories: (a) Fixed Money lease, (b) Fixed Produce lease, (c) Share of Produce lease, (d) Service Contract lease, (e) leased from Relatives, (f) Share of Produce along with other terms. Among the forms of tenancy contract, share-cropping is predominant, i.e., the shares of produce lease (Basole and Basu, 2009) (see appendix Table II.2).

Most of the contracts for share cropping and for kinds of rent are verbal. Further, land-owners change tenants frequently to frustrate the provisions of laws (Phukan, 1990).

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After share cropping, it is 'fixed money' term which has also been reported as the common form of tenancy in Assam. The incidence of tenancy in land leasing in Assam is lower than all India level. Table 2.13 compares the distribution of land leased out in terms of lease in Assam with India.

Table-2.13: Percentage distribution of area leased-out by terms of lease: 2002-03 and 2013

State	For Fixed Money		For Fixed Produce		For Share of Produce		Other terms		All	
	2002-03	2013	2002-03	2013	2002-03	2013	2002-03	2013	2002-03	2013
Assam	20.47	10	0.00	24	38.71	52	40.82	14	100	100
India	31.04	28	15.30	12	39.55	38	14.11	22	100	100

Source: (i) Govt. of India (2006), Household Ownership Holdings in India, 2003, NSS Report No. 491, (ii) NSSO, 70th Round Report (2013).

2.13: Land Tenure System in Assam:

The growth in productivity of agriculture depends mainly on two sets of factors- improvement of farm technology and favourable reforms in the existing system of cultivable land holdings. Among the technological factors, the use of better agricultural inputs and methods can help to raise productivity. The institutional factors, on the other hand, include the redistribution of land ownership in favour of the cultivating classes so as to provide sense of participation in the rural life, improving size of farm, and providing security of tenure by removing the feudal relations, regulation of rents, etc. which act as incentives among the cultivators to raise the farm productivity.

Regarding the land tenure system in Assam, the Assam Agriculture Commission stated that, "The present land tenure system and agrarian structure in Assam is not conducive to increase agricultural output. The land is not owned by the cultivator and a large portion of the cultivated area is on lease. Such a system leads to exploitation and no medium or long term land improvement measures are feasible. Unless tenurial security is ensured to the tenant farmers and rents are reasonable, even adoption of improved technology often becomes difficult."[23]

Report of the National Sample Survey on land holding in North East India (1953-54) indicated the overwhelming importance of tenant farming in this part of the country.

[23] Report of the Assam Agriculture Commission, Government of Assam, State Planning Board, Assam, June 1975. p. 99

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Of the tenant farmers, 67.8 percent constitute non-land-owning cultivators and 21.7 percent land-owning cultivators. Cultivators take on lease more than six times the area of their own land. Majority of tenant farmers are share-croppers (*Adhiars*) and they paid rent in kind to 50 percent or more of the produce, and that only a very few of them paid cash rents. Because of the fear of eviction tenants do not object to the high rate of rent paid in kind but at the same time no motive to improve methods of cultivation is deployed (Report of the Assam Agriculture Commission, 1975).

Mishra and Howbora (1990) observed that institutional factors play an important role in determining agricultural productivity and land utilization in the study area. The subsequent section discusses about the land tenure system and the land reforms adopted in Assam.

2.13.1: Origin of Land Tenure System and Land Reforms in Assam:

There is no reliable record on land tenure system in Assam before the Ahoms came into the region. Ahoms introduced a system known as "*khel*", according to which the whole population was divided into a number of *khels*, each comprising 1000 to 5000 adult persons. Each *khel* was again subdivided into '*Gots*', each '*Got*' consisting of four persons called '*Paiks*'(the individuals who had taken land from the King) or '*Raiyats*'(Das, 2012). In return of services rendered to the state or the king, a *Paik* was granted two '*puras*' (8 *bighas*[24] or 1.07 hectares) of '*rupit*'(paddy) land along with some plots of land for housing and gardening called '*bari*' (orchard) at free of rent (Sheikh, 1994). If a *Paik* cultivated any rice land in excess of his 2 *puras*, he was assessed to Re.1/- per *pura* (Das, 2011).

The Ahom kings used to make extensive grants of land to temple, *satras*, idols, priests, officers of the state and charitable institutes. In such gifts and grants, the kings alienated the proprietary rights in favour of the grantees. These lands were generally exempted from payment of revenue and were cultivated by '*Paiks*' attached to them. '*Paik*' system of revenue administration was introduced during the regime of King Pratap Singha in 1607 A.D. (Mali, 1984).

The British government brought in drastic changes in the existing land relation. During the British regime in Assam an agency for collection of land revenue was

[24] 1 *bigha*=0.13387 hectare

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brought into force in the year 1833, and each district was divided into some *mouzas* and members of commission agents, called *mouzadars*, were appointed for collection of tax from all the residents of *mouzas* (Bhagabati, 1990). Under the state ownership of land there existed three distinct types of land tenure in the state, namely (1) *La-khiraj* grantees, who could hold land without paying revenue (Free-Simple Estate holders), (2) *Nisf-khirajdars*, who could hold land by paying half revenue knows as landholder [Nisf-khirajdars were found only in 5 districts of Upper Assam (Das, 2011)] and (3) Settlement holders of land on annual lease basis. *La-khirajdars* enjoyed higher status from the British than the other two classes and were known as 'proprietors' (Dhar, 2007).

Some of the features of the existing land tenure in Assam are legacies of the pre-British and British period. The land tenure system was not uniform all over the state. Gangopadhyay (1990) said that "the different portions of Assam Province were formerly quite distinct and have different histories. They were brought under the British administration by stages. Land tenure systems in the different territories were therefore not uniform". Depending upon the rights and privileges enjoyed by the land holders, the land tenure system prevalent in the plain districts of Assam may be distinguished by two types: *Zamindari* and *Ryotwari* systems[25]. Owing to some historical reasons, the *Zamindaryi* system was prevalent in a few places in Assam, which was to some extent similar to the system prevalent in West Bengal and Uttar Pradesh (Daimari, 2008). Permanently settled estates were found only in the old districts of Goalpara and in the Karimganj sub-division of Cachar district and foothills of the Garo hills. The rights of the proprietors (*Zamindars* were proprietors as defined in the Land and Revenue Regulation of 1886 (Das, 2012)) have been acquired by the state Government under the Assam State Acquisition of *Zamindaries* Act, 1951. So, this class of proprietors has now completely disappeared (Das, 2011). In *Rytowari* system, the occupiers of relatively small independent holdings paid revenue directly to the Government. Excluding Goalpara and Karimganj the land tenure system remained all along under the rules of temporary settlement and thereby governed by the Assam Tenancy Act, 1935 which was amended subsequently in 1948, 1953 and in 1956, so as to confer important rights of land on tenants.[26] In the two hill districts of Assam, there was no private ownership of

[25] While *ryotwari* system was prevalent in other parts of the state, *zamindai* system was followed in Goalpara district and Karimganj sub-division.

[26] Under Assam Tenancy Act, 1935, a tenant means a person who holds land under another person who is landlord and would be liable to pay rent for that land to the latter. The Act recognizes four classes of

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land except in the plain areas of Karbi Anglong. All the lands of a village were collectively owned by the tribal community of that village.

2.13.2: Land Reform Measures introduced in Assam and their Effects:

The land reform measures were adopted by the Government of Assam to remove the defects and exploitative character of the land tenure system, which prevailed in the state prior to its independence. Agricultural production on the one hand and protecting cultivator in enjoying the fruits of their labour and reinvest in agricultural activities, on the other are main objectives of land reforms. Land reform measures adopted by the Government of Assam since independence are briefly discussed below:

(A) Abolition of Intermediary Tenures: Along with other states of India, the *Zamindari* system in Assam was also abolished through two Acts, viz, (i) The Assam Management of Estate Act, 1947 which came into force in 1952-53, and (ii) The Assam State Acquisition of *Zamindaries* Act, 1948, which came into force in 1953-54. The *Zamindari* system was finally abolished in 1955. With this abolition of intermediaries, a huge number of farmers have been brought into direct relationship with the state government and the state government prepared a tenant record-of-rights (Gangopadhyay, 1990). This was the first tool of land reforms.

(B) Land Ceiling: The Assam Fixation of Ceiling on Land Holding Act, 1956 came into force in 1958 in all plain districts of Assam and was amended extensively in 1972, 1975 and 1976. This is the second tool of land reforms. The principal objective of this act was to reduce the disparity among the holder of land by taking away the excess lands from large holdings and redistribute them among the landless and small landholders. The Act fixes a standard area for cultivator at 50 *bighas* (16.33 acres) and reduced the allowable area of orchards from 30 *bighas* (9.92 acres) to 15 *bighas* (4.96 acres) in 1972. As on 30th June, 1992, total amount of area declared ceiling surplus in Assam was 6.10 lakh acres, out of which area taken in possession was 5.49 lakh acres, distributed 4.62 lakh acres and total number of beneficiaries was 4.03 lakhs (Dhar, 2007). However, the recent record of distribution of ceiling surplus lands in Assam is not

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tenants or *raiyats*, namely, (i) Privileged *raiyats* who hold land at rates of rent not exceeding the revenue rates, (ii) Occupancy *raiyats* who have right of occupancy in the land, (iii) Non-occupancy *raiyats* who have no such rights of occupancy and (iv) Under-*raiyats*, i.e., tenants holding land under the *raiyats*. If a tenant can hold the land continuously for 12 years, he would be eligible for acquisition of the rights of the privileged *raiyats* [The Assam (Temporarily Settled Districts) Tenancy Act, 1935, Govt. of Assam].

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easily accessible. Govt. of Assam has discontinuously implemented ceiling act and distributed the acquired land to different sections of the society. But the performance of the state in respect of distribution of ceiling surplus land since 1998 is negligible. Till 31st December 1999, 613400 acres of land have been declared as ceiling surplus and land acquisition done in 612500 acres in Assam (Directorate of Land Acquisition, Requisition and Reform, Govt. of Assam). Acquisition and distribution of ceiling surplus land in Assam up to 31st March 1998 can be observed from the following table.

Table-2.14: Distribution of ceiling surplus land in Assam (upto 31st March 1998)

Sl. No.	Head of Ceiling	Acquisition and Distribution of land till March 1990 (in lakh ha.)	Acquisition and Distribution till March 1998 (in lakh ha.)
1	Area declared as surplus	-	6.12
2	Area taken possession of	2.47	5.76
3	Area Distributed (Total)	0.92 (100%)	5.05 (100%)
	Minority	0.136 (14.78%)	0.43 (8.51%)
	SC	0.136 (14.78%)	0.46 (9.11%)
	ST	0.188 (20.43%)	0.59 (11.68%)
	Ex-Tea Garden Labourer	0.289 (31.41%)	0.88 (17.43%)
	Institutions	0.08 (8.7%)	0.21 (4.16%)
	Others	0.087 (9.46%)	2.48 (49.11%)
4	No. of beneficiaries (in lakh)	7.1 (100%)	4.45 (100%)
	Minority	0.33 (4.65%)	0.39 (8.76%)
	SC	0.34 (4.79%)	0.44 (9.88%)
	ST	3.71 (52.25%)	0.42 (9.44%)
	Ex-Tea Garden Labourer	0.73 (10.28%)	0.83 (18.65%)
	Institutions	0.005 (0.07%)	0.00651(0.15%)
	Others	1.99 (28.05%)	2.36 (53.03%)

Note: Figures in bracket are the percentage of the total.
Source: Directorate of Land Requisition, Acquisition and Reforms, Govt. of India.

Higher land inequalities could be reduced and the constraint of land-man ratio could be eased if the availability and access to land of small and marginal farmers and also of landless labourers could be increased.

(C) Security to Tenants: To provide fixity of tenure, curbing the freedom of landowners to eject tenants and fixing the maximum rate of rent, the first legislation

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enacted in Assam was Goalpara Tenancy Act in 1929. The Act conferred occupancy rights to the sub-tenants and under tenants (Guha, 1991). The Tenancy Act of 1935 repealed and replaced by the new Assam (Temporarily Settled Areas) Tenancy Act (Assam Act XXIII of 1971) passed in 1971 to provide security and proper justice to tenant's rights. Along with it, the *Adhiar* Protection and Regulation Act, 1948 was also repealed as the *Adhiar* was given the status of a tenant under the new Act. An occupancy tenant cannot be ejected now for non-payment of rent; he can be ejected only if he renders the land unfit for cultivation. For acquisition right of the occupancy *raiyats*, a person should now hold land as tenant for not less than three years against 12 years. Maximum of rent both in cash and kind has been provided (Gangopadhyay, 1990).

(D) Consolidation of Holdings: The Assam Consolidation of Holding Act, 1960 was enacted in 1961 for consolidation or prevention of fragmentation of agricultural holdings below 5 *bighas* (1.65 acres) for better cultivation in the plain districts of Assam. Fragment means holding of less than one hectare in area (Das, 2011). A programme for consolidation of land holdings was in progress till 1969-70 and an area about 2005 *bighas* (662.81 acres) of land in 14 villages was brought under the scheme. But, since June 1969 this scheme had been kept in abeyance (Dhar, 2007).

(E) Protection of Tribal Land: In order to protect the interests of the plain tribal people of the State, the Government of Assam passed the Assam Land and Revenue Regulation (Amendment) Act in 1947 by adding a new chapter, Chapter X in the Assam Land and Revenue Regulation Act, 1886 on the basis of the recommendation by a committee headed by Mr. Hockenhull[27]. It enabled the state government to specify the backward classes and constitute compact areas as protected belts or blocks.[28] It also laid down the special protection measures applicable to the notified classes in the matter of settlement of Government land, rights of settlement holder and land holder, the restriction of transferring *patta* land, eviction of unauthorized occupant and jurisdiction of civil court (Gangopadhyay, 1990). Under the direction of this Act, 47 belts and blocks (17 belts and 30 blocks) were constituted in the areas predominantly inhabited by the tribal people in the plain districts of Brahmaputra Valley.

[27] Pegu, R., 2011. "Tribal Belts and Blocks in Assam: A Review and Present Status", The Assam Tribune, 2011.
[28] Tribal belts and blocks were products of the colonial policies which had created special provisions for various protected groups including tribes. Large areas are termed as 'belts' and smaller areas are called 'blocks'

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Section 162 (2) of Assam Land and Revenue Regulation (Amendment) Act, 1947, laid down that no person shall acquire any land in protection belts/blocks by way of transfer, exchange, lease, agreement or settlement in contravention of the provision of Chapter X. The land holders, i.e., the periodic lease holder, in a protected belt or block also has no right to transfer his land to any person belonging to non-protected classes, or to any person who is not a permanent resident in that protected belt/block (Gangopadhyay, 1990).

However, it is observed that the law was never enforced strictly. Pegu (2011) said, "It was a misnomer to use the phrases 'tribal belts' because other groups are also involved". The All Assam Tribal Sangtha (AATS) and All Bodo Students' Union (ABSU), two tribal organizations of Assam said "many indigenous people in the state did not have land *patta*." They are demanding immediate implementation of the Schedule Tribe Forest Dweller/Other Traditional Forest Dweller (Recognition of Forest Right) Act, 2006, to grant land *patta* to the traditional tribal forest dweller (The Telegraph, 2013).

A large number of land reform measures have been introduced and useful land reform acts have been passed in Assam since 1948. However, the implementation of these acts has not been properly organized and the impact has been negligible. Because of the absence of the required machinery to implement these acts in the field not much in the sphere of land reforms has been done (Report of the Assam Agriculture Commission, 1975). The faults in legislations, bureaucratic obstacles, lack of political will, vested interest of the large landowners, and the political nexus, etc. hinder proper implementation of land reform measures in Assam and it is still far away from its goal (Daimari, 2008).

2.14: Use of Modern Inputs in Agriculture in Assam:

For high cropping intensity and for high yield per acre inputs requirement is high. The relative backwardness of input uses in agriculture in Assam stands out clearly. Though the state is blessed by favourable natural inputs for agricultural development, limited use of modern inputs keeps the agriculture sector in a poor condition. A main reason for the yield gap between Assam and National average is the relatively slow spread of modern

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technology in Assam and the progress made in the use of modern farm inputs. Following section discussed the position of basic input uses in Assam agriculture.

Use of HYV Seeds:

Availability of good quality, disease-free and high yielding seed and planting material is a *sine qua non* for enhancing the production and productivity of crops. In an agrarian structure, the area under HYV seeds is an indicator of development of agriculture in respect of technology. Traditionally, in Assam, cultivators preserve a portion of their crop to be used as seeds for the next sowing. Agriculture in Assam faced the problem of availability of certified seeds for different crops. Assam was once wholly dependent on outside supply for meeting its own requirement of seed till Assam State Seed Certification Agency (ASSCA) was constituted in the year 1985.[29] Till now the state could not achieve self-sufficiency in production of its own requirement of seeds except paddy and mustard due to infrastructural inadequacy.[30] There is a dearth of quality seeds in the state and so the Seed Replacement Rate (SRR) (SRR is the percentage of area sown out of total area of crop planted in the season by using certified/quality seeds other than the farm saved seed) in the state stands at a very low level. The SRR of paddy in the state has increased from 12.3 percent in 1998-99 (Ahmed et al., 2011) to 47 percent in 2011-12 (Economic Survey, Assam, 2012-13). With the adoption of new agricultural strategy, the area under HYV paddy in Assam gradually increased from 1.34 lakh hectares in 1970-71 to 15.89 lakh hectares in 2013-14 (Dhar, 2002; Economic Survey, Assam, 2014-15). Total rice area under HYV seeds in Assam has increased from 47.5 percent to 63.5 percent in 2013-14 compared to 77 percent to about 78 percent in India. Table 2.15 reveals trend of growth of HYV seeds adoption in rice in Assam, Punjab and all India since 1980-81.

Table-2.15: Area under HYV Seeds Adoption Rates in Paddy in Assam, Punjab and all India during 1980-81 to 2013-14 (in percent)

Years/States	Assam	Punjab	India
1980-81	25.4	92.56	45.4

[29] There are three notified Seed Testing Laboratories under ASSCA in the state and the total annual testing capacity of these laboratories is 20000 seed samples (Economic Survey, Assam, 2012-13).

[30] In Assam, production of certified seed has been taken up in the Field Trial Stations (FTSs) and in some Government's seed farms & Assam Seed Corporation's seed farms. In 2002-03, there were 41 Seed Farms of Agriculture Department and 383 Seed Villages in Assam. Total area under seed villages in Assam is 35301 hectares and no. of farmers to be involved is 151584.

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1981-82	39.0	95.0	48.4
1982-83	41.1	94.9	49.2
1983-84	42.8	95.5	52.7
1984-85	44.4	96.3	55.3
1985-86	41.2	95.1	57.1
1986-87	45.0	94.5	58.4
1987-88	41.2	88.8	57.3
1988-89	46.1	94.3	60.9
1989-90	51.5	94.8	62.0
1990-91	46.5	94.6	64.2
1991-92	45.0	93.9	65.5
1992-93	44.5	92.3	65.8
1993-94	44.6	92.4	67.5
1994-95	45.0	92.9	72.0
1995-96	45.5	94.4	73.2
1996-97	47.52	94.5	77.2
1997-98	49.39	-	-
1998-99	51.91	-	-
1999-2000	52.95	-	-
2000-01	56.04	95.94	-
2001-02	56.33	-	-
2002-03	56.52	-	-
2003-04	54.04	-	-
2004-05	55.38	-	-
2005-06	59.9	-	-
2006-07	61.45	-	-
2007-08	60.0	100	-
2008-09	60.9	100	-
2009-10	62.83	100	-
2010-11	66.2	100	
2011-12	66.7	-	-
2012-13	68.0	-	-
2013-14	63.5	96	78

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Source: (i) Economic Survey, Assam, Various Issues, Directorate of Economics and Statistics, Govt. of Assam; (ii) Fertilizer Statistics (Various Issues).

It is clear that proportion of area under HYV seeds of paddy in the state has increased steadily from 25.4 percent in 1980-81 to 68 percent in 2012-13 but it is too low compared to agriculturally advanced states of the country as well as national average.

Consumption of Fertilizer and Use of Pesticide:

The HYV seeds are able to give higher yields than the traditional varieties, especially if the supply of nutrients to the soil can be increased. This calls for application of chemical fertilizers. But per hectare consumption of fertilizers in Assam is traditionally very low as compared to most other states of India (CMIE, 2009). The consumption of fertilizers in Assam during 1970-71 was 2.9kg per hectare of cropped area as against 19.86kg in Kerala, 13.63kg in West Bengal, 9.11kg in Bihar and 13.67kg for all India (Assam Agriculture Commission, 1975). A large quantity of fertilizers in Assam is consumed by tea industry and as a result the per hectare use of fertilizes to other cropped areas under ordinary field crops will be even less than 2.9kg per hectare (Deka, 1984). A crash programme for increasing the use of fertilizer was launched in 1990-91 and the year was observed as a 'fertilizer year' in the state (Economic Survey, 1997-98). As a result, there has been a substantial increase in fertilizer consumption during 1990-91(10.9kg per hectare of cropped area), but it has declined gradually in the subsequent three years (Saikia, 2014). The fertilizer consumption per hectare of gross cropped area in 1994-95 was 9.5kg. in Assam as against 175kg in Punjab, 136kg in Tamil Nadu, 126kg in Haryana and 75.7kg on an average in the country as a whole (Sahu, 2006).

The trend of fertilizer consumption in the state in terms of nutrient (NPK) per hectare gradually increased over the years but it is still much lower than the national average. According to the state Agriculture Department, consumption of fertilizer in the state was almost half of all India average and about one fourth of Punjab. In 2009-10, while Punjab apply 236.90kg fertilizer per hectare of GCA and India used 138.33kg/ha, Assam apply only 59.10kg/ha. In 2011-12, consumption of fertilizer in the state was 74.58kg per hectare against 141.30kg of national average. The consumption of chemical fertilizer is low during the *kharif* season than that of *rabi* season. The reason behind the lesser consumption is that the farmers are reluctant to use fertilizers during *kharif* season

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fearing monetary loss due to heavy rainfall and flood. Limited use of fertilizer may be ascribed partly to the ignorance, prejudice and partly to the limited purchasing power of the cultivators. High cost of fertilizers, non-availability of credit, lack of storage facilities and want of distributors in the interior areas, disrupted transportation, etc. are some of the factors for which the chemical fertilizers have not been widely used. Further, inadequate irrigation facilities and uncertainty of rain restricted the use of fertilizers (Gazetteer of India: Assam State, 1999). However, the practice of using bio-fertilizer has gradually increased significantly due to its motivation through extension programme by the Department of Agriculture. Consumption of chemical pesticides in Assam is also very low compared to national average. It was 39.80gm per hectare in 2011-12. Table 2.16 reveals the trend of use of fertilizers in Assam, Punjab, a highly agriculture developed state and all India average.

Table-2.16: Consumption of Fertilizer per hectare of Gross Cropped Area in Assam, Punjab and All-India since 1980-81: (Figure in kg/ha)

Years	Assam	Punjab	All-India
1980-81	2.8	111.4	31.9
1981-82	3.3	118.4	34.3
1982-83	3.8	128.9	37.1
1983-84	5.0	142.1	42.9
1984-85	3.9	149.4	46.6
1985-86	4.6	153.4	47.5
1986-87	4.8	154.6	49.0
1987-88	6.7	151.7	51.4
1988-89	7.3	151.0	60.6
1989-90	6.6	154.9	63.5
1990-91	10.4	159.7	67.5
1991-92	9.6	165.6	69.8
1992-93	7.2	158.8	65.5
1993-94	5.0	157.4	66.3
1994-95	10.3	167.0	72.1
1995-96	13.5	155.8	74.4
1996-97	14.6	158.43	76.0
1997-98	17.90	167.81	85.44
1998-99	18.74	177.71	88.49
1999-2000	27.66	175.43	95.33
2000-01	37.40	166.69	88.93
2001-02	38.8	169.97	90.13
2002-03	44.12	184.25	91.45
2003-04	49.5	139.25	88.11
2004-05	42.65	-	94.5
2005-06	52.85	208.68	105.5
2006-07	52.27	-	111.80
2007-08	56.20	213.00	116.80
2008-09	57.80	223.00	127.2
2009-10	59.10	226.00	138.33
2010-11	67.09	243.00	144.14
2011-12	74.58	246.00	141.30

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Note: Ratio of fertilizer consumption (N+P+K) to the total gross cropped area is reported.
Source: (i) Directorate of Agriculture, Govt. of Assam; (ii) Fertilizer Statistics (Various Issues), Department of Fertilizers, Govt. of India; (iii) Basic Statistics of NER, NEC, Crop, Shillong (Various Issues) and (iv) CMIE, 2009, (v) Agriculture at a Glance, Department of Agriculture, Govt. of Punjab, Chandigarh.

In 1980-81, while Punjab used 111.4kg fertilizer per hectare and India used 31.9kg per hectare, Assam used only 2.8kg per hectare. Although it rose subsequently, the rate of fertilizer use in Assam is low compared to Punjab and all India average. In view of such low level of fertilizer consumption in Assam, the relatively low yields rates of crops to the all India level are not very surprising.

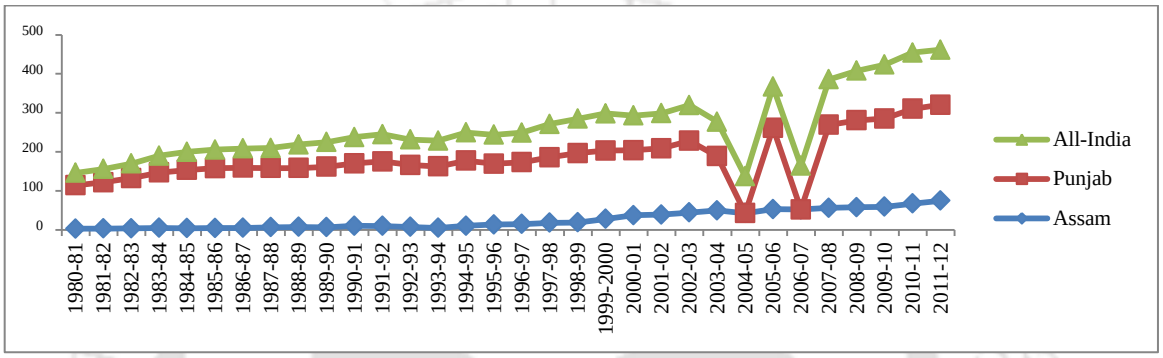

Fig.2.1: Consumption of Fertilizer per hectare of Gross Cropped Area in Assam, Punjab and All-India.

Irrigation Facilities:

Higher agricultural growth can come about mainly through more intensive use of the land under cultivation. This makes the role of irrigation in agriculture very crucial (Dutta, 2011). Though rainfall is generally abundant in Assam it is only for the summer season, the rest of the year remains dry and hence large cultivable land remains fallow in the *rabi* season. Assam falls under the heavy rainfall zone but more than 70 percent of the rainfall is concentrated during the months from May to September. Thus, two extremely opposite phenomena often occur alternatively-floods during the rainy seasons and droughts during the winter seasons. The general impression was that there is no necessity of irrigation in Assam where the rainfall is more than required and most of the area is flooded. Tapping of underground water will not be required as done in other states. This impression is wrong because the rainfall is not evenly distributed throughout the year and space. It was only in the third five year plan, a small beginning was made by allotting Rs.228 crores for irrigation and a number of medium size irrigation projects were taken up (Gazetteer of India: Assam State, 1999). The Assam Agriculture Commission recommended that as irrigation is one of the major pre-requisites for improving overall agricultural production, it is advisable to give due attention, to this

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subject in all its aspects in the climatic and environmental conditions, as existing in Assam (Report of the Assam Agriculture Commission, 1975). Most districts have less than 10 percent of the gross cropped area under irrigation (Singha, 2001). Lack of irrigation facilities is the main reason for which multiple cropped areas could not be increased in Assam (Goswami, 2002). In a study in the Brahmaputra Valley of Assam, Dutta et al., (2005) found that the farmers have been able to diversify their cropping pattern after getting access to irrigation facilities, especially through privately owned shallow tube-wells. Assam is endowed with huge amount of both surface and ground water reserve, but irrigation infrastructure in the state has remained weak which has been identified by researchers as one of the principal factors restricting farmers in the state from fuller utilization of the potentials of the Green Revolution technology (Dutta, 2011). The public sector investment on irrigation in the state was not encouraging. Only 13 percent of the gross cropped area of the state was irrigated during the quinquennium period 1995-96 to 1999-2000 compared to 94 percent in Punjab, 43 percent in Andhra Pradesh and 39 percent in all India average (Goyari, 2007). While this percentage has been slowly increasing over the years at the all India level, it has been almost stagnant at around 13 percent in Assam since 1985-86. As per data available, out of 2706000 hectares of net sown area, only 6.20 percent was irrigated in the state in 2003-04 as against 96.31 percent in Punjab, 84.01 percent in Haryana and 73.70 percent in Uttar Pradesh. The corresponding figure for the country as a whole was 39.11 percent. Net irrigated area as percentage of net sown area declined from 21.14 percent in 1991-92 to 20.79 percent in 1997-98 as against the national average of 38.42 percent. The neighbouring states like West Bengal (34.97%) and Orissa (34.14%) had a much better figure than Assam, even Manipur had about 46.43 percent of net sown area under irrigation (CMIE, 2001) (see appendix Table II.3). In 2011, the percentage of area under irrigation in the state was only about 15 percent of the gross cropped area or 20.7 percent of net cropped area (Directorate of Economics and Statistics, Govt. of India, 2012). In Punjab, irrigation coverage in 2012-13 was 98 percent of total cropped area (Raju, et al., 2015; Govt. of Punjab) and percentage of net irrigated area to net area sown was 97.9 in 2010-11 (Statistical Abstract, Punjab, 2011). Area of foodgrains under irrigation in Assam was only 4.6 percent compared to 47.8 percent in all India in 2010-11. Coming to the ratio of irrigation potential utilization to gross cropped area (GCA), it is more pathetic. Only about 7 percent of the GCA of the hill region, only 3.1 percent in the Brahmaputra valley and less than one percent in the Barak valley in the year 1998-99

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were the utilization ratios (Goyari, 2007). In 2010-11, the created irrigation potential was utilized only in 29.20 percent of the net sown area in the state (Govt. of Assam, 2013a).

According to the Economic Survey, Assam, 2014-15, the ultimate Gross Irrigation Potential (Annually Irrigable Area) has been estimated at about 27 lakh hectares in 2011-12 (10 lakh hectares by major and medium irrigation projects and the rest 17 lakh hectares under minor irrigation schemes[31]); which constitutes 64.9 percent of the GCA. In 2010-11, only in 29.20 percent of the net sown area in the state, the created irrigation potential was utilized (Govt. of Assam, 2013a; Tamuli, 2014).

There exists a huge gap between irrigation potential created and actual potential utilized and thus there is less coverage of assured irrigation. Dutta (2011) noticed sharp variation in the rates of utilization in the two types of irrigation schemes. The estimated utilization rate for government irrigation schemes was found to be 34.24 percent whereas the scheme for private schemes was 51.92 percent. Thus, the performance of private irrigation schemes is found to be better in so far as utilization of created potential is concerned.

The Central Ground Water Board (CGWB), Govt. of India reported that the state has the ground water potential for installation of about 8 lakh shallow tube wells (STWs). STWs have recorded phenomenal growth outstripping surface irrigation schemes (surface flow and surface lift) in the state in the late nineties of the twentieth century, and constituted about 87.29 percent in 2010-11. As per the Minor Irrigation Census, 2000-01 of Government of India, about 98 percent of the STWs in Assam are under the individual ownership.

Mandal (2011) mentioned that the main factor hindering full capacity utilization of STW based irrigation projects in the state is fragmentation of holdings. Defective irrigation management, lack of co-ordination among various implementing agencies and several technical defects cannot be ruled out. Apart from non-practicing of cropping

[31] The programmes for the development of irrigation facility in Assam have been taken up under three broad schemes, viz., Major, Medium and Minor Irrigation. This classification is based on command area of any scheme. If the command area of any irrigation scheme or project is greater than 10000 hectares, the scheme is labeled as major schemes while the command area of any scheme is less than 2000 hectares, they are called as minor irrigation schemes, any scheme with the command area lying between 2000 hectares to 10000 hectares is known as medium irrigation scheme. Based on the technology, irrigation schemes can be classified under five different types: surface flow, surface lift, dug well, deep tube wells and shallow tube wells. While surface flow and surface lift irrigation schemes have been exercised through major, medium and minor irrigation schemes, wells and tube wells are developed solely under minor irrigation schemes (Tamuli, 2014).

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pattern as per approved designed, non-repair of schemes, non-energization of pump sets and erratic supply of electricity, etc. are some of the reasons of under utilization of available irrigation potential from government schemes (Economic Survey, Assam, 2003-04). Moreover, occurrence of frequent flood, especially during *kharif* season in every year has been destroying infrastructures including irrigation.

Table-2.17: Irrigation Potential Created and Utilization in Assam (Area in hectare)

Years	Cumulative Irrigation Potential Created up to the year	Irrigation Potential Utilized During the Year			Utilization Rate (%)
		Kharif	*Rabi* & Pre-*Kharif*	Total	
1980-81	-	107407	11156	118563	-
1981-82	-	125994	19285	145279	-
1982-83	-	139704	18221	157925	
1983-84	280274	144463	20736	165199	58.9
1984-85	315712	151047	21065	172112	54.52
1985-86	339068	181092	21919	203011	59.87
1986-87	374150	200500	25257	225757	60.34
1987-88	397425	197659	24791	222450	55.97
1988-89	408914	195937	39394	235331	57.55
1989-90	418603	186790	36921	223711	53.44
1990-91	426019	201175	38018	239193	56.15
1991-92	443028	188611	38652	227263	51.29
1992-93	455650	186955	27967	214922	47.2
1993-94	466498	106862	23089	129951	27.9
1994-95	477011	130959	16290	147249	30.9
1995-96	480078	95955	17133	113088	23.6
1996-97	480590	100140	13960	114100	23.7
1997-98	481160	101561	12847	114408	23.78
1998-99	484030	100152	15774	115926	23.95
1999-2000	495440	97984	21238	119222	24.06
2000-01	503993	99901	14831	114732	22.76
2001-02	513340	99324	14156	113480	22.11
2002-03	520040	71860	7510	79370	15.26
2003-04	527000	61786	7614	69400	13.17

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2004-05	531190	52217	8553	60770	11.44
2005-06	535210	52559	14581	67140	12.54
2006-07	546360	104050	20790	124840	22.84
2007-08	561909	74462	14808	89270	15.89
2008-09	589709	75677	19994	95671	16.22
2009-10	626709	147769	21085	168854	26.94
2010-11	647591	108340	21480	129826	20.05
2011-12	8.23 lakh	-	-	1.58 lakh	19.2

Note: a) Data on irrigation potential created are as on March of each year, and do not refer to the potential created during the year. Irrigation potential created by the Department of Irrigation, Govt. of Assam.

b) Data on irrigation potential utilized are for each year.

c) Irrigation utilization rate for any year is the ratio of irrigation potential utilized in that year to irrigation potential created as on March of that year.

Source: (i) Data on irrigation potential for Assam (created and utilized) is from Statistical Hand Book of Assam, various issues, Govt. of Assam; (ii) Statistical Cell, Irrigation Department, Govt. of Assam; (iii) Economic Survey, Assam, 2011-12 & 2012-13.

From the above table it appears that utilization of created irrigation potential increased from 118563 hectare in 1980-81 to 239193 hectares in 1990-91. However, from 1991-92 it has been decreasing continuously till it reaches its lowest at 113088 hectares in 1995-96. The drastic fall in utilization during this period may be attributed to stopping of supply of electricity by the Assam State Electricity Board because of non-payment of dues by Irrigation Department (Dutta, 2011). The situation, however, improved thereafter till 1999-2000 and then again decreased except during 2006-07. Irrigation potentiality created has increased from 280274 hectares in 1983-84 to 8.23 lakh hectares in 2012 while utilization rate declined from 58.9 percent to 19.2 percent during this period. Thus, about 80 percent of the public irrigation potential created in the state is found to remain unutilized in 2012.

From the table 2.17, it is seen that about 90.59 percent of total utilization was for *kharif* crops while for *rabi* and pre-*kharif* it was as meager as 9.41 percent in 1980-81. The situation has not changed much over the years. In 2010-11, out of the total utilization of 129826 hectares, *kharif* crops alone accounted for 83.45 percent leaving only 16.55 percent for *rabi* and pre-*kharif* crops.

Availability of assured and abundant cheap power in the rural areas is a pre-requisite for the introduction of perennial irrigation in the agricultural field. The progress

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of rural electrification in Assam is low. The consumption of electricity in agriculture in Assam has increased from 2174 MWH in 2007-08 to 6998 MWH in 2009-10 or from 0.08 percent to 0.21 percent during the period (Economic Survey, Assam, 2010-11).The farm power availability in 2012-13 is about 1.02 hp per hectare in the state as compared to 2.05 hp per hectare at the national level (Govt. of Assam, 2013b).

Problem of Investment and Credit availability in Agriculture in Assam:

In a poor agricultural state like Assam where savings are negligible among the small farmers, agricultural credit appears to be a critical factor affecting agricultural productivity. However, in Assam, either for land development or infrastructure or acquiring assets it is very meager especially from the standpoint of farmers' owing to their weak economic background. Agriculture in the state is severely capital starved (Bhawmick et al., 2005). Credit disbursement per hectare (at 1980-81 prices) in Assam is far below the national average. By 1996-97 per hectare credit disbursed in Assam was only about 30 percent of the national average (Goyari, 2007). The credit use in agriculture in the state as on 1998 stood at Rs.791 per hectare against the national average of Rs.3633 per hectare. The analysis of credit availability indicates that direct short-term credit per hectare in the northeastern India is less than Rs.100 against a national average of Rs.421.50 per hectare (Baruah and Sarma, 2001). The low overall credit-deposit ratio amongst banks in Assam has been commented upon by many authors. The credit-deposit ratio of all scheduled commercial banks in Assam has increased from 33 percent in 2002-03 to 37.3 percent as on March 2014. However, it was far below when compared with all India ratio of 78 percent (Economic Survey, Assam, 2014-15). Although agriculture is one of the biggest recipient of credit from commercial banks, the major amount has been absorbed by plantation sector (about 95 percent of the total other agricultural credit) while in other major plantation states like West Bengal, Tamil Nadu, Andhra Pradesh, etc. such discrimination to rural cultivators does not exist. This shows that agriculture and allied occupations in the vast rural areas of the state have been very badly neglected by the national scheduled and commercial banks in the field of credit advancement. Only 15 percent farmers have been provided *Kishan* Credit Cards (KCC) to the farmers in the state. The cumulative position of issuance of KCC as on 31st March, 2003 was 52180 with Rs.4559.21 lakhs as amount sanctioned and Rs.2675.79 lakhs as amount disbursed against a target of one lakh KCC for the 2002-03 (Agriculture

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Development in Assam, 2001-02 & 2002-03). Achievement percentage in issuance was 52.18 and amount disbursement was 58.7. In Punjab, 2671195 KCCs are issued and Rs. 37742.63 crore sanctioned and Rs.36340 crore disbursed (96.28%) in 2012 (ENVIS Centre; Punjab). Currently, performance of KCC scheme in the state has been improved. During the year 2013-14, 3.08 lakh KCC were issued to the farmers of the state and sanctioned Rs.1505.67 crore. Cumulatively about 15.87 lakh KCCs have been issued up to March 2014 since introduction of the scheme. The scheme thus covered 58.34 percent of the total farmer family of the state at the end of March 2014 (Economic Survey, Assam, 2014-15).

It was only during the early part of the 20th century that the credit structure of Assam economy took some concrete shape. So long credit facilities were provided by the money lenders, indigenous banks, friends and relatives of landlords. The money lenders earned big profits on usury without check. Government also provided loans in times on natural calamities but the proportion of such loans was quite insignificant. The money lenders retained the predominant hold even after banking institutions like the co-operative credit societies, banks loan offices, etc., grew up. Because of poor development of the commercial banks in the state, especially in rural areas they accounted for less than one percent of the credit supply in most districts. The nationalized banks provide only long-term loans and are reluctant to give short-term loans except on security. As a result, a vast majority of the rural poor and marginal farmers are to approach the money lenders and are still in the grip of money lenders. The *Kabuliwalas* were found engaged in their usurious business of money lending all over Assam till 1990 (Gazetteer of India: Assam State, 1999). The small peasants are compelled to make a 'distress sale' of their agricultural products at a low price in order to repay the loan just after their harvest of crops.

Besides, improper utilization of credit often results in poor repayment and cause huge outstanding debt [32] and constrained the financial institutions to provide credit to agriculture sector (Bhawmick et al., 2005). Borbora and Mahanta (2005) noticed that, in Assam, even though the incidence of indebtedness is less in comparison to other major states in India, (share of indebted agricultural households in Assam was 17.5 percent whereas in Andhra Pradesh it is 92.9 percent, Telangana 89.1 percent and Tamil Nadu

[32] Average amount of debt per household with outstanding loan in India on 30 June , 2012 was 103457 (Kumar et al., 2015)

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82.5 percent and all India 51.9 percent. The average amount of outstanding loan in Assam was Rs.3400 compared to Rs.213600 in Kerala, Rs.123400 in Andhra Pradesh, and Rs.119500 in Punjab and in all India, Rs.47000 (NSS 70th Report, 2014)) the use of credit for productive purposes was found to be as low at 7.8 percent. As a result, there is not much improvement in farm productivity. Table 2.18 shows the credit disbursal in Assam agriculture in comparison to Punjab and all India average.

Table-2.18: Credit advanced to Agriculture in Assam, Punjab and all India (Rs/ha) (at 1980-81 prices)

States/Year	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97
Assam	343.2	374.2	320.5	315.2	266.4	249.3	272.4	240.8	266.4
Punjab	989.7	1060.4	997.0	997.1	1187.5	1168.0	1169.4	1000.5	1053.1
All-India	592.4	598.2	538.7	543.4	604.8	576.9	541.6	758.1	788.2

Source: (i) Indian Agriculture in Brief (Various Issues), CMIE, 1998; (ii) National Accounts Statistics of India (Various Issues)

While the credit advances to agriculture per hectare in Punjab and all India level increased gradually from Rs.989.70 to Rs.1053.10 and Rs.592.40 to Rs.788.20 during 1988-89 to 1996-97 respectively, in Assam it was decreased from Rs.343.20 to Rs.266.4 during the period. Both in case of per hectare credit advances and per capita credit to agriculture in Assam it is considerably lower than the all-India averages. The average credit per operational holding and per cropped hectare by size category in All-India, Punjab and Assam during 2006-07 is given in Table 2.19.

Table-2.19: Average credit obtained per cropped hectare and per operational holding in All-India, Punjab and Assam in 2006-07: (In Rupees)

State	Marginal farmers		Small farmers		Semi-medium farmers		Medium farmers		Large farmers		All farmers	
	Per OH	Per ha	Per OH	Per ha	Per OH	Per ha	Per OH	Per ha	Per OH	Per ha	Per OH	Per ha
All-India	4291	7754	10212	6024	15899	5113	29246	4572	45689	2953	8425	5580
Punjab	18630	13751	30629	11046	52646	10096	105780	9456	166395	5727	67722	8809
Assam	339	709	567	431	733	287	1544	321	2577	228	472	455

OH= Operational holding, ha: Hectare

Source: Agricultural Economics Research Review, Vol.25 (Conference Number) 2012.

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At the country level, an average loan of Rs.5580 was obtained per hectare. The marginal farmers obtained maximum amount (Rs.7754/ha), followed by small (Rs.6024/ha), semi-medium (Rs.5113/ha), medium (Rs.4572/ha) and large (Rs.2953/ha) farmers. Thus, credit amount per unit cropped area was inversely related to farm-size. Credit obtained per operational holding was Rs.8425 on all India basis with the ratio between what large farmers obtained to that availed by marginal farmers of almost 10. Punjab farm-households obtained the maximum credit of Rs.67722 per operational holding while in Assam the amount is a meager of Rs.472 by a farm-household.

Extension Services:

Agricultural extension services are one of the most common forms of public sector support to knowledge diffusion. In Kerala, the incentives and support system extended by Commodity Development Boards, especially for the development of plantation crops contributed to the emergence of commercial crop culture, especially under rubber. The process also influenced the emergence of new supply chain system, both for inputs and farm produces their processing and marketing, emergence of new socio-political and cultural habits and practices (Sirajudeen, 2013). Extension services in state agriculture can rise questions like-, a) whether extension facilities in state agriculture are adequate?, b) is it farmers friendly?, c) is it recurrent and need based?, d) whether resources allotted for research & development and for extension services are sufficient?, e) what is the rate of utilization of fund allotted?, f) what is the access rate?, g) is there any invention of new and high yielding variety?, h) what about its adoption rate?, i) what about the feedback of beneficiaries?, etc. Of course, it is little bit abstract to measure the magnitude of extension services, however, it can scale the utilization of fund allotted and compare to other developed states, evaluate number, diversity and frequency of activities organized, use of multimedia for creating awareness, participation and co-operation of farmers in extension programmes, staff strength at district level or below, extent of training and awareness campaign, gestation period of problem reported and problem solved, etc. Goswami (2012) observed that the agricultural extension service in the state is not very effective. Extension service has not had significant influence on the other production and productivity enhancing practices except on the proportion of area under HYV seeds in the total rice acreage. He further mentions that extension workers rarely visit the villages, as many as 38 percent farmers in his study did not even know who the

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village level extension worker (VLEW) is or *Gram Sevak* in their locality. Surprisingly, the farmers opine that the suggestions offered by the extension workers are not effective for augmenting the crop's productivity.

2.15: Role of Macro Factors in Agricultural Development in Assam: Inadequate support of the macro factors also hinder in the raise in productivity of state agriculture. However, data on expenditure on rural infrastructure and investment (both from private and public) in agriculture could not found properly especially in Assam. Never the less in view of the relevancy we tried and collect at least some recent data as follows.

In Indian agriculture, although private investment was stepped up in the post-reform period in responds to the liberalization of the economy and favourable terms of trade, real public investment continued to decline on account of fiscal compression and the failure to reduce input subsidies (Hanumantha Rao, 2001).

Like most of the states of the country, Assam is also lagging behind in respect of rural household's electrification. Out of the total 25,124 number of inhabited villages in Assam 16814 villages (67.0%) have been electrified till the end of March, 2010 as against 100 percent in Haryana and Punjab and 67.2 percent in India in 2011 (Population Census, 2011). The consumption of electricity in agriculture in Assam has increase from 2174 MWH (0.08%) in 2007-08 to 6998 MWH (0.21%) in 2009-10 (Economic Survey, Assam, 2010-11). Shortage of electricity in Assam increased from 6.15 percent in 2001-02 to 11.0 percent in 2013-14.

Although irrigation is the single most important pre-requisite for the introduction of new technology, only 30 percent of net cropped area is covered by assured irrigation facility. Fund for Command Area Development and Water Management (CADWM) declined from Rs.894.61 lakh in 2008-09 to Rs.292.00 lakh in 2011-12 (Economic Survey, Assam, 2014-15). Fund provision required for operation and maintenance of irrigation schemes in the State's budget is not adequate.

Facilities of commercial banks and co-operative banks are scarcely available to the peasant of Assam. Average population covered per bank branch office in Assam was calculated at 16.8 thousand as on March, 2014 compared to All India average of 10.5 thousand during the same period (Population Census 2011). The Credit-Deposit Ratio of all scheduled commercial banks in Assam was 37.3 compared to 78.0 percent in India in 2014.

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Although, chronically flood prone area are 4.75 lakh ha and drought prone area are 0.94 lakh ha, National Agriculture Insurance Scheme has not been able to provide desired solution to the risk hedging in the agricultural sector in the State.

There is a lack of Mechanical Service Centres within a reasonable distance from the peasants in Assam. This infrastructure is inevitable not only for rapid mechanization of agriculture, but also for creating an atmosphere in the rural areas attractive to the educated youths. Inadequate communication and transport facilities are major hindrances in the movement of bulky agricultural produce to the markets and consuming centres.

Assam has become a rice surplus state since 2010-11. Marketable surplus of rice in 2013-14 was 6 lakh MT. Although, procurement of paddy as a measure of price support is important, peasants of Assam are largely deprived. Total procurement target was fixed at 1.44 lakh MT during the 2012-13. Whereas, the ASAMB procured 7895.0 MT paddy with the involvement of Rs.13.923 crore, the FCI procured 20104.0 MT during 2012-13. Lacks of organized market, storage infrastructure (only 26 cold storages) also create problems to the peasants. Small farmers often sell immediately at low prices right after the harvest to middlemen. Following tables will highligh the public expenditure on agriculture and allied activities in Assam in recent periods.

Table-2.20: Capital and Revenue Expenditure of the Government of Assam on Agriculture and Allied Services: (Rs in Lakh)

Year	Capital Expenditure	Revenue Expenditure
2008-09 (Actual)	28850 (12.16%)	80349 (5.64%)
2009-10 (Revised Estimate)	87429 (18.54%)	129088 (4.33%)
2010-11 (Actual)	200 (0.099%)	141338 (6.16%)
2011-12 (Actual)	2467 (0.98%)	119182 (4.50%)
2012-13 (Actual)	908 (0.35%)	176399 (6.05%)
2013-14 (Revised Estimate)	4706 (0.61%)	271462 (6.58%)
2014-15 (Budget Estimate)	3775 (0.51%)	298458 (6.14%)

NB: Figures under bracket are the % of Total Expenditure.
Source: Statistical Hand Book, Assam, Various Issues.

Table-2.21: Sector-wise Outlay and Expenditure of Annual and Twelfth Five Year Plan, Assam on various Infrastructural Facilities: (Rs. in lakh)

Heads of Development Sector	Annual Plan 2011-12		Annual Plan 2012-13		Annual Plan 2013-14		Outlay for Annual Plan 2014-15	Outlay for 12th Five Year Plan 2012-17(P)
	Revised Outlay	Expenditure	Revised Outlay	Expenditure	Revised Outlay	Expenditure		
Agriculture and Allied	87502.05 (9.72%)	64642.35 (10.18%	95867.55 (9.13%)	82563.83 (11.41%)	125983.38 (10.08%)	92940.27 (11.48%)	146734.30 (6.99%)	582025.35 (5.90%)

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Services		)						
Rural Development	84535.50 (9.39%)	70626.40 (11.12%)	84618.59 (8.06%)	56828.90 (7.85%)	86678.00 (6.93%)	71154.65 (8.79%)	385363.03 (18.34%)	653525.00 (6.62%)
Irrigation and Flood Control	108897.25 (12.10%)	48886.93 (7.70%)	169624.30 (16.15%)	46076.34 (6.36%)	158292.57 (12.66%)	34870.17 (4.31%)	105579.00 (5.03%)	1431789.48 (14.51%)
Energy	43939.00 (4.88%)	24015.75 (3.78%)	41664.30 (3.97%)	28047.77 (3.87%)	66754.36 (5.34%)	63886.35 (7.89%)	74521.00 (3.55%)	784002.00 (7.95%)

NB: Figures under bracket are the % of Total Expenditure
Source: Statistical Hand Book, Assam, Various Issues.]

2.16: Change in Cropping Pattern in Assam in Recent Decades:

The cropping pattern of a state is an important indicator to show the proportion of area to GCA under different crops at a definite point of time. It may undergo changes over time in response to changes in a number of factors, namely economic, technological and other environmental factors. The cropping pattern in Assam has been more or less stable with marginal changes in the importance of a few crops. "Assam has experienced a change, very little, in its cropping pattern in comparison to that of the states like Punjab, Haryana, Karnataka, etc." (Daimari, 2008).

The basic feature of the cropping pattern in Assam is the predominance of food crops.[33] At the beginning of the 20th century, about 90 percent of the total cultivable land of Assam was put into food crops and remaining 10 percent land was put under non-food crops.[34] But gradually a change in the cropping pattern of Assam along with other states of the country occurred and accordingly, excluding plantation crops, area under food crops came down to 84 percent and that of non-food crops slightly rose to 16 percent. Then changes in the cropping pattern mainly occurred due to changes in the prices, in favour of non-food crops or cash crops (Dhar, 2007). In 2010-11, these figures reached to 66 percent (2767000 ha) and 34 percent (1392977 ha) respectively. Compound average growth rate of area under total foodgrains experienced a negative growth in

[33] Food crops group included foodgrains, sugarcane & sugar, condiments & spices and fruits & vegetables, i. e., food crops comprise both foodgrain crops and cash crops (Kumar & Gupta, 2015);
[34] Non-food crops group comprised of oilseeds, fibres, drugs & narcotics and plantation crops (Kumar & Gupta, 2015)

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Assam as well as in India, viz., -0.21 percent and -0.07 percent respectively per annum during 1990-91 to 2011-12. In case of total food crops, growth rate of area in Assam was 0.25 percent compared to 0.13 percent in India; while in case of total non-food crops these figures are 0.09 percent and 0.56 percent respectively and in regards to total crop sector, India's growth rate was 0.24 percent but Assam had 0.22 percent per annum during 1990-91 to 2011-12 (Land Use Statistics, Govt. of India; Kumar and Gupta, 2015).

Cropping pattern in Assam is dominated by rice. It is natural, because rice is the staple food for majority of people living in the state. However, total area under rice has declined from 80.2 percent in 1960-61 to 74 percent of the TCA in 2011-12. Among other cereals, wheat and maize are gaining some popularity among the farmers in Assam till 90s. Since 1990s, jute cultivation in Assam has not been adequately promoted by the government. Accordingly, area under jute in Assam has gradually declined from 5.5 percent in 1960-61 to 1.9 percent of TCA in 2011-12.

Bhowmick, et al., (2005) stated that "the cropping pattern in the state did not show any appreciable change over the years (1970s-1990s). State agriculture was primarily a cereal-based system, where rice accounted for a lion's share. Rice continues to cover about 75 to 78 percent area." The share of rice in total cereals stood at 95.34 percent which means that the share of other cereals commanded only 4.66 percent (Dutta, 2011). However, the allocation of area under different crops witnessed dynamism in the recent years. The normal *ahu* paddy was substituted to early *ahu*, summer rice and jute. Oilseed occupied 6.3 percent of cropped area in 70s, which increased to about 8 percent in 2010s. Pulses and fiber crops showed a gradual decline after 80s. However, area share of pulses have gradually increased and occupied 3.84 percent in 2011-12. Oilseeds have the largest acreage share next to rice, and then the fibers and pulses (Mandal, 2011).

Mandal (2011), in his study of change in cultivation pattern observed that during the period from 1991-92 to 2008-09, acreage share of summer paddy increased by around 6 percent whereas the share of autumn paddy and winter paddy declined by around 8 percent and 3 percent respectively. Pulses also lost area share during the same period. The acreage share of foodgrains has declined by 6.2 percent during 1991-92 to 2007-08. Among the non-foodgrains oilseeds, jute and sugarcane have lost their respective shares in total cropped area. On the other hand, spices and vegetables have

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shown an increase in their acreage share. Kumar and Gupta (2015) observed that the growth rate of area under plantation crops is significantly positive in Assam along with Karnataka, Madhya Pradesh, Maharashtra, Punjab, Rajasthan and Uttar Pradesh. Table 2.20 shows the area under different foodgrains and non-foodgrains or crop-wise land utilization from 1980-81 to 2011-12.

Table-2.22: The trend of crop-wise land utilization in Assam from 1980-81 to 2011-12: (in lakh ha)

Crop	1980-81	1990-91	2000-01	2001-02	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Winter Rice	16.22	18.01 (52.74)	17.77 (49.9)	17.15 (49.6)	16.36 (50.74)	17.07 (53.4)	14.98 (49.5)	16.47 (52.2)	17.73 (53.68)	17.9 (52.6)	18.76 (53.9)	18.76 (54.5)
Autumn Rice	5.72	6.08 (17.8)	5.40 (15.2)	4.96 (14.4)	4.36 (13.5)	3.98 (12.5)	3.79 (12.53)	3.54 (11.2)	3.51 (10.63)	3.46 (10.2)	3.13 (9.1)	2.76 (8.02)
Summer Rice	0.35	1.17 (3.43)	3.29 (9.23)	3.26 (9.43)	3.11 (9.65)	3.15 (9.8)	3.12 (10.3)	3.23 (10.2)	3.60 (10.9)	3.94 (11.6)	3.99 (11.6)	3.94 (11.5)
Total Rice	22.29 (69.1)	25.26 (68.62)	26.46 (74.2)	25.37 (73.4)	23.84 (73.9)	24.20 (75.7)	21.89 (72.36)	23.24 (73.6)	24.84 (75.2)	25.30 (74.4)	25.71 (74.6)	25.46 (74.0)
Maize	0.22	0.21	0.20 (0.56)	-	-	0.19 (0.59)	0.19 (0.63)	0.18 (0.57)	0.17 (0.51)	0.19 (0.56)	0.20 (0.58)	0.21 (0.61)
Wheat	1.06 (3.10)	0.84 (2.31	0.70 (1.96)	0.72 (2.08)	0.64 (1.99)	0.50 (1.65)	0.60 (1.9)	0.56 (1.7)	0.50 (1.5)	0.60 (1.76)	0.45 (1.3)	0.40 (1.16)
Total Cereals	23.57 (73.1)	26.42 (71.79)	27.53 (77.1)	26.37 (73.3)	24.75 (76.74)	24.97 (78.1)	22.75 (75.21)	24.05 (76.2)	25.56 (77.38)	26.14 (76.8)	26.41 (76.6)	26.11 (75.9)
Total Pulses	1.13 (3.44)	1.13 (3.12)	1.16 (3.1)	1.18 (3.4)	1.08 (3.35)	1.00 (3.13)	1.07 (3.54)	1.13 (3.58)	1.14 (3.45)	1.19 (3.5)	1.26 (3.7)	1.32 (3.84)
Total Food grains	25.21 (76.5)	27.55 (74.91)	28.58 (80.2)	27.55 (79.7)	25.83 (80.1)	25.97 (81.2)	23.82 (78.7)	25.18 (79.8)	26.71 (80.34)	27.35 (79.5)	26.40 (80.3)	27.43 (79.7)
Total Oilseed *	1.97 (7.08)	3.20 (8.81)	3.22 (9.03)	2.99 (9.26)	2.87 (8.9)	2.54 (7.9)	2.79 (9.22)	2.76 (8.74)	2.65 (8.02)	2.84 (8.35)	2.87 (8.24)	2.87 (7.21)
Sugarcane#	48 (1.2)	36 (1.05)	27 (0.76)	27 (0.78)	24 (0.74)	23 (0.72)	27 (0.89)	26 (0.82)	29 (0.88)	27 (0.79)	30 (0.88)	28 (0.79)
Cotton #	4	2	2	2	1	1	1	1	1	2	1	1
Jute	1.05 (3.77)	0.96 (2.85)	0.70 (1.69)	0.82 (1.97)	0.69 (1.8)	0.57 (1.78)	0.58 (1.9)	0.60 (1.9)	0.60 (1.82)	0.65 (1.9)	0.62 (1.8)	0.66 (1.91)
Tea	2.24	2.32	2.67	2.69	2.72	3.01	3.12	3.21	3.22	2.79	2.81	3.18

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	(6.09)	(6.43)			(6.87)				(8.05)			(7.64)
Rubber	-	-	0.12 (0.30)	-	0.14	0.15	0.17	0.18	0.21 (0.65)	0.23	0.27	0.32 (0.77)
Non-foodgrains	4.74 (23.5)	5.45 (25.09)	7.06 (19.8)	7.01 (20.3)	6.42 (19.9)	6.00 (18.8)	6.43 (21.3)	6.38 (20.2)	6.32 (19.66)	6.99 (20.6)	6.80 (19.7)	6.98 (20.3)

Note: (i) Figures are rounded off in lakh; (ii) figure in brackets shows percentage share of a particular crop area to all crops area excluding plantation crops; (iii) * excluding coconut oil; (iv)# '000 hectare

Source: (i) Directorate of Economics and Statistics, Govt. of Assam; (ii) Percentage shares are calculated by author.

Table 2.22 reveals that the cropping pattern of Assam is predominant in foodgrains production where foodgrains area has slightly declined from 80.2 percent in 2000-01 to 79.7 percent in 2011-12. On the other hand, non-foodgrains area has increased very slowly from 19.8 percent to 20.3 percent over the years.

Area under rice has increased from 69.1 percent of the TCA in 1980-81 to 74 percent in 2011-12. There are mainly four varieties of rice produced in the state viz., *Sali* or *Aman* and *Bao* (seasonally called as winter rice), *Ahu* or *Aus* (seasonally called as autumn rice) and *Boro* (seasonally called as summer rice), besides a number of local varieties. In terms of area and production, winter paddy has traditionally been the most popular crop in the state occupying highest position in area coverage and production and consequently highest value addition to GSDP. This is followed by autumn paddy and summer paddy. However, the acreage shares of winter rice and autumn rice in total rice area have been continuously declining due to flood damage or risk of frequent floods. On the contrary, the importance of summer rice which is grown during flood-free season, in the total area under rice, has been increasing due to its higher productivity and low risk. Summer rice, which used to occupy about 6 percent in 1970s, comprised 16 percent of the total area under rice in recent years. Changes in rice cropping pattern in Assam in recent decades has been discussed in details in Chapter III. Other foodgrains like pulses, wheat and other cereals cover near about 6 percent of the total area of cultivation in the state (Economic Survey Assam, 2011-12). Among the non-cereals the most important crop group in terms of area share is oilseeds, which is losing its acreage share over the years. In 1999-2000, 9.29 percent of TCA of the state was under oilseeds which declined to 7.21 percent in 2011-12. Jute area has declined from 2.45 percent to 1.63 percent over the years. Tea is grown extensively in the state. Share of tea area had increased from 6.1 percent in 1980-81 to 7.64 percent in 2011-12. Coffee and rubber plantation is also undertaken to a small extent in the state. However, rubber plantation became popular in

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the state in recent time. Area under rubber cultivation in the state was 0.12 lakh hectare or 0.3 percent of TCA in 2000-01which has increased to 0. 49 lakh hectare or to 1.17 percent of TCA in 2014-15. The cropping pattern of Assam has clearly neglected some important crops like wheat, pulses, oilseeds, sugarcane, and jute though there is an increase in tea and rubber plantation area. As per agricultural experts, production of pulses should be about 17 percent of foodgrains. In Assam, however, the area under pulses has remained almost in constant at around 4 percent of the TCA under foodgrains as against 8 percent in the country as a whole. Similarly, the area under some important cash crops should increase either to enhance earning of the state or to reduce dependence on imports from outside the state. But unless the concentration of area under rice is reduced through increased mechanization and intensive cultivation, no meaningful cropping pattern in the state can be achieved (Lekhi and Choudhury, 1996). Obviously, some improvement is observed in certain crops during the last few years.

The aggregate picture of cropping pattern in Assam is more or less similar in different districts, the percentage of paddy hectareage varying from 67.55 percent in Nagaon district to as high as 86.62 percent in Cachar district. The percentage of paddy hectareage is more than the state's average in the least crop diversified districts, viz., Sibsagar, Lakhimpur, Dibrugarh, Dima Hasao and Cachar. But in the relatively more crop diversified districts like Goalpara, Kamrup, Darrang and Nagaon, a variety of crops are introduced in the paddy fields in rotation. Some of the paddy fields are also devoted to some other crops in lieu of paddy, as a result of which the percentage of rice hectareage has been gradually dwindling in these districts during the recent years (Das, 2012).

However, changes in cropping pattern in the state in recent decades are far from uniform in nature. In Upper Assam, a large number of people have started small tea gardens. While in certain parts of Central Assam the shift has been towards floriculture. Floriculture in Assam has been limited to a cluster of villages in and around Hajo region of Kamrup district. In the remote riverine tracts of the river Brahmaputra (locally called as *Chars*[35]) of lower Assam, the shift has been towards cultivation of new variety of

[35] Char areas were defined as "small islands in the river bed which are formed by either frequent changes of the river or by shifting of the sands which lie on beds of those rivers' (Gangopadhyay, 1990). There are 2251 *char* villages in Assam spread over 14 districts along the route of the mighty Brahmaputra. Erstwhile Goalpara district had the largest number of char villages (558) in the state. Cultivable area under chars in the state is 2.42 lakh hectares. These remote tracts were brought under cultivation by migrating peasants from East Bengal (presently Bangladesh) during the last part of nineteenth century.

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paddy known as *Iri* cultivation from the latter half of the 90's. As the yield is higher, the availability of foodgrains has, therefore, increased for those who undertake *iri* cultivation. The *char* dwellers introduced large scale jute cultivation which till date is one of the major crops of Assam. They diversified and commercialized agriculture in the state by bringing in large tracts of uninhabited, uncultivated and remote areas under cultivation including the *char* areas. "By dint of hard work and gifted with superior agricultural skill, these *char* dwellers reaped gold from the barren land" (Das, 2012). On the other hand, in the western part of Assam, mainly in Goalpara, Bongaigaon, Chirang and Kokrajhar districts and some parts of Kamrup, Cacher and hills districts of Assam rubber plantation is becoming popular in recent years. A large number of tribal people of these districts could turn their unused land into productive land and can earn a profitable income from this cultivation.

Change in Agriculture is a welcome phenomenon, as long as, it does not reduce the foodgrain availability or its entitlement for the population group which undertake cultivation. In case of Assam, there are no apparent signs of the above mentioned phenomenon. Therefore, changes in agricultural practices as a whole can be regarded as a welcome phenomenon (Chakraborty, 2006).

2.17: Conclusion:

Agriculturally Assam is an important state and is a major supplier of foodgrains to the people of this region. But the low productivity and stunted growth have been the characteristic features of its small farmer dominated agriculture sector.

Agriculture in Assam has been dominated by rainfed rice based production system which accounts for as high as 80 percent of total cropped area. However, irregularity of rain poses a great threat in state agriculture. On the other hand, irrigation facilities offered to the farmers are not evenly distributed and are not adequate for increasing the crop productivity. Application of modern inputs is very much limited and investment either public or private is not encouraging. Rice, especially winter rice, occupies a pivotal position in agriculture in Assam. Gradual decline in the popularity of wheat and jute cultivation and emergence of rubber plantation in some districts of the state is a matter of great concern and interest. On the whole, agriculture in Assam has been faring poorly compared to the all-India average. The backwardness is also

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witnessed in the low use of various inputs such as fertilizers, irrigation, bank credit, extension services as well as farm equipment.

Thus, although the state is more agriculturally dependent than the rest of the country, paradoxically on the different parameters of agricultural development the state is lagging behind the rest of the country. This is what lies at the centre of the state's overall underdevelopment. Our purpose in the rest of the thesis will be to pin point the causes which may be responsible for low agricultural yield. Our ambit is more modest however. We have taken up three representative crops: winter rice, jute, rubber. In the next three chapters we shall focus on these specific crops and discuss the production condition of these crops in the state agriculture.

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Chapter-III: Rice Production in Assam

3:1 Introduction:

Rice is the World's second most important cereal crop following corn, in terms of area and production. It is a major staple foodcrop for the people of the World in general and for Asians (50% of the population) and people of tropical countries in particular (FAO). Rice provides two-thirds of the calories for most Asians which comprises of rice-based diets. In fact, rice is a necessity in the densely populated parts of the monsoon lands, as it gives more calories of energy per hectare than wheat (Gautam, 2013).

Rice production grew at 1.31 percent per annum but population grew at 1.55 percent per annum in 1990s. It should be noted that a decline in growth rates of both output and yield has taken place in all the major rice producing countries in Asia.

In Chapter III we discuss the production of the most important foodstuff in Assam, i.e., rice. The chapter begins with brief note on World rice production, climatic condition to rice grown and the rice production scenario in India in recent period. Different aspects of rice production in Assam like trend and growth of area, production and yield is discussed in the chapter. The chapter also discusses the gradual evolution of rice cultivation practices in Assam from pre-colonial to post colonial period. As rice is grown throughout the year in different environments, it is necessary to study rice ecosystem and methods of rice cultivation, seasonal and regional diversities of rice production in Assam. A comparative study is being made to examine the rice production in the state with other major rice producing states and national averages. The chapter concludes with a brief note on the natural and input constraints of rice production and economics of rice production in the state.

3.1.1: Origin of Rice and Climatic Conditions of Rice Growth:

The Russian agronomists Vavilov opine that wild species of rice were found in the wet swampy regions of South-Eastern Asia and tropical Africa. The principal species that was domesticated-*Oryza Sativa L* has retained all the characteristics that indicate an original swamp habitat. There are numerous varieties of rice-each with its own particular characteristics and requirements, but all must have high temperatures in order to germinate, bloom and mature.

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Rice requires a hot and humid climate, and thrives as a rainfed crop where the annual rainfall is more than 200cm. Rice requires a temperature of 27^0C and a rainfall of more than 100cm during the growing period. The plant needs to stand in water for some time. Flooding is most essential in the early part of growth. Rice requires highly fertile soils. Although it can be grown on a variety of soils, loams with a high silt and clay content are the best for it. Level lands, especially the alluvial soils of the river valleys and deltas are more suited for rice cultivation, though it grows in uplands too. Rice requires cheap and abundant human labour, as most of the works like tilling of land, transplantation of the plants, weeding, harvesting of the crop, husking and threshing of the paddy are still done by hand particularly in developing countries. For this reason, the densely populated monsoon lands are most suited for rice cultivation (Gautam, 2013). However, with the development of science and technology, mechanization in rice cultivation has taken place World-wide.

3.1.2: Rice Production in India:

Rice is the main source of carbohydrate and energy for a large section of population in India. India ranks first in rice area occupying 29.4 percent of the global area but is second in production (India produced 21.6% of Worlds' rice production in 2008-09, FAO) after China in the World because of the fact that yield levels in India are less than half of yield levels in China (Goyal et al., 2006). Productivity of rice in India (3124 kg/ha) is much below the World average (4112kg/ha). It is much lower than that of Egypt, Japan, China, Vietnam, USA and Indonesia. Rice is the staple food for about 65 percent of the country's population which contributes about 24 percent of the total cropped area, 36.9 percent of the foodgrains area, 42 percent of total foodgrains production and 45 percent of the total cereal production in the country (Diwakar, M. C., Directorate of Rice Development (2010). India produces about 104.3 million MT of rice in an area of 44.0 million hectares during 2011-12 (Economic Survey, 2012-13).

The performance of rice production in India was marked by yearly fluctuations during the last decade (2000-01 to 2010-11). CACP (2011) reported that in respect of individual crops, the major decline has been experienced by rice. Rice production for the period 1997-98 to 2008-09 registered a lower growth rate of 1.27 percent compared to 2.63 percent achieved during its preceding decade. Compound annual growth rate (CAGR) of rice production in India has also decreased to 1.63 percent during the period 1990-91 to 2012-13 from 2.87 percent of its preceding two decade, 1970-71 to 1990-91.

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In the consecutive decades from 1980, growth of rice production in India has been declining. During 1980-81 to 1989-90, growth rate was 3.62 percent which was declined to 2.02 percent and to 1.23 percent in two successive decades (Base: TE 1981-82=100) (Economic Survey, 2011-12). The year to year fluctuation in production indicates the continuing dependence of the crop on weather conditions.

One of the reasons for the lower growth rate of production was the stagnation in the area under rice. The area under rice during T.E. 1997-98 was 43.24 million hectares which was reduced to 41.9 million hectares in 2009-10. The decadal compound growth rate of rice area during 1980-81 to 1989-90 was 0.41 percent which is declined to 0.04 percent in 2000-01 to 2011-12. Moreover, the CAGR of rice yield declined from 3.19 percent during 1980s to 1.68 percent during 2000-01 to 2011-12 (Base: TE 1981-82=100) (Economic Survey, 2011-12).

3.1.3: Rice Cultivation in Assam:

Rice is the staple food for the inhabitant of Assam, almost 90 percent of the population is rice eaters (Rahman, 2006). Further, its importance in the consumption basket (the average monthly consumption per capita is about 13kg) also speaks volumes on the rice orientation of the state (Ahmed et al., 2011). The share of rice in total cereals stood at 97.5 percent in 2011-12. The soil, topography, rainfall and climate in the state in general are conducive for rice cultivation. Rice is grown extensively in every district of the state throughout the year and its cultivation follows mainly the traditional farming practices. In 2012-13, Assam's position in national production of rice was 8th with 5.82 percent in area and 4.87 percent in production share. Assam occupies a special place in the rainfed rice production system in the Eastern India (having a major rainfed rice-growing area) by covering about 9 percent of the total rice area and contributes 8 percent to the production of Eastern India. The area covered under paddy cultivation in the state was 25.71 lakh hectares and more than 91 percent of the total area under foodgrains in the state during the year 2010-11. During 2011-12, rice occupies 61.2 percent of Gross Cropped Area (GCA) and 90.6 percent of the Net Cropped Area (NCA) (Economic Survey, Assam, 2012-13). The average normal rice production during 2007-08 to 2011-12 in Assam was 41.83 lakh MT and it contributed around 27 percent to total value of agriculture output of the state (Govt. of India, 2013). Although Assam has become a rice surplus state since

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2010-11, (Economic Survey Assam, 2014-15); the procurement of rice at minimum support price in the state is negligible. More importantly, rice has been an important source of household income in Assam. Bhowmick et al., (2005) observed that the household income inequality could be substantially higher in the absence of rice income. Rice cultivation in Assam has been susceptible to the risk of floods, particularly the winter rice.

3.2: Historical Background of Rice Production in Assam:

The knowledge of iron together with that of cattle-powered plough and wet rice was brought to Assam by the Indo-Aryans. The knowledge of agriculture and the smelting and working of iron and other metals had reached Assam long before the Gupta age. From time immemorial, its agriculture had been dominated by various tribes, mainly of the Tibeto-Burman stock. The agrarian history of the Assam valley was particularly influenced by isolation of these tribes. Rice was the staple crop all throughout the ages as it is at present. Assamese literatures have mentioned varieties of rice grown in Assam. The *Yogini Tantra*, a presumably early 16th century Sanskrit work of Assam, speaks of as many as twenty varieties of rice, such as *Raja*, *Soma*, *Briha*, *Singha*, *Banga*, *Raktasali*, *Keteki*, *Kalabinka*, *Narayana*, *Madhava*, *Pradipa*, *Ashoka* and the like. It also speaks of the spring time rice called *brihi* which evidently meant *Ahu*. The *Katha Guru Charit* also contains numerous references to rice cultivation and mentions its varieties. Early epigraphic records mention that in ancient Assam land measurement was done in terms of the amount of rice (*dhanya*) produced in a given plot of land, i. e., in paddy yield. But as to the relative importance of *Sali* (wet rice) and *Ahu* (dry rice) varieties of rice or of permanent and shifting cultivation in pre-Ahom Brahmaputra valley, nothing is definitely known. The rice economy of the hill region, supplemented by food gathering, hunting and fishing, was never self-sufficient. According to Chatterjee (1955), many tribes of the Brahmaputra valley continued to maintain their own peculiar modes of cultivation.

The *Bodo-Kachari* and allied people of the Tibeto-Burman linguistic group adopted methods of shifting hoe cultivation that survived as late as the nineteenth century. However, in low-lying lands, as a result of closer contacts with the settled population, they had adopted both the plough and wet rice quite early. However, it is not possible to say when exactly the transition to plough cultivation began among them.

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There is an oblique reference in an old Assamese chronicle to the damming of a hill-stream of Upper Assam by a cattle-owning *Bodo-Kachari* tribe of the thirteenth century. This might suggest artificial irrigation as early as that date. In 1875, the *Meches* were going through a process of learning the use of the plough from their more advanced neighbours, the *Rajbangsis*.

The medieval Assam was relatively isolated from the rest of India. Throughout the period, Assamese society, except for its exposure to the *Vaishnava* movement in the sixteenth century, remained by and large cut-off from the mainstream of Indian life (Ahmed, 1990). Commercial agriculture was a rarity except for mustard cultivation in Kamrup and the north bank of eastern Assam (Das and Saikia, 2011). In medieval period Assam remained a very thinly populated region because of its difficult terrain, an agriculturally retarded tribal population and its forests and swamps. The central belt of *riverine* tract and belt of submontane tract covered with reed and grass jungles was unfit for any permanent cultivation and habitation. The only available area for permanent habitation and cultivation was the flat expanses of land between the aforesaid belts on either side of the Brahmaputra River. Isolation of the tribes influenced agriculture. It appears from the scant information contained in the Assamese chronicles that the bulk of the tribal population of Upper Assam were still carrying on primitive cultivation of dry crops but significantly no rice or paddy. However, from the very time of their entry into the Assam plains the Ahoms carried on their own *Sali* cultivation and for that Upper Assam owes much of its settled cultivation. Bonds and dykes had to be thrown up here and there so that the fields could retain rain and flood water in the right quantity which is so necessary for *Sali* paddy (Guha, 2015). The early *Morans* and *Borahis* could hardly produce any surplus rice over and above their subsistence. It may be assumed that the bulk of the *Morans* and *Borahis* gradually adopted the wet-rice culture of the migrant Ahoms and merged with the latter in course of a few generations.

In terms of usage, peasant lands were divided into three categories-raised or high lands suitable as homestead or garden sites (*bari* and *basti*), low-lying or wet lands (*rupit* or *rowit*) suitable for *Sali* paddy cultivation and *faringati* (land settled temporarily). It was in the *rupit* belt that the plough-using people had their earliest permanent settlements (Guha, 2015). Land reclaimed through collective efforts necessarily belonged to the community. The pressure of population on the *rupit* belt led peasants of all categories to resort to the practice on shifting cultivation of mustard, pulses and *Ahu* rice. Valley

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people were the dominant consumers of rice in comparison to the people inhabiting the hills. Households in Upper Assam chiefly produced *Sali or* winter rice which is sown in June-July, transplanted in July-August and harvested in October-November as well as *Ahu* or autumn rice (early maturing rice) sown by broadcasting method in February-March and harvested in June-August, along with other crops.[36] Until the thirteenth century Upper Assam appears to have been thinly populated, because of poor cultivation of the soil. Wet rice cultivation increased rapidly in this region and a better supply of food led to a rapid increase of population and further expansion of settled cultivation. Hundreds of miles of embankment-cum-roads were built in the interest of extending wet rice cultivation.

In Lower Assam, both wet and dry rice are grown. The *Katha Guru Charit* which contains stores of information about the socio-economic life of the people of the Lower Brahmaputra valley frequently speaks of *Ahu* rather than *Sali* variety of rice (Gogoi Nath, 2002). Almost entire population of Assam had only the simplest implements of cultivation. The inhabitants of the Lower Brahmaputra valley which came into contact with early Aryan migrants to this region had possibly known the use of plough drawn by a pair of bullocks much earlier to those of the Upper valley. This is indicated by the term '*hala*' to measure lands, i.e., lands which could be cultivated by one plough and a pair of bullocks. It is recorded in the Gazetteers that the agricultural implements included a wooden plough (*nangal*) with an iron tipped share (*phal*), wooden rakes (*jabaka*) and mallets (*dalimari*), a rough bamboo harrow (*mai*), Yoke (*juwali*), sickles (*kachi*), bill hooks (*da*), knives and different types of bamboo baskets like *duli, mer, kharahi, pachi,* etc. to keep the products (Gazetteer of India: Assam State Gazetteer, 1999). One traditional way of indicating economic differentiation in the country side was to classify the households on the basis of the number of ploughs operated and not the amount of land hold.

Every year after the *Sali* harvesting was over, the low-lying fields were temporarily thrown open as common grazing grounds, and this customary practice (*garu udang dia*) still remains very much alive in Assam. Under Ahoms, the peasant held his

[36]According to the seasons of seed sowing and seed harvesting rice are classified as *Sali*, *Ahu* or *Boro*. *Ahu* rice is a pre-*kharif* spring or autumn rice grown in high, medium and low agro-ecology and both in broadcast and transplanted method. It is an early maturing variety among the rice crops. *Sali* rice is *kharif* winter rice grown in medium and low lands by transplanted method. Usually more local varieties of rice are grown in this season. While *Boro* is a *rabi* or summer rice grown in rainfed low land and in assured irrigated area. *Boro* rice is cultivated by transplanted method.

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fields with mere usufruct rights. His wet paddy lands always went back to the community when he died or become over-aged. Though the quota of tax-free wet paddy land per eligible adult male was fixed at two *puras* or about 2.66 acres, it appears that in earlier times each family was allowed to hold as much land as it could reclaim and cultivate. However, in practice, the family's working capacity set the limit to 3 or 4 *puras* per adult male. Due to the impermanent nature of farming practice and paucity of investment, productivity of peasant economy remained low.

During the colonial period in Assam, there were broadly two type of peasant cultivation-permanent and fluctuating. Permanent cultivation was carried on both in *rupit* rice fields and on *basti* (homestead)/*bari* (garden) lands. The fluctuating or shifting plough cultivation which was reminiscent in many ways of tribal *jhum* (slash-and-burn) culture was, on the other hand, carried on in flood-prone or sub-montane jungle grasslands for growing early-maturing rice (*Ahu*), mustard-seed and pulses, etc. during the relatively dry season. These lands known as *faringati* rapidly exhausted their fertility in two or three years despite crop rotation to a limited extent. The *riverine* belt known as the *char-chapari* area is heavily flooded during the rains. Traditionally, *chapari* lands used to be put under two major crops, *Ahu* rice and mustard, sometimes with the advantage of double cropping. Weeding is as much difficult in the sub-montane (*Dooars*) as on *chapari* lands.

The rice economy of the Brahmaputra valley was capable of producing a considerable surplus in the past. Rice was produced in 'very great abundance' and Welsh (1794) asserted that 'a scarcity had never been known to happen from natural causes'. But as difficulties of export came in the way, production was limited by the absence of a local market. Of the three varieties of rice - *Ahu*, *Bao* and *Sali* grown in the Brahmaputra valley of Assam, *Sali* was the most productive. *Sali*-oriented agriculture of the Ahoms in Upper Assam yielded a higher surplus than the largely *Ahu*-oriented cultivation of others. The Assamese speaking Hindu mainstream people as well as the Tai-speaking migrant Ahoms cultivated transplanted wet-rice (*Sali*). *Sali* paddy was preferred in different aspects; it takes a long time, at least five months, to mature. Therefore, *Sali* fields rarely allow double-cropping. But as *Ahu* matures early, it is sometimes followed by another crop, pulses or mustard. *Sali* cultivation requires more labour at the stage of transplantation, but for the subsequent period labour requirement is less because no weeds grow at all on the water-logged fields. In a thinly populated labour scarce state,

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Sali rice harvesting did not pose any problem. Moreover, Ahoms are accustomed with the cultivation of *Sali* rice. *Ahu* cultivation requires continuous weeding out until harvesting. As *Ahu* fields are mostly situated in the forested sub-montane and riverine belt, the crops are exposed to wild animals or to untimely floods. Hence they are very much uncertain. Moreover, the yield of *Ahu* rice is small and its quality inferior as compared to *Sali*. The third variety of rice, *Bao* is generally sown broadcast. It matures late and its harvesting time coincides with that of *Sali*. Like *Ahu*, *Bao* also gives per unit of land a lesser yield than *Sali*. The yield of *Sali* was fifty to two hundred pounds higher than that of *Ahu* or *Bao* rice per acre of cultivated land. Moreover, in case of sowing broadcast that is practised in *Ahu* and *Bao*, the seed requirement is at least twice as high as that for transplanted *Sali*. Under the circumstances, the spread of *Sali* cultivation, at the cost of the two other varieties of rice, may be taken as a progressive trend in agriculture. Literary records of medieval times supported by early British records show that the extent of cultivation of the transplanted and high yielding *Sali* rice in Assam was larger than that of *Ahu* and *Bao*, the figure being 70 percent, 22 percent and 8 percent respectively. Watter Hamilton also states that about 3/4th of the produce of the crops formed transplanted rice (A Geographical, Statistical and Historical Account of Hindustan and the Adjacent Countries, Vol. 2, Reprint, Delhi, 1971). Production of *Sali* was much wide spread in the Upper Brahmaputra valley and that of *Ahu* and *Bao* or shifting rice had been extensive in the Lower part of the valley. Guha (2015) writes, "As one moves from the district of Sibsagar, the Cradle and Core of the Ahom dominion in the eastern extremity of the valley towards the west or towards the north one finds that the importance of *Sali* in the total rice crop goes on decreasing…….the percentage of the total rice lands under *Sali* in Sibsagar and Lakhimpur districts are the highest being 92 percent and 85 percent respectively."

Double cropping and crop rotation were practised only on a limited scale-the former never exceeding thirteen percent of the net cropped acreage. Yet, because of the natural soil fertility, the average yield of threshed paddy gram per acre could be favourably compared with that in other parts of India. This average came out to be 1512 Ibs per acre (or 6.2 *maunds*[37] per *bigha*) in the case of *Sali* (*aman*) variety of rice and 1322 Ibs per acre (or 5.4 *maunds* per *bigha*) in the case of *Ahu* (*aush*) rice. Around in 1852, the gross yield of rice (cleaned) from an acre of land in Assam was 12 *maunds* and

[37] 1 *maund*=40 kg.

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cultivated acreage per head of population was 1.02 in Assam proper in 1853. In the early years, the Assam Company had to import the entire supplies of rice to its labour from Bengal districts. Later, rice purchases were made also in Darrang and Nowgong districts, but occasional imports from outside did not stop. During the eighties and early nineties the rice imports from Bengal into the Brahmaputra valley ranged from four to five lakh *maunds* per year. An increasing inflow of labour recruits to the plantation and railways construction led to rising prices of rice. By the middle of the nineteenth century, Assam Proper had become a deficit area in foodgrains. The annual rice imports were estimated at not less than three lakh *maunds* in 1873.

Tea industries developed in the state had direct impact on the peasant economy as a source of market demand for rice. However, total acreage under rice does not appear to have had appreciatively increased in Assam in response to this demand because of the general shortage of manpower. In Assam Proper,[38] index of rice acreage base 1884-85=100, rose to 145 in 1886-87 but gradually fell and reached 113 in 189-92. Since 1893-94 acreage index of rice was around 120 but significantly fell to 116 in 1900-01. Percentage area under rice to total cropped area for Assam Proper declined from 73.47 percent in 1882-83 to 63.44 in 1891-92 and then it remained around 65 to 67 percent till 1900-01(Guha, 2015). Table 3.1 shows the yield of rice in Assam during British rule.

Table-3.1: Per Acre Yield of Rice in British Assam (1891-1946)

Year	Rice Yield (Ib per acre)
1891	743
1892	818
1893	842
1894	737
1895	791
1942	726
1943	896
1944	744
1945	807
1946	821

Source: Blyn (1966: 255-56, 292)

The late 19th century saw a rise in the price of rice. Price index rose from 96.71 (1861-64) to 153.45 (1898-1901) (Guha, 1991). But with limited market access, deficient labour supply and low marketable surplus, ordinarily peasants could not reap the benefits of this rise in price. As tea plantations were turning out huge profit, the percentage of cultivable areas of Assam under tea plantations grew from zero to 27.2 percent between

[38] Originally the erstwhile Ahom territory alone and later for the whole of the Brahmaputra Valley that was under common Commissionership [Gait, E.A., *A History of Assam* (second edition, Calcutta/Simla, 1926), p. 337]

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1839 to 1897-98 while acreage under rice kept pace with a slow growth (Das and Saikia, 2011). Under the pressure of an increasing immigrant population, the prices of paddy and other peasant crops recorded a rising trend, but not beyond the rates at which these could be obtained from Bengal. Hence, Assamese peasants' gain from the prices remained modest.

3.3: Rice Ecosystem in Assam and its Method of Cultivation:

Rice is mainly grown in rainfed ecosystems which are about 78 percent of total rice area in the state. The rainfed areas are further classified into upland (un-bunded) and shallow land (which is defined as medium land, 0-30cm water), areas with intermittent water (30-100cm water) and deep water (>100cm water). Of the total rainfed area of 1.96 million hectares the combined upland and shallow land was 60 percent of total rice area, low land (having intermittent water) was 26 percent and 14 percent of area was under deep water. With this diversity of production system, the rice economy in Assam is complex and challenging. Wide variation of physiographic features and climatic characteristics have resulted three distinct growing seasons of rice viz., *Ahu or Aus* (pre-*kharif*:autumn rice harvested in July-August); *Sali or Aman and Bao*[39](*kharif*: winter rice harvested in November-December) and *Boro* (*rabi*: summer rice harvested in March-April) besides a number of local varieties.[40] Medium and low lands were suitable for *Ahu* and *Sali* rice. *Ahu* variety is photo period insensitive (sunlight insensitive) and can be grown as early *Ahu* as pre-flood crop in flood affected areas whereas normal *Ahu* is grown in the areas where risk of flood is minimal (Ahmed et al., 2011). Although *Ahudhan* can be sown broadcast or transplanted, the broadcast type is popular. The growing season for broadcast *Ahu* extends from March-April to June-July, whereas for transplanted one it extends from June-July to October-November. Early *Ahu* matures within 80-130 days while normal *Ahu* within 100-135 days, grown on relatively higher grounds and harvested from June to August. While normal *Ahu* crop is grown under rainfed condition early *Ahu* is grown under irrigated condition. *Ahu* rice is confined to the plain districts of the Brahmaputra valley and Cachar. The *Sali* variety of winter rice is a dominant crop (accounting for more than 70% of the TCA) of the state grown throughout the state and is grown by the transplantation method while *Bao* rice is sown by the broadcast method.

[39] Deep water or floating rice.
[40]On the basis of the time of seed sawing and seed harvesting crops are classified as *kharif*, pre-*kharif* or *rabi* or winter, autumn or summer

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Sali is sown in seed-beds (commonly called *kathiatoli*) relatively high lands in June and July, transplanted in July or August and harvested from November and December. *Sali* class mainly includes normal *Sali* (*Sali* with coarse grains, *lahi* with medium grains), *joha* (scented), *chakua* (semi glutinous), *bora* (glutinous), late *Sali*, *asra* (up to water depth 100cm) and *bao* (red rice). *Baodhan* is grown in some low-lying flood prone areas of the state along with *Ahu*. It is sown broadcast in March-April and harvested during November-December and thus the crop is treated as winter rice[41]. *Asra* and *bao* have the capacity to withstand water stagnation or flood to various levels whereas late *Sali* is mainly suitable as post flood crop in flood endemic and also when *Ahu* crop is delayed due to late occurrence of monsoon in flood free double cropped areas. *Boro* rice (summer paddy) is grown in rainfed low-land which utilized the residual soil moisture having assured irrigation facilities (Bhowmick et al., 2005). *Boro* is grown along the margins of *beels* (swamps) by the transplantation method in November-December and is harvested in April-May. The lesson derived from rapid adoption of *Boro* rice in the neighbouring West Bengal and Bangladesh (Bhalla and Singh, 2000) has been adopted. Now-a-days, different varieties of new hybrid rice introduction in rice cultivation with differences in maturing period leads to a conflict on classifying the rice crop as *Sali* or *Ahu* or *Boro*.

Table-3.2: Rice Area by Ecosystems in Assam:

Ecosystems	Area('000 ha)	% of rainfed area	% of total rice area
Total rainfed rice	1959	100	78
Upland	544	28	22
Shallow (medium land) (0-30cm)	629	32	25
Intermittent (low land) (30-100cm)	514	26	21
Deep Water (>100cm)	272	14	10
Total irrigated rice	529	-	22
Wet season	412	-	17
Dry season	117	-	5
Total rice area	2488	-	100

Source: Huke and Huke (1997)

Area and proportion of shallow or medium land to total rice area is highest in the state. As rice production in the state is mainly dependent on rainfall, the aspects of precipitation - its timely arrival, adequacy, consistency and regularity have specific importance. On an average the state receives annual rainfall (normal) in different seasons as in winter (December to February) 48mm; in summer (March to May) 555mm; in

[41]Rice in Assam, 1981, Department of Agriculture, Government of Assam, p. 3.

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monsoon (June to September) 1523mm and in post-monsoon (October to November) 168mm and in all seasons (January to December) 2295mm.[42]

3.4: Rice Production Scenario in Assam in Recent Decades:

Since independence, the area under rice increased by about 64 percent, while the production has more than doubled registering about 116 percent growth, on account of area expansion and yield growth. However, Bhowmick et al., (2005) said, "The linear growth rate of productivity is barely 38 percent during the long period, which is quite low". To draw a precise comparison about the changes in area, production and yield of rice in the state over a long period from 1950-51 to 2010-11, the entire period is sub-divided into two: (i) period from 1950-51, starting of economic planning to 1980s, pre-economic reform and (ii) from period of economic reforms, 1990-91 to post reforms period.

(i)Trends and decadal growth of Area, Production and Productivity of Rice in Assam from 1950-51 to 1980s:

During 1950-51, total rice area in Assam was 1547 thousand hectares, total production of rice was 1398 thousand MT and the yield of rice was 919kg per hectare. During 1987-88, volume of area, production and yield increased to 2336 thousand hectares, 2715.7 thousand MT and 1180kg per hectare respectively. The compound growth rate of rice area during 1950-51 to 1960-61 was 1.04 percent which rose to 1.41 percent during 1960-61 to 1970-71, to 1.43 percent during 1970-71 to 1980-81 but fell to 0.38 percent during 1980-81 to 1987-88. The CAGR of rice production were 1.57 percent, 1.98 percent, 2.42 percent and 1.06 percent respectively and the growth rate of yield were 0.52 percent, 0.54 percent, 0.82 percent and 0.89 percent respectively during these periods. The CAGR of rice productivity in India during 1951-72 was 1.2 percent (Das, 1984). The most worrisome aspect is that the aggregate growth of area slowed down considerably in 1980-81 to 1987-88, and the productivity growth also staggered at a rate lesser than the population growth rate.

During 1970s, *Sali* rice covered 17 lakh hectares (71% of total rice area) of which 12 lakh hectares were under flood free shallow lowland. Shallow lowland is as good as irrigated areas and high yielding varieties like *Ranjit*, *Mahsuri*, *Bahadur*, *Pankaj* and

[42]RMC IMD, LGBI Airport, Guwahati, through Directorate of Agriculture, Assam, 2013.

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improved *Manohar Sali*, etc. can be fitted well and thus productivity of rice can be increased (Ahmed et al., 2011). *Ahu* paddy was grown in 4 lakh hectares (about 23% of gross rice area) in the state during 1970s. Summer rice was concentrated mainly in Goalpara, Kamrup and Darrang districts covered around 34 thousand hectares (only 6% of total rice area) during 1970s (Statistical Hand Book, Assam, 1980; Ahmed et al., 2011). While the 'typical' *Boro* rice was limited to some pockets, the area under irrigated *Boro* rice has been increasing gradually since 1980. Among the intra seasonal rice culture, the *Boro* rice emerged as the fastest growing alternative (Bhowmick et al., 2005).

Production of rice has been fluctuating overtime (Bezbaruah, 1997). Out of 2523 thousand MT of total rice produced in the state in 1980-81, *Sali* rice was 1978 thousand MT, *Ahu* rice was 502 thousand MT and *Boro* rice was 43 thousand MT. Contribution of *Sali* rice to total rice production decreased to 67 percent in 1990s from 72-73 percent in 1970s.

Although productivity of total rice in the state has been increasing since 1950-51 to 1987-88, it was well below the national average, the productivity of rice in the state was stuck at 1.35MT per hectare compared to about 2MT in India. The productivity of rice among *Ahu*, *Sali* and *Boro* is very different. Out of three varieties, winter rice comes first in terms of production and productivity in the earlier period. While the productivity of *Ahu* rice declined, productivity of *Boro* rice was fluctuating. Table 3.3 shows the average yield of three seasonal varieties of rice and their CAGR since 1951-52 to 1987-88.

Table-3.3: Average productivity of rice in different seasons of the year from 1951-52 to 1987-88(kg/ha):

Year	*Ahu* rice	*Sali* rice	*Boro* rice	Total rice
1951-52	663	987	901	918
1961-62	722	1032	893	968
1971-72	622	1133	1494	985
1981-82	647	1138	993	1109
1987-88	705	1344	1315	1180
CAGR of productivity during 1951-52 to 1987-88 (in %)	0.17	0.84	1.03	0.68

Source: (i) Das (1984); (ii) Rahman (2006).

The growth rate of productivity of *Ahu* rice was lower than other seasonal varieties which resulted low growth in total rice.

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(ii) Trends and decadal growth of Area, Production and Productivity of Rice in Assam since 1990-91:

Total area under rice in the state has increased from 23.36 lakh hectares in 1987-88 to 26.46 lakh hectares in 2000-01, highest in area while it has ever declined to 21.89 lakh hectares in 2006-07. Winter rice dominates in both area and production, followed by autumn and summer rice. The area under winter rice was 16.47 lakh hectares during 2007-08. Absolute area under autumn rice fell to 276 thousand hectares in 2011-12. On the other hand, area under summer rice increased from 117 thousand hectares in 1990-91 to 394 thousand hectares in 2011-12. During the period of 1991-92 to 2007-08 acreage share of summer paddy increased by around 6 percent whereas the same in case of autumn paddy and winter paddy declined by around 8 percent and 3 percent respectively (Mandal, 2011). Increase in summer area may be the cause for less time span required for the crop from sowing to harvesting with a higher yield rate.

In 2001-02, estimated demand for rice in the state was 39.17 lakh MT while estimated production of rice was 40.30 lakh MT and thus 1.13 lakh MT can be surplus production. During the year 2010-11 the state could produce all time record production of rice, 50.33 lakh MT registering about 14 percent increase in rice production compared to the previous year. Production of winter rice has decreased from 2565 thousand MT in 1990-91 to 1950 thousand MT in 2006-07; thereafter it has increased and ultimately reached to 3766 thousand MT in 2013-14. Similarly, production of autumn rice declined from 614 thousand MT in 1992-93 to 299 thousand MT in 2013-14. On the other hand, area and production of the summer (*Boro*) rice increased while area gained additional 7 percent, the production gained 11 percent during the period of 1989 to 2000 (Ahmed et al., 2011). Production of summer rice has increased from 183 thousand MT in 1990-91 to 1189 thousand MT in 2013-14.

In case of yield of different varieties of rice, summer rice has higher productivity and its growth rate is more than other two seasonal variety of rice. Although the cost of production of *kharif* rice is low, so is the productivity, largely because the farmers are hesitat to provide adequate inputs to this crop for fear of flood. Due to localized drought like situation and severe floods that the state had experienced during the peak *Sali* paddy season, yield rate of winter rice was low. To ensure sustainability of rice production system, a discernible break through in the productivity of winter rice is most essential as

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larger area of rice is occupied by winter paddy. The trend of yield rate of autumn rice was erratic during the period 2004-05 to 2010-11 but in last few years it has been encouraging. Summer rice performed outstandingly in the last decade, recording over two-fold increase in productivity level. Thus, the popularity of summer paddy among the farmers has risen and brought changes in the distribution of total paddy area among its seasonal verities of the state. There is no doubt that the increase in rice production in the state in recent years is the result of increase in yield. However, as compared to the other high rice growing states of the country as well as from the national average of yield Assam is lying behind. Table 3.4 shows the trends of area, production and yield of rice in Assam since 1990-91.

Table-3.4: Trend of Area, Production and Yield of Rice in Assam since 1990-91:

Years	Area (in '000 hectares)				Production ('000 MT)				Yield (Kg/Ha)			
	A R	WR	SR	TR	AR	WR	SR	TR	AR	WR	SR	TR
1990-91	608	801	117	2526	522	2565	183	3270	873	1446	1556	1313
1991-92	639	1805	128	2572	494	2487	216	3197	795	1399	1684	1006
1992-93	635	1776	148	2559	614	2442	243	3299	982	1396	1645	1290
1993-94	637	1798	128	2563	587	2556	219	3362	978	1434	1630	1323
1994-95	647	1708	132	2487	552	2590	235	3377	973	1472	1615	1350
1995-96	625	1760	155	2540	516	2623	251	3390	839	1513	1619	1354
1996-97	620	1736	172	2528	519	2455	349	3323	864	1494	1805	1336
1997-98	607	1743	175	2526	518	2456	348	3322	864	1493	1806	1359
1998-99	595	1635	224	2454	521	2288	446	3255	889	1474	1992	1326
1999-2000	557	1794	295	2646	514	2693	654	3861	938	1524	2219	1483
2000-01	540	1777	329	2646	558	2760	681	3999	1050	1576	2068	1568
2001-02	496	1715	326	2537	488	2713	653	3854	1000	1607	2003	1539
2002-03	464	1749	327	2540	445	2671	622	3738	973	1550	1901	1488
2003-04	441	1769	319	2529	430	2877	573	3880	991	1651	1794	1534
2004-05	436	1636	311	2383	286	2574	610	3470	667	1598	1959	1475
2005-06	398	1707	315	2420	398	2594	560	3552	1016	1543	1780	1487
2006-07	379	1498	312	2189	336	1950	630	2916	899	1321	2017	1369
2007-08	354	1647	323	2324	348	2239	732	3319	999	1380	2267	1445
2008-09	351	1773	360	2484	374	2866	768	4008	1084	1641	2133	1635
2009-10	346	1789	394	2529	335	3214	860	4409	982	1894	2185	1743
2010-11	313	1859	399	2571	356	3649	1028	5033	1155	1993	2577	1983
2011-12	276	1876	394	2546	338	3298	1080	4716	1242	1785	2744	1874
2012-13	238	1857	393	2488	313	3710	1165	5188	1317	1998	2965	2061
2013-14	223	1881	399	2503	299	3766	1189	5254	1340	2002	2981	2075

Note: Total may not be equalled due to rounding off to nearest zero; AR: Autumn Rice, WR: Winter Rice, SR: Summer Rice.

Source: (i) Directorate of Economics and Statistics, Govt. of Assam; (ii) Assam Vision, 2025

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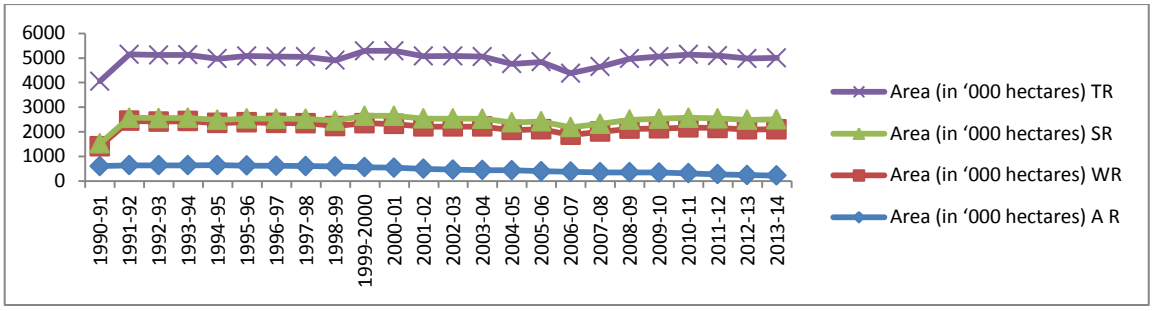

Fig.3.1: Trend of Area of Rice in Assam since 1990-91

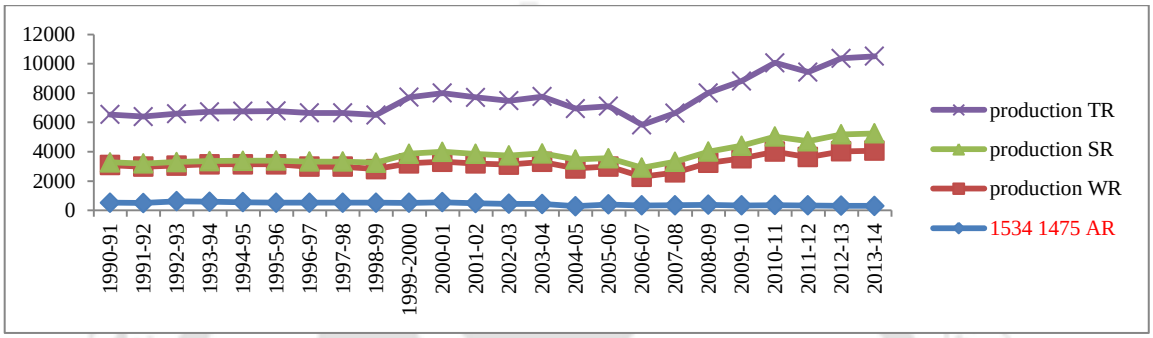

Fig.3.2: Trend of Production of Rice in Assam since 1990-91

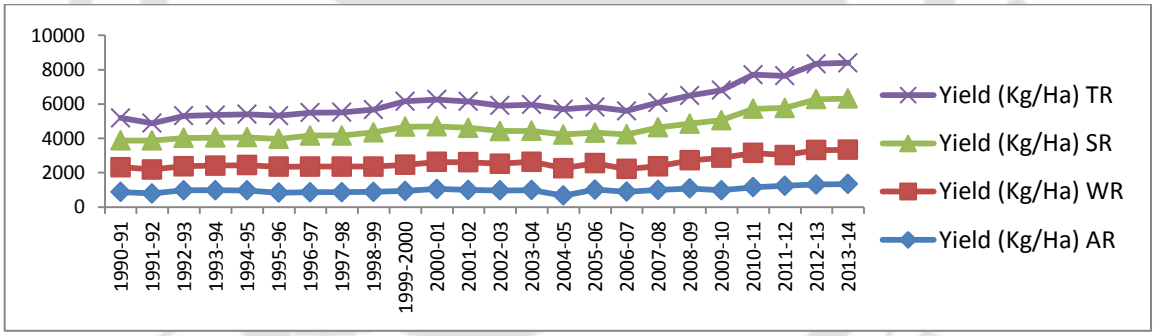

Fig.3.3: Trend of Yield of Rice in Assam since 1990-91

In table 3.5 we calculated the decadal compound growth rates of area, production and yield of rice in Assam from 1950-51 to 2013-14.

Table-3.5: Decadal Compound Growth Rates of Area, Production and Yield of Rice by season in Assam from 1950-51 to 2013-14: (in %)

Period	Area				Production				Yield			
	AR	WR	SR	TR	AR	WR	SR	TR	AR	WR	SR	TR
1950-51 to1960-61	-	-	-	1.04	-	-	-	1.57	-0.48	1.14	0.27	0.52
1960-61 to 1970-71	-	-	-	1.41	-	-	-	1.98	0.22	0.74	3.76	0.54
1970-71 to 1980-81	-0.45	0.45	1.06	1.43	-1.14	-0.12	1.96	2.42	1.29	0.81	0.23	0.82
1980-81 to 1990-91	0.30	1.09	11.33	1.05	2.44	4.05	13.63	2.63	0.52	1.71	2.03	1.70
1990-91 to	-1.18	-0.13	10.89	0.47	0.67	0.74	14.04	2.03	1.86	0.86	2.89	1.79

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2000-01												
2000-01 to 2013-14	-6.12	0.41	1.95	-0.40	-4.36	2.24	4.06	1.97	1.76	1.72	2.65	2.02
1970-71 to 2013-14	-2.34	0.46	5.75	0.55	-1.00	1.81	8.09	2.29	1.43	1.35	2.05	1.66
1990-91 to 2013-14	-4.09	0.18	5.24	-0.04	-2.30	1.61	8.11	2.00	1.80	1.36	1.01	1.93

Note: AR: Autumn Rice; WR: Winter Rice; SR: Summer Rice; TR: Total Rice.
Source: Calculated by the Author

By computing CAGR of area, production and yield of three seasonal rice varieties in Assam during nearly last six decades, it was found that there was a negative growth in production of autumn rice barring from 1980-81 to 2000-01because of negative growth in area though yield growth rate was at 1.8 percent from 1970-71 to 2013-14. Growth rate of production of winter rice had marginally increased by 1.61 percent due to growth in yield by 1.36 percent but there was a spectacular growth in area and yield of summer rice which resulted to 8.11 percent growth in production in summer rice during the period of 1990-91 to 2013-14.

The picture of decadal growth of area, production and yield is as follows. The overall growth of area under winter rice decelerated fast even showed negative growth, while the production growth has been positive all through since 1970s due to rise in growth rate of yield. Since 1990 growth of area and production of autumn rice have been falling and it became negative. In contrast, the summer rice showed a phenomenal growth. As a result, there was an overall upsurge in growth rate of summer rice area, especially in the 1980s and the 1990s. With significant growth in area and yield of summer rice, growth of production increased till 1990s but in next decade growth rates of summer rice fell. The question therefore has been that could summer rice be the main driver of future growth in rice economy in the state (Bhowmick, et al., 2005).

The growth scenario of rice production in the state can further be analysed by calculating annual exponential growth rates (exponential growth has the advantage over CAGR that it takes into account all observations, CAGR only accounts for the first and the last observations). Table 3.6 presents the calculated values of exponential growth rates of area, production and yield of rice by seasons by taking log regression from time series data of 24 years from 1990-91 to 2013-14 from Table 3.4.

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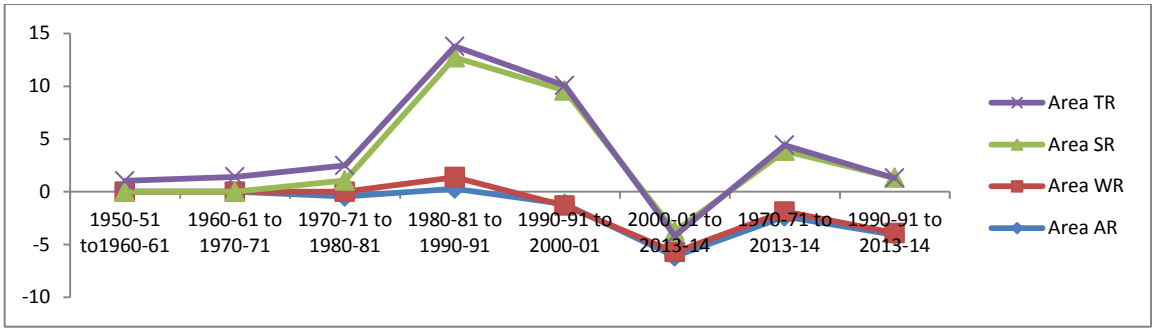

Fig.3.4: Decadal Compound Growth Rates of Area of Rice by season in Assam from 1950-51 to 2013-14

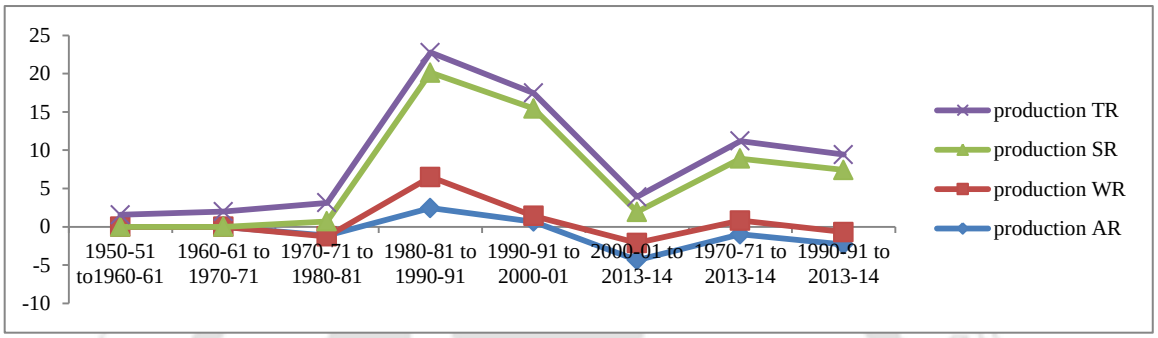

Fig.3.5: Decadal Compound Growth Rates of Production of Rice by season in Assam from 1950-51 to 2013-14

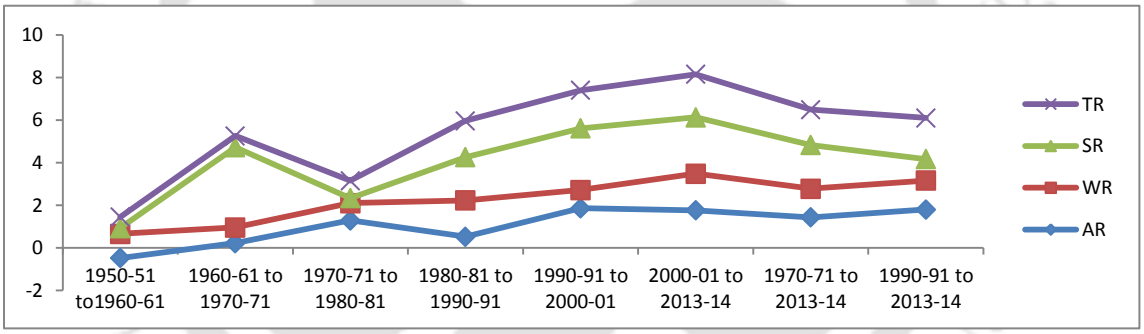

Fig.3.6: Decadal Compound Growth Rates of Yield of Rice by season in Assam from 1950-51 to 2013-14

Table-3.6: Comparison of Exponential Growth and CAGR of Area, Production and Yield of rice by season from 1990-91 to 2013-14: (in %)

Growth Rates	Area				Production				Yield			
	AR	WR	SR	TR	AR	WR	SR	TR	AR	WR	SR	TR
EGR	-4.51	0.08	5.73	-0.17	-2.95	1.35	7.88	1.72	1.39	1.25	2.35	2.06
CAGR	-4.09	0.18	5.24	-0.04	-2.30	1.61	8.11	2.00	1.80	1.36	1.01	1.93

Note: EGR: Exponential Growth Rate; AR: Autumn Rice; WR: Winter Rice; SR: Summer Rice
Source: Calculated by the author

Table 3.6 reveals that the exponential growth rates as well as CAGR of area and production of autumn rice and area in total rice in Assam has been from 1990-91 to 2013-14. The growth rates of area and production of winter rice and summer rice and production of total rice are positive and highly significant at 5 percent probability level, but growth rates of area and production of winter rice are lesser than the summer rice. Moreover, growth rate of yield of all seasonal varieties of rice in Assam during 1990-91

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to 2013-14 are positive and highly significant with time at 5 percent probability level, however growth rate of winter rice yield is comparatively lower. Thus, by comparing CAGR of area, production and yield of seasonal rice varieties with its exponential growth rates in Assam during 1990-91 to 2013-14 a similar trend is observed except some deviation in the result of summer rice yield.

Table-3.7: Change in percentage share of Area and Production of three seasonal and total rice crops to total crops excluding plantation crops in Assam since 1990-91:

Year	Rice Area Share of GCA (%)				Rice Production Share of All Crops (%)			
	Autumn	Winter	Summer	Total	Autumn	Winter	Summer	Total
1990-91	17.80	52.74	3.43	73.97	8.58	42.14	3.1	53.82
1991-92	18.95	53.53	3.81	76.29	-	-	-	-
1992-93	19.09	53.38	4.45	76.92	-	-	-	-
1993-94	19.26	54.39	3.88	77.53	-	-	-	-
1994-95	20.27	52.69	4.06	77.02	-	-	-	-
1995-96	18.83	53.06	4.68	76.57	-	-	-	-
1996-97	18.62	52.19	5.16	75.97	-	-	-	-
1997-98	18.25	52.39	5.26	75.90	-	-	-	-
1998-99	18.22	50.08	6.86	75.16	-	-	-	-
1999-2000	15.54	50.06	8.23	73.83	6.57	34.42	8.36	49.35
2000-01	15.2	49.86	9.23	74.29	7.14	35.33	8.72	51.19
2001-02	14.35	49.6	9.43	73.38	6.25	34.72	8.36	49.33
2002-03	13.52	50.96	9.53	74.01	5.91	35.48	8.26	49.65
2003-04	13.52	54.24	9.79	77.55	-	-	-	-
2004-05	13.5	50.74	9.65	73.89	3.26	29.33	6.95	39.54
2005-06	12.45	53.4	9.8	75.65	5.97	38.90	8.4	53.27
2006-07	12.53	49.5	10.3	72.33	5.20	30.20	9.76	45.16
2007-08	11.22	52.2	10.23	73.65	5.05	32.46	10.61	48.12
2008-09	10.63	53.68	10.9	75.21	4.84	37.08	9.94	51.86
2009-10	10.17	52.6	11.58	74.35	4.02	38.56	10.32	52.90
2010-11	9.1	53.9	11.57	74.57	3.94	40.38	11.38	55.70
2011-12	8.02	54.52	11.45	73.99	3.83	37.38	12.24	53.45

Note: GCA Gross Cropped Area

Source: (i) Basic Agricultural Statistics, Directorate of Agriculture, Govt. of Assam, Various Issues; (ii) Mandal, 2011; (iii) Calculated by the author.

Table 3.7 shows the changes in percentage share of area and production of rice by season to the total cropped area and production in Assam where share of autumn rice area has declined from 17.80 percent to 8.02 percent and production share declined from 8.58 percent to 3.83 percent during 1990-91 to 2011-12. Area share of winter rice remained more or less same while production share falls from 42.14 to 37.38 percent during the same period. The share of area and production of summer rice to total crop significantly increased from 3.43 percent to 11.45 percent and from 3.1 percent to 12.24 percent respectively during the period. Share of area and production of total rice to total crops remains almost same in 1990-91 and 2011-12 with little variation amidst the period.

With an improvement in yield of all three seasonal rice the yield of total rice in the state has been increased in recent years. However, in comparison to the all India

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average the yield of rice in Assam is still low and there is a considerable gap between state and the nation which can be visualized from Table 3.8.

Table-3.8: Yield rate of rice in Assam and All India: (kg/hectare)

Year	Assam	All India	Yield gap with respect to yield in Assam (in %)
1970-71	1022	1123	9.88
1980-81	1109	1336	20.47
1985-86	1160	1552	33.79
1990-91	1313	1740	32.52
1995-96	1354	1860	37.37
1996-97	1336	1882	40.87
1997-98	1359	1900	39.81
1998-99	1326	1921	44.87
1999-2000	1483	1986	33.92
2000-01	1568	1901	21.24
2001-02	1539	2079	35.09
2002-03	1488	1744	17.20
2003-04	1534	2078	35.46
2004-05	1475	1984	34.51
2005-06	1487	2102	41.36
2006-07	1369	2131	55.66
2007-08	1445	2203	52.46
2008-09	1635	2178	33.21
2009-10	1743	2125	21.92
2010-11	1983	2239	12.91
2011-12	1874	2372	26.57
2012-13	2061	2384	15.67
2013-14	2075	2424	16.82

Source: (i) CMIE, Report on Agriculture, November 1998; (ii) Assam Vision 2025*;* (iii) Assam Science Society, 2002; (iv) Economic Survey, 2009-10, 2011-12, 2013-14; (v) Agricultural Statistics at a Glance, 2008; (vi) Calculated by the author.

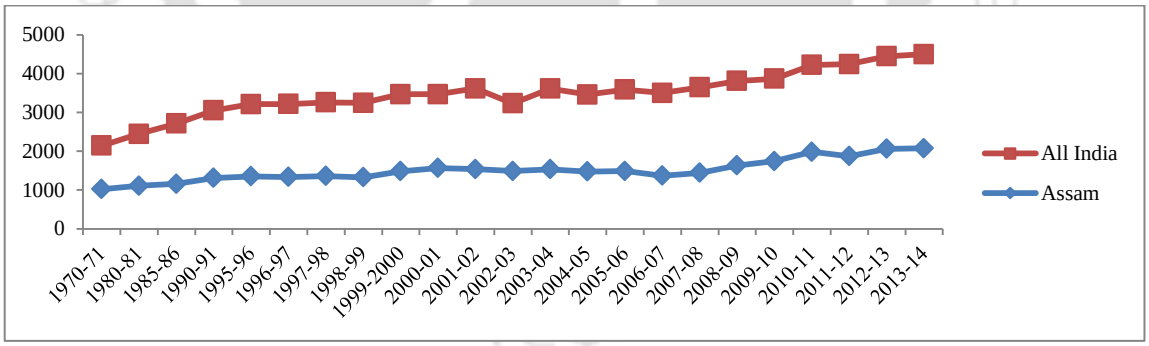

Fig.3.7: Yield rate of rice in Assam and All India

It is observed that the yield rate of rice in Assam throughout the entire period from 1970-71 to 2013-14 has been lower than all India averages. Mahanta and Neog (1968) mentioned that in 1950-51, the yield rate of rice in Assam was about 30 percent higher than that in India. But from 1970s Assam could not match with the growth of rice yield in India. Yield of rice per hectare during 1974-75 to 1978-79 (5 years average) in Assam was 983kg per hectare whereas it was 2247kg in Haryana, 1520kg in Kerala, 1271kg in

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West Bengal, 1173kg in Tripura and in all India it was 1203kg per hectare.[43]In Assam, improvement in productivity of rice has been marginal and fluctuating. While the productivity of rice in all India increased by 96.17 percent over the period from 1970-71 to 2007-08, the productivity of rice in Assam increased only by 41.39 percent during this period. Although the rice yield in the state is increasing gradually, the gap between state average and the national average is also rapidly increasing posing a serious future policy challenge. Over the years, the gap between average rice yield in Assam and India has increased from about 100 kg/ha in 1970-71 to about 350 kg/ha in 2013-14. In comparison to Punjab, Haryana, Tamil Nadu, etc. high rice growing states of India, the productivity of rice in Assam is low. In 1999-2000, where Punjab produced 5500 kg/ha, Tamil Nadu produced 3276 kg/ha and Haryana produced 2778 kg/ha, Assam has produced only 1483 kg/ha. But one interesting thing is that during last two decades from 1990-91 to 2011-12, the growth rate of yield of total rice in Assam becomes higher than the growth rate in India. While the CAGR of yield of total rice in India was 1.49 percent, it was 1.72 percent in Assam during the period.

Yield Gap in Rice Production:

Since there is no scope for horizontal expansion of the rice area, it is a great challenge for the state to produce more food from the limited land available. In order to meet the effective demand, the main options are breaking the yield ceiling of the existing varieties on the one hand and bridging the yield gap on the other hand. The rice yield in demonstration plots have been substantially more than the yield obtained by the farmers in their field. Therefore, there is possibility of increasing the yield level in the farmer's field in the state. The gap in productivity levels is not just in terms of aggregate yields, but is also true under both irrigated and unirrigated situations. Table 3.9 reveals the gap of rice production of some modern varities at research station and actual rice field in Assam.

Table-3.9: Yield difference between Research Station and Farmer's Field in some modern varieties of rice in Assam (kg/ha):

Modern Varieties	Season	Yield at Research Station	Yield at Farmer's Field
Ranjit	*Sali*	5500	4500
Bahadur	*Sali*	5400	4500
Luit	*Late Sali*	3500	3000
Jaymati	*Boro*	4500	5500
Lachit	*Ahu*	4000	3500

[43]Ministry of Agriculture, Estimates of area and Production of principal crops in India, 1978-79, New Delhi, 1980.

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Source: Rice Knowledge Management Portal, 2011

The reasons for the yield gap in rice may be different like vagaries of monsoon with weather aberrations, frequent flooding and water inundation in plains, periodic droughts in between showers in critical growth stages, high incidence of insect pest due to high humidity, non adherence of recommended package and practices, ignorance, inadequate supply of quality seeds, low light intensity during the *kharif* season, lack of awareness about the new varieties/technologies, management care, etc. (Ahmed et al., 2011). Investment in the area of infrastructure development and input marketing would be useful to thoroughly diagnose the cause-effect relationship and advocate suitable policy measures to overcome this lag.

3.4.1: Growth and Instability in Rice Production in Assam:

The rice production confronted the stagnant growth and almost static accompanied by low and unstable yield till the early 1980s. Although there have been some achievements in the production, especially in the late 1980s, the process again has weakened in the early 1990s mainly because of decline of winter rice area. More adoption of high yielding varieties, expansion of irrigation and a rapid shift in summer cultivation practices has improved the performance of summer and winter rice. During 2000s constant fall in area of autumn rice and fall in area and yield in winter and summer rice in the first half of 2000s caused decline in total production of rice. After 2007-08 area and yield of winter and summer rice increased steadily and hence total production of rice in the state could cross 5 million MT in 2010-11.

Flood, water logging, uneven distribution of rainfall and soil erosion are major sources of instability of rice production in the state. Low rate of adoption of modern techniques of production is also causing instability in production of rice in the state (Mandal, 2011).

3.4.2: Emergence of *Boro* or Summer Rice in Assam:

While both area and production of winter rice and autumn rice were stagnating, the summer rice showed the prospect for rapid growth. From barely 36 thousand hectares under *Boro* rice in the early 1970s, it expanded to as high as 399 thousand hectare in 2013-14. The rate of increase accelerated more rapidly after the 1980s. At the aggregate level, the summer rice area increased from 2 percent to more than 15 percent during the

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last 40 years. The area expansion when juxtaposed by productivity increase enhanced the importance of *Boro* rice in rice economy in Assam. Introduction of the *Boro* rice cultivation has contributed towards increase in the overall rice yield as well as total rice production in the state. The growth rate for summer rice area was exceptionally high at 9.85 percent and that of production was also impressive at 12.69 percent during 1990-91 to 2000-01. Comparing the yield of winter and summer rice, the later was 3.14MT per hectare, at least a ton of additional rice/ha during the triennium 1998-2000. Such a high growth was attributed to the implementation of suitable irrigation policy, which facilitated adoption of modern variety for summer rice (Bhowmick et al., 2005).

The increase in area under *Boro* rice has not only improved the utilization of *rabi* fallow land (rice fallow area in the state is about 15.49 lakh hectares), but has also enhanced the cropping intensity to more than 145 percent. This signifies that the *Boro* rice was an appropriate alternative to the risky winter rice in some of the districts in Assam. Achievement in summer rice can be done through creation of assured shallow tube well irrigation with assistance of World Bank (Assam Rural Infrastructure and Agriculture Service Project-ARIASP) and NABARD (Special *Kishan* Yojana-SKY) scheme (Assam Vision 2025-Agriculture). It is to be noted that the productivity of rice increased, even within lower irrigated area. This indicated that irrigation development, credit availability, accessibility of extension services, etc. would further enhance productivity.

3.4.3: Use of High Yielding Variety (HYV) and Hybrid Rice in Assam:

An important development during the post Green Revolution period (1970-73 to 1980-83) was the successful introduction of HYV rice, mainly IR-8 in the assured irrigated areas (Bhalla and Singh, 2000). In 1970-71, 134 thousand hectares (6.79% of TRA) was under HYV rice in the state which had increased to 1589 thousand hectares (63.5% of TRA) in 2013-14. HYVs are able to give higher yields than the traditional varieties, especially if the supply of nutrients to the soil can be increased. IR-8 variety had the potential to yield over eight tons per hectare under ideal cultural practices and field conditions, compared to less than three tons per hectare for traditional varieties in the tropics.

The Green Revolution in Haryana and Punjab is essentially the outcome of the extensive use of HYV seeds. Since 2004-05 about cent percent rice area in Punjab are

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under HYV seeds (Statistical Abstract of Punjab, 2005). It becomes possible because of the provisions of assured water supply, and mainly because of the emergence of the big capitalist farmers backed by a strong political-bureaucratic nexus. But Assam was deprived of all such advantages. Neither is there a class of capitalist farmers nor the government's initiatives are forthcoming. There is absence of assured water supply and adequate supply of modern inputs. However, in a very feeble way, steps were taken by the state government to introduce both locally developed seeds as well as HYV seeds developed by the all Indian Agricultural Research Institutes (Das, 1984). The Department of Agriculture, Govt. of Assam has introduced the high yielding variety of paddy in the state in 1965-66 and a special rice production programme was launched in 1985-86 (Gopalakrishnan, 2000). Though there is a steady increase in the area under HYV seeds of rice in Assam, the CAGR of rice yield per hectare was only 1.52 percent for the period 1980-81 to 2009-10. HYV seeds seem to have contributed very little towards improving productivity of rice in the state during this period (Saikia, 2014).

Presently different modern varieties of rice have been developed and thus considering the productivity, peasants of Assam prefer IR-8, IR-36, Native Taichungnating-1, *Monohar Sali* (locally developed), *Mala*, *Pusa*, *Lachit*, *Masuri*, *Jaya*, *Ranjit*, *Ratna*, *China Boro*, *Biplov*, *Bahadur*, *Kaveri*, *KrishnaPadma*, *Hankai*, *Kolangi* and Ch-63. These varieties are grown in the manner as *Ahu*, *Sali* and *Boro* paddy in the corresponding seasons. Average yield of TN-1 and IR-8 is 809.4 kg/ha when grown as *Ahu* and *Sali* paddy, while 1011.7 kg/ha when grown as *Boro* paddy (Gazetteer of India: Assam State, 1999). The HYV paddy has been adopted mostly by the immigrant Muslim peasants in the erstwhile four districts of Assam viz., Kamrup, Nowong, Darrang and Goalpara during 1975-76.[44] Among the HYV paddy, *Monohar Sali* (67%) was the most popular among the peasants in Assam. Das (1984) states that the HYV programme in Assam had not become successful because of inadequate supply of improved seeds and other supporting inputs. Among different agro-climatic zones of Assam HYV Paddy area as percentage of total paddy area are highest in Central Brahmaputra Valley Zone (68.61%) followed by Hill Zone (67.31%), Lower Brahmaputra Valley Zone (65.29%), North Bank Plain Zone (58.22%), Upper Brahmaputra Valley Zone (57.09%) and Barak Valley Zone (50.10%) and in all Assam, 61.41% in 2006-07 (Mandal, 2011).

[44]In 1975-76, only 412.6 tones of HYV paddy seed were distributed throughout the state.

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Total area under HYV of autumn rice, winter rice, and summer rice in the state has increased from 1174.85 thousand hectares in 1990-91 to 1901 thousand hectares during 2011-12. However area has declined to 1589 thousand hectares in 2013-14 (Economic Survey, Assam, 2014-15) and area under HYV seeds for autumn rice decelerated from 2.35 lakh hectares in 2005-06 to 1.86 lakh hectares in 2011-12 (Economic Survey, Assam, 2012-13).

Table-3.10: Area and yield of High Yielding Variety (HYV) of rice in Assam: (Area in '000 hectares; Yield in kg/ha)

Period	Autumn Rice		Winter Rice		Summer Rice		Total Rice
	Area	Yield	Area	Yield	Area	Yield	Area
1990-91	359.12 (59.06)	-	736.69 (40.9)	-	79.05 (67.56)	-	1174.85 (46.51)
1991-92	312 (48.82)	-	762.54 (42.2)	-	75.02 (58.61)	-	1150.00 (44.71)
1992-93	289.88 (45.65)	-	780.28 (43.9)	-	66.83 (45.16)	-	1136.99 (44.43)
1993-94	258.97 (40.65)	-	797.46 (44.4)	-	87.70 (68.52)	-	1144.13 (44.64)
1994-95	239.11 (36.96)	-	778.06 (45.55)	-	99.51 (75.39)	-	1116.67 (44.90)
1995-96	239.74 (38.36)	-	797.16 (45.30)	-	116.14 (74.93)	-	1153.05 (45.40)
1996-97	252.76 (40.77)	-	821.47 (47.32)	-	127.07 (73.88)	-	1201.31 (47.52)
1997-98	234.99 (38.71)	-	875.75 (50.24)	-	136.75 (78.14)	-	1247.49 (49.39)
1998-99	218.40 (36.71)	-	880.72 (53.87)	-	174.83 (78.05)	-	1273.95 (51.91)
1999-00	208.04 (37.35)	1752	975.32 (54.37)	2068	217.73 (73.81)	1693	1401.09 (52.95)
2000-01	251.51 (46.58)	1804	971.86 (54.69)	2154	259.47 (78.87)	2459	1482.84 (56.04)
2001-02	250.18 (50.44)	1720	920.02 (53.65)	2308	259.03 (79.46)	2445	1429.22 (56.33)
2002-03	253.30 (54.59)	1839	937.47 (53.60)	2262	244.91 (74.89)	2518	1435.67 (56.52)
2003-04	216.22 (49.03)	1778	929.14 (52.52)	2263	221.33 (69.38)	2220	1366.70 (54.04)
2004-05	222.29 (50.98)	1851	863.49 (52.78)	2303	234.00 (75.24)	2296	1319.78 (55.38)
2005-06	234.72 (58.97)	1866	950.45 (55.68)	2281	265.53 (84.3)	2192	1450.70 (59.9)
2006-07	214.98 (56.72)	1686	863.05 (57.61)	1990	267.05 (85.6)	2228	1345.08 (61.45)
2007-08	223.00 (63.00)	1858	894.00 (54.28)	2152	278.00 (86.1)	2509	1395.55 (60.0)
2008-09	224.02 (63.82)	1959	974.74 (54.98)	2256	313.63 (87.12)	2371	1512.39 (60.9)
2009-10	228.60 (66.10)	1683	1019.82 (57.00)	2345	340.64 (86.46)	2554	1589.06 (62.83)
2010-11	213.00 (68.05)	1465	1134.00 (61.00)	2551	354.00 (88.72)	2819	1701.00 (66.2)
2011-12	186.00 (67.39)	1470	1161.00 (61.87)	2590	351.00 (89.1)	2825	1901 (74.7)
2012-13	160.00 (67.23)	1558	1170.00 (63.00)	2860	361.00 (91.86)	3280	1691 (68.0)

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2013-14	143.00 (64.13)	1585	1222.00 (64.97)	3010	224.00 (56.14)	3400	1589 (63.5)

Note: Parentheses measures % area under HYV by season.

Source: (i) Directorate of Agriculture, Govt. of Assam, (ii) Economic Survey, Assam, Various Issues, Directorate of Economics and Statistics, Govt. of Assam.

From the table 3.10, it is clear that area under HYV seeds of rice in Assam has increased steadily. In 2011-12 it increased to 74.7 percent of total rice area in the state but marginally falls in the two subsequent years. Among three seasonal varieties, adoption of HYV seeds is higher in summer rice. However, summer rice area under HYV seeds declined in 2013-14 and as a result total rice area under HYV seeds has also declined to 63.5 percent compared to about 78 percent acreage brought under HYV seeds in India. Area under HYV of autumn paddy as percentage of total autumn paddy area exhibited the highest growth followed by winter paddy and summer paddy during 1990-91 to 2011-12.

Iri Paddy Cultivation:

From the latter half of the 90's a new variety of paddy known as *Iri* paddy cultivation is becoming popular among *char* and low land areas of Assam.[45] This cultivation got boosted with the availability of shallow water pumps either as a part of the government scheme or by personaly purchase. It starts during January-February and is harvested after three months. During this period there is negligible rainfall which necessities the use of shallow water pumps. This variety of paddy is undertaken with HYV seeds, high doses of chemical fertilizers, employing large number of agricultural labour and substantial amount of water.Thus, the cost of production of this variety is higher than rest. The overall productivity of *iri* paddy is more than all other varieties of paddy cultivated by the char dwellers. Another important trend noticeable among *char* dwellers is that they are leasing of land in *kayam* (settled) areas in large scale for *iri* cultivation. Although the exact amount of land under this cultivation could not be ascertained yet it was clear that it is increasingly becoming popular among the *char* dwellers.

Hybrid Rice in Assam:

[45] There are 2251 char villages in Assam spread over 14 districts along the route of the mighty Brahmaputra (Chakraborty, 2006). Cultivable area under chars in Assam was 2.42 lakh hectares which was 8% of total cultivable land of the state (Land Utilization Statistics, Directorate of Economics & Statistics, Assam).

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In addition to the HYV rice, the State Agriculture Department has started cultivation of hybrid variety of rice on experimental basis since 2009-10 considering the productivity of hybrid rice is more than double of HYV rice as well as farm income. The area under the hybrid rice is increasing gradually in some pockets of Assam. Under the National Food Security Mission (NFSM), cultivation of hybrid rice is also one of the components. The area under hybrid variety of rice covers only 1.9 percent of the total area under rice in the state in the launching year which has increased to 8 percent of total rice area in 2013-14 in Assam (Economic Survey, Assam, 2014-15).

Table-3.11: Area under Hybrid Rice in Assam (Area in '000 hectare):

Crop	2009-10	2010-11	2011-12	2012-13	2013-14
Kharif Rice (Autumn & Winter)	32.9	37.7	2.5	12.4	25.0
Rabi Rice (Summer Rice)	14.1	25.0	21.7	84.8	178.0
Total	47.0 (1.9)	62.7 (2.4)	24.2 (1.0)	97.2 (3.9)	203.0 (8)

Note: Total figure may not be equal due to rounding off to nearest zero;P Provisional; Figure in parenthesis shows the percentage to Total Rice Area.
Source: Directorate of Agriculture, Assam.

Recently a new initiative for increase in rice production in Assam, System of Rice Intensification (SRI) method of cultivation was introduced among the farmers of the state as an alternative to increase per unit productivity of rice.[46] Devi and Ponnarasi (2009), has calculated cost and return of cultivation of rice both in conventional method and SRI method in Tamil Nadu and find that the total cost of cultivation per hectare was lower by about 10 percent in SRI method (Rs.21655) than conventional method (Rs.25914). Further, it could be seen that the net returns were higher in SRI (Rs.27009) than conventional (Rs.14499) method (see appendix Table III. 3). It was mainly due to the higher productivity of paddy in the SRI method. It was also observed that the benefit-cost ratio was higher in SRI (2.25%) than in conventional (1.56%) method. Jayapalreddy and Shenoy (2013) mentioned that "SRI paddy was introduced to offset the heavy cost of traditional paddy cultivation. Although large number of labour were needed for weed management in traditional paddy, minimal labour was required for weed management in SRI paddy." SRI was introduced in Assam under the National Food Security Mission

[46]SRI method of cultivation originated in Madagascar, developed by Fr. Henri de Laulanie in 1980. It saves costly seed, fertilizer, nutrient and weeds management, and irrigation water and crop duration with maximum production. SRI shorten the crop duration facilitating 10 to 15 days ahead of harvesting time in comparison to normal practices and thus open the scope for double cropping (Economic Survey Assam, 2014-15).

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(NFSM).[47] Area under SRI has been increased fast from 882.2 hectares in 2008-09 to 65150 hectares in 2012-13.

The scheme of NFSM-Rice, launched by the Government of India in 2007-08, has been implemented in 13 districts of Assam selected on the basis of low production and productivity of rice. After six years of implementation from 2007-08 to 2012-13 production of rice increased by 98 percent while productivity increased by 158 percent in the districts (Economic Survey, Assam, 2013-14). The CAGR of productivity and production of autumn rice during the last five years from 2006-07 to 2010-11 were 5.14 and 1.16 percent respectively while in winter rice, there has been a significant growth of 8.57 percent in productivity and 13.35 percent in production and the summer rice has a growth of 5.02 percent in productivity and 10.27 percent in production. The CAGR of total rice has been 8.01 percent in productivity and 11.53 percent in production.

3.5: Agro-ecological Zones in Assam and Rice Production:

In Assam, rice is grown throughout the state in wide range of seasons, soil types and water regimes. The seasonal pattern of area allocation has been highly uneven across different agro-ecological zones. Winter paddy is the most popular seasonal variety of paddy across different agro-climatic zones. The acreage share of total paddy has declined in all zones except Central Brahmaputra Valley Zone (CBVZ). Among the six agro-ecological zones in Assam, the Lower Brahmaputra Valley Zone (LBVZ) has been the largest zone, which occupied 35 percent of total rice area in the state, with 50 percent of winter rice area, 29 percent of autumn rice area and 45 percent of the state summer rice area. In LBVZ, acreage share of winter paddy is 38.73 percent of total cropped area (GCA) and 58.01 percent of total paddy area (TPA) of the zone, acreage share of autumn paddy is 14.75 percent of GCA and 22.10 percent in TPA and acreage share of summer paddy is 13.28 percent of GCA and 19.89 percent in TPA. In the North Bank Plain Zone (NBPZ), the area share under winter paddy is 46.61 percent of GCA and 68.68 percent of TPA, followed by autumn paddy 13.52 percent of GCA and 19.93 percent of TPA while summer paddy area was 7.73 percent of GCA in 2007-08. The LBVZ together with the NBPZ occupied more than 55 percent of GCA of the state. The area share of winter paddy in CBVZ is 46.1 percent of GCA and 62.16 percent of TPA; autumn paddy area is

[47]Diwakar, M. C., *Package of Practices of Rice Intensification (SRI)*, Directorate of Rice Development, Patna (2010).

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6.42 percent of GCA and 8.65 percent of TPA. It has the highest acreage share under summer paddy (21.65% of GCA and 29.19% of TPA) compared to other zones. In the CBVZ, *Boro* rice area jumped from almost negligible area about a decade ago, to the highest share of 21.65 percent followed by LBVZ (13.28%) (Bhowmick, 2005; Mandal, 2011). The area share by rice culture (across the seasons) shows that winter rice occupied as high as 91 percent of total area in Upper Brahmaputra Valley Zone (UBVZ) during the triennium 1999-2001. However, it decreased to 74.18 percent in 2007-08, still highest across zones. But in other two seasonal variety of rice, the acreage share is lowest of all zones, 2.79 percent and 0.88 percent of GCA in autumn and summer paddy respectively. In Barak Valley Zone (BVZ), the acreage share of winter paddy is more than two third (67.84%) of its GCA and 81.85 percent TPA. This is followed by autumn paddy and summer paddy. Hill Zone (HZ) has the largest share of its GCA under winter paddy, 57.11 percent and 86.63 percent of TPA, followed by autumn paddy 8.02 percent. It is the smallest zone with 5 percent area and 6 percent production of rice in the state (Bhowmick et al., 2005). With 82.88 percent of total paddy area in total cropped area, BVZ is the most paddy cultivated zone while the lowest share was observed at 65.93 percent in the HZ in 2007-08 (Basic Agricultural Statistics, Directorate of Agriculture, Govt. of Assam). The proportion of area under winter paddy has declined in all the agro-climatic zones except BVZ and UBZV which are relatively less prone to flood. The area share of autumn paddy has declined in all the zones. The proportion of areas under summer paddy has increased in all the zones except in BVZ (Statistical Hand Book Assam (various issues); Mandal (2010).

The acreage share of summer paddy has increased in all but Hill Zone during 1991-92 to 2007-08. Regarding the growth rate of area, a negative growth noticed in all but Hill Zone. However, summer paddy has a positive growth rate of area in all the Zones (Mandal, 2011). Like area, the share of production has also been the highest in the LBVZ at 28 percent of total production in the state while Hill Zone the least. However, the productivity of rice is the least in LBVZ; frequent occurrence of flood hampers performance. The effect of the critical interaction among the factors is also responsible for the inter-zonal disparities. The yield growth in all the rice types was high in BVZ with winter rice having the highest rate at 2.44 percent. But except summer rice, yield growth rate of rice was low in most of the zones. Barring a few exceptions, the growth performance of various zones in the last five decades has been identical to that of the

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state. Until 1970s the rate of growth in the rice area was impressive in all the zones except in NBPZ where the growth rate started increasing after 1970s. During 1990s, the growth of area showed declining trends and in some cases crossed the horizontal axis (i.e., negative growth). On the contrary, the growth rate of yield showed improvement during and after 1980s. The decadal growth performance has been uneven and associated with substantial variability. The variability is much higher in case of summer crop as the crop is highly dependent on the input availability. Table 3.12, 3.13 and 3.14 presented the relative share of rice area by zone and season wise and area, production and yield zone wise respectively.

Table-3.12: Relative share of total rice area, production and yield with cropping intensityin different Agro-ecological zones in Assam during1999-2001:

Agro-ecological Zones	Rice area as % of total rice area of the state	Rice area in ha*	Rice production in tone*	Rice yield (kg/ha)	Cropping intensity (%)
LBVZ	36.67	900048 (77)	959017 (29.46)	1065	150
CBVZ	14.34	352037 (62)	554025 (17.02)	1573	126
UBVZ	16.45	403512 (67)	660398 (20.29)	1636	131
NBPZ	18.52	454487 (67)	521369 (16.02)	1147	163
BVZ	8.98	220294 (93)	386163 (11.86)	1752	142
HZ	5.04	123744 (70)	173860 (5.34)	1404	165
All	100	2454122 (67)	3254832 (100)	1326	146

Note: * % of total cropped area of the respective zones and % of total production.
Source: (i) Statistical Hand Book, Assam, (2001), (ii) Bhowmick et al., (2005).

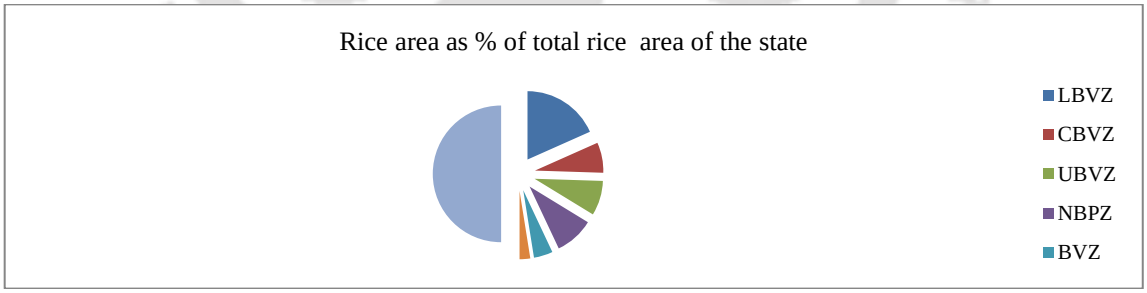

Fig.3.8: Relative share of total rice area in different Agro-ecological zones in Assam during1999-2001 (%).

Table-3.13: Trends in acreage share of different paddy seasons in area under total paddy across the agro-ecological zones from 1991-92 to 2007-08: (in %)

Agro-ecological zones	Paddy	1991-92	1993-94	1995-96	1997-98	1999-2000	2001-02	2003-04	2006-07	2007-08
LBVZ	Autumn	34.49	34.81	35.48	35.25	31.01	25.34	23.71	25.66	22.10
	Winter	60.56	60.52	58.35	57.15	56.00	57.27	59.04	53.62	58.01
	Summer	4.95	4.67	6.17	7.60	12.99	17.39	17.25	20.73	19.89
CBVZ	Autumn	23.96	24.00	24.69	25.92	17.01	18.28	15.81	12.41	8.65
	Winter	57.27	58.31	56.03	55.54	56.04	52.16	56.32	50.84	62.16

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	Summer	18.77	17.68	19.28	18.55	26.96	29.56	27.87	36.75	29.19
UBVZ	Autumn	13.34	10.67	9.51	6.98	8.35	8.00	5.49	3.98	3.58
	Winter	86.56	89.26	89.90	90.72	88.96	90.88	93.48	94.74	95.29
	Summer	0.10	0.07	0.60	2.30	2.70	1.12	1.03	1.28	1.13
NBPZ	Autumn	26.98	28.66	27.33	26.67	23.79	26.02	23.50	23.74	19.93
	Winter	72.32	69.82	69.52	68.83	67.64	63.68	66.65	66.46	68.68
	Summer	0.69	1.52	3.15	4.49	8.57	10.31	9.86	9.80	11.39
BVZ	Autumn	13.87	12.89	10.33	10.07	8.72	9.67	8.42	5.53	9.87
	Winter	79.60	79.92	84.09	84.24	84.85	83.94	84.38	88.06	81.85
	Summer	6.54	7.19	5.58	5.69	6.43	6.38	7.20	6.41	8.28
HZ	Autumn	-	-	-	-	-	-	-	-	12.16
	Winter	-	-	-	-	-	-	-	-	86.63
	Summer	-	-	-	-	-	-	-	-	1.21
Assam	Autumn	24.84	24.84	24.60	24.05	21.06	19.54	17.44	17.32	15.24
	Winter	70.16	70.16	69.29	69.02	67.80	67.60	69.93	68.41	70.87
	Summer	4.99	5.00	6.11	6.93	11.14	12.85	12.63	14.27	13.89

Source: Adopted from Basic Agricultural Statistics, Directorate of Agriculture, Government of Assam, Various Issues.

Table-3.14: Compound Annual Growth Rates of Area under paddy across zones in Assam, 1991-92 to 2007-08:

Zones/Crops	Autumn Rice	Winter Rice	Summer Rice	Total Rice	Total Cropped Area
LBVZ	-3.90	-1.05	10.96	-0.68	-0.48
CBVZ	-7.24	-1.57	2.53	-1.61	-1.87
UBVZ	-8.27	-0.48	18.01	-0.97	-1.18
NBPZ	-1.80	-0.26	14.95	0.04	0.13
BVZ	-3.08	0.22	1.68	-0.02	0.26
H Z	-0.51	0.33	14.98	0.30	0.49

Source: Calculated by the author from data on area under different crops collected from (a) Directorate of Agriculture (Basic Agricultural Statistics); (b) Directorate of Economics and Statistics (Estimates of area, production and average yield of principal crops in Assam), Govt. of Assam, Different Issues.

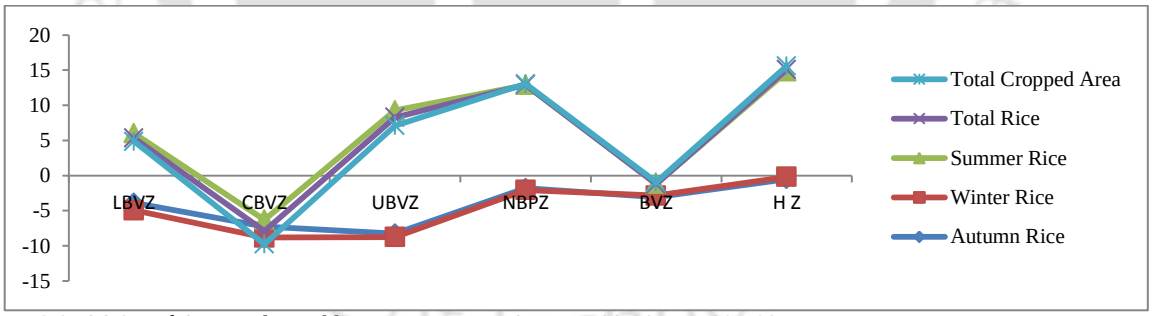

Fig.3.9: CAGR of Area under paddy across zones in Assam, 1991-92 to 2007-08

Compound annual growth rate of total cropped area during the period 1991-92 to 2007-08 was positive in BVZ, NBPZ and HZ while it was negative in LBVZ, CBVZ and UBVZ. Acreage growth rate of total paddy was negative except NBPZ and HZ. Autumn paddy has recorded a negative growth rate of area in all the zones whereas a similar pattern was observed in case of winter paddy in LBVZ, CBVZ, NBPZ and UBVZ. Contrary to autumn and winter rice the acreage share of summer paddy has increased in all zones and growth of acreage share is the highest in UBVZ.

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3.5.1: Infrastructure and Rice Yield across Agro-ecological Zones:

The deceleration in some zones and stagnation in others was caused by the disparity in infrastructure, as reflected by the positive correlation between agricultural infrastructure index and rice yield. Top performing zones with higher level of infrastructure had higher average yield, contrary to low yields and low infrastructure in the rest of the zones. The value of Agricultural Infrastructure Index (AII) for the top three zones, viz., UBVZ, BVZ and HZ being 69, 59, and 51 respectively (against all India = 100) was associated with corresponding higher average productivity of 1.63 ton/ha, 1.60 ton/ha and 1.53 ton/ha respectively. While Lower Brahmaputra Valley Zone showed in table 3.15 the lowest productivity as the lowest value of agricultural infrastructure index (AII) being at 35.

Table-3.15: Relationship between agricultural infrastructure index (AII) and rice yield in Assam:

Agro-ecological Zones	AII	Yield (ton/ha)
UBVZ	69	1.63
BVZ	59	1.60
H Z	51	1.53
CBVZ	45	1.41
NBPZ	40	1.34
LBVZ	35	1.22

Source: NIRD, 2000, India Rural Development Report, Hyderabad.

3.6: Rice Production in Assam (District level analysis):

Five largest districts of Assam in origin, viz., Kamrup, Goalpara, Darrang, Nagaon and Sibsagar together accounted for more than 73 percent of rice area, which contributed 72 percent of production in the state. Kamrup was the largest district within this group accounting for 20 percent of the total rice area of the state. It was observed that while both winter rice and autumn rice gained 5 percent area in 1999-2001 over the 1980s level, the summer rice area gained about 11 percent during the period. The summer rice area witnessed rapid increase at individual district level, notably, in Darrang (from 1% to 8%), Goalpara (from 3% to 19%), Kamrup (from 2% to 16%) and in Lakhimpur (from less than 1% to 13%). But the highest and significant increase took place in Nagaon (from 5% to 29%) during 1980s to 1999-2001 (Bhowmick et al., 2005). However, as old districts are sub-divided to constitute new districts, rice areas in these districts have been changed. Nagaon has largest area of rice (195.2 thousand hectares) with highest rice production (317.93 thousand MT) while Sibsagar district could produce rice highest per hectare (2490kg/ha) in the state.

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3.6.1: Inter-district Variation in Rice Yield:

Although the winter rice has been the major rice all over the state, its yield did not show appreciable improvement. The yields hovered around 2 ton/ha in almost all the districts. Bhowmick et al., (2005) noted that the highest winter rice yield of 3.19 ton/ha has been found in Cachar and the lowest of 1.94 ton/ha was in Kamrup and Goalpara district, while overall state average yield was 2.38 ton/ha. Judging by the average yield of winter rice, the Cachar and Sibsagar seem to have been the most productive and favourable rice environment. The yield in rest of the districts was medium. Except Lakhimpur, Cachar and Karbi Anglong, summer rice yield is more than 2.5 ton/ha in rest of the districts. The yield of summer rice was higher because summer rice crop is grown under irrigated condition. In 2008-09, it was seen that highest yield of winter rice of 2573 kg/ha was found in Karimganj district, highest yield of summer rice of 2756 kg/ha in Goalpara district and highest yield of autumn rice of 1943 kg/ha in Hailakandi district. On the other hand, Lakhimpur district had lowest in yield of all three rice varieties; 640 kg/ha in winter rice, 821 kg/ha in summer rice and 283 kg/ha in autumn rice in 2008-09 (see appendix Table III.4). However, in 2013-14, district-wise data of rice yield have shown remarkable changes where high yield of winter rice was recorded in Hailakandi, Goalpara, Golaghat, Kamrup (M), Dima Hasao and Morigaon district; high yield of summer rice was seen in the districts of Darrang, Dhubri, Barpeta, Goalpara, Sonitpur and Kokrajhar while low yield of summer rice recorded in Lakhimpur, Jorhat, Cachar and Hailakandi districts. Yield of autumn rice is high in the districts of Dibrugarh, Dima Hasao, Morigaon, Baska while low in the districts of Barpeta, Udalguri, Jorhat, Hailakandi, etc. The growth of area and yield for summer rice and total rice was significant in Morigaon, Dhubri, Kamrup, Goalpara, Golaghat, Hailakandi and Darrang districts. The growth rate of summer rice area was highly encouraging and significant in Darrang, Sibsagar, Goalpara, Nagaon, Karbi Anglong, Lakhimpur and Dibrugarh.

On account of extreme inter-district variation in production practices, it become essential to identify the hotspot of disparity, which is important for rice improvement policy interventions. Considering the time series data of rice yield in 1999-2001, the group of districts comprising Kamrup, Goalpara, Darrang and Lakhimpur was classified in the low-yield category with average yield of rice being around 2 MT or less compared to 2.3 MT per hectare in Assam (Bhowmick et al., 2005). These districts covered 56 percent of the state rice area, but contributed only 46 percent to the total production in

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the state. During the last three decades, the productivity of total rice in these districts has been stagnant by and large. These districts were also highly susceptible to frequent and multiple floods, which affected the winter rice adversely and damaged the prospect of total rice production. However, in recent years Goalpara, Darrang, Kamrup districts could improve the position. On the contrary, Golaghat, Sibsagar, Dibrugarh, Cachar, Karimganj, Hailakandi and Nagaon have been the high performing districts. These districts occupied 38 percent of rice area and contributed substantially at more than 48 percent of the total rice production in Assam. From the rice yield data in 2008-09, Kokrajhar, Chirang, Bongaigaon, Barpeta, Sonitpur, Lakhimpur and Dhemaji districts were listed in the low rice yield districts producing less than 1500 kg/ha. Table 3.16 presents the district-wise area, production and yield of rice by season in Assam during 2013-14.

Table-3.16: District-wise Area, Production and Yield of Winter Rice, Autumn Rice, Summer Rice in Assam during 2013-14: Area in hectare; Production in metric tone; Yield in kg/ha

Districts	Winter Rice			Summer Rice			Autumn Rice			Total Rice		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y
Baksa	85730	161484	1912	2750	5885	2140	10200	16672	1661	98680	184041	1893
Barpeta	67630	123146	1849	47877	158072	3302	19191	16796	889	134698	298014	2234
Bongaigaon	32690	66164	2055	13070	38727	2963	11021	17595	1622	56781	122486	2183
Cachar	82347	153041	1887	7700	12958	1683	6430	10288	1626	96477	176287	1853
Chirang	35250	58207	1676	7700	6025	2210	8879	11707	1340	46856	75939	1644
Darrang	48236	92981	1957	17837	64285	3604	3616	4050	1138	69689	161316	2341
Dhemaji	68300	105539	1569	4420	8883	2010	9630	14723	1554	82350	129145	1591
Dhubri	35140	63545	1836	47295	167391	3539	4169	5349	1304	86604	236285	2747
Dibrugarh	77479	146528	1920	403	1201	2981	188	325	1758	78070	148054	1925
Dima Hasao	9125	20277	2256	28	83	2981	6670	11477	1749	15823	31837	2044
Goalpar	49245	116414	2400	25290	82243	3252	8624	9625	1134	83159	208282	2531
Golaghat	117398	278929	2412	4838	11716	2422	1915	4432	1352	124151	295077	2412
Hailakandi	41550	106983	2614	2035	3596	1767	3090	3287	1081	46675	113866	2475
Jorhat	86181	178210	2099	4663	7233	1551	3267	3282	1021	94111	188725	2034
Kamrup(M)	20343	44745	2233	7990	23626	2957	895	1181	1340	29228	69552	2406
Kamrup(R)	71020	152006	2173	36808	107079	2909	13511	15175	1141	121339	274260	2284
Karbi Anglong	118841	203249	1736	2256	4257	1887	9103	12411	1386	130200	219917	1714
Karimganj	69394	138893	2032	6850	13501	1971	1255	1576	1276	77499	153970	2014
Kokrajhar	64633	127450	2002	23056	69796	3027	21800	25856	1205	109489	223102	2063
Lakhimpur	111700	215763	1961	16400	25187	1536	13000	19615	1533	141100	260565	1872
Morigaon	46495	109410	2389	41120	134956	3282	2500	4133	1680	90115	248499	2780
Nagaon	140244	295177	2137	44319	122928	2774	12088	18018	1515	196651	436123	2244
Nalbari	62000	115850	1897	11000	31823	2893	4930	5701	1175	77930	153374	1994
Sibsagar	95779	205295	2176	553	1649	2981	200	300	1532	96532	207244	2179
Sonitpur	123892	240086	1967	21493	67738	3152	20669	32904	1618	166054	340728	2079
Tinsukia	56890	97987	1749	85	253	2981	5346	7595	1444	62321	105835	1724
Udalguri	63205	91722	1473	6269	18767	2994	21145	20367	979	90619	13086	1465
Assam	**1880737**	**3709081**	**2002**	**399132**	**1189858**	**2981**	**223332**	**294440**	**1340**	**2503201**	**5193379**	**2101**

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Source: Directorate of Agriculture, Govt. of Assam.

For comparing the amounts of scatteredness of different sizes of area, production and yield of three seasonal rice varieties in 27 districts in Assam we have to reduce all those to a comparable percentage which can be calculated by the co-efficient of variation of these three parameters. The co-efficient of variation of area, production and yield of winter rice, summer rice, autumn rice and total rice across 27 districts of Assam in 2008-09 and 2013-14 are presented in the Table 3.17:

Table: 3.17: Co-efficient of variation of area, production and yield of rice across 27 districts in Assam since 1990-91 to 2013-14: in (%)

Year	Winter Rice			Summer Rice			Autumn Rice			Total Rice		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y
1990-91	-	-	-	-	-	-	-	-	-	68.14	67.77	55.65
1991-92	-	-	-	-	-	-	-	-	-	63.97	63.65	50.84
1992-93	-	-	-	-	-	-	-	-	-	66.59	67.19	49.62
1993-94	-	-	-	-	-	-	-	-	-	67.08	65.74	46.66
1994-95	-	-	-	-	-	-	-	-	-	67.02	67.68	47.97
1995-96	-	-	-	-	-	-	-	-	-	66.21	66.80	50.42
1996-97	-	-	-	-	-	-	-	-	-	65.99	64.70	51.40
1997-98	-	-	-	-	-	-	-	-	-	65.88	66.26	48.15
1998-99	-	-	-	-	-	-	-	-	-	67.28	69.86	48.74
1999-00	-	-	-		-	-	-	-	-	66.10	69.71	47.02
2003-04	65.32	70.18	50.38	133.25	162.9	66.81	103.7	98.46	59.82	-	-	-
2004-05	67.36	73.02	56.47	132.32	153.06	50.69	104.52	92.25	70.02	-	-	-
2005-06	53.22	59.44	20.76	108.7	137.63	32.85	83.54	79.06	37.90	-	-	-
2006-07	53.19	160.90	31.08	113.44	133.79	25.52	83.09	75.71	36.16	43.55	49.98	30.80
2007-08	51.62	58.05	30.79	105.95	124.02	22.69	74.09	68.40	35.57			
2008-09	47.16	57.88	27.82	104.43	112.13	31.1	85.38	79.07	34.81	55.83	47.22	26.04
2009-10	49.13	58.35	24.97	112.71	131.28	187.87	89.07	80.23	190.74	-	-	-
2010-11	49.12	53.30	18.88	114.99	126.73	24.92	84.48	72.28	38.28	-	-	-
2011-12	49.42	121.92	24.82	112.91	125.29	30.60	80.16	78.82	35.58	-	-	-
2012-13	52.9	52.35	21.00	109.26	119.52	29.32	77.52	80.05	30.97	-	-	-
2013-14	47.24	49.99	13.28	104.44	118.16	23.67	79.49	76.29	18.13	43.18	46.58	15.94

Note: A area, P production, Y yield.
Source: Calculated by the Author

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From table 3.17 it is clear that the variation in winter rice yield among the districts has reduced over the years and as a result production variations among the districts are also reduced. In summer rice, variation in yield decreased but that was not much reflected in production variation while in autumn rice variations in yield and production have been decreased. In total rice, variation in production among the districts has declined both for reduction in yield and area variation.

3.7: Constraints on Growth of Rice Production in Assam:

3.7.1: Natural Constraints: The state is prone to a number of natural and bio-physical problems resulting in subsistence agriculture with low-input-low risk technology. Rice crop in Assam is worst hit by **floods** because usually rice cultivated in low lying areas. Flood is the major problem in the state, which affects all the three classes of rice. *Sali* rice is damaged in its vegetative stage while *Ahu* and *Boro* get affected during their reproductive and maturity stage.The period from May to October is very crucial for almost all farmers in the state. Because this is the period when *Ahu* rice is harvested and *Sali* rice is cultivated. Unfortunately floods come during this important period. According to an estimate, nearly 4.75 lakh hectares rice area is chronically flood prone (19.91% of cropped area or 16.9% of NAS), about 2.41 lakh hectares are chronically floods affected and about a lakh hectare are occasionally flood affected area in Assam. Due to frequent floods many farmers have adopted a risk averse strategy of not using purchased inputs such as HYV seeds, chemical fertilizers, pesticides, etc. (Pathak, 2001) and hence hindering on adoption of improved agricultural production techniques. Crop insurance can be a measure to protect the farmers. National Agricultural Insurance Scheme (NAIS) is being implemented in the country since 1999-2000 with the objectives of providing financial support to farmers in the event of failure of crops due to natural calamities, pests attack and diseases. Weather based crop insurance scheme is also being implemented as a central sector scheme from *kharif* 2007 season (Economic Survey, 2011-12). Implementation of the crop insurance scheme is highly essential in Assam for its recurring flood and other calamities. Unfortunately, National Agriculture Insurance Scheme has not been able to provide desired solution to the risk hedging in the agriculture sector in the state. Lack of awareness, low subsidy premium (10%) for small and marginal farmers, delayed claim settlement, slow response of banks in issuance of *Kissan* Credit Cards, etc. affected a large number of farmers from getting benefit from the NAIS. Total 4.14 lakh farmer family with 3.15 lakh hectares were covered under the

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scheme since inception and only 0.70 lakh farmers were benefited till 2012-13, (Economic Survey, Assam, 2014-15).

Among the six agro-climatic zones, the highest share of flood-prone area of 39 percent lies in North Bank Plain Zone, followed by 32 percent in Lower Brahmaputra Valley Zone and 17 percent in Upper Brahmaputra Valley Zone (Bhowmick et al., 2005). Estimated cropped area damaged by flood in 2010 was 84.79 thousand hectares (5.67% of total area) in NBPZ, 77.67 thousand hectares (3.84% of total area) in LBVZ, 32.59 thousand hectares (5.86% of total area) in CBVZ, 27.18 thousand hectares (1.7% of total area) in UBVZ and 6.49 thousand hectares (0.93% of total area) in BVZ (Mandal, 2010). Although all the districts except two hill districts have been flood prone areas, yet Morigaon, Nalbari, Dhemaji, Lakhimpur, Cachar and Karimganj districts have substantial low lying areas hit by flood every year (Ahmed et al., 2011).

Although Assam receives very high amount of rainfall, yet its distribution is erratic over seasons and years. Rainfed *Ahu* rice suffers from prolonged **drought** due to late arrival of monsoon while transplanted *Sali* rice is affected by intermittent drought due to rainless periods during growing stages of the crop. About 0.94 lakh hectares (3.3% of NAS) are chronically drought prone area in Assam (Statistical Hand Book Assam, 2011). Drought causes substantial yield loss in rice when it occurs in panicle initiation stage of the crop. In a study of rice production in Nagaon and Golaghat districts of Assam, Bhowmick et al., (2005) observed that, "farmers considered drought and floods as major constraints to agricultural production in Assam. To an opinion and perception question, 53 percent respondents gave first rank to drought as a critical production constraint followed by flood, by 47 percent in Golaghat district of Assam."

Another natural problem of rice cultivation in Assam is the **water logging** of paddy fields (0.39 lakh ha or 1.4% of NAS are water logged area). A large area under *Sali* rice is low-lying and ill drained. Such areas get inundated either due to flood or rain water in the beginning of the season and remain submerged with more than 30cm of water throughout the growing period. Continuous water logging causes problems for the farmers in preparing the land, tilling, transplanting, and fertilizer application and sometimes in harvesting too which are also responsible for yield reduction in rice (Ahmed et al., 2011).

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Season of *Boro* rice cultivationis the most favourable as the sky remains clear during this period and is risk free so far as flood and drought are concerned. Farmers are encouraged to take up its cultivation in the season when irrigation facilities are available. However, the main environmental factor limiting *Boro* rice cultivation is the **cold stress**. The effect of cold is more in the districts of Upper Assam. Therefore, *Boro* rice is traditionally not grown in these districts. Cold also affects the late *Sali* rice in reproductive stage (Ahmed et al., 2011).

In Assam, an average **bright sunshine hour (BSH)** is less as compared to other states of the country due to overcast sky in summer and foggy forenoon in winter. The high rainfall and cloudy sky reduce the total sunshine hours needed for photosynthetic activity. The average BSH in *Sali* season is 5.1h/day while in *Ahu* and *Boro* are 4.7h/day and 6h/day respectively despite average BSH/day at different growth stages of rice in Assam. The insufficient solar radiation is the most important factor responsible for low productivity of rice in the state (Ahmed et al., 2011).

Soil of Assam is **acidic** and rice is grown under submerged condition of the soil after pudding. The reduced condition of soil with acidity (nearly 32% soils are strongly & moderately acidic) and low P^H (phosphorous content per hydrogen ion, ranges between 4.5 and 6.5) and high micronutrient deficiency in soil can cause low growth in rice plants and hence yield reduction.

There are more than 20 species of **insects** that attack rice plant in Assam and 2.23 lakh hectares area in Assam is pest endemic. Among them, stem borers attack the rice in all the seasons. Hot humid climate of Assam favours harboring of a number of insect pests and diseases in the rice crop. The disease causes yield loss of 30 to 32 percent on an average (Ahmed et al., 2011).

High rainfall and tropical climatic conditions favour **weed growth** in the state. They cause severe yield loss in rice crop if not properly removed. Weeds in direct seeded upland rice in Assam cause yield loss to the tune of 65 percent and in lowland transplanted rice the loss is about 29 percent. Although a number of herbicides have been recommended, yet their use in paddy field is limited in Assam (Ahmed et al., 2011). Mehta (2015) stated that with a absence of weeds, the possibility of consumption of fertilizer, manure and irrigation would decline.

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3.7.2: Input Constraints of Rice Production in Assam:

If one has to consider the fertility of the land and the abundance of water in the state, the two most important components for rice production, Assam should have been one of the better-developed states in the country. Yet in all the key inputs of rice production, such as irrigation, levels of mechanization, market access, credit, extension of technical knowhow, price or connectivity of rural areas, the state today lags behind the rest of the country (Borah et al., 2001). Following section has discussed about the status of basic input supply and support services for rice production in the state.

Use of Quality Paddy Seeds:

Non-availability of quality seeds is a perennial problem particularly of paddy in the state. It was observed that the HYV programme in Assam failed because of inadequate supply of improved seeds and other supporting inputs (Das, 1984). The long and time-consuming process of supply and hence untimely distibution of seed has been the retrograde factor, which discourage farmers to adopt modern varieties. Traditionally, in Assam, cultivators preserve a portion of their crop to be use as seeds for the next sowing. But agriculture of Assam faced the problem of availability of certified seeds (presently, seed rate of paddy in Assam is 40 kg/ha) and so the Seed Replacement Rate[48] in the state stands at a very low level. Seed replacement area of rice in Assam was 30 lakh hectares and SRR was 50 percent and seed replaced by 0.72 lakh MT in 2011-12.

Table-3.18: Season wise availability of Quality Seeds of Paddy in the state (in '000 quintal)

Season	*Kharif* season				*Rabi* season			
Year	2008-09	2009-10	2010-11	2011-12	2008-09	2009-10	2010-11	2011-12
Quantity	148.69	833.77	417.8	680.94	8.456	76.24	165.00	200.00

Source: Directorate of Agriculture, Assam

Fertilizer Use in Rice Production:

In Assam, annual fertilizer consumption is very low (58.5kg/ha) as compared to national average (128.5kg/ha) in 2012-13 and it is one of the important reason for low rice productivity in the state (Economic Survey, Assam, 2014-15). Among the rice varieties, as expected, fertilizer application is more in modern varieties than in traditional one.

[48] Seed Replacement Rate is the percentage of area sown out of total area of crop planted in the season by using certified/quality seeds other than the farm saved seed. Since certified seeds are better in productivity, the SRR is directly proportional to productivity. Thus, higher the SRR, higher is production as well as productivity (http://www.gktoday.in/blog/seed-replacement-rate/,accessed on 27-12-2015)

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Bhowmick et al., (2005) observed that about 26kg/ha of NPK was applied to traditional varieties as compared to 69kg/ha for modern varieties in Nagaon district, whereas, it was 15kg/ha and 67kg/ha respectively in Golaghat district in Assam. In TE-2010-11, Punjab uses 157.8kg/ha of Nitrogen (N), 49.1kg/ha of Phosphate (P) and 41.2kg/ha of Potassium (K) or total NPK use was 198.2kg/ha in non-Basmati paddy (Raju et al., 2015) while Assam uses only 74.58kg/ha of total NPK in 2011-12. Among six agro-climatic zones in Assam, fertilizer consumption is highest in CBVZ (123.50kg/ha) followed by LBVZ (85.81kg/ha), BVZ (58.18kg/ha), UBVZ (49.09kg/ha), NBPZ (29.90kg/ha) and lowest in Hill Zone (7.66kg/ha); while in all Assam it was 64.45kg/ha in 2006-07 (Statistical Hand Book Assam; Mandal, 2011).

Table-3.19: Trend of Fertilizer Consumption in Rice Cultivation in Assam and India: (in kg/ha):

Year	N	P	K	Total NPK consumption in Assam	Total NPK consumption in all India
1970-71	1.69	0.71	0.52	2.92	13.67
1980-81	2.1	0.3	0.4	2.8	31.9
1990-91	5.6	2.2	2.7	10.5	67.5
2000-01	18.4	9.1	7.7	35.2	88.93
2005-06	23.25	13.93	12.08	49.26	105.5
2006-07	26.95	13.41	13.13	53.49	111.80
2008-09	29.32	13.4	15.08	57.80	127.2
2011-12	40.86	13.28	20.45	74.58	141.30
2013-14	36.24	9.99	19.18	65.41	-

N: Nitrogenous; P: Phosphatic; K: Potassic.
Source: (i) Rice Knowledge Management Portal (RKMP), Hyderabad; (ii) Statistical Hand Book, Assam, 2014.

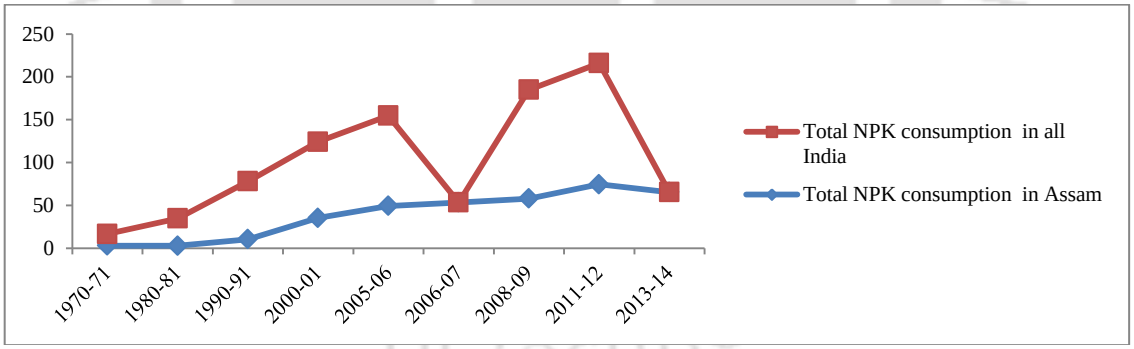

Fig.3.10: Trend of Fertilizer Consumption in Rice Cultivation in Assam and India

Historically Assam used lesser amount of fertilizer in rice cultivation. Barua (1915), a leading nationalist and scholar of Assam of the 19th century remarks that "the people of Assam did neither use fertilizer nor artificially irrigate their fields for the improvement of the fertility of the soil. Chemical fertilizer was hardly used in Assam, natural vegetation and soil fertility made the use of manure in Assam". The *Katha Guru Charit* and early British records mention how weeds had been burnt to clear the land by depositing ashes for *Ahu* rice and mustard cultivation. The most common class of manure was cow-dung,

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which was generally used to manure growing seedling for transplanted rice. "Shahibuddin Talish, a foreign visitor during Ahom regime noted in 1662 that here (i.e., in Assam) the soil is fertile, and whatever is planted grows well" (Sarkar, 1915). As pointed out by Robinson (1841), the sense of temporary ownership of lands did not encourage the people to use manure and to improve its qualities. Indeed, cultivation solely depended on what amount of fertility the soil naturally possessed. John M' Cosh has noticed that the Assamese prepared a well manured garden land to sow seeds to obtain healthy seedlings (Gogoi Nath, 2002).

Irrigation in Rice Cultivation:

Rice is a proliferate user of water, consuming half of all fresh water resources. Water needs of rice are two to four times more than that of the other crops of the same duration (Devi and Ponnarasi, 2009). Now-a-days farmers of the state are cultivating modern and high yielding variety of rice besides its traditional varieties. Thus, irrigation is a must for higher production. But the fact is that the irrigation facility in the state is very poor in comparison to high rice producing state of the country as well as national average. In 1970-71, net area irrigated as percentage of net sown area in Assam was 7.92 percent compared to 38.4 percent in all India and yield of cereals per hectare was 993kg against 1123kg in all India. During 2008-09, percentage coverage of irrigated area under rice in the state was 5.3 compared to 99.9 in Haryana, 99.5 in Punjab, 96.8 in Andhra Pradesh, 93.3 in Tamil Nadu and 58.7 in all India (Economic Survey, 2014-15). The gross and net area under irrigation in Assam was 15 percent and 20.7 percent respectively in 2011 (Govt. of India, 2012). In 2013-14, gross and net irrigated area in the state stood at 186806 hectares and 161398 hectares respectively and about 30 percent of net cropped area is covered by assured irrigation facility (Economic Survey, Assam, 2014-15).

Table-3.20: Crop & Season wise Rice Area Irrigated in Assam from 2007-08 to 2013-14 (P):(in hectare)

Years	*Kharif* Crop Season					*Rabi*& Pre-*Kharif* Crop Season				Grand Total
	Regular *Ahu*	*Sali* Traditional	*Sali* HYV	*Bao* Rice	Total	Early *Ahu*	*Ahu* HYV	*Boro* Rice	Total	
2007-08	-	-	-	-	74463	-	-	-	14808	89271
2008-09	-	-	-	-	75677	-	-	-	19994	95671
2009-10	459.0	117949	29366	0	14779	8412.2	5903.2	6769.6	21085	16884
2010-11	616.3	90407	11600	15	108185	11766	1066	4410	17242	125427
2011-12	419.5	93735	34594	5	132529	10530	1326	6515	18371	150900
2012-13	684	116949	33991	668	152292	9744	4651	7321	21716	174008
2013-14	608	125778	32816	55	159257	12123	6870	10365	29358	188615

Source: (i) Statistical Hand Book Assam, Various Issues, Directorate of Economics and Statistics, Govt. of Assam; (ii) Calculation by the Author.

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Although the facility of irrigating crop land is still poor in the state, the practice of irrigation is not a new one. The system of irrigation for rice culture was prevalent in some form among people of Assam since early times that were evidenced by some contemporary foreign accounts. Yuwan Chwang, the Chinese pilgrim, who visited the kingdom of *Kamrupa* in the middle of the 7th century noted in his account that water led from the rivers or from banked-up lakes flowed round the towns. Another pilgrim, Minhas Uddin Siraj refers to opening up of water dykes at the time of need. Ralph Fitch, the English traveller, who visited the *Koch* kingdom (then lower Assam) during the second half of the 16th century, observed that the people used to inundate lands by damming the streams above knee deep. The *Katha Guru Charit* records how the *Bhuyans* of Assam built embankments on the rivers *Tembuwani* and *Magurijan* for protection of crops and houses. Among the indigenous tribes, the *Kacharies* in the thirteenth century knew how to irrigate lands. It is found that they used to make dams across the hill streams several miles above the point at which the water-supply is required and then led the stored up water to the rice fields through a network of '*dung' or 'dong'* or '*Jan*' up channels (irrigation channels).[49] Under conditions of *dung* irrigation of the *Bodo-Kacharis*, *Ahu* was also transplanted. The *Meches*, a *Bodo-Kachari* tribe of Assam-Bengal border, were reported in 1875 to go in for artificial irrigation in a surprising manner. Even today, in *Boro-Kachari* areas, several villages often combine to construct *dongs* up to several miles long. It was only during the Ahom rule in Assam for long six hundred years (1228-1826) that irrigation and flood control work were undertaken as a state policy so that the flat level lands opened up for rice cultivation. King Suhungmung became known as *Dihingia Raja* for his building an embankment on the Dihing River, the largest of the southern tributaries of the Brahmaputra (Gogoi Nath, 2002). In respect of irrigation, the Ahoms had a definite superiority over their neighbours, *Boro-Kacharis* and other tribes. Thus, irrigation system was less in lower Assam due to exclusion from Ahom rule (Guha, 2015).

Though irrigation practices in Assam is as old as exercising settled cultivation, however, in the post independence period not much emphasis was given to development of irrigation in the state even after launching Green Revolution in the country. No allotment of fund for irrigation was provided in the state's first two plans. Moreover,

[49]Normally the length of a *jan* is less than a kilometer and is only about 0.61-0.91 meter wide and about 0.33-0.45 meter deep. These *jan* or *dong* system of watering paddy land is not sufficient and is not available throughout the season (Assam State Gazetteer, 1999).

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small farm size, fragmented landholding and lack of co-operation impeded irrigation development in the state. The spread of modern capital-intensive techniques of irrigation such as shallow or deep tubewell and low lift pump irrigation has tended to reverse the inverse relationship between farm size and land productivity. Sharma (1992) stated that because of fragmentation or the existence of a number of non-contiguous plots within the same holding, the viability in tube-well irrigation in Assam is falling far behind to Punjab and Haryana.

Moreover, there exists gap between irrigation potential created and actual utilization. Reasons of this gap are: (a) the shallow tube wells (STWs) installed long back (1993) are not effective; (ii) use of STWs/LLPs (low left points) has become crop specific and location specific; (iii) some schemes are not functioning due to damage of structures, lack of maintenance of old machineries and inadequate power availability, etc.; (iv) most of the schemes of minor irrigation in Assam (STWs and LLPs) are diesel operated and hence the cost of operation is high (Economic Survey, Assam, 2010-11). Inadequate rural electrification is considered as one of the important impediment to accelerate the development of irrigation and agriculture. Farmers were also not interested to have electricity driven irrigation pumps (Saikia, 1988).

Investment and Credit in Rice Production:

The predominantly small farmer-oriented monocrop farming practice in Assam is required to be supported by enhanced public investment to ensure the availability of basic infrastructure, health care and education and training. Dhekial Phukan, a leading nationalist and scholar of Assam would not put much faith in a process of autonomous development. He looked forward to the Government as the appropriate agency for modernization. Evidences showed that a huge investment on the infrastructure development did not come from the private sources. A meagre per capita income of the majority of the farmers could not generate investible surplus in the hands of farmers. Under-investment in agriculture resulted in the farm sector with a state of severe infirmity (Bhowmick, et al., 2005).

Capital investment of the low income households is predominantly of traditional nature, the major portion of investment being made in acquiring more land and on improvement on land. The moderate income households lay more emphasis on purchase of irrigation equipments and agricultural implements of traditional nature. The middle

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income households allocate major portion of their capital investment only on two capital items - irrigation equipments and agricultural machineries and implements of both traditional and modern types. For the high income households, more than 70 percent of their capital items go for acquiring their own irrigation resources and implements and also for purchasing agricultural machinery (Ghosh, 2005).

Although credit is positively associated with the efficiency of both local variety (LV) and modern variety (MV), the institutional structure of credit is extremely weak in the state. In the wake of the monetization and merchant capital penetration in the late 19th century, the number of money-lenders and credit-advancing village shopkeepers increased. Out of the 9801 money-lenders and their dependents in the Province of Assam in 1891, 7902 were in the Surma Valley (presently in Bangladesh), 1793 in the Brahmaputra valley and 106 were in the hills districts (Guha, 2006). Exorbitant interest rates and heavy peasant indebtedness constituted a normal feature of Assam's rural economy. The usual rate of interest charged by moneylenders was not less than 36 percent per annum. The debtors had virtually no legislative protection against usurious practices. In medieval Assam, traditional slaves continued to work on the land of the lords as tenants. Taking a loan by mortgaging one's labour was common in pre-colonial times (Guha, 1977). In colonial period, merchant capital mainly by Marwari merchants played a significant role in Assam's agrarian economy. As the source of credit shifted towards commercial capital, agreements to sell the standing crop to the creditor at a pre-specified price became common (Das and Saikia, 2011). The peasantry was caught in a never-ending cycles of credit to meet land revenue demands. Though the Government and the Marwari merchants accumulated resources with surplus extracted from the peasant sector, neither of them however, did much to improve rice production (Guha, 2015).

In the post independence period especially after nationalization of banks institutional sources of credit have been extended. However, in comparison to developed states in India, the institutional structure of credit in the state was poor. For instance, amount of borrowing from institutional sources in Assam was Rs.148/ha in 1992 which was increased to Rs.716/ha in 2013 at 1993-94 prices. But during this period per hectare amount of borrowing from institutional sources in Tamil Nadu increased from Rs.2388 to Rs.10350, in Punjab from Rs.1398 to Rs.5414, in Himachal Pradesh from Rs.1121 to Rs.9167, in Tripura from Rs.895 to Rs.1410, in Maharashtra from Rs.721 to Rs.2066, in

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West Bengal from Rs.641 to Rs.3285, in Haryana from Rs.578 to Rs.2552, in Gujarat from Rs.582 to Rs.1551, etc. And in all India level it has increased from Rs.545 to Rs.2926 per hectare. The compound annual growth rate of institutional borrowing and non-institutional borrowing in Assam were 7.4 percent and 2.1 percent compared to 7.9 percent and 7.0 percent respectively in India during 1992 to 2013 (48^{th} & 70^{th} Rounds, NSSO) (see appendix Table III.5). However, share in non-institutional credit (money lender) in Assam decreased from 55.9 percent in 2003 to 34.8 percent in 2013 against the increase in all India level from 67.3 percent to 69.0 percent during the period (59^{th} & 70^{th} Rounds, NSSO). Lapses of repayment of advances of bank credit also make scope to limit the institutional credit to farmers. Scheduled Commercial Banks' outstanding advance on paddy cultivation has increased from Rs.3455 crore in March, 2002 to Rs.13298 crore in October, 2011. In 2011-12, all together 378101 KCCs issued with credit limit sanctioned Rs.1315.38 crore. In 2012-13, 4.5 lakh KCC loan are targeted. However, the scheme could not cover the targeted farmers in practice. This is attributed to low level of crop loans issued to farmers, poor financial position of the Co-operative Banks and RRBs in the region, lack of infrastructure facilities which are a hurdle in the way of augmenting credit facilities. Moreover, after the introduction of new prudential norms in the banking sector, banks have been hesitating to invest in the agricultural sector of the state (State Agriculture Policy, Assam).

Agricultural Extension Services in Rice Production:

Bhowmick et al., (2005) found that extension services had positive effect with the efficiencies of both local and modern varieties of rice, which were significant at one percent level and indicates that the involvement of extension advisers tends to increase the efficiency of rice production. Extension services can provide better management, information and proper resource utilization processes which are equally important along with investment in inputs and can help to increase the efficiency of farmers (Mishra, 2010).

Since April, 1985, the National Agricultural Extension Project-III has been introduced in the state. There is a need to motivate, mobilize and activate the extension programme for adoption of modern technology in every nook and corner of the state (Ahmed et al., 2011). Access to information and resources on credit, technology, market, etc. are also crucial for rice production in the state. Unfortunately, most of the farmers

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derived required information on newer methods and innovative agricultural practices from their own experiences, relatives and neighbours. The availability of institutional sources has been negligible (Bhowmick et al., 2005).

Although the state have a well developed network of extension services, farmers are not getting the information regarding the development of the technologies and the solution of the field problems generously. It was reported that farmers rarely meet the extension workers in field and can consult their farm problems at proper time (Mandal, 2011; Goswami, 2012). However, in recent years some institutional set ups like Agricultural Technology Management Agency (ATMA), a district level programme planning and decision making body, Farmers Training Institute, departmental extension training centres as well as the Assam Agricultural University and farmers' training for capacity building of the Field Management Committees (FMCs) through MANAGES, Hyderabad, etc. have been adopted to effect reforms in agriculture extension and to ensure effective participation of farmers in planning and resource allocation.

Field Management Committees (FMCs) in Assam:

People's participation is absolutely necessary for successful implementation of any programme. With this end in view the Agriculture Department, Assam started organizing a new social institution at grass root level called Field Management Committees (FMCs) or *Pathar Parichalana Samittees* (PPSs), an association of farmers at the field level in the early sixties. This is farmers' voluntary body consisting of 60-80 farmers living near a big cultivated field cultivating a contiguous area of 27 hectares to 134 hectares.These committees are registered by District Agricultural Officers and are functioning as an extension wing of the Agriculture Department. There are 25938 registered FMCs in Assam at village level having co-ordination bodies at Block, District and State level. But only 5 percent FMCs are actively working (Department of Agriculture, Govt. of Assam). They carry out mainly the functions of motivation and liaise with the Agriculture Department. FMCs are projected as the hub of the future agricultural development activities in the state. However, it was found in our pilot survey that most of the FMCs in the study area in Bongaigaon are inactive, members are ignorant, no meeting is held regularly, government benefits are concentrated in a few members and departmental officials did not given due attention on their recommendations.

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Rice Research Gap in Assam:

Research orientation should be towards location specific or farmers' specific problems. The basic shortcoming in our research system is the absence of linkages. There is a need for inter-disciplinary linkages, within organizations and between organizations. Research remains supply driven and not demand driven. The basic rice research in the state, though far from adequate, has mostly been confined to the varietals development and improvement. [50] Very little attention has been paid to the crucial areas such as sustainability, ecosystem research, efficiency, marketing, etc. There are few micro level case studies at the village level or at the block level and fewer at the district level. These case studies generally pertain to farmers' adoption behaviour, gender, and energy use pattern and impact assessment. These studies are important for improving the production environment at the local level but hardly capable to address broader policy issues at the regional or state level. Studies at the zonal or regional level, based on homogenous agro-ecosystems, are very limited. Further, research in other frontier areas such as default irrigation facilities, credit constraints, risk management, pest control, crop diversification, efficiency on extension services, socio-economic condition, problem of procurement, marketing and trade, export, etc. are also necessary. Some Rice Research or Experimental Stations were established in different parts of the state like, at Titabor in Jorhat district, at Gossaigaon in Kokrajhar district and at Akbarpur in Karimganj district in Assam (Directorate of Agriculture, Assam). However, farmers remain in debacle in solving different problems on rice production in the state.

The most worrying aspect is that the winter rice has been staggering year after year barring recent few years. A pertinent question thus aroused was that, could *Boro* paddy with less than 10 percent of the area share increase the total rice production? Another relevant question has been that why was the existing technology and R & D innovation on winter rice failed to translate into growth opportunity (Bhowmick et al., 2005)? Persistently meagre investment on agricultural research and development system affected the agricultural production system adversely in the state. The CAGR of public expenditure on agricultural research and education in Assam has decreased from 6.09 percent in 1980s to 4.4 percent in 1990s and in 2000s it slightly rose to 4.82 percent. Agricultural research intensity ratio of Assam was 0.40 percent of agricultural GDP

[50]Assam Agricultural University has given so far 47 (27 new varieties) different rice varieties, in addition to screening and recommending a number of other varieties for the state

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compared to 1.19 percent in Uttarakhand and 1 percent in Jammu and Kashmir in 2009 (Singh and Pal, 2011). Over the years, the public investment on agricultural R & D has become ineffective and the system of monitoring, mid-term evaluation and correction almost non-existent. Agricultural R & D is found to be in a state of neglect in the state Chand (2005). Thus, it would require a radical change in rice research and development.

Procurement of Paddy and Price Support in Assam:

Procurement of rice at minimum support price can help to assure remunerative earning of the farmers. Since 2010-11, Assam has become rice surplus state due to improvement in productivity through better input management practices and adoption of improved technology. In 2013-14, marketable surplus of rice production in the state was 6 lakh MT (Economic Survey, Assam, 2014-15). According to the State Agriculture Department, there is a scope to procure 6.00 lakh MT of paddy annually. But the procurement of rice at minimum support price[51] in the state is negligible. During 2012-13, it was merely 0.20 lakh MT (0.39% of all India) which was lowest among ten major rice producing states in India (in Punjab, procurement of paddy was 81.35 percent in 2010-11 (Statistical Abstract, Punjab, 2011)). At national level, 30.1 percent foodgrains were procured in 2011 (Economic Survey, 2012-13). Disposal of produce by the farmers at un-remunerative prices discouraged them in adopting measures that can result in more yields. Moreover, infrastructural limitations of storage facility caused serious problem in preservation of produced rice. The farmers of the state face a crisis on account of the lack of procurement of surplus rice by the Food Corporation of India (FCI) at the minimum support price, and the sale of subsidized rice in the state through payment of wage employment schemes in kind. Though FCI has been procuring paddy since 2008-09 in the state, the result of procurement is not very encouraging due to high moisture contents of Assam paddy which is found to be around 20-22 percent against the standard permissible limit of 17 percent. Swaminathan (1999) suggested that an expansion of the geographical coverage of procurement and promotion of decentralized procurement may help to contain the rise in procurement prices. But for that transportation, storage and marketing facilities should be developed. State Government has also taken initiatives for procurement of paddy through Assam State Agricultural Marketing Board (ASAMB) in 2012-13 (Economic Survey, Assam, 2012-13).

[51]Minimum support price of rice in Assam for paddy (common) was Rs. 1080/- and Paddy (Grade-A) was Rs. 1110/- per quintal in 2011-12.

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Agriculture Marketing and Storage Facilities of Rice in Assam:

The spread of Green Revolution technology had led to the increased market dependence of cultivators for the supply of input and for the sale of output (Mehta, 2015). There exists huge problems of marketing of rice and the farmers do not get remunerative prices of the same (Rahman, 2006). Lack of organized marketing facility, storage infrastructure nearer the field, poverty and need of money after harvest for repayment of agricultural debt push the farmers to dispose off their produces at the earliest immediately and too at low prices. However, recently, agriculture marketing is gaining some priority in the state agriculture sector.

The Assam Agricultural Produce Marketing Act, 1972 has been amended in 2006 to make provisions for (a) Private Marketing, (b) Direct Marketing, (c) Consumer-Farmers Market and (d) Contract Farming as per guidelines of Govt. of India.[52] The act also empowers Marketing Boards to levy cess and relieve existing restrictions on movement, storage and transportation, etc. of agricultural produces. Moreover, the Assam State Agricultural Marketing Board was formed on the 24th September 1976. Adequate, well dispersed and efficient handling, storage and transportation infrastructure for agriculture commodities is essential for reducing post-harvest losses, maintaining food quality and for promoting export. Storage capacity is a major problem facing by the state. Infrastructure for post-harvest management and logistic support from the farm gate up to the retail marketing level should be adequate, efficient and economical. At present, the price spread from the farm-gate to the consumer is very high on account of deficiencies and inadequacy in existing infrastructure (10th Five Year Plan, 2002-07).

3.8: Economics of Rice Production (Cost and Return to Rice Production):

From the profitability point of view the discussion on economics of crops cultivation is relevant. Cost of cultivation by various factors include material inputs like, seed, fertilizer, insecticide, manure, bullock, tractor, irrigation and total labour cost. The cost of cultivation and return of rice crop can be calculated separately for traditional variety and modern variety. Hossain (1989) estimated relative economic and price efficiency between modern technology adopters and non-adopters using Cobb-Douglas profit function and found that modern technology adopters were fully price efficient in the

[52] Agriculture markets are regulated in India through the APMC Acts.

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allocation of fertilizer compared to the non-adopters. Bhowmick et al., (2005) found that the estimated values among the individual components, the cost of seed of modern varieties was higher than that of traditional varieties. Usually, the seed of traditional rice varieties was treated as a non traded item (self supplied), and therefore it seemed likely that imputed value may appear over estimated. Next critical input is fertilizer and manures. Cost of fertilizer used on modern variety is two to three times higher than that of the traditional varieties. They estimated, on average, Rs.164/ha for traditional varieties as against Rs.629/ha for modern varieties in Golaghat district, whereas, the corresponding cost estimates were Rs.256/ha and Rs.635/ha respectively in Nagaon district. Between labour and material, cost of the former was relatively higher. On the whole, total paid-out cost of material input was Rs.4849/ha and Rs.3044/ha for modern varieties and traditional varieties respectively in Nagaon district, while the corresponding costs were Rs.4159/ha and Rs.2878/ha in Golaghat district. Again the Agricultural Statistics at a Glance (2013) mention that the cost of production of paddy in Assam was Rs.824.34/ per quintal in 2010-11. If minimum support price of rice is assured at Rs.1080/- per quintal, farmers can earn surplus of Rs.255.66/ per quintal.

Based on the calculations of profitability and income share, rice-only system has been found inadequate to meet the household needs, yet the cultivation of rice could hardly be neglected because rice has been important for household food security. Thus, there has been urgent need to look at the rice plus policy (policy of producing rice with other crops simultaneously) as alternative source of household income security (Bhowmick et al., 2005). Haque (1996) observed that both gross and net returns from rice in the traditional rice growing states of Andhra Pradesh, Assam, Bihar, Madhya Pradesh, Orissa, Uttar Pradesh and West Bengal were comparatively lower than that of non-traditional rice growing states of Punjab and Haryana.

It is a matter of debate whether future growth of rice production is assured in the state, largely because of higher cost of cultivation, poor price realization and low return. In the present scenario of depressed price of rice coupled with low productivity as well as the possible adverse impact of the WTO agreement on agriculture like restriction on input subsidy, high input cost, competition and inflow of agricultural produce from outside the state, change in trade policy, change in credit delivery system, etc., the future of the rice farmers does not look positive. In the past few years, it has been seen that

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there is a surplus of rice production and the price of rice has become quite depressed, leading to distress selling and hardship to the farmers (State Agriculture Policy, Assam, New Delhi).

3.9: Conclusion:

As an easy source of carbohydrate and energy, rice is a major foodgrain for the country and the state as well. Although India has a good position in area and production, lower productivity of rice compared to World average and some non-traditional rice grown countries is a matter of concern. The CAGR of rice production in India has decreased from 2.87 percent during 1970-71 to 1990-91 to 1.63 percent in 1990-91 to 2012-13.

As a traditional rice producing state, it has a historical significance and cultural relevance in the state of Assam, apart from being the staple food. Development of rural economy of Assam cannot be expected without assuring production of rice. Rice is grown in a wide range of agro-ecological situations of Assam and the soil, topography, climate, etc. are conducive for its growth. The tribes and Aryans in the ancient Assam had been adopted different modes of rice production and the extension of rice area restricted due to limited supply of labour in the pre-colonial Assam as recorded in literature. Marketable surplus productions of rice were rarely materialized due to capital scarcity and lack of market or difficulty in exporting or large import of rice from neighbouring state in colonial period. Traditionally *Sali* paddy was preferred among three different seasonal varieties.

Rice crop is unique in Assam because it has been grown in varied eco system, rainfed or irrigated upland, lowland, flood-free and flood-prone, medium land, deep water and hill area and in all three seasons in a year, viz., pre-*kharif*, *kharif* and *rabi*. Among the seasonal varieties *Sali or* winter rice area and production are the highest but in productivity summer rice is significant and since 1980s growth of area and yield of summer rice has been increasing. Since 2010-11, state has been producing marketable surplus of rice. However, low productivity in winter rice resulted by farmer's hesitation to provide adequate inputs for fear of flood contracted the growth of total rice production in the state.

It is observed that the yield rate of total rice in Assam throughout the period from 1970-71 to 2011-12 was lower than the all India average and the gap between state

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average and the national average has been rapidly increasing. The unstable growth scenario of rice production in the state has resulted in low and unstable yield, decline in area due to flood, drought, water logging and soil erosion, nutrient deficiency, low adoption rate of modern technique of production, etc. There is a considerable seasonal and regional difference in rice production in the state. Although LBVZ occupied the biggest share of rice area and production, its productivity is low. Autumn rice area declined across the districts and its yield is highest in Hailakandi district. On the other hand, Lakhimpur district produces lowest yield of all three paddy varieties.

Rice production in the state has also been hampered by deficit and irregular supply of quality inputs and infrastructural facilities. Farmers are not getting information and solution of the field problems at proper time. Farm Management Committees (FMCs) are not performing well. Farmers of the state are mostly deprived of the minimum support price of rice due to paucity of rice procurement at the supportive price and other facilities. Due to high cost of production but low return, there has been urgent need to look at the rice plus policy as alternative source of household income security.

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Chapter-IV: Jute Production in Assam

4.1: Introduction:

Jute is a field crop classified as fibre crop with industrial value. Jute fibre is obtained from the stem of a definite variety of plant. The tissues grown on the stem between the central wood and the outer cortex of the plant form the jute fibre. It is known as a 'blast fibre'. The jute plant belongs to "*Corchorus*" family. It is the World's foremost blast fibre which provides a strong and cheap fibre, a principal material in manufacturing coarse textile for conversion into sacking, hessian and carpet-packing cloth. In terms of volume and usage, jute is now the second most important fiber in the World, next to cotton. Jute is classified as a cash crop because it is grown for its monetary value and is used for the production of commodities like-upholstery, rugs, carpets and roofing fabrics. Though jute plant is known principally for its versatile fibre, every part of the plant has its usage. Secondary products of jute are food from its tender shoots and raw young leaves which are cooked and consumed as vegetables, medicines from its dried leaves, oil from its seeds that may have industrial uses and is both medicinal and edible and fuel and paper from its stems (Kundu, 1956)**.** Jute plant is also consumed by a few communities and is used for medicinal purposes**.** Dry jute sticks are used as fuel and building material by the farming community and for handicraft and decorative articles. Its cultivation enhances the fertility of soil by crop rotation and by residual parts of jute like leaves and roots. About 1 MT of dry matter is put back into the soil and about 3 MT of roots remain per acre of land (Govt. of India, 2015).[53]Apart from the versatility of the jute plant, the plant compares very favourably in terms of its ecological footprint when compared with synthetic packaging materials (FAO Statistics, December 2014).

Jute was utilized even in ancient times for making cords and ropes by twisting bundle of fibre by hand. Gradually hand driven machines were developed to spin jute into yarn. In nineteenth century, however, machines suitable for jute spinning and weaving were developed in England which could successfully spin jute into yarn and manufacture different types of fabrics. These fabrics were well utilized for packaging purpose and also for making lining materials for different household goods. Jute, the golden-fibre, meets all the standards for 'safe' packaging in view of being a natural,

[53]Green jute leaves can purify air. The plant itself has a very high carbon dioxide assimilation ability; in the 120 days of its growing period, an acre of jute absorbs about 6 MT of carbon dioxide from atmosphere and releases 4.4 MT of oxygen; several times higher than trees.

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renewable, bio degradable and eco-friendly product. On account of comparatively cheaper price, the demand for jute fibre increased which led into the development of jute industry. In earlier days jute goods were mainly utilized for the purpose of jute twine, sacking, bags, hessian and canvas, etc. Jute fibres find use in sophisticated fields like decorative and furnishing materials such as lamp shades, wall covers, curtains, rugs, carpets, roofing fabrics and union fabrics, upholsteries and jute wastes are utilized as fillers for plastics, etc. Depending upon the demand of the jute goods, jute industry gradually diversified its products. Today it is the least expensive fibre of mass consumption.

A number of factors have contributed for augmenting the demand for jute and jute products worldwide in contemporary society. First of all, more and more countries are leaning towards jute as environment-friendly. It is conceived to be a potential substitute against the synthetic products which are damaging our ecosystem. Jute is proving to be competitive against its synthetic substitutes. The increasing demand for jute products have contributed to significant price hike of raw jute and jute goods by 33 percent in the international market (The Financial Express, Bangladesh May 14, 2011). Realizing the importance of jute the UN General Assembly in 2006 has declared 2009 as the International Year of Natural Fibres.

Jute is one of the important cash crops in Assam. However, area under jute in Assam has been drastically reducing in the recent decades. Chapter IV discusses about the conditions of jute production, scenario of jute production in India in the context of World jute production, emergence of jute cultivation in Assam, its growth and development, input uses, constraints, economics of jute production, etc.

4.1.1: Jute Production Condition and Production System:

Jute grows in rainy season. Hot and humid climate with temperatures between 24^0C and 35^0C and a relative humidity of 90 percent is ideal for the growth of the plant. The annual rainfall should be more than 180cm as the crop requires large quantities of water for both growing and processing. Though jute can be grown on nearly all types of soils, generally of alluvial origin and varying in texture from clay to sandy loam, it thrives best on inundated lands of good depth near river banks (Muthiah, 1987). Water-logging in the early stages is unfavourable. Before sowing, the land is thoroughly pulverized by ploughing and laddering five to six times. In acidic soils, addition of calcium increases

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yield. Finally, ample supply of water during the growth of plant as well as for retting the plants and for washing/stripping the fibre and availability of suitable efficient labour to handle the crop at proper time is important in jute cultivation.

There are two distinct varieties of jute commonly known as 'White' and 'Tossa' and they are obtained from two different varieties of jute plant commonly cultivated in the eastern part of the Indian sub-continent. The botanical names of these two varieties of plant are "*Corchorous Capsularis*" and "*Chorchorous Olitorius*". They are hard and highly adaptable, and grow in low and high lands. *Capsularis* can grow on high, medium or low lands, but *Olitorius* prefers high or medium lands. White jute is obtained from the former type of plant while Tossa variety is obtained from the latter (Jute Corporation of India, Govt. of India). Mesta is also a blast fibre obtained from a different type of plant botanically known as '*Habisas Cannabinus*'. The plant is grown in an identical climatic condition as required in jute.

4.1.2: Agricultural Operation of Jute:

Preparation of Field, Sowing Seeds, Weeding and Harvesting:

Jute is sown on small holdings under very primitive conditions by the Indian farmers. Preparation of soil commences as early as February and continues upto the month of June depending on the area and the variety to be grown. Fields are ploughed, rolled and wallowed repeatedly to clean and break down the soil until a clean seedbed free from weeding is obtained. Seed is sown in the months between March and May depending on the behaviour of the monsoon and the availability of water. Average requirement of seed for sowing is 7kg per hectare (International Jute Study Group, IJSG, 2012). As the jute grows at least 3 weeding operations have to be carried for the proper growth of the plant. It takes about 90 to 120 days to mature the plant depending on the character of soil and rainfall. As the plant matures, it is harvested for processing. The plants harvested at budding stage take less time than the plants which are more mature. The crop is cut down at ground level and left in the field for two to three days and then tied into bundles.

Process of the Jute plant:

After harvesting the jute plants, different stages of processing of the plants are started. The quality of the fibre much depends on careful implementation of retting and stripping operations. There should be shedding of leaves before the plant is steeped in water for

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retting purpose. Unless the leaves are properly shed off the top ends do not remain submerged in water during retting period and as such the fibre is rendered croppy. To have good fibre uniform retting is desirable - both under-retting and over-retting should be avoided. The period of retting depends on the type of water, weather condition and the stage at which the plants have been cut. The bundles are kept under water for fifteen or more days to rot. When the barks become soft and easily removable from the stem, the bundles are broken in the middle and beaten to and fro in the water till the inner part drops out and only the fibre remains. The fibres are then dried and tied in bundles and they become ready for use.

There are several types of retting water for processing of jute plant: (1) stagnant water, (2) running river water and (3) slow moving water. The last one is ideally suited for retting operation and gives best result. There are several methods or techniques in stripping the fibre, among which the single stripping yields best results. After stripping the fibre, it is washed and dried in sun for 2/3 days and then made into bundles for marketing (Jute Corporation of India, Govt. of India).

4.1.3: Jute Production Scenario in India in the context of World Jute Production:

Jute production is confined to a limited area of the World. It is one of the most common natural fibres in Third World countries such as India, China, Bangladesh, Nepal, Myanmar, etc. Area under jute in the World has been decreasing and growth rates becoming negative since 1988-1990. In 1988-90 average area under jute was 2066 thousand hectares which declined to 1155 thousand hectares in 2010. The growth rate of area under jute in worldwide declined from (-) 2.8 percent per year during 1988-90 to 1998-2000 to (-) 3.0 percent per year during 1998-2000 to 2010 (FAO, World Jute.Com.). Similarly, production of jute in the World has also declined from 3311 thousand MT during 1988-1990 to 2801 thousand MT in 2010-11 (FAO; IJSG, Dhaka, 2012). Growth rate of production of jute in the World annually declined by (-) 1.9 percent from 1988-90 to 1998-2000 and by (-) 1.6 percent from 1998-2000 to 2010. During the year 2006, Bangladesh exported 59.5 percent of the total jute goods, while India shared 26 percent. But over the years, it was on the wane as most farmers had abandoned or reduced jute cultivation because of low yield and price and due to lack of government patronization and appropriate policy. They switched over to other crops in Bangladesh (The Financial Express, Bangladesh, May, 2011).

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According to FAO, out of 2066 thousand hectares in average of World area under jute cultivation, area under jute in India was 947 thousand hectares or 45.84 percent during 1988-90. When the World area under jute declined, India's area under jute increased to 969 thousand hectares in average during 1998-2000 but it was projected to decline to 702 thousand hectares in 2010. The annual growth rate of jute area in India declined from (-) 0.1 percent in 1988-90 to 1998-2000 to (-) 2.8 percent during 1998-2000 to 2010.

India is the largest producer of jute in the World occupying first position in area and contributing 61.2 percent of the total World production. Jute cultivation area of total agricultural land in India was 0.75 percent and share of jute production of all agricultural crops was 0.83 percent in 2010-11. Share of jute in agriculture GDP was 0.183 percent and in total GDP it was merely 0.032 percent in 2012 (IJSG, 2012). In India, more than 40 lakh people derive their livelihood from jute cultivation and its processing. Before independence it had monopoly in World jute production. But after partition, 80 percent of the jute growing area went to East Pakistan (now Bangladesh) (Raja, 2012). There was phenomenal increase in the country's jute growing area and production in the immediate post partition years as a result of 'grow more jute campaign launched by the government'. In 1951-52, area under jute was 7.90 lakh hectares which was increased to 13.42 lakh hectares in 1961-62 but fell to 11.46 lakh hectares in 1985-86. During 1985-86 to 1995-96 a declining trend was witnessed in area and decline was of 35.6 percent. Over the period, the area coverage under cultivation of jute and allied fibres was characterized by fluctuations. There was a phenomenal increase in production from 4.72 million bales in 1951-52 to 8.24 million bales in 1961-62 but fell to 6.84 million bales in 1971-72. Performance of jute was unsatisfactory in the 1980s, despite remarkable improvement in its yield growth from 0.81 percent in the 1970s to nearly 3 percent in the 1980s. Statistically non-significant growth in jute production in period 1981-82 to 1991-92 appears to be the result of greatly fluctuating yet gradually declining area under jute (Sawant and Achuthan, 1995). Instability in production of raw jute continues to be a major problem in India which is caused by many factors like weather condition, rainfall, flood, etc. It is also greatly influenced by the prices of jute during the previous year. It has been observed that whenever the jute price has come down due to over production, the cultivators have switched over to the production of other agricultural commodities like paddy, etc. during the subsequent years. Hence, year to year fluctuations in the

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prices of jute relative to the prices of paddy would generally influence the relative allocation of land between the two crops. Unless a certain amount of stability in price is ensured, jute growers will find it increasingly difficult to allocate land to jute in preference to another crop where they are reasonably assured of remunerative market prices (Muralidhara Rao and Ramaswamy, 1974).

It was estimated that in 2012-13, area under jute will be in 8 lakh. The annual compound growth rate of jute area in India has been zero during the period 1990-91 to 2012-13. Production of jute in India attained the peak level of 116.78 lakh bales (of 180kg each) in 2001-02. Thereafter, the output was marked by declines and projected to decline to 1494 thousand MT in 2010 and then a marginal dip when production became 106 lakh bales in 2012-13 (4thAdvance Estimates, Directorate of Economics & Statistics, Ministry of Agriculture). The growth rate of production increased by 1.4 percent per year during 1988-90 to 1998-2000 but declined by (-) 0.8 percent per year during 1998-2000 to 2010 (FAO, WorldJute.Com.). The lowest level of yield was recorded in the initial year 1998-99 of 1722kg/ha. Yield level reached the peak of 2492 kg/ha in 2009-10. CAGR of jute yield has also declined from 2.20 percent of 1970-71 to 1990-91to 1.24 percent during 1990-91 to 2012-13. The analysis reveals that barring the year 2009-10, the substantial determinant of production of jute and allied fibres has been the extent of area under cultivation rather than the level of yield (see appendix Table IV.1). Indian raw jute is dominated by medium to inferior grades of jute fibre. Currently, grades lower than TD4 dominate India's raw jute spectrum. The low quality jute is fit only for hessian and sacking production. During the decade 2000-01 to 2009-10, the share of these two product items together remained the range of 81-84 percent of the total production of jute goods (CACP, 2011).

In order to meet the demand of the jute goods in various countries as well as in internal markets in India, the total requirement of raw jute including mesta is estimated around 70 lakh bales. Average domestic demand of jute goods (last four years) in India was 1384 thousand MT per annum (Jute Corporation of India, Govt. of India, 2013-14). India is the net importer of raw jute and jute products. Import increased from 2.00 lakh bales in 2008-09 to 9.00 lakh bales in 2013-14. India does not export raw jute; it exports jute goods. Currently, about 85 percent of the total production is consumed domestically and only 15 percent is devoted for sales abroad (Jute Section, Ministry of Textile, Govt. of India).

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The production and cultivation of jute in India is restricted mainly to the states that lie along the Ganga-Brahmaputra delta in West Bengal and in Bihar, Orissa and Assam. However, jute cultivation has also been extended to the states of Andhra Pradesh, Meghalaya, Tripura, Tamil Nadu, Maharashtra and Uttar Pradesh. In the undivided India, jute was mainly cultivated in East Bengal and partly in Assam, Bihar and Orissa. After the partition of India, the cultivation of jute extended intensively in West Bengal while in the states of Assam, Bihar and Orissa more areas were brought under the cultivation of jute. Assuming a long time normal average (average of 1990s) production of 70 lakh bales, the approximate state wise production may be indicated as below:

Table-4.1: State-wise Production of Jute:

State	Production (in Lakh bales)	Production (in %)
West Bengal	38.0	54.30
Assam	11.0	15.70
Bihar	9.0	12.86
Orissa	4.0	05.70
Andhra Pradesh	4.0	05.70
Tripura	2.0	02.86
Other States	2.0	02.86
Total	70.0	100

Note: the figures indicated above are only a guideline and varies widely from year to year
Source: Jute Corporation of India, Calcutta.

It is observed that eastern and north eastern states in India are the main producer of jute. While West Bengal occupied the first position, Assam retained third in production of raw jute in India accounting for 7.87 percent of its total area and 6.68 percent of its total production in 2007-08 (Raja, 2012) with the yield of 19.76 quintals per hectare. However, the strength of raw jute in Assam is stronger than the raw jute grown in the state of West Bengal (Das, 1995).

4.2: Historical Background of Jute Cultivation in Assam:

Jute is like indigenous *rhea* (*Urticanivea* Linn.), the main cash crop in the lower Brahmaputra Valley (Sarma, 1966). The indigenous *rhea* plant cultivated mainly by the fishermen, yielded material for making ropes and threads for their fishing nets, a marginal garden produce in pre-British days. Guha (2015) mentioned that throughout the medieval times, fishing communities cultivated *rhea* (*riha*/*kankhura*) as source of fibre for making their fishing nets and ropes. Other fibres of marginal importance were jute and mesta. Jute, unlike today, was grown on small patches on high grounds near

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homesteads. It is believed that jute cultivation was not popular in Assam. Although agro-climatic conditions of Assam were favourable for production of jute, its cultivation was not known to the people of Assam upto the 12th century (Choudhury, 1960).

Brahmaputra valley was found suitable for both types of cultivation of jute; one in high and dry tracts beyond the reach of annual floods, the other was in alluvial lands which were more or less flooded during the rains. The first could be grown on the higher grounds towards the hills and the second in the *chapori* tracts on the Brahmaputra and its tributaries. The meteorological conditions, the occurrence of floods in the Assam valley materially did not differ in character from those obtaining in East and North Bengal where cultivation of jute had been done primarily (N.A.I., Monahan, F. J., Report on Jute Cultivation in Assam, 1898). Although cultivation of jute was more profitable than that of *aus (Ahu)* rice, at the same time it required a great deal of more labour. Jute and *ahu* rice were grown in the same land in the Brahmaputra valley. It is to be noted that in comparison to Bengal, labour was more expensive in Assam. Therefore, it would never pay to have jute cultivation done by hired labour. Because of the same reason the capitalists too did not undertake jute cultivation (Goswami, 2001). Government also neglected jute cultivation together with the problem of non-availability of labour and the huge expenditure required in jute cultivation; thus giving the maximum attention towards the tea industry. In colonial period, the administration's efforts to popularize jute cultivation among the indigenous peasants in the riverine plains of the Brahmaputra of Assam were unsuccessful (Das and Saikia, 2011).

Under the circumstances the government came to the conclusion that without the increase of population the extension of jute cultivation would not take place. They therefore, encouraged immigration and reclamation of waste land to stimulate jute cultivation, and for that purpose distribution of jute seeds through the agency of the district officers to cultivators desirous of experimenting with the crop, providing information with regard to the methods of cultivating jute and preparing the fibre for the market through the Department of Economic Products etc. were resorted to (Goswami, 2001).

Assam would have never become prominent as one of the principal jute growing states of the country had there been no immigration from East Bengal (Bhuyan, 1977). Assamese cultivators only came to know of jute cultivation through the immigrant

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cultivators, who carried with them the art of jute cultivation and changed the fellow *chapori* lands into productive jute land (Report on the land revenue and settlement of Kamrup, 1928). In trading list of Assam jute did not have any place upto the first part of the 19th century. However, in the late 19th and early 20th century jute area got extended in Assam. Extension of its cultivation to Assam was a direct impact of large-scale immigration of land hungry peasants from the neighbouring over crowded districts of the then East Bengal now Bangladesh, viz., Mymensing, Pabha, Rangpur and Sylhet in the second half of the 19th century to the first half of the 20th century (Barman, 1985). Sir Henry J. Cotton, the then Commissioner of Assam put forward a scheme in 1896 for jute cultivation in the waste land of Assam by settling the immigrants of Bengal. The jute-oriented peasants of East Bengal came by thousands to colonize the riverine waste lands. The soil and climate is akin to that of earlier East Bengal, the queen amongst jute growing regions. Assam valley is a natural extension of Bengal basin and with the development of jute industry in Bengal, cultivation of jute started expanding in Assam too. It appears that the history of cultivation of jute in Assam is closely linked to the history of colonization of Assam by the British and subsequent planned migration to Assam so that immigrants could raise the raw jute for export to England to feed the jute mills set up there. In Goalpara district, jute cultivation started in a big way in the 2nd part of the 19th century. Gradually, they spread to other districts of the province. For the first time the cultivation of jute became important in Assam Proper[54], increasing from less than 500 acres before 1901 to over 6000 acres by 1911. The total jute acreage exceeded one lakh acres by 1930-31 and to two lakh acres by 1961.

Jute was the highest export earner for India in the early 20th century. From 1903-04 to 1919-20, the export of raw jute grew more than three times. Thus, it was natural for British capital to look for more land to grow jute, jute land in Bengal was saturating (Baruah, 1980). As a result, Assam began to get more attention for expansion of jute cultivation. There was plenty of land in Nagaon, Lakhimpur, eastern part of Darrang, eastern Duars region of Goalpara and Barpeta sub-division of Kamrup district that was found to be ideal for jute cultivation (Das and Saikia, 2011). Although the availability of land posed no great difficulty, labour remained a tricky issue. Government thus encouraged immigration in the state from the economic point of view. In Goalpara, the

[54] Assam Proper constituting the five districts of Kamrup, Darrang, Nagong, Sibsagar and Lakhimpur (Mukherjee, 1979).

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Zamindars had been encouraging peasants from East Bengal to settle and cultivate jute in *char* areas (River Island and banks formed by silt deposit). Immigration and settlement of peasants from East Bengal in large swathes of waste land including grazing reserves and other common lands saw rapid growth of jute acreage. With the superior techniques of cultivation, immigrant peasants taught Assam how to grow jute and several other crops. The acreage under jute in the Brahmaputra valley increased, as a result of great population movement, from a little less than 30000 acres in 1905-06 to more than 106000 acres in 1919-20 (Guha, 2006). From 1903-04 to 1919-20 acreage grew 3.6 times. By the Second World War Assam became the third largest jute producer of the country (Das and Saikia, 2011).

Jute cultivation in the state exacerbated the hold of commercial capital. As it was not a food crop, the market was the only medium through which peasants could obtain means of subsistence. Thus, extraction of surplus value was increasingly mediated through exchange relations. The peasants needed an initial investment to set up establishment in the alien land and the credit market therefore expanded. Although Marwari merchants were the main creditors, local co-operative credit societies, village money lenders, buyers of the produce were other sources of credit. Marwari traders and even Assamese money lenders of Barpeta provided a substantial part of the necessary finance to enable the immigrant peasants to bring virgin soil under the plough (Guha, 2006). The interest rates were exorbitant and varied depending on the value of the collateral, ranging from 12 percent to 37 percent per month. Migrant and Assamese peasants were charged different rates of interest.

The area under jute production gradually increased in Assam after partition of India. Since the partition of India in 1947, the major jute growing regions having gone to East Pakistan, Assam has made rapid progress in the cultivation of jute. The Muslim immigrants who migrated to other districts of Assam helped in the growth of jute cultivation in Assam (Das, 1995). Jute cultivation is mainly concentrated in the four districts viz. Goalpara, Kamrup, Darrang and Nagaon where most of the immigrants are settled. These four districts taken together accounts for more than 90 percent of the total area under jute which has form the nucleus of jute belt in Assam (Das, 1995).

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4.3: Jute Production in Assam in Recent Decades:

Jute is an important cash crop in Assam occupying about 1.5 percent of total cropped area in 2010-11 (Economic Survey, Assam, 2012-13). Jute was second highest contributing crop to GSDP and it retained second in rank in value worth till 2009-10 (Directorate of Economics and Statistics, Assam). Jute was ranked sixth to seventh in area coverage among ten major crops produced in Assam from 2003-04 to 2012-13. The quality of raw jute in Assam is also found to be superior. Assam has favourable agro-climatic condition for the cultivation of jute. Of specific importance are the aspects of precipitation - its timely arrival, adequacy, consistency and regularity. Two varieties of jute are grown in the state. *Titamora* (C*orchorus Capsularis*) grown comparatively in low lying areas and *Mithmora* (*Capsularis Olitirius*) grown on higher areas. In Assam *capsularis* jute is mainly grown, but the area under *olitorius* is increasing. Jute from the Brahmaputra region, which includes Darrang, Goalpara, Kamrup, Sibsagar, Lakhimpur and Nagong districts, and from the Cachar district is placed under this category. Preparation of land to cultivate jute in Assam starts from February and six to seven ploughings are given to obtain a fine till, seeds are sown in April-May and plants are cut in August and September just at the time of small pod stage. The area under jute in Assam as percentage of total cropped area under different crops was 5.5 percent in 1960-61 which was gradually declined to 2.7 percent (95.0 thousand hectares) in 1997-98 (Dhar, 2001**)** and further declined to 1.9 percent (66 thousand hectares) in 2011-12. During the period from 1970-71 to 1983-86 there was a decrease in jute area by 0.15 lakh hectares. Bhuyan (1977) said that it may be ascribed to the fact that the indigenous Assamese peasants in many areas have almost avoided the cultivation of jute because of the hard labour needed for its production on the one hand and the frequent fluctuation of its price on the other. However, in the all India level, gross area under jute remains almost same at 0.8 million hectares during the period 1970-71 to 2011-12. Where the share of the state of jute producing area in all India was 10.9 percent in 1980-81, it has declined to 7.22 percent in 2009-10. The total production of jute which was 912 thousand bales in 1980-81, gradually declined to 410 thousand bales in 2004-05 (Dhar, 2001 and 2007). In 2011-12, jute production in Assam was decreased to 608 thousand bales. State's share of jute production in all India has also declined from 11.11 percent in 2000-01 to 6.63 percent in 2008-09. On the contrary, production of jute in all India level increased from 4.9 million MT in 1970-71 to 10.9 million MT in 2011-12 due to

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improvement of yield from 1186kg per hectare to 2422kg per hectare. Table 4.2 reveals the trend of area, production and productivity of jute in Assam and India.

Table-4.2: Trend of Area, Production & Productivity of Jute in Assam and India:
(Area: '000 hectare; Production: '000 bales of 180kg each; Yield: kg per ha)

Year	Area			Production			Productivity	
	Assam	India	% of All India	Assam	India	% of All India	Assam	India
1960-61	299.0	600	49.83	813	4100	19.83	1229	1183
1970-71	128.0	800	16.0	936.8	4900	19.12	1305	1186
1976-77	106.2 (3.3%)	-	-	704.2	-	-	1202	-
1977-78	99.6	-	-	544.8	-	-	984.6	-
1978-79	114.9	-	-	899.0	-	-	1408.36	1281
1979-80	115.0	-	-	885.0	-	-	1385.22	-
1980-81	105.0 (3.77%)	900	12.5	912.6	6500	14.04	1463	1245
1983-84	100.8	-	-	853.9	6500	13.14	1524.82	-
1984-85	108.5	995.4	10.9	827.0	-	-	1372	-
1985-86	129.6	-	-	1179.1	10900	10.82	1637.64	-
1986-87	96.7	-	-	951.1	7400	12.85	1770	-
1990-91	96.0 (2.85%)	800	12.0	865.9	7900	10.96	1632	1833
1991-92	102.0	1041	9.8	867	-	-	1537	-
1992-93	92.5	770	12.0	1033.7	7850	13.17	2011.52	1454
1993-94	76.0	817.2	9.3	667	-	-	1579.74	-
1994-95	91.0	875	10.4	925	-	-	1829.7	-
1995-96	88.6	736.77	12.03	844.2	7674.7	11	1715	1875
1996-97	94.03	897.35	10.48	802.9	9960.6	8.06	1537	1998
1997-98	95.0	906.3	10.48	904.1	9959.8	9.1	1720	1978
1998-99	78.7	848.3	9.3	687.2	8836.5	7.78	1572	1875
1999-2000	73.0	846.6	8.62	657.0	9428.3	6.98	1605	2005
2000-01	69.5 (1.69%)	827.9	8.4	668.1	9317.0	11.11	1730	2026
2001-02	68.0 (1.67%)	873.1	8.32	675.0	10583.9	9.52	1781	2182
2002-03	68.0	864.5	7.87	691.0	10273.7	9.09	1830	2139
2003-04	64.0 (1.66%)	849.0	7.54	665.0	10251.6	8.89	1870	2173
2004-05	58.0 (1.8%)	773.9	7.5	410.4	9399.3	7.12	1830	2186
2005-06	57.8 (1.78%)	759.8	7.61	680.0	9969.5	5.81	1836	2362
2006-07	58.0 (1.9%)	792.9	7.31	579	10317.1	5.42	1744	2342
2007-08	60.0 (1.9%)	814.1	7.37	559	10221.0	6.43	1976	2260
2008-09	61.4 (1.82%)	811.9	7.56	657.0	9634.0	7.02	1939	2207
2009-10	65.0 (1.9%)	800	8.13	647	11230	6.37	1967	2492
2010-11	62.0 (1.8%)	800	7.75	626	10000	6.26	1808	2344
2011-12*	66.0 (1.91%)	800	8.25	608	10700	5.58	1669	2422
2012-13*	65.1	-	-	558	10600	5.26	1543	-
CAGR**	-3.72	0.96	-	0.21	2.21	-	0.93	1.47
CAGR***	-2.16	0	-	-1.67	1.19	-	0.54	1.24

Note: Figure in parenthesis refers percentage of GCA; *Fourth Advance Estimate; ** CAGR of jute from 1960-61 to 1990-91 in %; *** CAGR of jute from 1990-91 to 2010-11 in %;

Source: (i) LOK SABHA, Minister of State for Textiles, GoI & World Jute.Com. FAO, Ganashakti, 14th July, 1994;(ii) Indian Economy, Basic Statistics, Supplement to the RBI Bulletin, December, 1987,(iii) Agriculture Development in Assam, 2001-02 & 2002-03, Govt. of Assam, Dept. of Agriculture; Statistical Hand Book of Assam, Govt. of Assam, 1982, 1984, 1987; (iv) Economic Survey, 2009-10, 2010-11, 2011-12, 2012-13; Directorate of Economics and Statistics, Ministry of Agriculture; (v)Calculation of the Author.

Table 4.2 shows that area under jute in Assam has decreased from 299 thousand hectare to 66 thousand hectares since 1960-61 to 2011-12, while in all India it has increased

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from 600 thousand hectares to around 800 thousand hectares. Production of jute in Assam increased from 813 thousand bales in 1960-61 to 1179.1 thousand bales in 1985-86 and then gradually fell and in 2011-12 it becomes 608 thousand bales while in all India production of jute retained almost 10000 thousand bales. State's share of jute production in all India has also declined over the years with marginal variation. Looking back to 1950-51 it is noticed that the yield rate of jute in Assam was about 33 percent higher than that in India (Mahanta and Neog, 1968). While jute productivity in Assam was 1229kg per hectare in 1960-61, it has increased to 1967kg/ha in 2009-10 compared to 1183kg/ha and 2492kg/ha in all India in the corresponding period. Until 1980s yield rate of jute in Assam was better than all India average which has almost altered thereafter. Although Assam has a prominent place for jute production, indices of area, production and productivity of jute in the state was quite low compared to all India indices (see appendix Table IV.5).

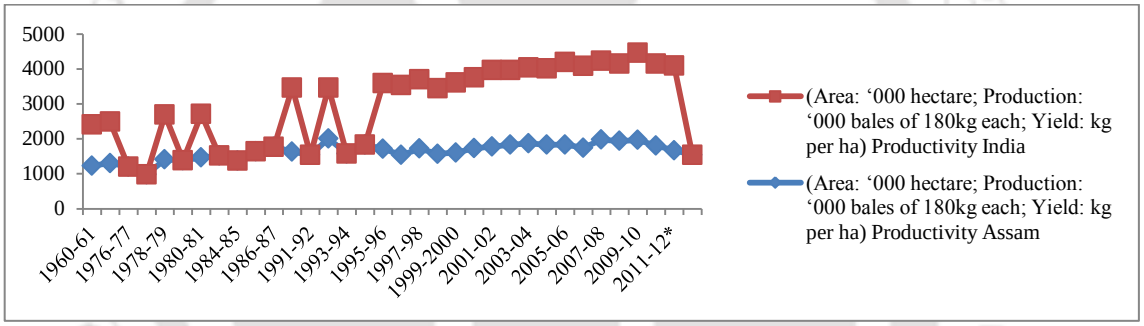

Fig.4.1: Trend of Productivity of Jute in Assam and India

4.4: Zone-wise and District-wise Jute Production in Assam:

There is a marked spatial variation in the distribution of jute in the state. The Barak Valley in Assam appears to be insignificant so far jute cultivation is concerned. Similar is the condition in case of the Upper Brahmaputra Valley and Hill Zone. On the other hand, the lower and the central parts of the Brahmaputra valley form a region of relatively high jute hectareage. The Brahmaputra valley is an alluvium plain of about 450 miles in length having an average breadth of 50 miles which are well drained and the majority of the areas are suitable for jute cultivation. The percentage shares of Gross Cropped Area in jute cultivation across the agro-climatic zones in Assam from 2003-04 to 2012-13 are given in table 4.3:

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Table-4.3: Zone-wise percentage share of jute area in Assam:

Zones	% share of GCA of the zones				
	2003-04	2006-07	2007-08	2010-11	2012-13
CBVZ	2.56	3.59	3.73	3.11	3.75
LBVZ	2.56	2.88	2.76	2.52	2.56
NBPZ	1.76	1.60	1.35	1.22	1.15
UBVZ	0.12	0.16	0.13	0.05	0.05
BVZ	0.05	0.06	0.06	0.05	0.04
HZ	0.85	-	0.84	0.7	0.69
ASSAM	1.62	-	1.82	1.5	1.6

Source: (i) Mandal, 2010; (ii) Calculated by the author.

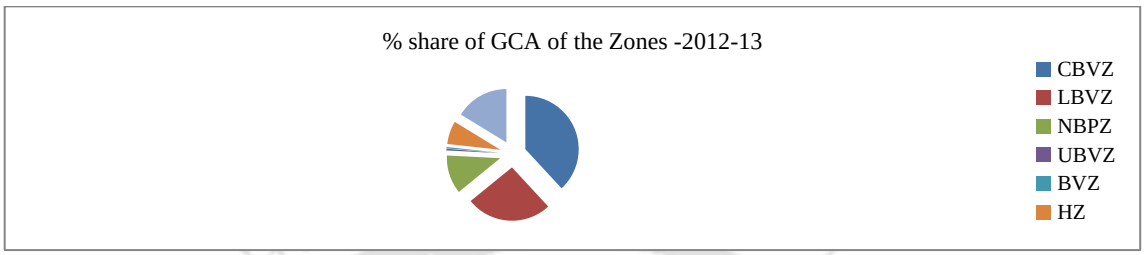

Fig.4.2: Zone-wise percentage share of jute area in Assam

Table 4.3 reveals that jute cultivation in Upper Brahmaputra Valley, Barak Valley and Hill Zone in Assam is very low, less than 1 percent of total cropped area of the zones. Although jute cultivation in CBVZ and LBVZ in the state has either increased or remained constant, acreage share of other agro-ecological zones in their GCA is declining.

Basically four districts of Assam viz., Goalpara, Kamrup, Darrang and Nagaon are the main centre for jute production in Assam. Goalpara district had largest area of jute cultivation (75794ha) while Nagaon had 64734 hectares, Kamrup 50509 hectares, Darrang 25119 hectares, Lakhimpur 2016 hectares, Sibsagar 902 hectares and Cachar district was least in jute cultivation with 496 hectares in 1980-81. In recent years, Goalpara, Kamrup (R), Dhubri, Kokrajhar, Bongaigaon, Barpeta, Nalbari, Morigaon, Nagaon, Darrang, Udalguri, Sonitpur, etc. districts found place in the map of jute production in the state and contributed about three-fourth of the state's production. Nagaon has been the traditionally jute growing district which occupies the large area under this crop, but it belongs to the medium yield category district. Dhubri has the highest percentage (20.1%) followed by Nagaon (14.86%) in the state total jute area in 2012-13. Lakhimpur, Sibasagar and Cachar districts are other important jute producers. The *char* lands or reclaimed waste lands contribute a major share in the jute production (Gopalakrishnan, 2000). Table 4.4 shows the trends of jute production in different districts in Assam since 1990-91.

Table-4.4: District-wise area and production of jute in Assam during 1990-91 to 2012-13:
(Area in ha; Production in MT)

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Districts	Item	1990-91	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Baska	A	-	-	-	382	1478	1364	913	906	570	848	590
	P	-	-	-	3540	14320	9533	8087	8290	8750	6365	3372
Barpeta	A	-	7775	7580	7006	6294	3774	5667	7182	6469	6151	1294
	P	-	77543	5615	65703	63576	39205	46004	61035	50524	61441	5823
Bongaigaon	A	-	3440	3002	2838	2156	2250	2222	2281	2153	2371	2278
	P	-	35141	30708	25931	22362	20421	24436	26333	24657	24965	24694
Cachar	A	150	75	81	73	49	52	53	53	52	51	52
	P	-	779	574	745	474	571	571	579	522	472	445
Chirang	A	-	-	-	1242	1209	1385	1081	1101	1416	1041	2165
	P	-	-	-	12379	11714	14389	10879	11013	13329	9749	18561
Darrang	A	3500	11600	9445	4000	3082	2534	3260	4203	3115	3874	3330
	P	-	157129	69718	35067	19982	17752	21371	42217	23086	38503	26789
Dhemaji	A	-	164	161	91	91	95	80	101	84	87	86
	P	-	1704	1140	928	881	1043	862	1104	844	807	739
Dhubri	A	-	13528	12170	10992	10049	12202	11176	12725	12195	12750	13075
	P	-	86626	73162	90619	87318	114084	100813	107232	93229	122184	108922
Dibrugarh	A	-	10	10	26	18	8	8	6	05	6	8
	P	-	104	71	265	174	88	86	66	50	56	67
Dima Hasao	A	-	54	55	51	49	47	48	55	61	60	59
	P	-	561	389	520	475	516	517	601	613	556	506
Goalpara	A	8000	2300	2300	2371	2750	3000	3370	3200	3010	3300	4150
	P	-	18055	22655	23460	24964	38200	51954	43040	48913	31570	38828
Golaghat	A	-	687	685	700	551	418	303	362	316	310	350
	P	-	5932	5858	7712	3608	3741	2777	3956	3175	2875	3000
Hailakandi	A	-	30	25	25	35	30	35	35	40	35	25
	P	-	312	177	255	339	329	377	382	402	325	217
Jorhat	A	-	143	109	145	136	121	140	93	73	89	55
	P	-	1485	772	1479	1317	1328	1508	1016	734	832	472
Kamrup (M)	A	-	-	-	69	67	139	145	60	51	47	50
	P	-	-	-	969	649	1526	1562	656	512	436	428
Kamrup (R)	A	6500	3357	3335	3322	3401	3616	3449	3077	3359	3843	3987
	P	-	28204	18463	45923	49780	54942	52748	44012	51505	31855	25533
Karbi Anglong	A	-	1951	1989	1036	1866	1711	1711	1744	1757	1711	1713
	P	-	23390	14078	13248	20067	18783	19011	17610	16734	15865	14684
Karimganj	A	-	55	80	80	70	75	61	65	61	66	60
	P	-	571	566	816	678	823	657	710	613	612	517
Kokrajhar	A	-	2491	2445	3071	4138	4953	4481	4766	5803	4300	3884
	P	-	26316	20828	29221	41783	57158	39842	54186	51019	46651	33294
Lakhimpur	A	450	464	403	404	395	372	412	378	360	143	98
	P	-	2683	2833	3304	2213	2023	2459	2476	2365	1062	839
Morigaon	A	-	2800	2300	3000	3088	4350	4000	4100	3656	4336	6345
	P	-	25760	14388	25267	33024	44518	48089	40499	28029	31316	61861
Nagaon	A	9500	9682	8548	7744	8465	9548	9506	9955	9273	9860	9670
	P	-	140453	106883	98315	103023	138175	138944	146932	115965	94952	87962
Nalbari	A	-	1300	1260	1046	929	900	950	900	890	2724	4660
	P	-	11917	4165	8908	7824	8565	8191	6420	8420	24667	46494
Sibsagar	A	200	45	48	42	47	53	69	59	38	43	25
	P	-	468	339	429	455	582	744	645	381	398	211
Sonitpur	A	-	2070	1930	1940	1639	1890	1903	2145	2314	2504	2646
	P	-	19810	16886	18060	9827	12840	15873	16927	18194	21039	22383
Tinsukia	A	-	12	20	19	17	12	12	13	8	9	9
	P	-	125	141	193	164	132	130	142	80	83	77
Udalguri	A	-	-	-	5042	5594	4943	5056	5705	5138	5001	4428
	P	-	-	-	65602	37573	55554	48963	75215	62930	38387	31272
Assam	A	28300	64033	57981	56757	54063	59842	60111	65270	62267	65560	65092
	P		665068	410409	578858	558564	656821	647455	713294	625575	608023	557990

Note: A: Area; P: Production.

Source: Directorate of Economics& Statistics, Assam (2015).

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From the table 4.4, it is observed that in recent years area under jute has declined in almost all the districts in Assam. However, some exceptions are reflected in the table where jute areas in the non-traditional districts have been increased. Area under jute in Dima Hasao district has increased from merely 54 hectares in 2003-04 to 59 hectares in 2012-13. Similarly, in Kamrup (R), it has increased from 3357 hectares to 3987 hectares, in Morigaon area increased from 2800 hectares to 6345 hectares, in Nalbari from 1300 hectares to 4660 hectares and in Sonitpur area increased from 2070 hectares to 2646 hectares during the period from 2003-04 to 2012-13. Production of jute in the districts of Bongaigaon, Cachar, Dhemaji, Dibrugahr, Golaghat, Hailakandi, Jorhat, Kamrup, Karbi Anglang, Lakhimpur, Nagaon, Sibsagar and Tinsukia has decreased which was caused mainly by decline in jute area. Dhubri, Nalbari, Sonitpur districts could experience growth in jute production. In Goalpara, jute production has gradually increased upto 2008-09, thereafter some variation is observed.

Inefficient functioning of Government procurement agencies, lack of credit support, price support, etc. have caused decline in growth of this cash crop in the state. Initially, decline of area under this crop was caused by the gradual diversion from jute to food crops i.e., mainly *Ahu* paddy which fetches higher prices at low cost of production. Barman (1985) mentioned that "jute, an important fiber crop grown in the state, exhibits the highest number of times the area decreased, i.e., 11 times out of 27 years (1951-52 to 1977-78)". Adverse weather conditions in the jute season, a gradual shift from jute to food crops due to comparative economic advantage, lack of adequate seed supply, inadequate supply of pesticides, high labour cost, minimum price of jute as announced by the government of India (which was non-remunerative), availability of alternative crops, etc. were some of the causes responsible for poor performance of jute production. Goswami (2002) stated, "One of the reasons for decline in jute acreage in the state was receiving unremunerative price by the farmers for imperfect market and operation of a chain of middlemen and money lenders". Hazarika, (2006) and Saikia (2013) states that due to problem of retting, processing, marketing and cultivating alternative crops the area under jute in Assam is declining. Rice is substituting jute area. Production of jute is highly affected by the fluctuations of area under its cultivation.

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4.5: Input Uses and Institutional Support in Jute Cultivation in Assam:

Excluding jute seeds and labour input, it is observed from the field survey that usually input requirements in jute cultivation are lesser than in rice and other food crop cultivation. Farmers do not use much of fertilizers or pesticides, irrigation, etc. in jute cultivation. However, a brief note on the use of inputs in the jute cultivation in Assam is given in the following section.

Use of Seeds:

Usually jute cultivation requires 3kg seeds of traditional varieties to sow an acre while high yielding varieties need 2.4kg per acre. In the earlier days farmers used traditional variety of seeds from self preservations or collected from the local markets. Now a day, modern high yielding varieties are available in the market and the government also distributes jute seeds either at subsidied price or at free of cost. However, the price of jute seeds in the open market becomes almost doubled in five years as reported by the respondent farmers during study. Again the problems of untimely and inadequate distribution of seeds constrain the extension of jute cultivation in the state. Production of certified seeds by the Department of Agriculture was 3800 quintals but its distribution was only 1903 quintals or 50.1 percent in 2010-11(Profile of Agri-Horti Sector of Assam, June, 2012). Table 4.5 presented the jute seed rates and seed replacements rates in Assam.

Table-4.5: Seed Rates (SR) (kg/ha) and Seed Replacement Rate (SRR) of Jute in Assam:
(Based on actual distribution of Certified Seeds)

SR (kg/ha)	SRR (in %)			
	2009-10	2010-11	2011-12	2012-13 (Target)
6.00	22.5	42	44	100

Source: Profile of Agri-Horti Sector of Assam, June, 2012.

Seed replacement rate in jute cultivation in Assam has gradually increased. And it was targeted to achieve cent percent modern variety of seed replacement in 2012-13.

Use of Fertilizers:

Jute is a natural product that makes nature richer by virtue of it being a natural. Leaves that fall off a jute plant are an excellent source of fertilizer for the next year's crop, thus reduces the cost of fertilizer needed. Most of the respondent farmers in Goalpara and Bongaogaon districts do not feel need much in using chemical fertilizers. Cow dung has

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been mostly used in jute cultivation. However, a few farmers also uses urea, DAP and other fertilizers as per requirement of the soil. Although uses of insecticides are very much limited, weedicide is gradually becoming popular among the jute growers in the study area to reduce cost on weed removing by human labour.

Irrigation in Jute Cultivation:

Farmers of Assam rarely feel the need of irrigation in jute cultivation. Jute cultivation in Assam mostly depends on rainfall. The bulk of the crop cultivation has to depend on rainfall; for instance, in West Bengal, largest jute producing state in the country, only 1.5 lakh hectares (or 5.3%) of the total jute area was under irrigation (Agriculture Census, 2010-11). However, bringing in more jute area under irrigation will considerably help in avoiding production uncertainties. In the study area, jute cultivation has been undertaken mainly in low lying area and cultivators use irrigation in need base only in the early stages of growth.

Credit Availability:

In jute cultivation the main component of recurring expenditure is the payment on labour used particularly in weed removing, harvesting and retting. Credit is required mainly for payment on labour as informed by the respondents. As the cultivation of jute is basically labour oriented, it is observed that the cost of cultivation of jute is increasing for higher labour cost and thus farmers require credit. In India, availability of credit to the jute growers was inadequate which also has had its impact on the method of marketing (Muralidhara Rao and Ramaswami, 1974). Farmers collect credit for jute cultivation mainly from the informal sectors at high rate of interest due to lack of accessibility of institutional credit. To repay the credit they may sell their produce immediately after harvesting and could not store the same till rise in the price.

Minimum Support Price (MSP) for Raw Jute:

Minimum support price for raw jute and mesta is fixed every year to protect the interest of farmers. While fixing prices of different grades, the issue of discouraging production of lower grade jute and encouraging production of higher grades jute are taken into consideration. The minimum support price is fixed by the Government of India on the basis of recommendations of the Commission for Agricultural Costs and Prices (CACP). CACP undertakes a study every year to recommend the Minimum Support Price of raw

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jute. Jute Corporation of India (JCI) is the Price Support Agency of the Government of India for jute. It was set up in April 1971 primarily to protect the interest of the jute growers through procurement of raw jute under the MPS fixed by the Government of India and also to stabilize the raw jute market for the benefit of the jute farmers and the jute economy as a whole.[55] In Assam, STATFED has entered into jute procurement operation as an agent of the JCI since 1979-80 and was procuring jute at government fixed prices from the farmers in order to save them from distress sale. The federation procures jute on the basis of grade specification. This grade specification is based on six qualities, i.e., strength, colour, fitness, density or heaviness, root content and defects for each grade of white (*Capsularies*) and tossa/daiser (*Olitories*).[56] However, functions of STATFED in the state have collapsed since long back (Das, 1989).

The procurement of jute under MSP is contingent upon the prices prevailing in the market for raw jute at any point of time. In addition, it is often seen that it may be more remunerative for farmers to sell directly to traders/manufacturers as the price of raw jute is not just determined by input costs but also by demand for it. Since last couple of years it is seen that the market prices (MP) of jute are much higher than its MSP. The

[55] Raw jute is transacted in over 500 centres countrywide. Presently, JCI is operating only at 171 Departmental Purchase Centres. Co-operatives operate at about 40 centres. JCI in turn purchases the jute procured by these Co-operatives. Government of India provides a subsidy of approximately Rs.55 crores per year to enable JCI to maintain the infrastructure and manpower for meeting the requirements of MSP operations.

[56] Indian jute mills, on the basis of their requirements for the production of either hessian cloth or sacking bags, have fixed certain standards regarding jute. Quality is judged by assessing length, strength, colour, luster, percentage and quality of cuttings, proportion of faults (roots, specks, knots, runners, hard crop, etc.), uniformity and slipperiness of the yarn produced, and such general features of the fibre as fineness, stiffness and hardness. Of these, strength is the most important, and is estimated as the breaking load in pounds of unit length of fibre. The quality ratio is the strength of the yarn, manufactured from the fibre, in pounds multiplied by 100 and divided by its grist (weight in pounds of 14,400 yards of yarn) (Kundu, 1956).

A fibre having good length and strength, high luster, fineness, pliability, and good colour and cleanliness free of any fault and with the smallest percentage of cutting is regarded as of good quality, and that which spins into the finest yarn is of the best. The quality of jute depends on its spinning characteristics, i.e., its suitability for spinning into various types of yarns. Work at the Technological Research Laboratories of the Indian Central Jute Committee has shown that fibre that feels heavier in the hand tends to have a higher spinning quality.

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comparison between minimum support price and market prices (TD-5 variety) is sown in Table 4.6.

Table-4.6: Minimum support price and market prices of Jute from 2010-11 to 2015-16: (Rs/Qlt)

Months	2010-11		2011-12		2012-13		2013-14		2014-15		2015-16	
	MSP	MP	MSP	MP	MSP	MP	MSP	MP	MSP	MP	MSP	MP
July	1575	3005	1675	2447	2200	2661	2300	2636	2400	2636	2700	4180
August		2786		2386		2726		2526		2696		4034
Sept.		3206		2438		2661		2589		2709		
Oct.		3335		2195		2469		2650		2857		
Nov.		3377		2079		2393		2627		3011		
Dec.		3364		1960		2354		2897		3071		
Jan.		3382		2138		2465		2881		3158		
Feb.		3298		2386		2685		2820		3248		
March		3209		2422		2886		2816		3252		
April		3204		2391		2901		2964		3305		
May		3217		2344		2808		3139		3454		
June		2724		2483		2638		3035		4047		

Source: Jute Sector, Govt. of India.

Table 4.6 shows that MSP of jute has been increased in every year and the market price of jute always prevailed higher than the government fixed MSP. From 2010-11 to 2011-12, MSP increased by 6.4 percent, from 2011-12 to 2012-13 it has increased by 31 percent, from 2012-13 to 2013-14 by 4.5 percent, from 2013-14 to 2014-15 by 4.35 percent and from 2014-15 to 2015-16 MSP increased by 12.5 percent. Since the MSP is lower than the market price, one may question why has it at all? MSP is supposed to provide a minimum remunerative price when market prices are depressed. If it is below the market price it does not serve any purpose.

Variation in Jute Price and Jute Acreage:

Jute prices are subject to high inter and intra seasonal fluctuations. Prices go down during the months of September-October when the market arrivals remain at their peak. This is since the private mills do not procure at a time quantity in excess of their requirement for a month or two. The procurement operations by JCI are limited vis-a-vis the requirements.

Hussain and Haque (1967) have tried to explain the price elasticity of jute acreage for different periods in India-Pakistan. The result obtained in their studies suggested that jute farmers in India-Pakistan were responsive to prices and that the co-efficient of elasticity was larger when only *aus* rice was considered as the competitor--which could be expected.

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Goswami and Gogoi (1971) studied the effect of price on cultivation and the disposal of paddy and jute of Nagaon district of Assam. They find that in the short run price fluctuations do not affect the farmers' decision to increase or to decrease crops unless they are sure of a permanent increasing trend in prices.

Government Policy and Support:

Government policy and programme influence the productivity of jute in the state. In a study on the functioning and progress of Integrated Jute Development Programme (IJDP) in Nagaon district in Assam, Gohain and Gogoi (1980) concluded that the impact of the IJDP was satisfactory. The peasants were benefitted and per hectare production was higher in the district due to IJDP operation. But because of inadequate inputs supply, farmers cannot adopt improved package of practices fully. The Government of India has introduced the Jute Packaging Materials (Compulsory Use in Packaging Commodities) Act 1987, as a measure to help the jute industry against the synthetic sack industry. The Act that initially made it mandatory to pack several bulk commodities in jute sacks, is now limited to the compulsory packing for foodgrains and sugar. In the National Jute Policy, 2005, Government emphasizes the need for diversification of jute products.

The condition of infrastructure and functions of the establishments of Jute Corporation of India set up years ago in different parts of Goalpara and Bongaigaon districts are very miserable as noticed during the field study. Equipments and machines used for grading, baling and other stages of processing are lying off abandoned since long back.

Jute Research:

The Govt. of Assam has established a separate Directorate for jute to raise the area, average yield and total production of jute in Assam. A Jute Research Centre has been set up at Dhing of Nagaon district to explore the potentialities of jute production in Assam. However, very little attention has been articulated in the research and development aspects in jute and jute grower's socio-economic condition. A jute research farm was started at Sarbhog near Barpeta in 1957 by Indian Central Jute Committee, which was handed over to Agriculture Department in 1961. The activities of this research station were shifted to Shillongoni in 1965, which is now under the Assam Agriculture University, Jorhat (Agriculture Development in Assam, 2001-02 & 2002-03, Govt. of

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Assam, Department of Agriculture). Achievements of this research farm were not known.

4.6: Constraints in Jute Cultivation in Assam:

Jute acreage as well as production of raw jute has been gradually decreasing even though it is comparatively profitable to rice cultivation. Apart from delayed monsoon rain it was both disproportionate costliness of the basic inputs and lack of its easily accessible supply channels that contributed to decline in acreage under jute cultivation. Cultivation of jute in Assam suffers by different problems which are summarised in the following section.

Problems of Seeds:

Untimely distribution of seeds supplied by the government department and price rise in jute seed in the open market creates problem for the farmers. One of the issues in jute cultivation in the country is the limited availability of certified seed production which meets only about 35 percent of the total demand. Problem of availability and distribution of quality seeds particularly high yielding varieties of seed developed by research institutions are being faced by jute farmers. Moreover, it was reported that there is a considerable mixing/adulteration in the certified seeds available in the market. CACP recommends that the government should form and vigorously implement programmes for multiplication of certified quality jute seeds and their proper distribution and ensure timely availability to the jute growers at reasonable price.

Problems of Natural Causes:

Recurring flood and other natural causes in the jute growing area hamper the production of jute in the state. Jute has the highest acreage share in chronically flood prone areas of Dhubri district (Mandal, 2011). Usually jute cultivated in the low lying areas and due to fear of flood growers of Goalpara and Bongaigaon districts may have to harvest jute in a pre matured stage as reported by the respondents. Besides flood, drought, wind, storms also destroy the jute fields. Attack by pest and diseases destroy the acres of jute cultivation.

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Problems of Labour Availability:

As jute cultivation is labour oriented and more labour to be involved in cultivation and processing, cultivators are facing problem of labour availability and thus are reluctant to cultivate jute. Officials and farmer representatives highlighted that with the emergence of other crops cultivation and engagement in other occupation have created labour shortage in farm sector and increased the cost on labour for jute production. The problem has become more pronounced with the progress in the implementation of MGNREGA.

Availability of Alternative Crops:

Availability of alternative crops that can be cultivated in jute area and jute season discourages to grow jute. The inter crop price parity between jute and other *kharif* crops particularly paddy is more relevant as the jute farmers are switching over to the paddy cultivation. In this regard, it is to be noted that at the level of minimum support price for paddy and jute, the estimated net returns for paddy is higher by about 200 percent at all India level than on jute for the two consecutive years of 2008-09 and 2009-10 (CACP, 2011).

Problem of Market:

The problem of raw jute marketing has received some attention from the successive Jute Inquiry Commission and other government sponsored studies by the Ministry of Commerce and Industry, Government of India and Indian Central Jute Committee.

The jute passes through the hands of different small village intermediaries and reaches the upcountry markets where it is assorted and baled. It then comes to the terminal markets through a chain of intermediaries. Ultimately, it finds way to the mills through a definite set of brokers or big sellers. Middle men between the growers and consumers collect and store the material which they then carry to baling stations where it is pressed into bales for transport to Calcutta or other consuming or export centres. Most of the jute grown is disposed of in this manner by the growers at their doors, and some dealers advance money to them when the crop is still in the field (Kundu, 1956). Most of the jute growers, having only a small quantity to market, prefer to dispose of the produce either in the village itself or in the nearby *hat* (Muralidhara Rao and Ramaswami, 1974). Besides, respondent farmers said that small growers are compelled to sell their produce

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to the local intermediaries due to advance receipt of money for payment on labour and to meet household expenditure.

On an examination of the marketing pattern, it would appear that rural indebtedness and pressure from creditors, urgency of cash, lack of adequate storage accommodation and communication facilities, smallness of individual offering for sale, diversity and manipulation of weights, arbitrary deduction, want of warehousing arrangement for the growers in the secondary market tend to make the growers traditionally shy of the secondary markets and prone to dispose of their jute at their very door-step. This accounts for 61 percent sale of jute at the village level in India. So, it may be said that the entire marketing system of raw jute was under the clutches of a large number of traders, who enjoy a big margin of profit while the growers were left uncared for.

There is no sound marketing and pricing policy in the state. The result was imperfect market and operation of middlemen. A few regulated markets for jute in Assam were established in Gauripur, Howly, Kharupetia and Dhing localities in Assam whose functions are very much limited.

Problems of Jute Mill in Assam:

With the development of agriculture and industry, the need for jute goods, especially gunny bags and hessian began to be felt. Assam produced about 10 lakh bales of jute per year and to exports almost the same to Calcutta which justify setting up as many as 6 to 8 mills in the state. However, only a modest beginning could be made for setting up of a small jute mill in the co-operative sector, The Assam Co-operative Jute Mill Limited at Silghat in Nagaon district in 1959. But in West Bengal, 64 jute mills, in Andhra Pradesh, 7 and in Bihar 3 jute mills were established (The Telegraph, India, May 17, 2011). Silghat jute mill happens to be the first co-operative jute mill in the country. It was commissioned in the year 1971 with a complement of 100 sacking and 50 hessian looms having annual processing capacity of 6900MT raw jute (Das, 1989). The mill has been chronically sick over the years particularly due to low capacity utilization and sustained huge losses years after year and subsequently the mill was declared closed on 6th March, 1984. But later reopened as per the Assam Accord as a result of which the employees were benefited. Since then the mill has been managed properly with profits till now. It may be mentioned that in 2010, the mill was awarded ‘A’ grade among the public

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enterprises, Government of Assam and also awarded Nava Ratna Award. Moreover, Government of Assam has laid foundation stone for two jute mills, one at Dalgaon in Darrang district under the public sector and another at Guagacha in Barpeta district under the co-operative sector. In 1994, the Assam Industrial Development Corporation (AIDC) has set up another jute mill in Assam. There is one more jute mill at Gopinath Nagar in Guwahati (Jute Textile Mills of Assam, 2011).

Assam in spite of being the third largest jute producing state in India has not been able to draw sustenance from development and diversification of jute products. About 70 percent of total jute produced in Assam is purchased for processing outside the state. It was estimated that Assam can run more number of jute mills in the state, but because of several problems like lack of infrastructural facilities, capital and entrepreneurship there is only a few jute mills in the state.

4.7: Economics of Jute Production (Cost and Return to Jute Production):

Cost of cultivation of jute includes cost on material inputs like, seed, manure, fertilizer, insecticide, weedicide; capital cost on bullock, tractor or other equipments; hiring cost on bullock or tractor, and the labour cost on cultivation and processing. Cost also includes transportation and marketing of the produce. Return on the other hand means gross return, net return above paid-out and non-paid cost. It is observed that farmers preferably cultivate modern variety of jute than the traditional variety for more yields. Farmers who collect seeds from the open market spent almost twice in recent years compared to the previous years. Cost of fertilizer used on modern variety is higher than that of the traditional variety. Farmers who cultivated local variety of jute rarely use chemical fertilizers. Although the use of insecticides in jute field is usually minimal, expenditure on weedicides has been recognized by the farmers to reduce the labour cost on weed removing. A considerable paid-out cost on labour involved in the cultivation as well as in processing of jute. Between labour and material, cost of the former was relatively higher. The jute being a labour intensive crop, human labour component constitutes about 70 to 75 percent of the total input cost. To sell the produce farmers incur expenditure on transportation and marketing. However, cost of cultivation of jute differs from location to location although farmers can receive almost similar price in different markets. Table 4.7 present estimated cost of jute cultivation in Assam and West Bengal in 2006-07 to 2007-08.

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Bhuyan, (1976) confines his work to the Economics of jute cultivation of Koliabor Development Block in Nagaon district. It covers all the aspects of cultivation of jute and contended that in comparison to the costs of production the prices of jute are often much lower. He also found many mal-practices in the process of marketing. Thus, the effort to study the economics of jute cultivation in Assam is not sufficient. The jute economy needs more exhaustive investigation from various angles.

Table-4.7: Cost estimates of raw jute in Assam and West Bengal in 2006-07 to 2007-08:

States	Years	A2+FL /ha	C2/ha	A2+FL /qtl	C2/qtl	C3/qtl	Yield (qtl/ha)	Implicit price (per qtl)	MSP (qtl)
Assam	2006-07	16778	20813	795.22	987.57	1136.36	19.86	1130.25	1000
	2007-08	16888	20105	837.79	1017.68	1140.28	17.56	957.67	1055
West Bengal	2006-07	20519	30299	778.85	1152.29	1282.85	24.48	1376.70	1000
	2007-08	22334	31310	776.22	1093.30	1211.63	25.48	1147.79	1055

Note: A2+FL Family Labour; ha hectare; qtl quintal; MSP Minimum Support price.
Source: CACP Report, 2011

4.8: Conclusion: Jute is a significant crop for its monetary value and its domestic uses especially in developing countries. As a versatile but cheap natural strong fibre, jute was used from the ancient times for making cords and ropes and gradually it has been using in diverse field from packaging purposes to decorative fabrication and hence diversified jute product industries were developed.

Compared to the growing potentiality of demand, production of jute is confined to a limited area in the World and the area under jute has been decreasing and growth rate become negative. Although India is the largest producer of jute in the World, a declining trend was witnessed. Despite remarkable improvement in yield, performance of jute production was unsatisfactory. Requirement of raw jute in the country could not meet by its domestic production and hence India is a net importer of raw jute and jute products. As a jute producing state, Assam is the third largest jute producer in the country. It declined from its second highest position. In spite of suitable agro climatic condition and of superior quality of raw jute (strength of raw jute in Assam is stronger than West Bengal) area under jute cultivation has declined from 5.5 percent of GCA in 1960-61 to 1.9 percent in 2011-12. Although indigenous people of Assam cultivated jute like fibre crop (rhea), extension of jute in Assam takes place after huge immigration of Mohammedan people from Bangladesh.

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Versatility of the jute plant, high demand for raw jute and jute products in the national and international market and favourable agro-climatic conditions of Assam for jute production, etc. reflects the potentiality of jute cultivation in the state. However, the trend of area and production of jute cultivation in the state has been dwindling in recent years compared to 1960s. Area under jute has been drastically reduced in the recent decades corresponding to 1960s. State's share of jute production in all India has declined from 11.11 percent in 2000-01 to 6.63 percent in 2008-09.

Jute cultivation in Assam is constrained by problems of inadequate supply of certified seeds, delayed monsoon rain, lack of accessible supply of channels, problems of labour, etc. Availability of alternative crops that can be grown in the jute area and jute season also contributes to reduce jute cultivation in the state. During the primary survey it was observed that the farmers can earn reasonable surplus with efficient practice in jute cultivation unlike the rice cultivation. However, problem of wage labour and laborious process of harvesting and retting make the farmers reluctant to cultivate jute. Inefficient functioning of procurement agencies, lack of favourable credit support, high labour cost (in comparison to Bengal labour is more expensive in Assam) and receiving unremunerative price, availability of synthetic fibres, change in trade policy, etc. also caused decline in the growth of jute in Assam as respondents said.

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Chapter-V: Rubber Production in Assam

5.1: Introduction:

An important and recently popularized plantation crop in Assam that is placed next to 'tea' is Natural Rubber (NR). It is one of the most versatile industrial raw materials of plant origin; a unique raw material for the production of a wide variety of strategic, industrial, agricultural and household goods. From simple pencil eraser to aircraft tyre, the basic raw material for over 50000 products is natural rubber (Lalnunmawia, 2014). Its demand, both domestic and global has been growing much faster than increments in production. Auto-tyre manufacturing industry accounts for around 70 percent of the global demand for NR. In addition to tyres a modern automobile has more than 300 components made out of rubber. Use of NR in hoses, footwear, foam mattresses, cushions, sports goods, balloons, toys, insulated material for cable, tube, etc., are well-known. In addition to this, NR is extensively used for soil stabilization, in vibration absorption and in road making (Rubber Grower's Companion, 2016). Global dependence on natural rubber is likely to increase further because of the shrinking of the production of petroleum, which is the source for synthetic rubber.

Natural Rubber is a perennial tree crop, whose production differs from that of annual crop by the long gestation period between initial capital investment and the first output (six to seven years), a long and continuous period of output (economic life of about 30-32 years) and finally a gradual decline in yield (Lalnunmawia, 2014). Due to its long gestation period, followed by extended period of output flow, choice and decision of the growers has to be seen as a dynamic inter-temporal optimization exercise. Nath (2009) thus argues, from an economic point of view, the growers' decision to invest in rubber plantation can be an outcome of maximization of present value of net return from the investment. Latex (milky sap like fluid), the economic produce is harvested by controlled wounding, termed as tapping, on the bark of the tree, from which it flows out and is collected.[57] It is not storable and hence requires processing within the day for economic viability and success of the agricultural activity of rubber growing. The fact that rubber is an extremely commercial crop, the produce is not used for home

[57]Natural rubber is the latex (juice or milk) derived from trees of the most important which is *Hevea brasiliensis*. The bark on tapping yields latex (the crud agricultural produce from rubber trees). The latex contains up to 40% natural rubber, the rest being water and other constituents (Rubber Grower's Companion, 2016).

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consumption, the price and its movement has a major significance for the growers than the price of other crops. Natural rubber has been found in the latex of over 2000 species of plants belonging to 311 genera of 79 families. However, improved varieties of the *Hevea brasiliensis* in South Eastern Asia remain the major source of natural rubber, other sources afford some possibilities. *Ficus Elastic* (other sources of natural rubber), in Northern India yields a product known as Assam Rubber.

In Chapter V we would like to discuss the emergence of rubber plantation in Assam along with a brief discussion on World and India's scenario in natural rubber. We discuss the activities related to rubber plantation like, - input requirements, institutional support, cost-benefit analysis, etc. It is also important to know the consideration or recommendation to cultivate rubber as an alternative crop and the role of growers in the market of natural rubber plantation industry.

5.1.1: Climatic Conditions for Rubber Plantation:

Rubber tree grows in a wide range of agro-climates and soil conditions if it has well-distributed rainfall of about 250cm and 125 to 150 rainy days per annum. *Hevea* tree grows well in areas, having high temperatures from 21^0C to 35^0C and minimum of about 20^0C. Weather conditions should be warm as cold weather hinders the growth of the plant, affects the latex containing vessels and renders tapping difficult. The atmospheric humidity must be high throughout the year of the order of 70 to 95 percent with moderate wind. Areas prone to strong winds are not suitable for rubber cultivation. Elevation should be below 450 meter MSL. Bright sunshine amounting to about 2000 hour per annum at the rate of 6 hour per day throughout all the months is required for rubber trees (Rao and Vijaykumar, 1992). The terrain should be gently sloping so as to prevent water logging. Deep clay loam well-drained soils of pH below 6.5 and free from underlying sheet rocks are well suited for the cultivation of rubber (Rubber Grower's Companion, 2016). The cultivation of rubber is comparatively labour intensive and requires high investment at the starting. Thus, cheap and abundant labour is essential.

5.1.2: Historical Background and Origin of Natural Rubber Plantation:

The Amazon Basin is the original home of the wild rubber. In 1730, the France Academy of Science had sent an expedition team to Amazon Valley to discover the tree producing latex. Later it was identified as rubber tree whose scientific or botanical name is *Hevea*

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braziliensis. In 1763 two Chemists of France mentioned the usefulness of rubber for surgical treatment in medical science. English Chemist Joseph Pristlee (1733-1804) surprisingly invented that rubber can erase pencil marks. Very rapidly different goods from rubber started to be produced and sold and its use increased with tyre making from rubber; bi-cycle and automobile industries have created an enormous demand for it. The latex was known to the native American Indians as *Cahuchu* (wood tears), and was used to weather proof the moccasins. Schurer (1957) said that "long before the discovery of the American continent by the European colonial powers, rubber was known to the native civilizations of Tropical America. In the Inca civilization of Peru, the Maya civilization of Yocatan and the ancient Mexican civilization, rubber was used as a magic substance and had a significant role in rituals, sorcery and witchcraft. Protective garments and solid playing balls made of rubber and banners spread with rubber have also been recorded by the earliest visitors to that continent."

According to Thomas and Panikkar (2000), *Hevea brasiliensis*, a forest tree which is indigenous to the tropical rain forests of Central and South America is one of the most recently domesticated crop species in the World. The inhospitable tropical environment and the scattered distribution of the *Hevea* trees through the forests were great handicaps in the exploitation of wild rubber resources of the Amazon Basin. Moreover, the supply of wild rubber was not sufficient to meet the ever increasing demands. Therefore, during the latter half of the nineteenth century, efforts were made to introduce *Hevea* in other parts of the World and to cultivate it on estates. Rubber is the youngest crop in the earth whose cultivation started from 150-200 years ago. It was introduced to tropical Asia and Africa by the efforts of British Government during the later part of 19^{th} century. The modern age natural rubber plantation actually started during the 1870s when the British successfully transported *Hevea* seeds from Brazil for planting in the British India (Thomas and Pannikar, 2000). In 1876, Henry A. Wickham, an Englishman, carried some rubber seedlings from Brazil to England, where they were planted in the Royal Botanical Gardens at Kew, near London. In 1881, seedling from the Kew gardens were planted in India and Ceylon (now Sri Lanka), and later in Malaya (now Malaysia) and Indonesia. The tree is now grown in the tropical regions of Asia, Africa and America. In 2013, World produced 12 million MT natural rubber and consumed 11.4 million MT. Asia accounted for 93.1 percent of the global production and 72.2 percent of the global consumption of rubber during 2013.

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Malaysia, Thailand, Indonesia, India and China are the top five NR producing countries in the World. The colonial powers initiated a scheme for introducing rubber as a wonderful plantation agricultural crop in the South-East Asia (Nath, 2009) for ideal geographical conditions. Cheap supply of native workers proved to be an advantage. At present, South-East Asian countries dominate the World natural rubber production. Almost half of the World rubber is produced in Malaysia (Sarma, 2016).

5.1.3: Basic Activities and Technical Aspects of Rubber Plantation:

Rubber plantation requires some sort of basic and technical knowledge from the land preparation to the latex collection and sheet preparation. The following section allow on a brief discussion on major activities of natural rubber production.

Land Preparation:

Land preparation for new planting and replanting can be continued during the month of April. After felling and drying of trees of the existing vegetation by a light burn and by slashing the ground can be cleaned for planting operations. Lining, terracing, drainage and pitting also may be undertaken during this period. The recommended planting density for proper growth and development of rubber is about 420 to 445 plants per hectare. In the case of budded plants,[58] it is preferable that the density should not exceed 500 plants per hectare. Thus, in plan area 15' x 15' or 16' x 16' and in hill slope 20' x 10' or 22’ x 11' distance are recommended.

Pitting and Refilling:

The size of the pits depends upon the type of planting material and the nature of the soil. The standard size of the pit is 75cm x 75cm x 75cm. In hard and stony soils, size of pits can be 90cm x 90cm x 90cm. Well decomposed and powdered cow dung or compost at the rate of 12kg and rock phosphate at the rate of 175gm per pit may be mixed with the top 30cm soil in the pit.

Planting Materials:

[58] Budded plants are pulled out and the stock is cut back at a height of about 7.5 cm above the bud patch with slope towards the opposite side of the bud and the cut end is sealed with wax. Tap root and laterals are pruned as for seedling stumps.

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Generally used planting materials are seedling stumps, budded stumps, poly bag plants and root trainer plants. Tissue culture plants are used only for research purposes. Presently, budded stumps are getting popularity for its high yield.

Mulching, Shading, Irrigation and Whitewashing:

The soil around the plants should be mulched properly with cessation of rains to conserve soil moisture, maintain optimum soil temperature and control weed growth. Young plants during the year of planting are provided with artificial shade during summer. Life-saving irrigation during summer reduces casualty. From the second year onwards, brown portion of the main stem is whitewashed using lime or china clay to prevent sun scorch till the canopy develops partial shade.

Weeding:

Weeds suppress growth of young rubber by competing for light, nutrients and soil moisture especially during its initial years. Four to five rounds of manual weeding are required during the first two years. Weeds can be controlled either manually or with herbicide.

Inter-cropping:

Rubber sapling is planted at a wide spacing and hence sufficient land and light are available in the inter-row areas for inter-cropping with suitable short duration crops during the initial three to four years in the plantation site. It helps to control weed growth and save the cost of weeding.

Fertilizer application:

Fertilizer recommendation to the individual fields based on soil and leaf analysis will be more advantageous and economical. Using fertilizer is different in case of immature and mature rubber tree.

(a) April-May is the planting season and no fertilizer application is required for new plantings during this time. For the initial four years (in immature trees), the discriminatory fertilizer recommendation based on the initial soil sample analysis if available can be followed. Two types of fertilizer mixtures either with magnesium (Mg)

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or without magnesium are recommended. For North Eastern Region, 12:12:6 mixtures are recommended (see appendix Table V.1).

(b)The fertilizer requirements during the remaining period of immaturity (from the 5th year to tapping) depend to a great extent on the cultivation practices.

(c) The general fertilizer recommendation for mature rubber under tapping is 30kg each of nitrogen (N), phosphorus (P) and potash (K) compared to 100-120kg nitrogen, 50kg phosphorus and 50kg potash in paddy or wheat (Gopinath, 2013). In rubber cultivation the nutrient requirement is mostly met by organic matter generated inside the plantation.

Plant Protection:

Influence of diseases and pests on growth and yield of rubber is profound and therefore timely plant protection operations are warranted to ensure healthy growth and economic production. Several non-microbial (non-parasitic) maladies occur in rubber plantations during various stages of growth causing considerable loss in stand, growth and production. However, in Assam spread of this disease is very limited.

Anything that may suppress the growth of the rubber plants during initial two to three years may adversely affect its growth in future and will consequently affect the economic stability of the crop in later stages

Summer care:

The plant bases are to be mulched using dried plantain leaves, shading or white washing. Mulching nurseries and basins of young plants is recommended before the onset of summer season to reduce soil temperature and to conserve moisture during summer months. During the year of planting, the young plants should be protected by shading before the onset of summer.

Rain Guarding:

During rainy season tapping can be carried out by fixing a rain guard above the tapping cut. Thus, by preventing loss of tapping days due to rain, regular tapping can be ensured by rain guarding under any given tapping frequency. Rain guarding is essential for regular tapping, a prerequisite to get good yield (*Robor Sangbad*, January, 2015).

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Tapping Operation:

After 6 to 8 years of age of plantation, tapping operation on the rubber tree is started. Budded plants are tappable when they attain a girth of 50cm at a height of 125cm from the bud union. For tapping of rubber tree breath (diameter) of each tree plant should be minimum 45cm. It will be generally economic to begin tapping when 70 percent of the trees in the selected area attain the standard girth (Rubber Board Bulletin, 2016). The best period for tapping of rubber trees in our climate is March-April.

It is necessary to commence tapping early in the morning as late tapping reduces the exudation of latex. The tapping task (number of trees tapped on a day by one tapper) in India is around 300-400 trees compared to 400 to 500 trees in other countries. Completing tapping and latex flow in the early hours (02.00AM to 06.00AM) favours better production during summer and wind prone areas (Rubber Board Bulletin, 2016).

Processing and Marketable forms of Natural Rubber:

After collection of latex, they must process immediately to form rubber sheet. Some of chemical components are required for processing the collected latex. The important forms in which the crop can be processed and marketed are - (1) sheet rubbers, (2) crepe rubbers, (3) preserved field latex and latex concentrates, (4) technically specified rubber (block rubber), and (5) specialty rubber (Rubber Grower's Companion, 2016).

Smoking:

The sheets after four to six hours of dripping in shade are put in the smoke house where the temperature is maintained between 40^0C and 60^0C. In the smoke house sheets are dried gradually to avoid blisters. Four days of smoking is generally sufficient under normal conditions, but during the rainy season five to six days may be required for satisfactory drying.

Grading and Packing of Sheet Rubber:

The rubber must be dry, clean, strong, sound and evenly smoked and free from blemishes, specks, resinous matter (rust), blisters sand dirty packing and any other foreign matter. The quality of rubber sheet is assessed by thickness of the sheet, colour of the sheet (preferably golden yellow), and transparency, free from air babbles, dust and proper smoking. The completely dried sheets are graded according to the standards as

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per IS-15361-2003. This standard provides for six grades of ribbed smoked sheets, viz., RSS 1X, RSS 1, RSS 2, RSS 3, RSS 4 and RSS 5 (Mazumdar, 2015). The grading of sheets is carried out by visual examination. The sheets after grading are packed in bales of 50kg (for domestic market) or 111.11kg (for international market) each.

5.2.1: Historical Background of Rubber Plantation in Assam:

Although rubber plantation has emerged as a recent agricultural venture in the state, there has been a long historic presence of wild rubber in the state forest and its exploration. The trees were *Ficus elastica*, the wild rubber of Assam, and not *Hevea braziliensis*. In the early fifties of 19th century export of rubber was gaining ground. A European-owned rubber press was set up at Tezpur to process the juice collected from wild rubber trees (Guha, 2015). In a discussion on different varieties of natural rubber, Thomas and Panikkar (2000) mentioned that long before the introduction of the Para rubber tree to India and other South East Asian countries, indigenous rubber yielding trees known as Assam Rubber (*Ficus elastica*) were tapped on a commercial scale in Assam. The recorded average annual production of rubber during 1882 to 1887 was 207 tons (Schurer, 1957).

Royal Botanical Gardens, Kew (1896) mentioned in the Bulletin of Miscellaneous Information that, the Assam rubber plant (*Ficus elastica*) is a large evergreen tree found in damp forests from the base of the Sikkim Himalaya eastward to Assam and Arracan. In a memorandum, Mr. Gustav Mann, Conservator of Forests, Assam, described the growth of trees from seeds (Kew Bulletin, 1891). In the Kew Bulletin (1892), it was stated that "the imports into this country (England) of Assam and Rangoon rubber in 1891 amounted to 350 tons".

The Government of India issued directions in May 1884 that for five years from that date the Assam plantations should be increased by 200 acres a year. At the same time, endeavours should be made to induce private persons to plant Indian-rubber trees on their estates, seedlings being offered by the Forest Department at cost price and also suggested to undertake by the Forest Department the experimental planting of *Ficus elastica*. The Government of India also desired that in order to test the financial results of rubber cultivation, 50 mature trees were experimentally tapped annually. Annual yield shows great irregularity; while the yield in one year was as much as 26 pounds per tree, it would fall in another year to a little over two pounds (Kew, 1896). Owing to doubts as

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to the financial results of the cultivation of *Ficus elastica*, the work undertaken by the Government of India was suspended. The total area of the plantations already established is estimated at about 2000 acres, but it is admitted that many parts are not fully stocked.

There is another important point of Assam rubber as mentioned in Kew (1896) that "in spite of the abundance of the tree under cultivation in the tropics of both the Old and New World it has nowhere proved valuable for the production of rubber except in the mountainous parts of Assam". The position of the rubber industry in Assam has been discussed in a "Note on an Inspection of Certain Forests in Assam," (Kew, 1896) by Mr. H. C. Hill, Officiating Inspector-General of Forests, dated the 31st March 1896.

To meet the rising demand of rubber and to maintain its supply it was essential for the government to start artificial cultivation of *Ficas elastica*. Plantations are the only means of assuring a continuous rubber supply. In 1873, plantations were begun simultaneously at Kulsi in Kamrup district and at Charduar near Tezpur in the Darrang district.[59] The Kulsi plantation had an area of 100 acres and the Charduar had 2754 acres and both these plantations had yielded considerable output of rubber every year. The rubber cultivation thus became the most lucrative and hopeful of all plantations as was opined by G. Henderson, Superintendent of the Royal Botanical Garden.[60]

Allen (1927) reported that the great development of rubber planting in the East was anticipated by the Assam Government by nearly 20 years. The quantity of rubber exported annually from Assam to Calcutta was 3500 *maunds*, worth Rs.3.5 lakhs and Government earned royalty at Rs.12/- a *maund* amounts to Rs.42,000/- a year.

Regarding the financial prospects of the plantations, the Inspector General of Forests, decided in 1894, that the further extension of the plantation was not advisable because a considerable amount of expense would be unearned, and there was a great doubt whether the expenditure would prove remunerative; and further because, even if it were remunerative, many years must elapse before any profits could be obtained. But Mr. Smythies and Mr. Home, Conservator in Assam, were hopeful of the financial prospects of the plantation (Kew, 1896).

[59]A. S. R. Report on the Administration of Assam for the year 1911-12, Part-II, p.19.
[60]A.S.R., File No. 119/216, 1873, No.6, cited in Goswami, P., op. cit., p. 170.

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Dr. Mann, Asstt. Conservator of forest, said that "the prospects of the rubber plantation was very doubtful and because of the length of the time it required for paying returns, the smallness of the returns when they were obtained, the doubt as to the market fitness to twenty years hence made the investment in Assam rubber culture, as a separate venture a very doubtful speculation" (Kew, 1896). He argued, the cultivation of *Ficas elastica* would be profitable only as a by-product to tea culture of land lying waste and unsuitable for tea. Dr. Mann of course, admitted that future discoveries with regard to improved methods of growth, means of tapping the plants without injury or of growing a large number of high yielding plants on the same area may alter the opinion above expressed (Agricultural Journal of India, No. IV).

Gupta (1908) mentioned that there were three species of rubber trees found in Assam viz., *Ficas elastica*, *Ficas laccifera* and *Ficas obstusifolia* and among them the first was found in large numbers. The commercial value of the article is due to its being a non-conductor of electricity and to being impervious to air and water.

In the Assam State Gazetteer (1999) it was mentioned that lac, rubber, gum, *katha* or *khoir* can be extracted from forests and production can be continued and expanded with proper plantation planning in Assam.

Goswami (2001) states, the waste land policies which were framed for the first time in 1838 were modified time and again in order to open up the waste lands in Assam initially for the cultivation of all special crops such as tea, rubber, sugarcane, coffee, etc. Rubber cultivation proved profitable initially; but owing to certain difficulties it was eventually abandoned. It is interesting to note that the Indian rubber (*Caoutchouc*) was discovered in Assam soon after the province was occupied by the British. And it was extended over large areas in Kamrup, Darrang, Nowgaon, Sibsagar and Lakhimpur districts. But, in spite of having great economic prospects the plantation of rubber proved unsuccessful in the long-run. The destructive methods of tapping had led to the killing of many old rubber trees which virtually affected its production.

It can therefore be concluded that the illicit tapping, uneconomic local methods of tapping the rubber, non-availability of skilled labour and above all, the length of time involved in getting back profitable returns were the main deterrents that stopped the European capitalists from investing in rubber plantations in Assam (Goswami, 2001).

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In the post independence period, the initial trial plantations of *Hevea* rubber on experimental basis were laid out from as early as 1957 in various locations of Assam, like Karbi Anglong, Cachar, Neli (Ouguri), Kaki, Baithalangso, Darrang, Kohora, Matia (Goalpara), etc. with the then available improved seedling varieties by the pioneering efforts of veteran M. C. Jacob, who headed the Forest and Soil Conservation Department in undivided Assam. The plantations in the above localities proved very successful and the yield performance were also very encouraging.

Encouraged by the results obtained in the trial plantings undertaken in early 1960s in Assam, commercial scale plantations were raised by Soil Conservation Department, Assam (Krishna Kumar, 1990) and a state's public sector corporation, Assam Plantation Crops Development Corporation (APCDC) Ltd. from the year 1974-75. APCDC planted rubber under government scheme for rehabilitating the *jhum* cultivators of Karbi Anglong and North Cachar districts of Assam[61]. The Corporation successfully created 1033 hectares of rubber plantation under Integrated *Jhumiya* Development Programme (IJDP) scheme funded by Govt. of India. A total of 1110 *Jhumiya* families were thus rehabilitated. The Corporation had planted rubber with the improved bud grafted clones in over 1400 hectares of land distributed mainly in Karbi Anglong, N. C. Hills, Darrang and Kamrup districts of Assam (Sarma, 1989). In some pockets of Assam, rubber can help in converting *jhum* land into settled cultivation which may permanently increase employment opportunities and income of the tribal people (Purkaytha, 2008). Commercial production of rubber in Assam was started from 1975.

5.2.2: Rubber Production in Assam in Recent Decades:

Rubber cultivation is gaining its popularity in the state due to congenial agro-climatic condition and its remunerative eco-friendly activity. The important consideration in spread of rubber is the alternative that rubber provides to the *jhum* cultivation, not only for better economic use of the *jhum* lands but also restoration of eco-balance (Dowerah Bhuyan, 2005). Rubber plantation works are exclusively labour oriented from its inception period till productive stage, i.e., up to 25 to 30 years, hence permanent employment as well as economic support to a large-scale weaker section people could be envisaged. The rubber plantation industry creates a profound influence on the social and

[61]Initially 15 plantations were started by APCDC, each plantation site have processing unit as well as smoke house, approximately 100 tone latex collected annually.

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economic life of the people where it has been developed and its total benefits can be summed up as it enables productive and economic utilization of cultivable fallows and underutilized lands generates rural employment opportunities that provide regular employment at the rate of 1 person per hectare, etc.

Rubber cultivation in India has been traditionally confined to a narrow belt (approximately 700km in length) extending from Kanyakumari district of Tamil Nadu in the South to whole of Kerala, and Dakshin Kannada and Kodagu districts of Karnataka in the North (8^0N to 12^0 N) and lying in general west of the Western Ghats which enjoys the benefit of both the south-west and north-east monsoons. This region accounted for 74.7 percent of the area and 90.3 percent of the production of natural rubber during 2012-13. Growth of rubber plantation in India has been mainly through the expansion of its cultivation in Kerala during early part of 20^{th} century. India was the fourth largest producer of NR with 8.9 percent share in World production in 2008 and the fourth largest consumer of NR next to the USA, China and Japan. The domestic production and consumption of NR in India was 831400 MT and 930565 MT respectively in 2009-10, deficit in production compared to consumption was about 1 lakh MT. The area under rubber plantation in India increased from 74,915 hectares in 1950-51 to 518,000 hectares in 2013-14. During the same period, the production increased from 15830 MT to 844,000 MT and the average yield increased from 284 kg/ha to1629 kg/ha (Rubber Grower's Companion, 2014).

A characteristic of Indian rubber consumption is the sectoral concentration, dominated by the automotive tyre manufacturing sector which accounts for as much as 66.5 percent of the total consumption of NR in 2013-14. In 2013, India became fifth largest producer and second largest consumer of NR; it accounted for 7.1 percent of the global production and 8.5 percent of the global consumption. India is the third in productivity, sixth in total area and fifth in mature rubber plantation area in the World. Natural rubber accounted for 67 percent of the total quantity of rubber (natural and synthetic) consumed in the country during 2013-14. In terms of extension of area, production and productivity, natural rubber has achieved the highest growth rate among the major crops in the country during the last five decades (Rubber Board, 2011) (As per the Rubber Board, India now occupies the first rank in terms of productivity at 1819kg/ha) (Lalnunmawia, 2014). Due to rapid industrialization in the country, rubber remains to be a commodity that is eternally in short supply. The widening gap between

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production and consumption points to the need for increasing the production of natural rubber. The rubber farming community is spread over the 16 states in India; Assam is also one of them. The northeastern region accounted for 18.6 percent of the area and 6.1 percent of the production in the country during 2012-13. Most of the farmers in this region are new to rubber cultivation. Though the entry of this crop was started on experimental basis during 1950s, it gained momentum only after 1985 through the project Accelerated Development of Rubber Plantation. Many farmers in the north east can get yield of rubber ranging from 1600kg to 2200kg per hectare annually under good agro-management practices (Debray, 2015). The future of natural rubber will be bright in view of its special quantities and its competitiveness with synthetic rubber, the production of which is dependent on the high priced and non-renewable petroleum resources (Sarma, 1989). Table 5.1 shows the region and state wise growth of area and production of natural rubber in India.

Table-5.1: Region and State wise Area and Production of NR in India from 2007-08 to 2013-14:

Regions	States	Total Rubber Area (in Ha)						Production (in MT)					
		2007-08	2008-09	2009-10	2011-12	2012-13	2013-14	2007-08	2008-09	2009-10	2011-12	2012-13	2013-14
Traditional Region	**Kerala**	**512045 (80.6)**	**517475 (78.2)**	**525408 (76.5)**	**539565 (73.4)**	**545703 (71.9)**	**548225 (70.4)**	**753135 (91.3)**	**783485 (90.6)**	**745510 (89.7)**	**798890 (88.4)**	**800050 (87.6)**	**648220 (83.8)**
	Tamil Nadu	19410 (3.05)	19355 (2.92)	19545 (2.85)	19790 (2.69)	20770 (2.74)	20890 (2.7)	23820 (2.89)	24355 (2.82)	24695 (2.97)	25220 (2.79)	25350 (2.77)	25000 (3.2)
Non-Traditional (North Eastern States)	Tripura	41165 (6.48)	50070 (7.56)	55415 (8.07)	64480 (8.78)	67730 (8.94)	71370 (9.2)	20299 (2.46)	23280 (2.69)	24880 (2.99)	30590 (3.38)	33220 (3.64)	39000 (5.0)
	Assam	**18225 (2.87)**	**23705 (3.58)**	**28102 (4.09)**	**38090 (5.18)**	**43335 (5.72)**	**47945 (6.1)**	**5108 (0.62)**	**6395 (0.74)**	**6771 (0.81)**	**10310 (1.14)**	**11740 (1.28)**	**13600 (1.8)**
	Meghalaya	6830 (1.07)	7740 (1.17)	9196 (1.34)	11875 (1.62)	12865 (1.7)	13875 (1.8)	4199 (0.51)	5760 (0.67)	5045 (0.61)	6380 (0.71)	7110 (0.78)	7570 (1.0)
	Other states	5620 (0.88)	7350 (1.11)	8972 (1.3)	14025 (1.91)	17105 (2.26)	22430 (2.9)	1364 (0.15)	1805 (0.21)	1904 (0.24)	2760 (0.31)	3210 (0.35)	3520 (0.4)
Non-Traditional (Other than NER)	Karnataka	28830 (4.54)	32415 (4.9)	34777 (5.07)	41588 (5.66)	44900 (5.93)	47055 (6.1)	16450 (1.99)	18175 (2.1)	21331 (2.57)	27890 (3.09)	31250 (3.42)	35230 (4.6)
	Others	3275 (0.52)	3870 (0.58)	5100 (0.75)	5367 (0.73)	5785 (0.76)	6610 (0.8)	970 (0.11)	1245 (0.14)	1264 (0.15)	1660 (0.18)	1770 (0.19)	1860 (0.2)
Grand Total (India)		**635400 (100)**	**661980 (100)**	**686515 (100)**	**734780 (100)**	**758193 (100)**	**778400 (100)**	**825345 (100)**	**864500 (100)**	**831400 (100)**	**903700 (100)**	**913700 (100)**	**774000 (100)**

Note: P Provisional; Parenthesis indicate % share of NR in India
Source: (i) Rubber Grower's Guide, 2010, (ii) Rubber Grower's Companion, 2016

From table 5.1 it can be inferred that the total area under rubber plantation in traditional region has increased during 2007-08 to 2014-15, but the share in all India has decreased.

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Production share of Kerala in all India has also decreased during the period. In the North Eastern region, share of area as well as production in all India have gradually increased. In case of Assam, percentage share of NR in India has increased both in terms of area and production.

The Rubber Board of India has identified Assam as a potential state. From the productivity point of view, Assam too has ample scope of rubber plantation. A number of researchers attempted to examine economic feasibility of rubber plantation in the state with some differences in their methodology. Barah (2001) argued that the general production condition in the state is fevourable for plantation crops. Among the plantation crops, the cultivation of tea, rubber and coffee are of the most commercial significance. Maibangsa and Subramanian (2000) studied the economic feasibility of small scale rubber plantations in Goalpara, Kamrup, and Karbi Anglong districts of Assam. They estimated the cost of production and returns from investment in rubber plantation (Nath, 2009).

In the western part of Assam rubber plantation has been taken up as an occupation by unemployed youths. Under Bodoland Rubber Cultivator Association in Chirang district of Assam about 3000 hectares of land are used for cultivation of rubber and about 5000 people are engaged in this cultivation and yearly about Rs.2.5 crore businesses is done in Bodoland area (*Asomia Pratidin*, Feb. 2011). In 2012-13, 34537 hectares were planted in the state (The Rubber Board, 2013) which increased to 45000 hectares at present (Barua, 2016). Out of seven states in north-east, Assam is second in rubber plantation area and in production after Tripura. During 2007-08 percentage share of Assam in all India of rubber plantation area was 2.87 percent and production share was 0.62 percent which are increased to 6.1percent and 1.8 percent respectively in 2013-14. Until 2008-09, only 7.4 percent of the potential area has been utilized under natural rubber in the state. Three types of rubber growers are there in the state - individual, group and departmental. One of the features of rubber plantation in the state is the young nature of the trees resulting in larger non-tappable area. New areas present opportunities in the form of relatively young age structure of tree stock, utilizing unused land and better access to nearby markets (Nath, 2009). Table 5.2 states the growth trend of area, production and price of natural rubber in Assam since 1990-91.

Table-5.2: Plantation Area, Tapping Area, Production and Productivity of Natural Rubber in Assam and all India average since 1990-91: Area in hectare; Production in MT; Yield* in kg/ha

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Year	Plantation Area	Tapping Area	Production	Average Yield in Assam	Average Yield in India
1990-91	9380	-	110	-	1076
1991-92	9740	-	148	-	1130
1992-93	9885	-	197	-	1191
1993-94	-	-	-	-	1285
1994-95	-	-	-	-	1362
1995-96	-	-	-	-	1422
1996-97	-	-	-	-	1503
1997-98	-	-	-	-	1549
1998-99	-	-	-	-	1563
1999-2000	-	-	-	-	1576
2000-01	12675	1488	2580	1733.9	1576
2001-02	12806	1600	2700	1687.5	1576
2002-03	14170	2009	2750	1368.8	1592
2003-04	13541	-	2580	-	1663
2004-05	13692	-	2700	-	1705
2005-06	14835	-	3050	-	1796
2006-07	16508	-	4750	-	1879
2007-08	18271	3320	6395	1926.2	1799
2008-09	20975	3518	5097	1448.8	1867
2009-10	23075	6505.03	9832	1511.5	1775
2010-11	27082.6	7686.25	10213	1328.7	1806
2011-12	32117.43	8607.96	10950	1272.1	1841
2012-13	34537.62	7633.83	11054	1448.0	1813
2013-14	49000.95	10000.63	13700.19	1369.9	1629
CAGR during 1990-91 to 2000-01	3.06%	-	37.1%	-	3.89%
CAGR during 2000-01 to 2010-11	7.89%	17.84%	14.7%	-2.63%	1.37%
CAGR during 1990-91 to 2010-11	5.44%	-	25.43%	-	2.62%

*Worked out on the basis of tapped area. During 2013-14 and 2014-15, a portion of the mature area was kept untapped.

Source: (i) The Rubber Board, Zonal Office, Guwahati; (ii) Economic Survey Assam, 2013-14; (iii)Rubber Grower's Companion, 2016.

Table 5.2 shows that the area under plantation, tapping area and the production of natural rubber in Assam increased rapidly over the years. However, average yield of natural rubber in Assam is fluctuating, although in the earlier years yield in Assam was higher than all India average but after 2001-02 yields in Assam became lower than national average. Purkayastha (2008) said the average yield per tree per year is about 4.7kg which could be raised to 6kg with known technologies. The research to develop new inputs, techniques and products are making good progress.

Thus, unlike declining popularity of autumn rice, wheat, jute, etc., rubber cultivation has gained its popularity in the state. Different schemes of the Rubber Board of India also encourage first generation growers of rubber plantation. However, rubber is mainly used in automobile industries. The demand for the natural rubber grown in the state is basically derived from outside of the state because the state has no such industrial units that can use this cash crop extensively. So the question arises at this moment

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whether the growers of this non-food crop are protected enough with assured market and sustain profitability for their produce in future. Dose rubber cultivation can convert uncultivated or low productive land to productive land and add to the total cropped area and crop production in the state?

5.2.3: Size of Land Holding of Rubber Plantation in Assam:

It is mainly the small holdings that occupy the sector. More than 93 percent of the total area in smallholding sector is occupied by high yielding cultivars and the sector is much ahead in adopting short-term productivity enhancement measures (Goswami and Challa, 2007). Individual growers are also contributing to fast growth of rubber cultivation in the state. In Goalpara district, it was found that about 80 percent of the rubber plantations (65% of the total area) are of individual holdings having single ownership. The rest 20 percent holdings (35% of the total area) are owned by groups (Nath, 2009). About 64 percent of the total holdings in Goalpara district are small and marginal (less than 0.5 hectare) and they occupy about 46 percent of the total area. About 28 percent of the holdings are in the size class of 0.5-1.0 hectare and their share in the total area is about 35 percent. The rest 8 percent of the holdings occupies the remaining 19 percent of the area is in the category of above 1 hectare. The average size of holding in the district was found to be 0.68 hectare (Field Officer, Rubber Board, 2007). Though the average size of holding in Goalpara is higher than all-India average, most of the holdings in the district are within the size of 2 hectare or slightly more than that (Nath, 2009). Smallholdings enjoy dominance in supply of natural rubber in all major producing countries as well as in India (Rubber Grower's Companion, 2016). The contribution of smallholdings to rubber production in Malaysia has been significant for the last three decades. In Malaysia, the size of a smallholding is typically from one to four hectares and either consists of a family operation, or based on shared return with tappers (Mohamed and Saad, 2010). In the Indian natural rubber sector we observed the preponderance of small holders with 98.4 percent of them having plantation holdings of less than 2 hectares. It is estimated that there are 1.25 million small holding units with an average holding size of about 0.55 hectare which dominates the production sector by sharing as much as 90.5 percent of the planted area and 93.5 percent of the production in India during 2012-13 (Rubber Growers Companion, 2013). Small holdings dominate the natural rubber economy of Kerala with a share of 91 percent in the area under cultivation.

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5.3: District-wise Rubber Plantation in Assam:

Rubber plantation industry is emerging as a promising cultivation in rural Assam and an extensive plantation of rubber tree is done in recent time in the state especially in the western part of Assam. The prospective areas for rubber plantation in the state are mainly distributed in Goalpara, Kamrup, Dhubri, Kokrajhar, Baksa, Bongaigaon, Nagaon, Karbi Anglong, Darrang, Cachar and Karimganj districts and selected pockets of Lakhimpur, Sivasagar, Jorhat and Dibrugarh districts. All these identified areas are the uncultivated or underutilized, fallow high lands and low elevation hills used for environmentally hazardous *jhum* cultivation. However, in extension at individual level some of the land cultivated for *ahu* paddy, sesame, grams or vegetables was shifted for rubber. Table 5.3 shows district wise area and production of natural rubber from 2009-10 to 2013-14.

Table-5.3: District-wise area and production of Rubber in Assam during 2009-10 to 2013-14:

District	Area (in Ha)				Tapping Area (in ha)				Production (in MT)			
	2009-10	2011-12	2012-13	2013-14	2009-10	2011-12	2012-13	2013-14	2009-10	2011-12	2012-13	2013-14
Baksa	522.0	695.0	67.9	106.4	5.0	10.0	-	-	7.0	14.0	0	0
Barpeta	36.0	36.0	22.54	32.8	12.0	12.5	11.3	14.4	18.0	19.0	16.9	25.6
Bongaigaon	1971.2	2548.5	2083.5	2944.0	242.2	350.3	174.0	462.3	334.0	380.0	475.9	321.6
Cachar	1171.0	1406.0	1535.0	2169.2	624.1	685.0	398.4	675.3	936.0	940.0	460.0	569.3
Chirang	448.4	675.0	761.5	1076.6	27.4	28.25	63.0	510.0	37.0	38.0	88.1	106.1
Darrang	306.0	406.0	165.2	243.4	20.0	25.0	20.6	32.7	30.0	36.0	25.5	49.2
Dhemaji	22.9	44.6	69.7	99.40	16.8	22.8	22.3	26.5	16.0	23.0	22.0	44.8
Dhubri	885.8	935.8	903.7	1277.4	155.8	160.4	21.0	28.1	210.0	220.0	240.7	32.6
Dibrugarh	70.0	88.0	70.60	100.7	12.3	27.0	16.1	32.0	12.0	19.0	16.0	32.6
Dima Hasao	102.6	150.6	293.7	163.30	80.1	82.1	30.3	38.2	112.0	116.0	40.0	43.3
Goalpara	7045.6	8045.6	7640.14	10792.7	1006.6	1558.0	1900.0	2340.0	1625.0	1745.0	2625.8	4440.0
Golahgat	397.3	435.0	447.1	632.5	62.0	76.0	24.7	27.2	90.0	120.0	110.0	49.8
Hailakandi	942.0	1025.0	2385.0	3369.8	495.2	610.0	228.1	491.4	732.0	824.0	500.0	326.3
Jorhat	25.7	38.0	33.1	47.72	10.7	16.7	3.2	28.2	10.0	16.0	14.0	7.12
Kamrup (M)	345.0	390.0	-	51.0	130.0	185.0	-	6.0	195.0	280.0	-	7.13
Kamrup (R)	1560.0	1710.0	2125.9	3007.8	305.0	450.0	364.0	16.6	450.0	490.0	544.2	620.0
KarbiAnglong	4174.0	5172.0	6542.4	9242.1	2060.0	2355.6	2226.5	2600.2	3351.0	3439.0	3519.9	4062.3
Karimganj	3221.6	4200.7	6240.0	8815.0	826.5	1452.2	1493.2	1943.2	1074.0	1494.0	1500.0	2100.3
Kokrajhar	936.4	1833.0	1792.9	2533.4	126.4	138.4	214.0	280.4	155.0	180.0	340.7	390.14

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Lakhimpur	31.24	51.24	17.7	46.9	8.6	12.0	7.7	9.5	8.0	12.0	-	12.1
Morigaon	316.0	395.0	267.8	379.3	27.0	30.0	78.6	89.5	40.0	45.0	106.0	111.8
Nagaon	502.9	850.64	181.8	257.8	89.0	130.0	108.5	124.4	156.0	255.0	176.0	193.33
Nalbari	12.0	12.0	11.5	16.5	0	0	-	-	0	0	0	0
Sivasagar	76.5	85.0	77.02	109.7	10.4	15.4	27.2	6.4	13.4	16.0	15.0	54.9
Sonitpur	295.6	445.63	198.7	330.6	108.0	132.4	178.8	198.6	171.0	180.0	186.0	53.4
Tinsukia	138.2	148.1	139.9	198.6	21.0	32.0	22.9	19.7	16.0	32.0	21.0	76.8
Udalguri	250.0	295.0	463.6	956.5	23.0	11.0	-	-	34.0	15.0	10.1	-
Assam	**25806.0**	**32117.4**	**34537.6**	**49001.0**	**6505.0**	**8608.0**	**7633.8**	**10000.6**	**9832.4**	**10950.0**	**11053.8**	**13700.2**

Note: M Metro; R Rural
Source: Statistical Hand Book Assam, 2010, 2012, 2013, 2014.

Although almost all the districts are included in the map of rubber plantation in Assam, however it is significant in the districts of Goalpara, Bongaigaon, Cachar, Kamrup (R), Karbi Anglong and Karimganj have more than thousand hectares of plantation area. Goalpara district is first in plantation area and in production, but second in tapping area. In tapping area of NR, Karbi Anglong is the highest among the districts of Assam in 2013-14.

5.4: Input Uses, Institutional Support, Training, Research:

To accelerate development of agriculture and allied activities, certain basic infrastructure and support services are needed especially in cash crops. Availability of appropriate technology with regard to quality seeds/planting materials, efficient management of watering, efficient farm machineries, well developed farm lands, proper supply chain system, proper harvesting yards, storages, transportation, markets, information dissemination centres and service providing agencies, etc. are required. Rubber requires lesser amount of chemical fertilizer than field crops and low quantity of other inputs like water, insecticides and pesticides when compared with tea/cardamom, etc. (Gopinath, 2013). Following section discussed about the input uses and support services in rubber plantation sector in Assam.

Planting Materials:

Earlier rubber plantations in Assam were established from seedling trees. Such trees do not normally reproduce the distinctive characteristics of their mother trees. Therefore,

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vegetative propagation is the only method of retaining the desirable character in the progeny. In *Hevea*, the modern method of multiplication of high yielding clones is through budding. But one of the major problems encountered in rubber cultivation in Assam is the long gestation period in the main field. Hence, nursery techniques to produce advanced planting materials have to be introduced to overcome these problems. Transplanting planting materials from nursery to the main field after successful budding with the high yielding rubber clones results in a shortening of the gestation period as compared to planting with the traditional 'seed-at-stake' method (Sarma, 1989). Rubber Board has supplied materials to encourage rubber plantation in Assam either at free of cost or at subsidized prices. There is a Central Rubber Nursery of Rubber Board located at Topatali, Jagiroad (Assam). Besides, growers could collect high yielding planting materials from different Rubber Board licensed private nurseries promoted in the districts of Goalpara, Kamrup, Kokrajhar, Karbi Anglong and Cachar. However, new growers face a problem in selection of more productive planting material and sometimes they may be misled. Availability of genuine material of recommended variety/clones is far too short vis-à-vis the demand (Lalnunmawia, 2014).

Fertilizer Use:

Rubber cultivation requires lesser amount of chemical fertilizer than field crops (Gopinath, 2013). For mature rubber the fertilizer recommendation is 35:35:35 NPK kg/ha. This can be supplied through 350kg of 10:10:10 NPK mixture either in single dose or in two equal split one in April-May and the second in September-October (Rubber Board Bulletin, 2016). In the short run, the producers adjust the yield in response to short run price expectations. But the biological nature of rubber plantation requires at least one year in changing the yield through cultural and manorial practices. The lag between fertilizer application and its effect on latex yield varies from one year to three years (Viju and Prabhakaran, 1988).

At the time of planting, cow dung and NPK are used 100gm to 150gm per sapling. After 2 years, use of cow dung and NPK is increased to 200gm to 250gm. Subsequently, after 4 years, it is increased to 1.5kg to 2kg for four saplings. Growers said use of more fertilizers make the soil soft and tree becomes weighted by heavy leaves which can bend the tree in wind and cause the risk of breakdown of the tree. Moreover, high dose of fertilizer generate more weeds which causes high cost in weed removing.

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Irrigation:

Rubber plantation also requires lesser amount of irrigation compared to field crops (Gopinath, 2013). To ensure vigorous growth of the young rubber plants in the nursery, in summer season as the rainy season is over, regular irrigation is recommended. Irrigation, sufficient to drench the nursery, once in four days is enough (Rubber Board Bulletin, 2016). Providing irrigation as a life saving mechanism for the first 3 years will ensure proper establishment of plantations. A mature rubber tree uses maximum 50 liters water during summer (Debray, 2015). In certain states like Karnataka, Goa, Maharashtra and Orissa, limited irrigation will have to be resorted to for young plants in the field during dry seasons (Rubber Grower's Guide, 2010). According to Agriculture Census, 2010-11, out of 609236.18 hectares, 9440.58 hectares (1.55%) are irrigated area under rubber in India. In the study area we observed no irrigation in rubber plantation; it is fully dependent on rainfall.

Investment and Credit:

Rubber is a perennial tree and its plantation involves high investment in the planting year or during the establishment period. The main investment involved is in land preparation, collection of planting materials, fencing and labour input in the first year. In the subsequent 5-6 years maintenance cost is involved. When plantation becomes mature for tapping, cost on collection of tapping materials, materials for processing of rubber sheets comes. Growers have to invest about Rs.60000 to Rs.70000 for preparing a hectare of rubber plantation and for that small grower seek credit from informal sources as informed by respondents. Self finance, subsidy received from Rubber Board and credit from money lenders and relatives are the sources of finance. Self financing is the major source of both investment and working capital in rubber. Nath (2009) found that nearly 97 percent of the working capital is self financed. Although Rubber Board granted subsidies for rubber plantation growers can receive it after inspection of the plantation site which takes about 3 to 4 years from the year of establishment. However, borrowing from professional money lender is found to be negligible in the study.

Institutional Support and Extension Services:

Rubber plantation sector receives wide range of extension service from the public sector. For promotion and development of natural rubber plantation in India, the Government of

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India enacted the Rubber (Production and Marketing) Act in 1947 and set up the Indian Rubber Board which was renamed later as Rubber Board in 1947. Rubber Board continues to be the major motivator, promoter and service provider in the Indian rubber sector; it provides incentives through financial and technical assistance and the existence of assured market for rubber for cultivators to bring new areas under it. Rubber Research Institute of India (RRII), a wing of Rubber Board is engaged in research right from evolving high yielding and disease tolerant varieties to improving the primary processing mechanism of rubber. The up-to-date research findings and technologies are passed on to the target clientele in remote villages by the extension officers (Mohanan, 2012).

Rubber Board is concentrating on enhancing production of natural rubber in Assam by offering incentives; research support, development packages and extension which are creating awareness and bringing more areas under rubber cultivation (Goswami and Challa, 2007). To make up for the losses during the gestation period, subsidy is given to the growers having holdings upto 20 hectares under the Rubber Plantation Development (RPD) Scheme (1980). Board's scheme for promoting, processing and marketing of rubber such as providing assistance for tools for tapping, sheet rollers, implements for processing, smoke houses, community processing centres, etc. are implemented in the non-traditional regions also (Nath, 2009). Rubber Board regularly updates the international and domestic prices of natural rubber on a day to day basis through its own website. Commenting on the institutional support, Kannan and Pushpangadan (1990) observed "Rubber is a monocrop unlike other perennial crops such as coconut, pepper and areca nut and one which has perhaps best institutional support among all the major crops in Kerala".

Rubber Board extended support to the individual small growers who have established systems for irrigating young rubber plants for a financial assistance of Rs.3000 per hectare, a scheme for subsidizing cost of hand operated rollers to promote quality improvement in production of ripped smoked sheets with financial assistance @ 50% of the cost of the roller limited to Rs.10000 per set, financial assistance @ 50% of the cost of construction of biogas plants for treating the effluent generated in their processing sheds limited to a maximum of Rs.8000 per unit, assistance for fencing @ Rs.12500 for barbed wire fencing and Rs.5000 for bamboo fencing per hectare (upto 2 hectares), assistance granted @ 50% of the cost of construction limited to a maximum of Rs.20000 for per smoke house. There was also an additional assistance granted for

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successful use of poly bagged plants @ Rs.6 per plant (Rs.8 per plant for participants belonging to SC/ST categories) subject to maximum of 450 plants per hectare. Under the RPD Scheme's Phase IV, the rate of planting grant in Assam in 2000 was Rs.16000 per hectare and Rs.12000 per hectare for areas upto 5 hectare and upto 20 hectare respectively (Rubber Grower's Guide, 2010). The minimum extent required to be planted by any participant under the scheme was 0.10 hectare. However, it was reported by the respondents of Bongaigaon and Goalpara districts that the financial assistance under different schemes have not been obtained regularly and some of them were pending since last couple of years and the revised norms for eligibility for subsidies are getting harder. The current 1:4200 ratio between the Rubber Board's extension officer and growers has to grow further. Moreover, other public sector extension agencies such as State Agriculture Departments, Agricultural Universities, NABARD, etc. have played very limited role in the rubber development in the state.

Rubber Producers' Societies (RPSs):

From the mid 1980s onwards, the Rubber Board has encouraged and promoted formation of Rubber Producers' Societies (RPS), a voluntary self help associations in the rubber growing areas to help small growers to organize themselves at grass-root level and work jointly to acquire up-to-date knowhow in improvement of productive efficiency, group processing and competitive marketing. RPS has made a significant impact in the modernization of the sector. Besides undertaking community processing and marketing of rubber, it also procures and distributes plantation requisites to the small growers at reasonable price and ensures adoption of recommended agricultural operations by the growers.

Working through group growers reduce their cost by sharing the costs of processing, storage, transporting and selling and group marketing can increase the bargaining capacity of the farmers. Rubber growers have formed three RPSs in Goalpara district and one RPS in Bongaigaon district with community processing centre through Rubber Board and are working to protect the interest of the local growers.

Training and Skill Development, Research and Development and Insurance:

In the NR production sector, Rubber Board has identified eight sub-sectors for skill development - rubber nursery, rubber plantation, latex harvesting, latex processing, field

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coagulum processing, rubber sheet (Ribbed Smoke Sheet-RSS) processing, RSS trading & marketing and rubber wood processing, etc. and Rubber Board promotes training and skill development at different plantation centres.

The Rubber Board has organized an orientation programme (*Sasthra darshan*) for the growers from non-traditional area. Select growers are brought to Kerala and other traditional rubber cultivated area in order to give firsthand knowledge of plantation industry. But for last couple of years such programmes has been postponed as reported by the growers.

The research and development efforts in the rubber sector have been successful in achieving the results in five high-yielding clones of rubber that have been introduced, protocols have been evolved for somatic embryogenesis, genetic transformation of *Hevea*, etc. However, research work, so far done, on rubber crop in Assam is very negligible and published results are not available. There is a gap on evaluation of the socio-economic development of the rubber growers in the state

Insurance Schemes for Rubber Plantations:

Since 1988, provision has been made to bring rubber plantations under insurance coverage to natural calamities provided by M/S National Insurance Company Ltd. through the Rubber Board and introduced the Insurance Scheme for Rubber Plantations (ISRP). All immature plantations raised under the Board's Rubber Plantation Development Scheme should be insured for the first 8 years and all mature plantations upto 22 years of age are provided insurance coverage (Rubber Grower's Guide, 2010). However, since last 2008-09, no such scheme is continuing and growers face problem to get compensation on damaged plantation as reported by the respondents.

5.5: Role of Market Forces, Prices and Government Policy:

Forces of supply and demand, subject to imperfections in market structures and government interventions, primarily determine the price of rubber. Any changes in the balance of demand and supply and in expectations which may be affected by strikes in major rubber consuming industries, transport difficulties and political uncertainties influence the market price of rubber (Grilli et al., 1980). Availability of substitutes, international price, foreign trade policy, technological innovations in downstream sector, etc. also influence price of natural rubber (Nath, 2009). The most striking feature of

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India's rubber market is that growers are able to realize more than 92 percent of the terminal market price for their produce at the farm gate (Sreekumar et al., 1990). Small rubber growers in most other countries are not known to realize more than 70 to 85 percent of the terminal market price at their farm gate. Tolley (1983) points that government policy is more concerned with the extent of price fluctuation than with the average level of prices. Referring to international moves for coping with price fluctuations, George and Sethuraj (1996) observed that natural rubber is one among the ten core commodities covered by the Integrated Programme for Commodities (IPC) under the United Nations Conference on Trade and Development for assistance.

According to the model developed by Kumar and Sharma (2006), the major determinants of yield are the prevailing price in the market and technology, which can shift production upward in the short run. The results indicate that rubber growers positively respond to price incentives. Nath (2009) argued, higher expected price of rubber had positive impact on new plantation. Again lower expected price of the competing crop led to increase in rubber acreage.

Discussing the effects of intervention for stabilization of domestic price of rubber in India, George (1987) observes that the statutory price regulation of natural rubber prices initiated since 1942 was a major milestone in the evolutionary growth of area under the crop in the state of Kerala. The subsequent market intervention by different government agencies under the central and state governments were primarily guided by the motive of ensuring remunerative prices to the growers so as to achieve self sufficiency in natural rubber production. In the second half of the 20th century, as synthetic rubber became progressively more important in World markets, its prices set the overall trend, and natural rubber producers became, to a large extent, price takers. Since 2008, the price of natural rubber fell considerably in line with the trend observed in case of synthetic rubber (Nath, 2009). Price of RSS4 grade rubber at Kottayam, Kerala has declined from Rs.191.77 per kg in July 2013 to Rs.125.37 per kg in July 2015 (i.e., declined by 34.6%). Similarly, in RSS5 grade, price declined from Rs.185.15 per kg to Rs.123.46 per kg (i.e., declined by 33.32%) during the same period (Sen, 2016).

The main causes of fall in price of rubber are that merchants can procure rubber at cheap price from outside the country because at international market price has been declining. Automobile sector needed high quality rubber sheet but at Indian market it is

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very much scarce. Surplus import of cheap rubber by tyre companies caused decline in rubber demand in the domestic market. This deteriorated the economic conditions of the rubber producers especially the small and marginal growers. As their area of plantation is small and they can daily produce small amount of sheets, they could not give due attention on quality and are compelled to sell at low prices. Growers are also deprived of recommended prices for malpractices of dealers. Rubber Board innovate rubber sheet grading on the bases of 'Green Book' regulation which is the grading measure of natural rubber. But dealers collect the sheets on the basis of external quality and exploit the growers by offering lower prices for a 'visually downgraded' produce. With rubber production becoming a regular activity, imperfections in the primary rubber market have also been on the rise. It is reported that, earlier, the rubber prices offered to the growers were highly competitive and at par with the prices prevailed in the Kottayam or Cochin market. But in recent years, the differences in prices have gone to the extent of R.15 to Rs.20 per kg in this region (Barua, 2016).

Moreover, market of rubber depends upon economic conditions of the country. If economic condition is not developed, demand for tyre and automobile sector would not rise and rubber market will crash. Gradual fall in crude oil prices, decline in prices of synthetic rubber have indirectly affected the price of natural rubber (Sen, 2016). The economic reform process being introduced by the Government of India since 1991 has been a crucial factor determining the price of rubber in the country.

S. Thomas, Secretary General, Association of Natural Rubber Producing Countries stated that natural rubber sector is going through an extremely difficult phase of very low prices, which will have serious implications for the future of the entire rubber industry value chain. However, sustained production of natural rubber is critical for protecting the income of the rubber farmers and ensuring availability of natural rubber for rubber product manufacturers (Rubber Board Bulletin, 2016). The current scenario is that of over-supply, which has led to lower prices. However, Debray (2015) argued, the recent fluctuation of rubber prices is not a worry. If price becomes half of the present rate still it will remain a profitable cultivation. In order to make one kg sheet rubber we need to spend R.40 to Rs.50 only. So, even if the selling price is Rs.90 or Rs.100 a kg, yet it is worthy to the farmers.

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The raw rubber produced in Assam is being sent out of the state for further value addition. The rubber produced mostly as sheet rubber was initially marketed through a three tier network of private traders operating as local level dealers, town level dealers and terminal market dealers who are rubber manufacturers or manufacturers-cum-exporters. The rubber marketing system is institutionalized in the state through the licensing system regulated by the Rubber Board. Rubber Board grants licenses to a good number of dealers in the rural areas for the benefit of the smallholders.

Mahesh (1999) found that state intervention played an important role in the cropping pattern changes in the state of Kerala. The government can play a key role to safeguard the interest of rubber farmers by fixing minimum and maximum price for rubber, limiting the quantum of import or by enhancing import duty, reduction of tax for the producers till the market becomes stable. To increase the price of rubber, Government has enhanced import duty on rubber from 20 percent to 25 percent. Government of India has initiated National Rubber Policy for those who are concerned with rubber cultivation and rubber industry. Government of Kerala formed a corpus fund of Rs.300 crores for assisting rubber growers. With this corpus fund, government has fixed minimum price of rubber produced by farmers at Rs.150 per kg (Sen, 2016). If market price of rubber sheet or latex is less than Rs.150, the shortfall will be compensated from this fund. Government initiation for expansion of rubber plantation was the main factor for success in Tripura. The East Garo Hills district of Meghalaya administration has taken up rubber plantation under MGNREGA programme in 2009 and 2010 (Borgoyary, 2012). However, in Assam such initiatives are still far away and government of Assam did not take any major initiative to encourage rubber plantation in the state.

5.6: Production Economics of Rubber Plantation and Cost and Return of Rubber Cultivation:

It was estimated that in comparison to tea plantation, cost of rubber plantation is less. Tea plantation requires high recurring cost with high maintenance cost for fertilizer, watering, pesticide and insecticide, labour wage, etc. There are issues of fluctuation of price of green leaf, lack of regulation of price, monopsonistic exploitation by big factory owners, etc. On the other hand, rubber has a low maintenance cost. According to the report of the rubber growers interviewed the cost of production of 1kg natural rubber is

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approximately Rs.30, while price is about Rs.110 to Rs.140 per kg, almost 4 times more than the cost of production. It takes nearly 7 years for starting tapping of latex and it continues to another 30-32 years. Besides latex, rubber wood is useful for timber and preparing furniture.

Lekshmi and George (2003) analyzed the expansion of area under natural rubber in the state of Kerala during the period from 1968-69 to 1995-96. In their analysis, they used relevant secondary data on six selected crops, viz., paddy, coconut, tapioca, tea, rubber and cardamom. Comparative stability of prices of the selected crops was analyzed by using an instability index. Tea had the lowest rank in instability index but its growth rate of area was negative during the study period. Rubber had the highest growth rate of area but ranked fourth in the instability index. They found that next to cardamom, rubber had the highest growth rate in revenue among the six selected crops and it partially explains the area expansion of the crop.

A number of researchers attempted to examine economic feasibility of rubber plantation with some differences in methodology. Maibangsa and Subramanian (2000) studied the economic feasibility of small scale rubber plantations in Goalpara, Kamrup and Karbi Anglong districts of Assam. They studied in 1996-97 agricultural year and concluded that rubber plantation is economically viable and cost effective in the districts mentioned above. Nath (2009) mentioned that rubber has contributed significantly to the betterment of the district of Goalpara by generating income and employment.

The cost of production of rubber consists of two parts-establishment cost and variable or maintenance cost. The establishment cost of rubber plantation is spread over the first six/seven years of plantation. While calculating establishment and variable costs, it is found that the paid out costs does not reveal the actual cost of production since a large portion of both material and labour costs are contributed by the growers themselves. The imputed values of these components of the cost of production have been estimated at existing market rates. It is seen during field study that almost no respondent growers could remember all the costs incurred during the establishment period. Growers rarely keep records of expenditure. To estimate the establishment cost, the last year's cost data of a grower have been collected. Thus, for a grower who is in the 3rd year of commencement of farming could give data of cost of the 2nd year, a farmer in the 4th year could provide the data of establishment of the 3rd year, and so on. The establishment cost

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per hectare of individual growers has been taken as the summation of estimated cost per hectare in the first six/seven years of planting. Table 6.24 in chapter VI shows the operation-wise cost on the establishment period and cost on tapping in a hectare in a year by an individual grower.

Nath (2009) stated, operation-wise ten functions are carried out in establishment of a rubber plantation. He has estimated total establishment cost (sum of first six years) of a hectare rubber plantation was Rs.65620. Year-wise, 39.9 percent of the total establishment cost was spent in the first year itself. In the subsequent years, the cost share hovers between 10 to13 percent (see appendix Table V.2). This shows the high capital requirement during the first year of plantation. As soon as tapping of latex starts, the variable or maintenance costs arise. Maintenance or variable costs are those costs which the growers have to spend during the tapping period after six/seven years of plantation in the heads of fertilizer and manure, cultural operation, plant protection, tapping, processing and marketing, etc. As Nath (2009) estimated, the total cost of maintenance of a hectare was Rs.38151 of which 82.3 percent was labour cost and the rest was for material cost (see appendix Table V.3). Fertilizer, manure and plant protection are minor heads of expenditure during tapping period of a plantation. Thus, total cost of plantation upto the first year of tapping was Rs.103771 in a hectare. As the maximum economic life of rubber plantations is 32 years, the total establishment cost is divided by 32 to find out its annual share. Annual total cost (annualized share of establishment cost, (65620/32=2050.63) + annualized maintenance cost (Rs.38151)) was Rs.40201.63[62]. The average yield per hectare per year of rubber found in Goalpara district was 1869kg in 2009 (Nath, 2009). This yield rate was quite high as compared to all-India yield rate of about 1600kg (Rubber Board, 2003). Gross value of output was calculated by multiplying the average yield with the average price received by the growers. Gross value of output was Rs.161272.10/ha and net profit per ha was Rs.1,21,070.47 has been calculated. Lalnunmawia (2014) said the initial investment required for the six years of immature period is fairly high. The cost of development of rubber plantation in one hectare with a spacing of about 4.5m x 4.5m and accommodating 500 plants is estimated to be Rs.1,57,000 spread over a period of 6 years in Mizoram. The average annual yield per hectare in Mizoram is estimated to be 1500kg.

[62] Excluding rental value of land, interest on fixed capital, depreciation on fixed assets, land revenue, etc. from fixed cost.

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With the domestic market price of rubber ranging between Rs.100 to Rs.150 per kg, a hectare plantation could generate an annual income between Rs.1,50,000 to Rs.2,25,000.

5.7: Risks involved in Crop Diversification towards Rubber Plantation and Constraints of Rubber Plantation in the State:

The development of agriculture through high productivity growth is usually emphasized because of its beneficial effects in terms of productive employment in agriculture, poverty removal and also giving fillip to the non-farm sector. For instance, Dholakia and Sapre (2011) noted that the high growth of agriculture in the recent decade in Gujrat is achieved through significant diversification in cropping pattern, from low-value to high-value commercial crops. Chand et al., (2009) said, Kerala is among the high agriculture productivity states of India mainly due to high share of plantation crops in the area under cultivation. However, rubber plantation is non-food crop cultivation. Entire consumption or demand of the produce is exogenously determined. Usually growers of rubber are price takers rather than price makers. If a considerably large number of farmers cultivate rubber, the price advantage of rubber plantation would likely disappear as a result of an increased supply of the product.

The constraints on full-scale development of the natural rubber sector include poor state of the growers and inadequate financial support to the planters for understanding scientific plantation. Problem arises because of non-existence or underdevelopment of supporting physical and institutional infrastructure and processing and marketing linkages. Low price realization in the wake of a glut in the international market, steep fall in prices in last couple of years and rapid fluctuation in price are other disincentives. Quality awareness among the planters and their willingness to adopt the latest technology has been far from satisfactory (10^{th} Five Year plan, 2002-07). Krishnakumar and Meenattoor (2000) noted that in addition to the agro-ecological constraints, development of rubber plantations in the north-east confronts various limitations such as lack of technical knowledge among growers, poor infrastructure, lack of availability of institutional finance, relatively inadequate extension support, poor financial condition of the growers, lack of availability of high yielding planting materials, lack of availability of skilled tapers, peculiar land tenure system, provisions of the forest conservation act preventing planting of rubber even in denuded areas and

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frequent socio-political disturbances. During the field study, growers raised the problems of non-receipt of due subsidies at time, insurance benefits, state government's apathy towards problems of rubber cultivation in the state, etc.

5.8: Conclusion:

It is believed that the importance of rubber is increasing in the World in such a way that without rubber the modern civilization will be paralyzed. In comparison to its consumption, supply of natural rubber is growing less. Rubber tree is grown in limited area in the tropical regions of Asia, Africa and America. Under the prevailing state of technology in the cultivation and production of rubber on a plantation basis, the dominant aspect of all essential conservation processes is basically labour intensive. This means the use of a regular and continuous supply of labour is essential. The profitability of rubber plantation depends primarily on the maintenance of cheap labour (Selvaratnam, 1988).

In terms of extension of area, production and productivity, natural rubber has achieved the highest growth rate among the major crops in the country during the last five decades. However, indigenous production of natural rubber was insufficient to meet growing domestic consumption and hence India is a net importer of natural rubber. The future of natural rubber will be bright in view of its special quantities and its competitiveness with synthetic rubber. The share of traditional region in rubber plantation in all India has gradually decreased; but share in north eastern region and in Assam has been increasing. While in Tripura, Public Sector Corporations are leading in the rubber plantation and in Meghalaya, Manipur, Mizoram and Arunachal Pradesh the role has been played by the State Forest and Soil Conservation Departments; but in Assam rubber plantation basically expanded either by individual efforts or through societies. Although, the state has a long history of the presence of wild rubber, *Ficas elastica*, the commercial scale plantations in the state were raised from the year 1974-75 and gained momentum since 1990s. Now individual growers are contributing to fast growth of rubber cultivation in the state. Rubber plantations created the opportunities for the un-arable uplands and fallow lands and checked the unabated encroachment of government land in this region. Problem areas are non-existence or underdevelopment of supporting-physical and institutional infrastructure and processing and marketing linkages.

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The Rubber Board has identified Assam as a "Potential State". From the "Productivity" point of view, Assam has ample scope of rubber plantation and the growers are encouraged by various schemes of the Board. In comparison to other crops rubber growers in the state can avail different extension services which include financial incentives for planting and replanting, marketing of the output along with research and development activities for improving the varieties. Rubber Producers Societies promoted by Rubber Board are also playing important role for extension of rubber plantation in the state. However, rubber is a commercial non-food crop, the produce is not used for home consumption, its entire consumption or demand is exogenously determined, thus price and its movement has a major significance for the growers than the price of other crops.

As a perennial crop and long gestation period, growers must possess high patience and finance. Nath (2009) stated, higher expected price of rubber had positive impact on new plantation. In recent years price of natural rubber is fluctuating and faces declining trends. The low prices will have a critical bearing on planting and replanting decisions and future availability of NR. Providing safety nets for small-holders to protect them against price and other risks is a critical task which has to be deliberated seriously (A. Jayathilak, Chairmen, Rubber Board Bulletin, 2016). Since the rubber plantation is very much price sensitive, persistent downfall in price of NR would stop its extension or will convert rubber plantation site to alternative crops in near future that is also probable question for the growers.

Rubber cultivation can convert uncultivated or low productive land to productive land and can add to the total cropped area and crop production of the districts which can significantly contributed to economic betterment of the populace. In traditionally rubber producing states, the government played a key role to safeguard the interest of rubber farmers by fixing minimum price for natural rubber, limiting the quantum of import or by enhancing import duty, reduction of tax for the producers, granting land, etc. Such incentives should also be initiated in the state. Our study will try to focus on which areas the policies should focus.

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Chapter-VI: District Profiles and Field Data

Different authors have empirically and synthetically analyzed the causes of low agricultural production in the state. We tried to test the reasons of low agricultural production in Assam in recent period by conducting a primary survey in two districts of western Assam viz., Goalpara and Bongaigaon as sample. These two districts are neighbouring and located in a similar socio-economic and climatic condition cultivating the sample three crops, rice, jute and rubber. But their performances in agricultural production are different on many counts. This is the reason of taking two neighnouring districts, Goalpara and Bongaigaon. We wanted to understand if one district is doing things better than the other in spite of having roughly similar characteristics. The discussion is based on aggregate data collected from various government and semi-government sources. We also discuss the data of winter rice, jute and rubber growers in two districts.

6.1: Study Area and Collection of Data:

We surveyed 23 villages under 9 Community Development Blocks (CDBs) and 8 Agriculture Development Officer (ADO) circles in two districts of western Assam, Goalpara and Bongaigaon. We interacted with 184 growers of winter (*Sali*) rice (Traditional Variety) and among them 78 growers have cultivated winter rice of Modern Variety as well. We have taken interview of 115 jute growers (Modern Variety) in 12 villages under 6 CDBs and 8 ADO circles and of 102 growers of rubber crop in 10 villages under 4 CDBs and 4 ADO circles in these districts. Two separate questionnaires have been framed to collect data from the growers as well as from the district agriculture office. The data were collected in the *Kharif* season of 2015 and 2016. Table 6.1 shows the division between the districts in terms of samples and number of respondents for each crop.

Table-6.1: Division of samples between the districts:

Districts	Goalpara	Bongaigaon	Aggregate
CDB	05	04	09
ADO Circle	04	04	08
Revenue Village	12	11	23
No. of Respondents in Winter Rice (traditional variety, TV)	92	92	184
No. of Respondents in Winter Rice (modern variety, MV)	21	57	78
No. of Respondents in Jute	68	47	115
No. of Respondents in Rubber	52	50	102

Source: Field Study.

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6.2: Method of Selecting the Sample-the Districts and the Crops:

(1) From the discussion of introductory chapter (Chapter I) we see that Assam fares poorly compared to the all India agricultural performance for a number of crops and agricultural parameters.

(2) We aim to detect the reasons for the poor performance. We have chosen three important crops for our study. These are rice, jute and rubber. Rice is the most important crop of the state in terms of production and area under cultivation. Jute has been a very important cash crop of the state. Although the area under jute has been declining Assam still holds the third position in jute production in India. Rubber is an upcoming crop of the state. It is experiencing fast growth of production as well as area under cultivation in last few decades.

Within Assam we find that the lower Brahmaputra valley zone (LBVZ) is the only agro-climatic zone which has production of all the three crops in large quantity. In rice LBV zone has the highest contribution towards production as well as area among the six zones of the state. In jute it is the second largest producer. As far as rubber is concerned, the crop is grown in large quantity in the LBV zone, unlike other zones. Half of the rubber production of the state in 2013-14 came from Goalpara and Bongaigaon districts of the LBVZ (Table 6.19).

Within lower Brahmaputra valley zone we have chosen Goalpara and Bongaigaon districts. These two districts are neighbouring districts. Hence their climatic as well as socio-economic conditions are similar. We want to find if there is any difference in the agricultural performance in the districts which cannot be attributed to input use and other individual farmer-level parameters. Therefore, we have purposefully selected these two neighbouring districts in order to detect any impact of the operation of district administration. There are many precedence of such kind of statistical exercise. For example, Banerjee et al., (2002), Gupta et al., (2014).

From the pilot survey we found that the villages usually have 100-150 farmer households. Taking roughly 10 percent representations we took a sample of 8-12 households from each village. From each village we have selected the households randomly.

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23 sample villages (12 in Goalpara and 11 in Bongaigaon) have been selected by the following method. From each ADO circle we have picked up at most three villages. Out of the 24 villages thus identified one village had to be dropped because it did not have rubber plantation. Thus, we arrived at the figure of 23 sample revenue villages. For the selection of the ADO circles and selection of the villages we purposively had chosen those circles and villages which have the likely of prevalence of farming of the three chosen crops. But at the village level we have selected the households through random method. The random selection is done by using the list of farmers of each village. These lists are prepared by the Farm Management Committees (FMCs) of each village.

6.3: Profile of Districts and District Agriculture: Goalpara District:

Goalpara, one of the oldest administrative districts in Assam is situated in the south bank of river Brahmaputra. The geographical location of the district is between North latitudes of $25^0 53'$ & $26^0 15'$ and East longitudes of $90^0 07'$ & $91^0 05'$. The district is bounded by Kamrup district in the East, Dhubri district in the West, West and East Garo Hills districts of Meghalaya in the South and Bongaigaon district and river Brahmaputra is all along in the North. The geographical area of the district is 1824 Sq Km (as per 2011 census), which ranks 20^{th} in terms of area among Assam districts. Total population in the district is 1008183 (as per 2011 census). Physiographically, the district is occupied both by hills and plains, mostly flat plains. The climate of the district is moderate during winter and hot in summer and monsoon starts from April. The average annual temperature is 24.6^0C and the average annual rainfall is 2739mm (Central Ground Water Board, 2013). The soil of the district is of alluvial origin suitable for cultivation. The soils vary from sands to loams. It consists of sand and clay in varying proportions with soil pH range 4.5-7.0. Main soil problems of the district are soil erosion, water logging and sand deposition.

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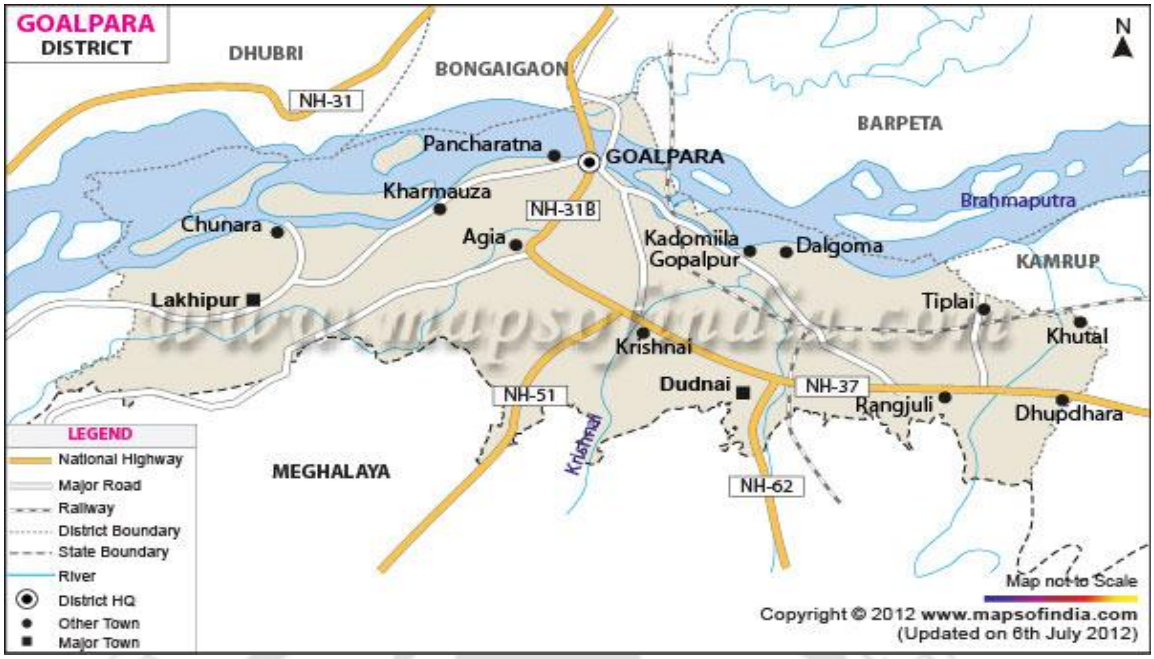

Fig. 6.1: Map of Goalpara District.

Goalpara district consists with 2 Civil Sub-Divisions, 5 Revenue Circles, 8 CD Blocks, 81 *Gaon Panchayats* and 829 Revenue Villages; 2 Agriculture Sub-divisions with 12 ADO circles, 82 Village Level Extension Worker (VLEW) *Elekas* and 977 *Pathar Parichalana Samittees* (Farm Management Committees). Total cultivable land in the district is 62262 hectares (Agriculture Department, Govt. of Assam). Total area not available for cultivation was 62265 hectares, barren and uncultivable land was 32538 hectares, cultivable waste land was 675 hectares, current fallow land was 187 hectares and total fallow land was 559 hectares in 2011-12. Total cropped area was 126989 hectares and net cropped area was 80753 hectares. Area sown more than once in the district was 44489 hectares. Cropping intensity in the district is 158 percent compared to146 percent in all Assam (Statistical Hand Book, Assam, 2011; District Agriculture Office, Goalpara). In 2016, total and net cropped areas in Goalpara were158208 hectares and 100011 hectares respectively and area sown more than once was 49567 hectares (District Agriculture Office, Goalpara). As per Agriculture Census (2005-06), the average size of holding is 1.02 hectares which is smaller than the state average (1.11ha). Number of marginal operational holding was 59360 with area of 29710 hectares, number of small holding was 17700 with area of 23596 hectares, number of semi-medium holdings was 9296 with area 24277 hectares, number of medium holdings was 2306 with area 11715 hectares and number of large holdings is 27 with area of 1196 hectares (Agriculture Census, 2005-06). Landless farmers in the district were 43015 in number. In 2014, number of cultivators who work as main workers was 108908 (30.04% of total

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main workers of the district) while the total number of cultivators who work as marginal worker was 17641 (18.34% of total marginal workers in the district) (Statistical Hand Book Assam, 2014).

The district is primarily agrarian as 90 percent of the population depends for their livelihood on agriculture. The principal agriculture produces are paddy (total rice area is 83159ha or 62.89% of cropped area), jute, green and black gram and potato, etc. Agriculture in the district is characterized by over dependence on rainfall, predominance of seasonal crops, and traditional methods of cultivation and vulnerability to flood.

Profile of Districts and District Agriculture: Bongaigaon District:

Bongaigaon district was a part of erstwhile undivided Goalpara district until 1989 when Government of Assam decided on the formation of a new district. Accordingly, curving out areas from Goalpara and Kokrajhar, the district of Bongaigaon started functioning with effect from 30.10.1992. The District falls within $26^0$28' N to $26^0$54' N latitude and $89^0$28' E to $90^0$96' E longitude. The district is bounded by Barpeta in the East, Dhubri and Kokrajhar districts towards the West, Goalpara in the South and Chirang in the North. The geographical area of the district is 1093 Sq Km (as per 2011 census) with 25th rank in terms of area among Assam districts. The topography of the district is generally

Fig. 6.2: Map of Bongaigaon district

plain. The climate of the district is characterized by high rainfall and sub-humid climate. The average annual temperature is 24.3^{0}C and the annual rainfall is 3219mm (Central

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Ground Water Board, 2013). The soil of the district is sandy loam alluvial and clay to clay loam and mixture of red and grey soil with pH range 5.5-6.5. The soil is acidic in nature. Main soil problems of the district are soil erosion, water logging, lacking in moisture retention capacity and sand deposition. The water level in the district is very low. As per 2011 census total population in the district is 738804.

The district consists with 2 Civil Sub-Divisions, 5 Revenue Circles, 5 CD Blocks, 65 *Gaon Panchayats* and 563 Revenue Villages. There are 2 Agriculture Sub-Divisions, 8 ADO circles, 65 VLEW *Elekas* in the district. Area not available for cultivation in the district was 64715 hectares, barren and uncultivable land was 28226 hectares, cultivable waste land was 3900 hectares, and current fallow land and total fallow land were 7780 hectares and 9221 hectares respectively in 2011-12. Net cropped area in the district is 67635 hectares and total cropped area is 105421 hectares with 37786 hectares area sown more than once. Cropping intensity in the district is high, 194 percent compared to158 percent in Goalpara district and 146 percent in all Assam.

As in Goalpara, economy of Bongaigaon district is basically agrarian in nature with about 80 percent of the population dependent on agriculture. About 70 percent of the rural population is directly involved with agriculture as their livelihood. Rice is the major crop of the district which occupies 57 percent cropped area during *kharif* and 43 percent cropped area during *rabi* season. Other important crops includes oil seeds, pulses, cash crop like *rabi* and *kharif* vegetables, jute, sugarcane, rubber, etc. As per Agriculture Census (2005-06), the average size of holding is 1 hectare which is smaller than average size in Goalpara district (1.02ha) and the state average (1.11ha). Number of marginal operational holding was 33427 with area of 16537 hectares, number of small holding was 16838 with area of 20450 hectares, number of semi-medium holdings was 4904 with area 12801 hectares, number of medium holdings was 1173 with area 6012 hectares and number of large holdings was 68 with area of 824 hectares (Agriculture Census, 2005-06). There were 18,790 landless families owning only 4087 hectares of land. Cultivators comprise the major rural work force in Bongaigaon. In 2014, numbers of cultivators who work as main worker in the district were 66767 (26.10% of total main workers of the district). Moreover, 16675 cultivators worked as marginal workers (26% of total marginal workers in the district) (Statistical Hand Book Assam, 2014).

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6.4: Extent of Agriculture Input Uses in the Districts:

Seeds or Planting Materials:

Farmers generally use their own seed stored from production of previous years and also purchase some from public or private agencies. In case of paddy (traditional variety), self-stored produce are used as seeds in the next year. The concept of seed replacement is yet to be popularized among the farmers and it is only 1-2 percent against a target of 15-20 percent. In Goalpara district, 32009 hectares (61.89% of total rice area) are under HYV of winter rice compared to 21249 hectares (59.63% of total rice area) in Bongaigaon district. Jute growers mostly use modern varieties which are basically purchased from the market. Public supply of jute seeds is not sufficient and do not reach at due time. Rubber growers collected planting materials either from the Rubber Board nursery or from private nursery.

Fertilizer:

Total fertilizer consumption (NPK) in Goalpara district was 4530.44MT (3.77% of the state) in *kharif s*eason and 4708.34MT (3.08% of the state) in *rabi* season while in Bongaigaon district these figures were 5232.07MT (4.35% of Assam) and 5105.89MT (3.34% of Assam) respectively in 2013-14 (Statistical Hand Book, Assam, 2014). Table 6.2 shows the consumption of fertilizer in Goalpara and Bongaigaon district with state average in 2013-14.

Table-6.2: Consumption of Fertilizer (N+P+K) in Bongaigaon, Goalpara and all Assam, 2013-14:

Districts	Quantity (in M. tones)	% of the state consumption	Per ha consumption (in kg)
Goalpara	9238.78	3.43%	73.77
Bongaigaon	10337.96	3.85%	98.06
Assam	273029.84	100%	65.41

Source: Directorate of Agriculture, Assam

Irrigation:

In Goalpara district, out of the gross cropped area of 105421 hectares, the extent of irrigated land is 26295 hectares, i.e. 24.94 percent of total cropped area and the rest is under rainfed conditions. As per Potential Linked Credit Plans (PLP) of NABARD (2016-17) studies, out of the total area sown of 126989 hectares, the extent of irrigated land is 26511 hectares (20.88%) which was brought under irrigation through canal, lift irrigation and STW (shallow tube well). Similarly, cropping system in rainfed condition

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is mostly adopted in Bongaigaon district; 79693 hectares (77.61%) of the net cultivable area is rainfed and only 25,403 hectares (22.39%) is irrigated through canal, lift irrigation and STW. Minor irrigation cover only 8.02 percent of the net cropped area of the district out of which the area irrigated through ground water and surface water are 20 percent and 80 percent respectively (Strategic Research and Extension Plan of Bongaigaon District, MANAGE, Hyderabad, 2006). Minor irrigation was developed through the distribution of STW under private/individual ownership (Tamuli, 2014). Most of the public lift irrigation schemes in these districts are now defunct due to lack of maintenance. Table 6.3 and 6.4 shows the irrigation potential created and target and achievement of additional irrigation potential created in Goalpara and Bongaigaon districts.

Table-6.3: Source wise irrigation potential created in Goalpara, Bongaigaon and all Assam, 2013-14 (cumulative): (in ha)

District	Minor Irrigation	Medium/Major Irrigation	Total	Trough ASMIDC (STW/LLP)	Grand Total	% in all Assam
Goalpara	13071	-	13071	2721	15792	1.85%
Bongaigaon	8207	-	8207	2502	10709	1.26%
Assam	440153	262613	702766	149205	851971	100%

Source: Statistical Handbook, Assam, 2014.

Table-6.4: Target and achievement of additional irrigation potential created in Goalpara, Bongaigaon and Assam, 2013-14: (in ha)

Districts	Target (Total)	Achievement (Total)	% of achievement
Goalpara	560	60	10.72
Bongaigaon	620	530	85.48
Assam	91772	19713	21.48

Source: Statistical Hand Book, Assam, 2014.

District Agriculture Department, Goalpara has created irrigation potential of 17,268 hectares against the target of 26350 hectares (65.53%) by 20 irrigation schemes (LIS, STWS and DTWS). But most of the schemes are inoperative due to lack of fund and constant flood damage. However, as per District Irrigation Department Report (2016), 218 irrigation projects (LIS, FIS & DTWs) are in functional stage in the district. The utilization rate of irrigation potential is 26 percent. In case of rice, gross irrigated area is 41134 hectares and net irrigated area is 34950 hectares. In jute and rubber cultivation irrigated area is almost zero.

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Credit:

Given the socio-economic set-up in a region, the demand for credit mainly originates from two major sets of variables, namely, economic and technological. The economic variables include the size of the operational holding, extent of irrigation, intensity of cropping pattern and the productivity per hectare. The technological variables include the use of fuel, pump set or motors, tractors, fertilizers, pesticides and HYV seeds (Sarma et al., 1978). Although functionality of various banks has improved rapidly in these districts, still informal sources are playing a vital role as a source of credit for rural people. Credit-deposit (C-D) ratio in all scheduled commercial banks is similar to the state average; 38.75 and 37.47 in Goalpara and Bongaigaon respectively compared to 37.28 in Assam. However, the C-D ratio in regional rural banks in Bongaigaon district (55.29) is slightly lower than all Assam (55.83) but noticeably lower than Goalpara district (65.17) and the stipulated norm of 60 percent as of March, 2014 (Statistical Hand Book Assam, 2014). In Goalpara district, number of application sponsored for KCC loan was 4596 where application sanctioned were 3325 against the target of 14000 and the amount sanctioned was Rs.1279.75 lakh. Thus, only 23.75 percent targets were achieved upto 31st March, 2015 (District Agriculture Officer, Goalpara).

Extension Services:

The District Agriculture Office, Goalpara has reported that except schematic dependent schemes there is no other budget provision for extension services to the farmers. Moreover, fund allotted for extension services is not sufficient; however, fund is sanctioned at due time. Services extended under public extension services include transfer of technology to farmers through training, workshop, seminar and demonstration. These are organized either once in a week or once in a fortnight or once in a month and beneficiaries are selected by ADO, VLEW and *Gaon Panchayat* member. Participation rate in the programmes is very good. About the time needed to give the solution of any farm related problem, it is reported that solution may be in the instant or within a week or within the month depending upon the depth of the problem. However, District Agriculture Office is suffering by shortage of staff strength as well as infrastructure. In Goalpara district, only 44 VLEWs are extending services in 82 VLEW *Elekas* (norms 1 VLEW for 1 GP) but 38 VLEW posts are lying vacant for long. Similarly, 5 posts of 16 ADOs are lying vacant; among 24 Agriculture Inspectors and

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Assistant Agriculture Inspectors, 7 posts are lying vacant for long. Moreover, the district office has no go-downs necessary for storage of agri-inputs like seed, fertilizers, pesticides, equipments, etc. There is 8 Farmers' Farm School reported in Goalpara district.

6.5: Crop-wise Discussion: Winter Rice:

Winter Rice is the major crop of Goalpara and Bongaigaon and it covers about 75 percent of the total gross cropped area in the districts. In 2012-13, total area, production and yield of winter rice in Goalpara district were 49200 hectares, 144566MT and 2938.33kg/ha respectively. Similarly, in Bongaigaon district these figures were 35931hectares, 87872MT and 2445.58kg/ha. The subsequent discussion in this section is basically confined to the analysis of the responses of winter rice growers in the study area.

6.5.1: Demographic Background of Winter Rice Growers:

The total number of growers included in the sample of winter rice is 184 (92 in each district). Among them 78 growers (21 in Goalpara and 57 in Bongaigaon) cultivated modern varieties besides traditional one. Among the respondents, general category growers are more in Goalpara (51.33%) while growers in other backward class (OBC) category are more in Bongaigaon (63.1%). More than half of the respondents (56.7%) in Goalpara are from Muslim community while 74.6 percent are Hindu in Bongaigaon. Assamese speaking farmers are more in Bongaigaon than in Goalpara. Family size among respondents in Goalpara is bigger than in Bongaigaon. The sample growers had a wide range of family size ranging from 1 to 19 members with an average of 6.35 members per family in Goalpara whereas in Bongaigaon average family size is 5.94 with minimum 3 and maximum 14 members per family. Dependent minor family members are more among the growers of Goalpara district. The average number of family member involved in agriculture is more in Goalpara (2.07) than Bongaigaon (1.94). However, involvement of females in farming is more in Bongaigaon district (42.06%) than in Goalpara district (28.35%). Among different age groups, farmers in the range of 50-60 years contributed most in cultivation. The average age of the head of household in aggregate is 46.33 years. About the education received by the household head, compared to Bongaigaon (9.4%) illiterate growers are more in Goalpara (20.35%). In aggregate,

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14.12 percent respondent growers are illiterate, 12.98 percent are below primary, 40.08 percent are below matriculation and rest 32.82 percent are matriculate or above. The demographic composition of winter rice growers is given in Table 6.5.

Table-6.5: Basic demographic profile of the respondents Winter Rice Growers in Goalpara and Bongaigaon districts:

Sl. No.	Items	Category	Goalpara	Bongaigaon	Aggregate
1	Caste/Category	General	58 (51.33%)	45 (30.20%)	103 (39.3%)
		OBC	18 (15.93%)	94 (63.09%)	112 (42.75%)
		ST	37 (32.74%)	01 (0.67%)	38 (14.5%)
		SC	0 (0%)	09 (6.04%)	9 (3.44%)
2	Religion	Hindu	55 (48.67%)	117 (78.52%)	172 (65.65%)
		Muslim	58 (51.33%)	32 (21.48%)	90 (34.35%)
3	Household Size	Mini	1	3	1
		Max	19	14	19
		Average	6.35	6	6.2
4	Age of the Head of the Household	<30 Years	07 (6.19%)	09 (6.04%)	16 (6.11%)
		30-40 Years	31 (27.43%)	33 (22.15%)	64 (24.43%)
		40-50 Years	30 (26.55%)	44 (29.53%)	74 (28.24%)
		50-60 years	33 (29.20%)	48 (32.21%)	81 (30.92%)
		>60 Years	12 (10.62%)	15 (10.07%)	27 (10.31%)
		Average	45.8	46.7	46.33
5	Education of the Household Head	Illiterate	23 (20.35%)	14 (9.4%)	37 (14.12%)
		Below Primary	16 (14.16%)	18 (12.08%)	34 (12.98%)
		Below Matriculation	42 (37.17%)	63 (42.28%)	105 (40.08%)
		Matriculation and above	32 (28.32%)	54 (36.24%)	86 (32.82%)

Source: Field Data

6.5.2: Land Holdings, Occupational Profile and Tenancy Practices of the Winter Rice:

In the study area in Goalpara district 92 growers have a total 192.47 acres of land under winter rice traditional variety. Most of the growers are marginal (72.83%) and small (18.48%) farmers. Their average size of land holding is 2.09 acres. In case of modern variety of winter rice, 21 growers cultivated in 22.13 acres and their average land holding is 1.05 acres in Goalpara district. On the other hand, in Bongaigaon district, total land holdings of 92 growers of winter rice traditional variety is 172.17 acres and their average size is 1.87 acres. Among respondents, 69.57 percent are marginal and 26.1 percent are small growers. On the other hand, 57 respondents of winter rice modern variety have 92.5 acres and their average size is 1.62 acres. So the land size in traditional variety is bigger than modern variety in the study area. Moreover, in aggregate 71.2 percent respondent are marginal and 22.29 percent are small growers and compared to Bongaigaon marginal growers are more in Goalpara. The size-class wise distribution of operational holdings of 184 winter rice growers in two districts is presented in Table 6.6.

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Table-6.6: Operational holdings and area operated by sample farmers of winter rice (T) of Goalpara and Bongaigaon districts:

Category of Size Class	Goalpara			Bongaigaon			Aggregate		
	No.	Area (ha)	% of No.	No.	Area (ha)	% of No.	No.	Area (ha)	% of No.
Below 1 hectare	67	29.16	72.83	64	32.00	69.57	131	61.16	71.2
1-2 hectares	17	25.40	18.48	24	29.00	26.1	41	54.4	22.28
2-4 hectares	07	18.40	7.61	04	8.40	4.35	11	26.8	6
4-10 hectares	01	4.67	1.09	0	0	0	1	4.67	0.54
Above 10 hectares	0	0	0	0	0	0	0	0	0
Total	92	77.63	100	92	69.40	100	184	147.03	100
Fragmentation of Rice plot (Max)	10	-	-	06	-	-	08	-	-

Note: T Traditional;
Source: Author's calculation based on Field Data

The distribution in Table 6.6 reveals that the marginal and small size classes of cultivators dominate the sample in terms of land holding.

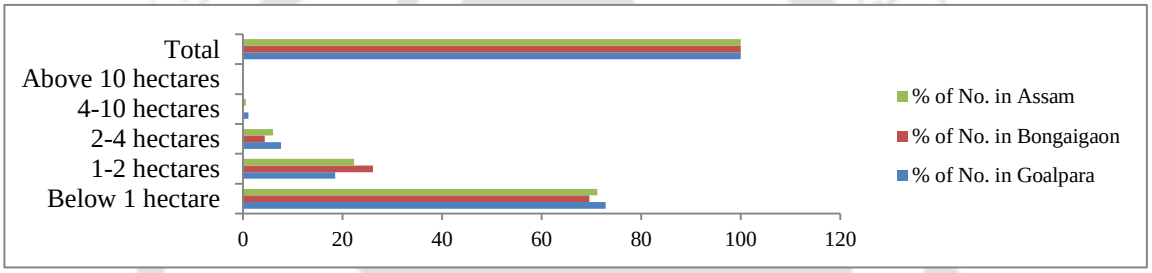

Fig.6.3: Percentage of no. of operational holdings by sample farmers of winter rice (T) of Goalpara and Bongaigaon districts

Occupational profile of the main grower and their family members involved in farming are studied by taking into account their nature of involvement as primary or subsidiary or supportive. In Goalpara district 93.81 percent growers reported farming as primary, 5.31 percent reported as subsidiary and 0.88 percent reported as supportive occupation. In Bongaigaon district, 97.32 percent, 2 percent and 0.67 percent growers reported winter rice growing as primary, subsidiary and supportive occupation respectively.

In Goalpara, 59.3 percent growers are purely cultivating owner who have cultivated only in their own land; 5.31 percent are purely cultivating tenant who have no own land but cultivated in hired land and 35.4 percent growers are owner cum tenant. Correspondingly, in Bongaigaon, purely cultivating owner is 51 percent, purely cultivating tenant is 13.42 percent and cultivating owner cum tenant is 34.9 percent; 0.67 percent grower is cultivating owner and rent receiver. Thus, compared to Bongaigaon district, tenancy practice in Goalpara district is less. Share of pure tenant and owner cum tenant in Bongaigaon is 57.14 percent compared to 45.67 percent in Goalpara. In

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aggregate, 54.58 percent growers are cultivating owner, 9.9 percent are tenants and rest 35.11 percent are owner cum tenant. In the study area we also observed the prevalence of different forms of tenancy practices and among them, share cropping and yearly fixed money rent are most dominating. In Goalpara district, share cropping is highly popular where 37 percent tenant growers have adopted it, followed by fixed money rent yearly by 30.43 percent, fixed crop rent by 23.9 percent, and fixed money rent season wise by 8.7 percent. In Bongaigaon, fixed money rent yearly tenancy is prominent where 57.53 percent tenant adopted, followed by share cropping 28.77 percent, fixed crop rent by 10.96 percent and fixed crop & money rent yearly by 2.74 percent.

In aggregate, 87.50 percent growers have own cultivable winter rice land and their average size is 1.52 acres. Number of growers having own land is more in Goalpara district than in Bongaigaon district. Number of growers who leased in land for winter rice cultivation is more in Goalpara district (48.67%) compared to Bongaigaon district (45.64%) and average area of leased in land is also higher in Goalpara (1.97 acres) than in Bonaigaon (1.48 acres) which is higher than average owned land. Maximum land size leased in was 9.75 acres in Goalpara district whereas 4.96 acres in the Bongaigaon district. Similarly, leased out of winter rice land in Bongaigaon district is also less; only 18.8 percent growers have leased out their land whose maximum size of land is 6.3 acres, minimum is 0.33 acre and average is 1.73 acres. However, 33.63 percent respondents of Goalpara have leased out land whose average size is 1.35 acres smaller than Bongaigaon district. Fallow rice land is higher in Bongaigaon district than in Goalpara district.

6.5.3: Use of Capital Goods in Winter Rice Cultivation:

Although most of the farmers are now using modern equipment like, tractor, power tiller to till their paddy land, but most of them are in hire. Only 5.93 percent farmers have their own tractor or power tiller. Usually growers till their paddy land 3 times by tractor or power tiller, paying Rs.756 to Rs.1059 per till per acre. Bullock pairs and wooden ploughs are also used and 60 percent respondents have their own bullock pairs. About 73 percent farmers have their own traditional plough shore and no farmer hired it. In aggregate 38.74 percent rice growers have their own STW or pump set or water machine to water their paddy lands which is higher in Bongaigaon district (43.65%) than in Goalpara district (36.22%). About 11 percent growers bought water from fellow growers

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in the study area. The recurring cost incurred on watering paddy land ranges from Rs.1500 to Rs.11350 per acre (approx) or in average Rs.5050 per acre. It is observed that growers of Goalpara spent more on watering, in average Rs.5121/acre compared to Rs.4979/acre in Bongaigaon. Pesticide sprayer is usually used by the farmers of the study area. Among the respondents, 61.83 percent have their own pesticide sprayer. Growers of Goalpara have more sprayers than the growers in Bongaigaon. Only 26.34 percent growers have weed removers whereas growers of Bongaigaon are ahead in terms of use of weed removers. No respondent farmers have any crop harvester. None of the farmers hired harvester but use of thresher machine is seen among the paddy cultivators of the districts. Although farmers have no owned thresher machine, 13.44 percent growers have hired it at the rate varying from Rs.1059 to Rs.1512 per acre and most of them are in Goalpara district.

6.5.4: Input Use in Winter Rice Cultivation:

There is variation in the use of seeds in winter rice cultivation among the farmers in the study area. This variation depends on the quality of the seeds, efficiency in sowing the seeds and in land pattern. Most of the growers (almost 72%) have used seeds from the stock of their previous years' yield. Rest has purchased from fellow farmers or from local huts whose price varies from Rs.10 to Rs.30 per kg in the study area. Price of seeds has increased by about 33 percent in last 5 years. On the other hand, cost of winter rice (modern) seed varies from 3kg to 30kg per acre depending on the variety used and the pattern of soil. Almost all the growers of modern variety of winter rice have purchased seeds from the local seeds & fertilizer shopkeepers. Price of the modern varieties varies from Rs.200 to Rs.450 per kg which has increased from 33.33 percent to 50 percent in last 5 years. It has been observed that the price of modern seeds is higher in Goalpara than in Bongaigaon. Table 6.7 has been presented the input uses in winter rice cultivation by the sample farmers in the study area.

Table-6.7: Input use in Winter Rice Cultivation in Goalpara and Bongaiaon Districts (per acre):

Inputs	Items	Unit	Traditional			Modern		
			Goalpara	Bongaigaon	Aggregate	Goalpara	Bongaigaon	Aggregate
Seed	Mini	Kg/ acre	15.13	15.13	15.13	3	2.12	2.57
	Max		45.38	45.38	45.38	30	30	30
	Avg.		29	29	29	13.67	16.34	15
Irrigation	Nos. of grower	No. (%)	23 (25)	6 (6.52)	29 (15.76)	13 (61.9)	18 (31.58)	31 (39.74)
	Irrigated Area	Acre	35.37	5.62	41	12.26	23.47	35.74

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		(%)	(18.38)	(3.26)	(21.64)	(55.41)	(25.38)	(31.15)
	average irrigated area	Acre	1.54	0.94	1.24	0.94	1.30	1.12
	Irrigated by STW*	No. (Acre or %)	21 (28.6 or 80.8%)	6 (5.62 or 100%)	27 (34.22 or 83.47%)	12 (10.25 or 78%)	17 (22.4 or 95.42%)	29 (32.65 or 91.35%)
	Recurring cost for irrigation (per crop season)	Rs.	1421.5	1225.15	1323.33	1746.15	1559.65	1652.9
Fertilizer-Urea	Nos. of grower	No. (%)	39 (42.39)	34 (36.96)	73 (39.67)	21 (100)	56 (98.25)	77 (98.72)
	Mini	Kg	15.13	3	3	15.13	9.1	9.1
	Max		60.5	121	121	60.5	60.5	60.5
	Avg.		34.79	24.2	29.5	41.2	27.1	34.12
Fertilizer-SSP	Nos. of grower	No. (%)	25 (27.17)	13 (14.13)	38 (20.65)	21 (100)	32 (56.14)	53 (67.95)
	Mini	Kg	15.13	12.1	12.1	9.1	6.05	6.05
	Max		60.5	90.1	90.75	60.5	75.63	75.63
	Avg.		29.34	30	29.68	36.45	29.13	32.79
Fertilizer-MOP	Nos. of grower	No. (%)	21 (22.83)	21 (22.83)	42 (22.82)	21 (100)	42 (73.68)	63 (80.77)
	Mini	Kg	6.05	3	3	9.1	9.1	9.1
	Max		30.25	75.63	75.63	45.38	30.25	45.38
	Avg.		15.55	16.37	15.97	25.71	16.34	21.02
Fertilizer-DAP	Nos. of grower	No. (%)	31 (33.7)	33 (35.87)	64 (34.78)	12 (57.14)	34 (59.65)	46 (58.97)
	Mini	Kg	12.1	9.1	9.1	15.13	9.1	9.1
	Max		30.25	30.25	30.25	45.38	151.25	151.25
	Avg.		21.51	18.69	20.12	25.47	24	24.74
Pesticides	Nos. of grower	No. (%)	11 (11.96)	14 (15.22)	25 (13.59)	12 (57.14)	38 (66.67)	50 (64.1)
	Mini	Ml gram	30.25	15.13	15.13	30.25	15.13	15.13
	Max		302.5	756.25	756.25	453.75	756.25	756.25
	Avg.		202.13	189.1	195.6	204.19	260	232.11
Weedicide	Nos. of grower	No. (%)	5 (5.43)	4 (4.35)	9 (4.9)	6 (28.57)	3 (5.26)	9 (11.54)
	Mini	Ml gram	302.5	151.25	151.25	151.25	151.25	151.25
	Max		453.75	756.25	756.25	1815	302.5	1815
	Avg.		332.75	403.32	368.05	529.38	201.68	365.54
Labour	Mini	Manday s/ acre	27.23	24.2	24.2	33.28	27.23	27.23
	Max		148.23	136.13	148.23	111.93	133.1	133.1
	Avg.		60.95	53.3	57.14	57.17	59.68	58.44

*Unit number meant no. of growers irrigated by STW, area irrigated by STW in acre or % of STW area to total irrigated area

Source: Field Data

Among the winter rice (Traditional) growers only 15.76 percent have used irrigation and it is mostly in Goalpara district where 35.35 acres (18.38%) area are irrigated and in Bongaigaon district only 5.62 acres (3.26%) are irrigated. The average irrigated winter rice (T) area among growers in Goalpara district (1.54 acres) is larger than in Bongaigaon district (0.96 acre). However, in case of modern varieties of winter rice opposite is the position; Bongaigaon has more irrigated area than Goalpara. The main source of irrigation of the respondents is STW where 86.4 percent areas are irrigated by STW in aggregate. The existence of canal, tank, DTW and medium and major irrigation system is almost nil or negligible in the sample villages. Stating the causes of poor

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irrigation uses, 47.03 percent growers informed that there is no public irrigation facilities, 2.28 percent said public irrigation plants are out of order, 5.02 percent raised issues about high irrigation charge while 10.05 percent reported that they have no money to install own irrigation system and 32.62 percent cited other causes like insufficient land, so not needed, etc. Those who have irrigated paddy land have to spend money from Rs.1500 to Rs.12700 or in average Rs.5000 (approx) per acre per crop season as recurring cost of irrigation. It is also observed that the recurring cost on irrigation per acre per crop season is higher in Goalpara (Rs.5282.10) than Bongaigaon district (Rs.4717.94). In sample villages of Goalpara district, 67 percent respondents have electricity connection but only 7.9 percent uses it in agriculture. On the other hand, in Bongaigaon district, 88 percent growers have electricity connection of which 9.5 percent uses it in agriculture. Thus, uses of electric power operated irrigation appliances are more in Bongaigaon than Goalpara district and the cost of electricity used in agriculture is lower in Bongaigaon (Rs.5369.38) than in Goalpara district (Rs.9276.77) per farmer per acre per crop season.

From Table 6.7 it is seen that farmers have applied Urea, SSP, MoP, DAP, and other chemical fertilizers in a varied quantity in their cultivation of paddy. It is observed that those who have small plots of land apply more fertilizers, particularly in the religious minority dominated areas. Tribal farmers are generally reluctant to use chemical fertilizer particularly in winter rice (Traditional). However, in modern varieties almost all the growers apply urea. Use of urea is more among the farmers in Goalpara district than among the farmers of Bongaigaon district. Similarly, number of farmers who applied SSP in winter rice (both in Traditional and Modern) is more in Goalpara district compared to Bongaigaon although volume of use is almost same. Prices of urea and SSP are almost same, varying from Rs.8 to Rs.12 per kg which has increased by 50 percent to 80 percent in last 5 years in the study area. About the use of MoP, the same number of winter rice (Traditional) growers in each district has applied it (about 15.13kg per acre in average). Like earlier two varieties of chemical fertilizers, use of MoP in Goalpara is more than Bongaigaon district in modern variety. About one third farmers in winter rice traditional variety and more than half of the farmers in modern variety have used DAP. Compared to Bongaigaon average consumption of DAP in winter rice (both variety) is high in Goalpara district. It was reported that the price of DAP is higher in Goalpara than in Bongaigaon and the price has increased by 65 to 70 percent in last 5 years. Cow dung is traditionally used as manure in rice cultivation in the state. Tribal and

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indigenous farmers prefer to use cow dung rather than chemical fertilizers. Use of cow dung is more in winter rice (Traditional) to winter rice (Modern) varieties. It is also observed that in comparison to Goalpara more growers in Bongaigaon district have used cow dung. In addition, some of the farmers have applied some micro nutrients like zinc, soil, *poros,* vitamin, etc. of amount 3-6kg per acre in winter rice.

Use of pesticides and weedicides in the cultivation of winter rice (Traditional and Modern) is very limited in the sample villages in the districts. However, growers of Bongaigaon have applied more pesticides compared to the growers of Goalpara. In weedicide the position is reversed. Price of weedicides varies from Rs.50 to Rs.300 per 100ml. Five years earlier use of pesticides and weedicides were very low and the price was almost half.

In paddy cultivation labour is involved in different stages of activities right from land tilling to marketing of the produce. Although power tiller or tractors are gradually occupying important place in tilling and other farm activities, bullock pairs and wooden plough shores are still prominent in the study area. In winter rice cultivation farmers engaged labour in the activities of land tilling, seeds sowing and transplanting, weeding and harvesting and in threshing. Both family and hired labours are engaged in these activities. It is found that average mandays used in winter rice (T) in Goalpara is more than in Bongaigaon. In winter rice (T), farmers did not devote much labour mandays on weed removing but in cultivation of modern variety weed removing is an important activity in the study area. In harvesting and threshing maximum respondents have used hired labour. Average mandays per acre required in various activities of cultivation of winter rice (M) is 57.17 in Goalpara whereas it is 59.68 in Bongaigaon district. Compared to Bongaigaon, hired mandays engaged in winter rice (T) cultivation in Goalpara district is higher; however in modern variety, Bongaigaon is ahead of Goalpara district. Wages per manday ranges between Rs.200 to Rs.250 in Goalpara and Rs.150 to Rs.250 in Bongaigaon district.

6.5.5: Production and Sale of Winter Rice:

It is observed that average output produced by the growers of traditional winter rice in Goalpara is 2241.32kg compared to1742.96kg in Bongaigaon. Although the minimum and the maximum yield among the growers of two districts are similar, average yield in Goalpara is1136.19kg/acre compared to1029.71kg/acre in Bongaigaon. On the contrary,

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average production of winter rice modern variety per grower in Bongaigaon is higher (2098.96kg) than in Goalpara (1490.48kg). However, yield of modern variety is also higher in Goalpara, 1798.06kg/acre than Bongaigaon 1541.54kg/acre as in traditional variety.

Out of 92 winter rice (T) growers in Goalpara district only 33.7 percent growers sell their output in an average of 1160kg; and in Bongaigaon district, 23.9 percent growers sell 1138kg in average. However, in winter rice (M), 52.63 percent growers sell in an average of 1160kg in Bongaigaon and only 47.62 percent growers in Goalpara district sell 1068kg in average. It is also observed that the price of traditional variety is comparatively higher than the modern variety of winter rice in the study area. The maximum market price fetched for winter rice traditional one year before the date of survey as reported is Rs.1250 per quintal and the minimum price is Rs.1000 per quintal in the sample villages. The maximum average price of winter rice modern variety in the sample villages is estimated to be Rs.1125 per quintal against the minimum average price of Rs.875 per quintal.

6.5.6: Expenditure Incurred and Revenue Earned in Cultivation of Winter Rice:

From the field survey it is found that growers have to incur cash expenses on the purchases of farm inputs, payment of labour wages, rent on hired capital or interest on borrowed money for cultivation of winter rice. Table 6.8 present the average cost incurred by farmers in different items in the production and expected revenue and profit or loss of winter rice.

Table-6.8: Average cash expenditure on cultivation expected revenue of winter rice in Goalpara and Bongaigaon Districts: (in Rs./Acre)

Items	Winter Rice (T)		Winter Rice (M)	
	Goalpara	Bongaigaon	Goalpara	Bongaigaon
Seeds	456.17	457.02	989.18	821.47
Fertilizers & Manure	1261.30	1402.60	2188.22	1655.37
Pesticides & Weedicides	771.38	333.75	380.48	314.45
Hiring Capital Goods	2740.95	2392.50	2706.59	2641.82
Fuel Cost	2756.11	3341.11	5125.68	3314.28
Payment for wage lobour	4607.74	4869.89	6250.86	5204.70
Imputed value of family labour*	4101.90	3206.50	2135.65	3055.25
Total labour cost (paid + imputed)	8709.64	8076.39	8386.51	8259.94
Interest on Borrowed Money	3377.93	1512.50	1739.38	1119.25
Expenditure on Selling	1047.86	464.79	652.80	682.14
Total Expenditure	**21121.34**	**17980.66**	**22168.83**	**18808.72**
Total Revenue	**12009.55**	**11285.67**	**19113.46**	**17111.22**
Profit (+)/Loss (-)	**9111.78 (-)**	**6694.99 (-)**	**3055.37 (-)**	**1697.51 (-)**

*Imputed value of family labour is calculated by taking minimum market wage rate for manual workers prevailing in the study area @200/- multiplied by no. of mandays.
Source: Field Data

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Among the different components of cost of production of winter rice (T), in Goalpara, highest cost involved is in payment for wage lobour for tilling, sowing, weed removing, harvesting and threshing followed by interest on borrowed money, fuel cost, hiring capital goods, etc. Similarly, in Bongaigaon district, payment for wage lobour is highest among the different components of cost on cultivation of winter rice (T), followed by the cost on fuel, hiring capital goods, etc. While farmers in Goalpara incurred minimum expense on seeds, respondents in Bongaigaon incurred minimum on pesticides and weedicides. On the other hand, in case of cultivation of winter rice (M), as in traditional variety highest cost involved is in payment for wage lobour followed by fuel and hiring capital goods both in Goalpara and Bongaigaon. Sample growers have incurred minimum cost on pesticides and weedicides in the cultivation of winter rice in the study area. Growers of Goalpara pay more interest on borrowed money compared to that of Bongaigaon. Considering total expenditure on cultivation of winter rice, it is observed that expenditure on cultivation in Goalpara is higher than in Bongaigaon. Similarly, total revenue earned by the growers in Goalpara is more than the growers in Bongaigaon. If we include the imputed wages of the growers and their family labour in the calculation of total expenditure in cultivation of winter rice, it is not at all a profit making activity.

6.5.7: Capital Expenditure During the last 5 Years:

Among the respondents of winter rice 24.78 percent in Goalpara and 16.12 percent in Bongaigaon have invested money in major farm equipment like tractors, power tiller, etc. Percentage of expenditure in major farm equipments to total expenditure in capital in last 5 years is 23.38 percent and 12.50 percent respectively in Goalpara and Bongaigaon districts. Percentage share of expenses in bullock pair in total expenses in Goalpara and in Bongaigaon districts are 37.48 percent and 9.28 percent respectively. Percentage of investment in minor farm equipment like sprayers, weed remover, plough shores, etc. to total investment is 5.34 percent in Goalpara and 5.03 percent in Bongaigaon. Among investments in different capital goods, 26.55 percent of growers in Goalpara and only 4.7 percent in Bongaigaon have spent money for purchases and development of land. No grower in Goalpara has spent money for developing the processing and storage facilities but 6.04 percent growers have invested money for the same in Bongaigaon.

Table-6.9: Capital expenditure during the last 5 years (in Rs.):

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Items	Goalpara		Bongaigaon	
	No. of growers (in %)	Average investment (in Rs.)	No. of growers (in %)	Average investment (in Rs.)
Major farm equipment	24.78	16615.32	16.12	31030.43
Bullock pairs	22.12	26642	16.11	23050
Minor farm equipments	18.58	3792.38	21.48	1248.17
Purchases and development of land	26.55	116283.33	4.7	36400
Processing & storage facilities	-	-	6.04	124833.33
Total	57.52	71075.68	15.44	24834.78

Source: Calculated from field data.

6.5.8: Sources of Finance for Winter Rice Cultivation:

Winter rice cultivation expenditure is largely borne by the farmers themselves. In Goalpara 65.49 percent growers have spent own money while in Bongaigaon, 43.62 percent have not borrowed money from others. However, 9.73 percent and 28.86 percent growers in Goalpara and Bongaigaon respectively have borrowed money from the fellow farmers with no interest. They have also borrowed money either from land lords or from local money lenders or from other non-institutional sources by paying interest at the rate of Rs.3 to Rs.5 per month on 100 rupees, for 4 months, that is for one crop season to mitigate their short-term requirements. The meagre earnings and recurring expenses both in farming and in household consumption are the main reason for increasing indebtedness in the study area. Demand for credit for current investment (crop loan) is highest among small growers in the sample villages. Source wise distribution of credit shows that fellow farmers and informal sources are major sources of credit in the sample villages. Village landlords and money lenders are next major sources of credit. 20.35 percent respondents in Goalpara and 19.46 percent growers in Bongaigaon districts availed the government or institutional assistance for agricultural activities. However, only 13.04 percent loan recipients have repaid the loans fully, 34.78 percent did not repay at all and 52.17 percent repaid partially in Goalpara. On the other hand in Bongaigaon 24.14 percent have fully repaid, 31.03 percent have partially repaid while 44.83 percent did not pay at all.

Table-6.10: Sources of finance for winter rice cultivation:

Sources	Goalpara		Bongaigaon	
	No. of growers (in %)	Average (in Rs.)	No. of growers (in %)	Average (in Rs.)
Self finance	65.49	3754.09	56.34	27858.43
Borrowing from fellow farmer	9.73	3500	28.86	3741.93
Borrowing from land lord	1.77	2000	7.4	4000
Borrowing from money lender	9.73	5722.22	2.0	2000
Borrowing from NGOs, MFs & village fund	13.27	5800	5.4	3312.5
Total	100		100	

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Source: Calculated from field data

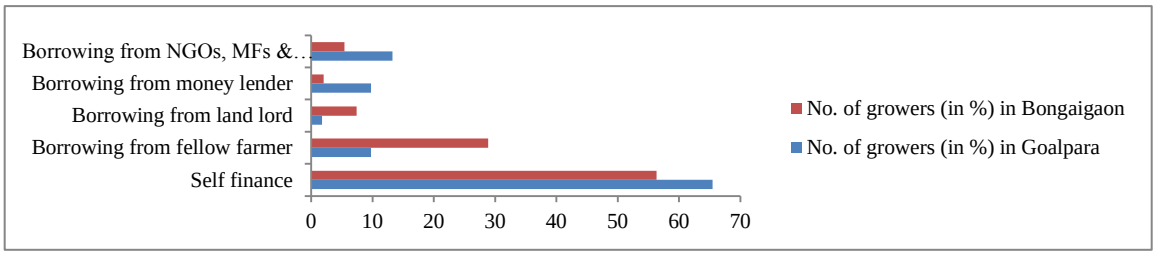

Fig.6.4-: Sources of finance for winter rice cultivation

6.5.9: Scope of Extension Services in Winter Rice Cultivation:

Public extension services in different stages of winter rice farming are not satisfactory. Only 34.51 percent farmers in Goalpara and 4.03 percent farmers in Bongaigaon got advices from public extension workers. Decisions have been taken by farmers themselves and advices received from the fellow farmers in this respect are very significant. Received knowledge and information from the fellow farmers on the uses of fertilizer, pesticides, weedicides or in solving farming problems are significant. Seeds and fertilizer shops and marketing agencies also played an important role. In other farming matters like new public schemes, crop failure, natural calamities, etc. more farmers in Goalpara than in Bongaigon have taken advices from the public extension workers. Role played by public extension workers in access to market of the crops produced is more in Bongaigaon than in Goalpara district. Table 6.11 represents the source wise extension services received by the sample growers.

Table-6.11: Source wise extension services:

Farm Matters	Unit	Goalpara			Bongaigaon		
	% of growers	Self	Private Extension Services	Public Extension Services	Self	Private Extension Services	Public Extension Services
Advice on seed variety		32.75	32.74	34.51	85.23	10.74	4.03
Fertilizer application		25.66	19.47	54.87	48.32.	24.83	26.85
Pesticides application		29.20	11.51	59.29	38.26	43.62	18.12
Other farming matters		11.50	38.06	50.44	34.23	39.6	26.17
Access to market		21.24	75.22	03.54	34.23	60.4	26.17
Knowledge about VLEW or GS	% of growers	Yes=59.29; No=40.71			Yes=46.72; No=53.28		
Consult farm problems		Yes=37.00; No=63.00			Yes=67.88; No=32.12		
Meet VLEW or GS once in a year		70.21			78.49		
Meet twice or more in the year		29.79			21.51		
Followed advices of VLEW or GS		48.03			37.23		
Met during last six months		14.96			52.55		
Information on awareness/ training/workshop on farming		37.80			29.93		
Participated in the programme		31.5			23.35		

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Participation in exhibitions/fairs or any exposure tours		14.17	38.69
Grading performance of agriculture department		Very Good=3.94; Good=27.56; Satisfactory=37.01 ; Not satisfactory=31.57	Very Good=12; Good=80.16; Satisfactory=3.97; Not satisfactory=3.97
Farm input support, viz., seeds and fertilizers		Yes=49.56; No=50.44	Yes=64.43; No=35.57

Source: Field Data

Regarding access to information and circulations of government programmes on farming, growers of Goalpara are more aware than growers in Bongaigaon district. However, in public support on farm inputs, viz., seeds and fertilizers, more number of farmers in Bongaigaon district could avail compared to Goalpara district. Participation of the sample farmers in different awareness/training/workshop on farming is very poor in the districts. About 37.80 percent sample farmers in Goalpara and 29.93 percent farmers in Bongaigaon get the information about said programmes. Only 27.10 percent respondents in aggregate have been taken part in government sponsored exhibitions or fairs or any exposure tours. To know the comments of the respondents about the overall performance of agriculture department in the district we adopted four points rating, very good, good, satisfactory and not satisfactory.

If farmers are affiliated with any organization in agriculture and allied sectors or listen Radio, watch TV and collecting book/hand bill, etc. it will develop the professional skill among the farmers. Unfortunately, except in Farm Management Committee (FMC), it is observed that sample farmers are rarely affiliated to any farm organization. Moreover, only 45.42 percent respondents of winter rice in two districts have been listening to Radio or watching TV programme on agriculture. Bongaigaon is in better position than Goalpara. Although farmers are cultivating paddy crops as primary occupation generation after generation, they have rarely interacted with books and guide supplements of farming. In the field study, it is found that only 21.24 percent in Goalpara and 17.45 percent farmers in Bongaigaon have farm guide books. However, it is encouraging that a large numbers of farmers in both the districts have mobile cell phones.

6.6: Crop-wise Discussion: Jute Crop:

Jute is an important cash crop in Goalpara and Bongaigaon districts. In 2012-13, total area, production and yield of jute in Goalpara district were 4150 hectares, 38828MT and

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9356.14kg/ha respectively. Similarly, in Bongaigaon district these figures were 2278 hectares, 24694MT and 10840.21kg/ha.

6.6.1: Demographic Profile of Jute Growers:

The aggregate sample size of jute growers is 115; 68 from Goalpara and 47 from Bongaigaon. All sample jute growers in Goalpara district are of Muslim community who belong to the general category. However, in Bongaigaon district, although Muslim community growers (70.21%) were prominent, growers of other backward class (OBC) (12.77%) and scheduled caste (SC) (17.02%) are also found in small number. Assamese speaking farmers are more in Goalpara than in Bongaigaon. Family size among jute growers in Goalpara is bigger than in Bongaigaon. The average household size of the growers in Goalpara is 7.04 with minimum member 1 and maximum 15 whereas in Bongaigaon it is 6.45 with minimum 2 and maximum 14. It is found that among different age groups most of the jute growers (32.35% in Goalpara and 34.04% in Bongaigaon) are in the range of 50 to 60 years. The average age of the jute growers in Goalpara is 47.28 years and in Bongaigaon 45.53 years. Average number of family member involved in jute cultivation is more in Goalpara (2.07) than in Bongaigaon (1.94) in the study area. About the education received by the household head among jute growers, illiterate farmers are more in Bongaigaon (46.81%) compared to Goalpara (39.71%) (opposite of the winter rice growers). In aggregate 42.61 percent growers are illiterate, 6.09 percent are below primary, 19.13 percent are below matriculation and 32.16 percent are matriculate or above. Jute farmers are less educated than paddy farmers. The demographic composition of jute growers in Goalpara and Bongaigaon districts are given in the Table 6.12.

Table-6.12: Basic social profile of the respondents of jute growers in Goalpara and Bongaigaon districts:

Sl. No.	Items	Category	Goalpara	Bongaigaon	Aggregate
1	Caste/Category	General	68 (100%)	33 (70.21%)	101(87.83%)
		OBC	0(0%)	06 (12.77%)	06 (5.22%)
		ST	0 (0%)	0 (0%)	0 (0%)
		SC	0 (0%)	08 (17.02%)	08 (6.96%)
2	Religion	Hindu	0 (0%)	15(31.92%)	15 (13.04%)
		Muslim	68 (100%)	32 (68.09%)	100 (86.96%)
3	Family Size	Mini	1	2	1
		Max	15	14	15
		Average	7.04	6.45	6.75
4	Age of the Household Head	<30 Years	04 (5.88%)	02 (4.26%)	06 (5.22%)
		30-40 Years	11(16.18%)	12 (25.53%)	23 (20%)
		40-50 Years	21 (30.88%)	12 (25.53%)	33 (28.70%)
		50-60 years	22 (32.35%)	16 (34.04%)	38 (33.04%)
		>60 Years	10 (14.71%)	05 (10.64%)	15 (13.04%)
5	Education of the	Illiterate	27 (39.71%)	22 (46.81%)	49 (42.61%)

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	Household Head	Below Primary	03 (4.41%)	04 (8.51%)	07 (6.09%)
		Below Matriculation	14 (20.59%)	08 (17.12%)	22 (19.13%)
		Matriculation and above	24 (35.28%)	13 (27.67%)	37 (32.17%)

Source: Field Data

6.6.2: Land Holdings, Occupational Profile and Tenancy Practices of the Jute Growers:

In the study area in Goalpara district, sample jute growers have possessed 70.613 acres of land while in Bongaigaon district 47 jute growers have possessed 33.7 acres. On the basis of nature of involvement 92.65 percent growers reported jute cultivation as primary occupation in Goalpara district and rest 7.35 percent reported as subsidiary occupation. In Bongaigaon district, 97.87 percent and 2.13 percent grower reported jute cultivation as primary and subsidiary occupation respectively.

Among the respondents, 81.74 percent have their own cultivable jute land with average size of 0.76 acres. Number of growers having owned jute land is more in Goalpara than in Bongaigaon and their average sizes are 0.87 acre and 0.64 acre respectively. Although average area of leased in land is high in Goalpara (0.83 acres) than in Bonaigaon (0.52 acres) like in winter rice, number of growers land leased in for jute cultivation is more in Bongaigaon (48.94%) than in Goalpara (32.35%). However, a maximum of 2.98 acres leased in area in Goalpara is bigger than a maximum of 0.99 acres leased in area in the Bongaigaon. Contrary to leased in, farmers percentage who leased out jute land in Bongaigaon is less; only 6.38 percent growers leased out their land whose maximum size of land is 1 acre and average is 0.66 acre. However, in Goalpara district 22.06 percent respondents have leased out their jute lands whose average size is 0.65 acre. Thus, average size of cultivated jute land (owned plus leased in) is bigger in Goalpara district (1.04 acres) than in Bongaigaon district (0.72 acre). Moreover, fragmentation of jute land is high in Goalpara (max. 5 plots) than in Bongaigaon (max. 4 plots). Table 6.13 presents percentage of jute farmers in different size categories, in tenurial groups and extent of tenancy practices in sample area.

Table-6.13: Land holdings, tenurial group and tenancy practices of jute growers in Goalpara and Bongaigaon districts:

Sl. No.	Items	Description	Unit	Goalpara	Bongaigaon	Aggregate
1	Category	Marginal	% of No.	94.12	100	97.06
		>1ha	% of No.	5.88	-	5.88
		Average size of jute holding	Acre	1.04	0.72	0.88
2	Tenurial group	Purely cultivating owner	% of No.	45.59	40.43	43.48
		Purely cultivating tenant	% of No.	05.88	19.15	11.3

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		Owner cum tenant	% of No.	48.53	40.43	45.22
3	Forms of tenancy practices	Fixed crop rent	% of No.	31.58	14.29	24.51
		Share cropping	% of No.	26.32	10.71	19.94
		Share cropping & fixed crop rent	% of No.	26.32	71.43	49.13
		Fixed money rent yearly	% of No.	15.79	3.57	10.80
4	Fragmentation of jute plots		Max. in No.	5	4	5

Source: Field Data

Compared to Goalpara district, tenancy practices in jute cultivation in Bongaigaon district is less. In the study it is also observed the prevalence of different forms of tenancy practices in jute cultivation. In tenant cultivation of jute crop, some of the growers practiced both share cropping and fixed crop rent simultaneously and it is dominating.

6.6.3: Use of Capital Goods in Jute Cultivation:

Like winter rice, most of the farmers use modern equipment like, tractor and power tiller to till their jute land. However, only 2.61 percent farmers have their own tractor or power tiller in the study area. Most of the farmers (97.39%) use tractor and power tiller on hire and the rent of hiring a tractor or power tiller are same as in winter rice, from Rs.756.25 to Rs. 907.50 per tilling per acre. Bullock pairs and wooden ploughs are also used and 18.26 percent respondents have their own bullock pairs. About 42 percent jute farmers have their own traditional plough shore. In aggregate only 6.96 percent jute growers have their own STW (shallow tube well) or pump set or water motor to water their jute lands. Only a single jute grower in Goalpara district has irrigated jute land by hiring water pump set. In aggregate, 62.61 percent jute growers in the study area have their own pesticide sprayer, whereas growers of Goalpara have a little more compared to the growers of Bongaigaon. Only 40 percent growers have weed removers across the districts. However, compared to Goalpara more number of growers in Bongaigaon have pesticide sprayer and weed remover at free of cost under government schemes. The average current expense on all capital goods used for jute cultivation has been calculated to Rs.6536.63 per acre in aggregate and it is higher in Bongaigaon (Rs.8506.91) than in Goalpara (Rs.4566.33).

6.6.4: Input Use in Jute Cultivation:

There is a wide variation in the use of inputs in the cultivation of jute in the study area and it depends on variety of seeds and land pattern. Almost all the growers in Goalpara and 85 percent growers in Bongaigaon have purchased the seeds from local shop keepers

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and traders. Price of seeds in Bongaigaon is slightly less than in Goalpara district. However, growers are very much concerned about the rise in price of jute seeds in every crop season. Price of jute seeds has increased by about 100 percent in last 5 years. Table 6.14 presents the uses of inputs in jute cultivation in the study area.

Table-6.14: Input use in Jute Cultivation in Goalpara and Bongaiaon Districts (per Acre):

Inputs	Description	Unit	Goalpara	Bongaigaon	Aggregate
Seed	Mini	Ml gram/acre	2420	1815	2117.5
	Max		6050	6050	6050
	Avg.		3267	3303	3285.15
Irrigation	Nos. of grower	No. (%)	5 (7.35)	6 (12.77)	11 (9.57)
	Irrigated Area	Acre(%)	55.96 (8.66)	37.81 (12.26)	93.78 (9.82)
	Average irrigated area	Acre	11.19	6.35	8.74
	Irrigated by STW	Acre(%)	55.96 (8.66)	37.81 (12.26)	93.78 (9.82)
	Average recurring cost for irrigation (per crop season)	Rs.	4386.25	6806.25	5596.25
Fertilizer-Urea	Nos. of grower	No. (%)	67 (98.53)	44 (93.62)	111(96.52)
	Minimum	Kg/acre	13.61	12.10	12.10
	Maximum		151.25	151.25	151.25
	Average		51.67	49.85	50.76
Fertilizer-SSP	Nos. of grower	No. (%)	28 (41.18)	17 (36.17)	45 (39.13)
	Minimum	Kg/acre	24.2	15.13	15.13
	Maximum		75.63	151.25	151.25
	Average		45.16	29.95	37.57
Fertilizer-MOP	Nos. of grower	No. (%)	10 (14.71)	15 (31.91)	25 (21.74)
	Minimum	Kg/acre	3	12.10	3
	Maximum		75.63	30.25	75.63
	Average		17.24	18.54	17.91
Fertilizer-DAP	Nos. of grower	No. (%)	39 (57.35)	25 (53.19)	64 (55.65)
	Minimum	Kg/acre	9.10	9.10	9.10
	Maximum		90.75	60.5	90.75
	Average		25.53	27.41	26.47
Pesticides	Nos. of grower	No. (%)	7 (10.29)	7 (14.89)	14 (12.17)
	Minimum	ML gram/acre	75.63	151.25	75.63
	Maximum		30.25	30.25	30.25
	Average		196.63	259.30	227.96
Weedicide	Nos. of grower	No.(%)	44 (64.71)	34 (72.34)	78 (67.83)
	Minimum	ML gram/acre	151.25	151.25	151.25
	Maximum		756.25	3025	3025
	Average		333.45	458.20	395.82
Labour	Minimum	Mandays/ Acre	39.33	51.43	39.33
	Maximum		169.4	151.25	169.4
	Average		90.96	90.30	90.63

Source: Field Data

Traditionally it is believed that irrigation is not required in jute cultivation because the season of cultivation is in rainfall period. However, a few growers have irrigated their jute land in early stages of growth on need basis. Average irrigated area in Goalpara district is higher than in Bongaigaon district. The only source of irrigation in jute land of the respondents is STW. Regarding causes of poor irrigation uses, growers have raised multiple causes as in winter rice like no public irrigation facilities, public irrigation plants set up long before are out of order, high irrigation charge or no money to install

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own irrigation system, etc. Some of the respondents mentioned other causes like small size of land holding, no requirement, etc. Farmers who irrigated jute land had to spend from Rs.3025 to Rs.9075 or on average Rs.3630 per acre per crop season as recurring cost of irrigation. It is observed that the recurring cost for irrigating jute land is higher in Bongaigaon compared to Goalpara. Although 73.04 percent respondents have electricity connection, only 13.04 percent uses it in agriculture where average cost involved is Rs.7332.99 per acre per crop season as reported by the respondents.

Jute growers have applied chemical fertilizers like Urea, SSP, MoP, and DAP and manure, cow dung in their jute cultivation. While 98.53 percent jute growers in Goalpara district have applied urea on an average of 51.67kg per acre, in Bongaigaon, 93.62 percent growers have applied the same in the quantity of 49.85kg per acre. Similarly, 41.18 percent jute growers in Goalpara have applied SSP of 45.16kg/acre on average and in Bongaigaon district, 36.17 percent growers have applied by 29.95kg in an acre. The volume of SSP use among the jute growers is higher in Bongaigaon than in Goalpara. About the use of MoP, 14.71 percent farmers in Goalpara district and 31.91 percent growers in Bongaigaon district have applied about 18.15kg in average in an acre. Moreover, 57.35 percent growers in Goalpara have applied DAP at the rate of 25.53kg per acre and in Bongaigaon district, 53.2 percent growers have applied 27.41kg per acre in average. Thus, it is observed that the use of chemical fertilizers in jute cultivation is relatively higher in Goalpara than in Bongaigaon. Unlike winter rice number of growers using cow dung in jute cultivation in Bongaigaon is less than in Goalpara. The calculated per acre average expenses on total fertilizer and manure use in jute cultivation in Goalpara is higher (Rs.4084.81) than in Bongaigaon (Rs.3670.08).

Use of pesticides in jute cultivation is very limited. Only 10.29 percent and 14.89 percent growers in Goalpara and in Bongaigaon respectively have applied pesticides at the rate of 196.63ml gram and 260.15ml gram in average per acre. Use of weedicide is to some extent popular in the study area and its popularity has increased to reduce the labour cost on weed removing which is an expensive activity in jute cultivation. In Bongaigaon, 72.34 percent growers have applied weedicide in average by 458.29ml per acre which is larger than the amount used by growers of Goalpara (333.45ml/acre). However, five years earlier growers in the study area rarely used any chemical pesticides and weedicides in jute cultivation and the price of them was almost half as respondents remarked.

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Jute cultivation is a labourious activity. In comparison to the paddy cultivation more labour has to be engaged in different stages of activities right from land tilling to ready the produce for marketing. Although power tiller or tractors are used in tilling the land but for other activities like sowing, weeding, harvesting, retting, drying and bundling of jute manual labour is needed. It is estimated that about 90.75 mandays (family and hired labour) per acre is needed for such activities in the study area. Relatively more number of hired labour are used in harvesting and retting in the study area followed by weed removing and it is more expensive in Bongaigaon district.

6.6.5: Production and Sale of Jute Crop:

It is found in the study that growers of Goalpara produce more jute on average than the producers in Bongaigaon district; average production of jute among the growers in Goalpara district is 1137.5kg compared to 868.1kg in Bongaigaon district. Like winter rice difference in output of jute between the districts is accounted for by both area and yield. Average yield of jute among growers in Goalpara is higher (1185.8kg/acre*)* than growers in Bongaigaon (1141kg/acre). Thus, yield as well as production of jute among the growers in Goalpara is higher than the growers in Bongaigaon. All the growers of study area have sold their produce in their local market and they are able to receive more than the minimum support price set by the government. Thus, growers did not face any problem to sell their produce or in price of raw jute in the study area. However, most of the growers are compelled to sell their produce immediately after harvesting; they could not store and wait till the price shot up in the market because of their poverty and debt. It is observed that growers in Bongaigaon sell their product at higher price (Rs.38.11/kg) than the growers in Goalpara (Rs.34.63/kg).

6.6.6: Expenditure Incurred and Revenue Earned in Jute Cultivation:

Jute growers have to incur cash expenses on the purchases of different farm inputs, for payment of labour wages, rent on hired capital or rent on borrowed money, cost on selling etc. in jute cultivation. Table 6.15 gives the average cost incurred by growers in jute production and revenue expected in sample villages in Goalpara and Bongaigaon district

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Table-6.15: Average expenditure and revenue on cultivation of jute in Goalpara and Bongaigaon Districts: (in Rs/acre)

Input/Items	Goalpara	Bongaigaon
Seeds	707.85	573.99
Fertilizers & Manure	1468.03	1712.00
Pesticides & Weedicides	527.56	497.92
Hiring Capital Goods	2400.19	2386.42
Fuel Cost	Nil	Nil
Payment for wage lobour	16802.06	14644.03
Imputed value of family labour*	1724.25	1270.5
Total labour cost (paid + imputed)	**18526.31**	**15914.53**
Interest on Borrowed Money	2525.86	2135.65
Expenditure on Selling	779.72	603.03
Total Expenditure	**26935.54**	**23823.54**
Total Revenue	**41148.17**	**43484.68**
Profit (+)/Loss (-)	**14212.63 (+)**	**19661.14(+)**

* Imputed value of family labour is calculated by taking minimum market wage rate for manual workers prevailing in the study area @200/- multiplied by no. of mandays.
Source: Field Data

Among different components of cash expenditure of jute cultivation, highest cost involved in wages paid to the hired labourers engaged for tilling, sowing, weeding and harvesting and retting. Most of the labour cost is incurred on harvesting and retting; followed by interest on borrowed money, hiring capital goods for tilling, cost on fertilizers and manures, etc. On the other hand, minimum cost is incurred on pesticides & weedicides. Farmers of Goalpara pay more interest on borrowed money compared to Bongaigaon. Considering total expenditure, it is observed that expenditure on cultivation of jute in Goalpara is higher than in Bongaigaon as in winter rice. As the revenue earned by the farmers are comparatively higher than the cost incurred in cultivation farmers can enjoy an encouraging profit in jute cultivation. Growers in Bongaigaon can earn more profit than the growers in Goalpara due to lower cost on cultivation.

6.6.7: Capital Expenditure during the last 5 Years:

Jute growers in the study area may invested money in the purchases of different major and minor farm equipments, bullock pairs, land development or in processing and storage facilities during the last 5 years. However, all the growers did not spend money for all such items. For example, while no jute growers in Goalpara district have invested money in major farm equipments like tractors, power tiller, etc. during the last 5 years, 8.5 percent growers in Bongaigaon district have invested Rs.12500 in average in such capital. On the other hand, no grower in Bongaigaon has invested in purchasing of bullock pairs during the last 5 years, but 4.41 percent growers in Goalpara have spent Rs.16500 in average. Table 6.16 shows the investment in different heads in Goalpara and

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Bongaigaon districts. Compared to Bongaigaon district, growers of Goalpara invested less capital for jute crop production.

Table-6.16: Capital expenditure in jute cultivation during the last 5 years in Goalpara and Bongaigaon district:

Item	Goalpara		Bongaigaon	
	% of growers	Average capital expenditure	% of growers	Average capital expenditure
Major farm equipment	Nil	Nil	8.5	Rs.12500/-
Bullock pairs	4.41	Rs.16500/-	Nil	Nil
Minor farm equipments	4.41	Rs.1150/-	12.77	Rs.1450/-
Purchase and development of land	Nil	Nil	4.26	Rs.112500/-
Processing and storage facilities	4.41	Rs. 37500/-	Nil	Nil
Aggregate	11.76	Rs.20681.25/-	23.4	Rs. 54904.55/-

Source: Field Data

6.6.8: Sources of Finance and Access to Credit for Jute Cultivation:

Growers of jute in the study area have to incur cash expenses on the purchases of different farm inputs and for payment to labourers engaged in jute cultivation. However, major portion of their expenses are from own sources and the rest of the expenditure is met through borrowed money from fellow farmers or from other informal sources of finance. Source wise distribution of finance in Table 6.17 shows that fellow farmers and informal sources are important source of credit for the jute farmers in Bongaigaon and in Goalpara district like in winter rice. Village landlords and money lenders are next major source of credit. The rate of interest is usually 3 to 5 percent per month and growers borrow money for 4 to 5 months till the harvesting is over. Only 5.9 percent growers in Goalpara and 19.15 percent growers in Bongaigaon district accessed credit from formal sources.

Table-6.17: Sources of finance and access to credit in jute cultivation in Goalpara and Bongaigaon district:

Sources	Goalpara (% of growers)	Bongaigaon (% of growers)
Self	82.35	68.1
Partially self and partially borrowed from the fellow farmers and relatives at without interest	7.35	27.66
Complete borrowed from land lords or local money lenders or traders by paying interest	10.29	4.26
Total	100	100
Accessed credit from formal sources	5.9	19.15

Source: Field Data

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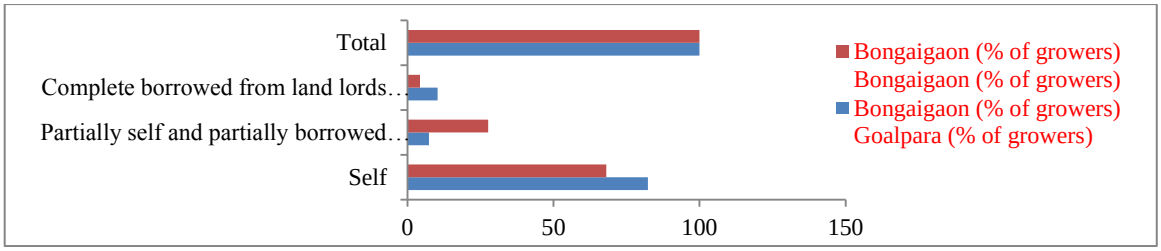

Fig.6.5: Sources of finance and access to credit in jute cultivation in Goalpara and Bongaigaon districts.

6.6.9: Scope of Extension Services in Jute Cultivation:

As in winter rice, role of the public extension services in different stages of jute cultivation is not satisfactory in the study area. About 57.35 percent growers in Goalpara are dependent on private agencies and 42.65 percent accessed services from the public extension services. Similarly, in Bongaigaon 63.83 percent jute growers have access extension services from private agencies and only 25.53 percent from public agencies for different things. 10.64 percent jute growers in Bongaigaon did not receive any extension services from any sector. Growers received advices from public extension services basically in the selection of seeds, application of fertilizer and use of pesticides and weedicides whenever needed. Table 6.18 presents source wise extension services in different farm matters.

Table-6.18: Source wise extension services:

Farm Matters	Unit	Goalpara			Bongaigaon		
	% of growers	Self	Private Extension Services	Public Extension Services	Self	Private Extension Services	Public Extension Services
Advice on crop variety		49.00	24.53	26.47	40.00	30.21	29.79
Fertilizer application		42.50	38.38	19.12	23.5	50.97	25.53
Pesticides application		26.75	55.6	17.65	16.75	53.46	29.79
Other farming matters		25.5	55.38	19.12	9.5	58.59	31.91
Access to market		58.82	39.71	1.47	44.68	48.94	6.38
Knowledge about VLEW or GS	% of growers	Yes=50; No=50			Yes=50; No=50		
Consult farm problems		Yes=51.06; No=48.94			Yes=44.68; No=55.32		
Meet VLEW or GS once in a year		26.50			23.40		
Meet twice or more in the year		08.85			25.52		
Followed advices of VLEW or GS		35.29			46.81		
Met during last six months		08.82			12.77		
Information on awareness/ training/workshop on farming		47.06			34.04		
Participated in the programme		33.82			31.91		
Participation in exhibitions /fairs or any exposure tours		21.50			13.28		
Grading performance of agriculture department		Very Good=5.88; Good=17.65; Satisfactory= 36.76; Not satisfactory=39.71			Very Good=4.26; Good=25.53; Satisfactory=29.79; Not satisfactory=40.43		
Farm input support, viz., seeds and fertilizers		Yes=39.71; No=60.29			Yes=53.19; No=46.81		

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Source: Field Data

Advices and information received from the fellow farmers, traders, seed and fertilizer shopkeepers, etc. are significant in cultivation of jute in the study area. In other farming matters like new public schemes, crop failure, catastrophes, etc. more farmers in Bongaigon compared to Goalpara have taken advices from the public extension workers.

Knowledge about the presence of any Village Level Extension Worker (VLEW) or agriculture *Gram Sevak* (GS) in the locality of study area is partial; about 50 percent growers are unaware about their presence. Participation of the jute farmers in different awareness or training or workshop on farming is very poor. In aggregate 17.39 percent respondents took part in government sponsored exhibitions or fairs or any exposure tours and their participation rates are higher in Goalpara district.

Like winter rice, jute growers in the sample area are inactive to organize themselves. Except in Farm Management Committee (FMC), it is observed that most of the sample farmers are not associated with any farm based organization. However, compared to Bongaigaon (80.85%) more farmers in Goalapara (95.59%) are involved with FMC. Only 11.76 percent farmers in Goalpara and 8.5 percent farmers in Bongaigaon are members of different self help groups (SHGs) or non-government organizations (NGOs). Moreover, only 35.65 percent respondents in the study area listen to Radio or watch TV programme on agriculture and listeners are more in Bongaigaon than in Goalpara district. Although sample farmers have been cultivating jute since long back, they have rarely interacted with any books and guide of jute cultivation. In the field study, it is found that only 17.65 percent in Goalpara and 8.5 percent growers in Bongaigaon have any farm guide books. However, as in winter rice, most of the sample jute farmers have mobile cell phone.

6.6.10: Brief Review in Problems of Jute Cultivation:

Respondents in the sample villages have stated that earlier most of the farm families cultivated jute at least in small plot to fulfill their household needs like for use as vegetable, making rope, for dry stick, etc. But the habit of consuming jute leaves has decreased, plastic ropes are available in the market, use of dry stick has decreased and hence jute cultivation has gradually declined and jute lands are now used for other crops like paddy, maize, vegetables, etc. Those growers who are practicing double or triple

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crops in the same small plot of land are compelled to harvest pre-mature jute plant because they will prepare the land for cultivation of other crops. Thus, yield of jute is low in some villages. Moreover, growers face the problem of labour shortage and high cost of labour. The Mahatma Gandhi National Rural Employment Guarantee Scheme (MNREGS, 2005) has helped casual workers rather than farmers. In Goalpara, jute area declined due to loss of pre-matured jute plants due to unknown disease, damage by wind, flood and conversion of jute land for vegetable cultivation. Late receipt of seeds, distribution of unseasonal varieties and that too in inadequate quantity makes the free distribution of seeds by the government meaningless. Jute growers of Bongaigaon district were not able to get bank credit. Moreover, agriculture extensions officials are engaged in other government duties like on National Registration Certificates (NRC) update process, household survey, etc. for a long time which caused less visit to the jute field and farmers rarely meet them to consult their farm problems.

6.7: Crop-wise Discussion: Rubber Crop:

Rubber plantation is found to contribute much to the economic betterment of the districts of Goalpara and Bongaigaon by generating income and employment. The potential of rubber plantation as a source of livelihood and employment in the context of Goalpara has been highlighted by Maibangsa and Subramanian (2000). In Goalpara district total plantation area increased (matured and immature) from 1990 to 2016 is 8445.12 hectares and total number of holdings (planting units) is 13320. Total area under rubber tapping in the district was 4309 hectares and total production of rubber sheet and scraps was 4740 MT in 2015-16. Table 6.19 presents the area and production of natural rubber in Goalpara and Bongaigaon districts.

Table-6.19: Area, Production and Yield of Natural Rubber (sheet & scraps) in Goalpara, Bongaigaon and Assam in 2013-14:

Districts	Plantation Area (in Ha) (%)	Tapping Area (in Ha) (%)	Production (in MT) (%)	Yield (kg/ha)
Goalpara	10792.69 (22.03)	4309 (43.09)	6355.00 (46.39)	1474.82
Bongaigaon	2943.95 (6.01)	462.30 (4.62)	321.62 (2.35)	695.70
Assam	49000.95 (100)	10000.63 (100)	13700.19 (100)	1369.93

Source: Rubber Board, Zonal Office, Guwahati and Rubber Regional Office, Goalpara.

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6.7.1: Demographic Profile of Rubber Growers:

Unlike rice and jute, rubber is a non-traditional and public sponsored crop that extensively grew in popularity in the study area of western Assam. In the sample survey, we have interviewed 102 respondents, 52 from Goalpara and 50 from Bongaigaon district. Respondents are purposefully selected from 5 villages under 2 ADO circles and 2 CD Blocks in each district from those growers who have already started tapping of rubber latex, the commercial produce of rubber tree. In Goalpara, sample rubber growers are mainly from tribal community and backward class belonging to schedule tribe (ST) (80.77%) and other backward class (OBC) (19.23%) category. However, in Bongaigaon district, growers are mostly in OBC (80%) and scheduled caste (SC) (20%). Interestingly, no growers of the general category and religious minority community are found in the study area and all growers are Hindu in religion. Assamese speaking farmers are slightly more in Goalpara (80.77%) than in Bongaigaon (80%). However, 19.23 percent growers in Goalpara are Bodo speaking and 20 percent growers in Bongaigaon are Bengali speaking. As in winter rice and jute growers, family size among rubber growers in Goalpara district is bigger than in Bongaigaon district. The average household size of the respondents in Goalpara is 6.25 and in Bongaigaon is 5.94. It is found that most of the rubber growers are in the age group of 50 to 60 years; 26.92 percent growers in Goalpara and 32 percent growers in Bongaigaon are in this age group. The average age of the sample rubber growers in Goalpara is 44.38 years while in Bongaigaon it is 46.52 years. About the education received by the household head among rubber growers, equal number of illiterate farmers is found in Goalpara and Bongaigaon and in aggregate 7.84 percent growers are illiterate. However, 63.73 percent rubber growers in the study area are either matriculate or having more education. Thus, in comparison to rice and jute farmers, growers of rubber have more education and are younger. It is quite probable that the high literacy among growers have helped them take up rubber plantation as it requires some technical knowledge and some formalities to be completed in order to get benefits and incentives from the government agencies (Nath, 2009). The demographic compositions of individual rubber growers in the sample villages are given in the Table 6.20.

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Table-6.20: Basic social profile of the respondents of rubber growers in Goalpara and Bongaigaon districts:

Sl. No.	Items	Category	Goalpara	Bongaigaon	Aggregate
1	Caste/Category	General	0 (0%)	0 (0%)	0 (0%)
		OBC	10 (19.23%)	40 (80%)	50 (49.02%)
		ST	42 (80.77%)	0 (0%)	42 (41.18%)
		SC	0 (0%)	10 (20%)	10 (9.8%)
2	Religion	Hindu	52 (100%)	50 (100%)	102 (100%)
		Muslim or others	0 (0%)	0 (0%)	0 (0%)
3	Family Size	Mini	3	2	2
		Max	19	12	19
		Average	6.25	5.94	6.1
4	Age of the Household Head	<30 Years	07 (13.46%)	04 (8%)	11 (10.78%)
		30-40 Years	14(26.92%)	11 (22%)	25 (24.51%)
		40-50 Years	12 (23.08%)	12 (24%)	24 (23.53%)
		50-60 years	14 (26.92%)	16 (32%)	30 (29.41%)
		>60 Years	05 (9.62%)	07 (14%)	12 (11.76%)
		Average Age	44.38 years	46.52 years	45.45 years
5	Education of the Household Head	Illiterate	04 (7.69%)	4 (8%)	8 (7.84%)
		Below Primary	06 (11.54%)	02 (4%)	8 (7.84%)
		Below Matriculation	12 (23.08%)	09 (18%)	21 (20.59%)
		Matriculation and above	30 (57.69%)	35 (70%)	65 (63.73%)

Source: Field Data

6.7.2: Land Holdings, Occupational Profile and Tenancy Practices of the Rubber Growers:

The rubber growers surveyed in Goalpara district have possessed total 32.83 ha of rubber tapped area. Among the respondents 62.85 percent are marginal farmers and they are possessing 20.63 hectares or 62.84 percent of total rubber tapped area. Only 37.15 percent growers have more than one hectare of rubber tapped area in Goalpara district. On the other hand, in Bongaigaon district, total rubber tapped area of sample rubber growers is 42.53 ha and 64 percent sample growers are marginal farmers occupying 16.32 ha or 38.38 percent of total rubber tapped area.

Table-6.21: Operational holdings and Tapped area of sample rubber growers in Goalpara and Bongaigaon:

Category of Size Class	Goalpara			Bongaigaon			Aggregate		
	No.	Area (ha)	% of No.	No.	Area (ha)	% of No.	No.	Area (ha)	% of No.
Below 1 hectare	43	20.52	62.85	32	16.43	64	75	36.95	73.53
1-2 hectare	9	12.31	37.15	15	19.14	30	24	31.45	23.53
2-4 hectare	0	0	0	03	6.96	06	03	6.96	2.94
4-10 hectares	0	0	0	0	0	0	0	0	0
Above 10 hectares	0	0	0	0	0	0	0	0	0
All	52	32.83	100	50	42.53	100	102	75.36	100
Fragmentation of rubber plots (Max.)	5			4			5		

Source: Calculated by the author from Field Data

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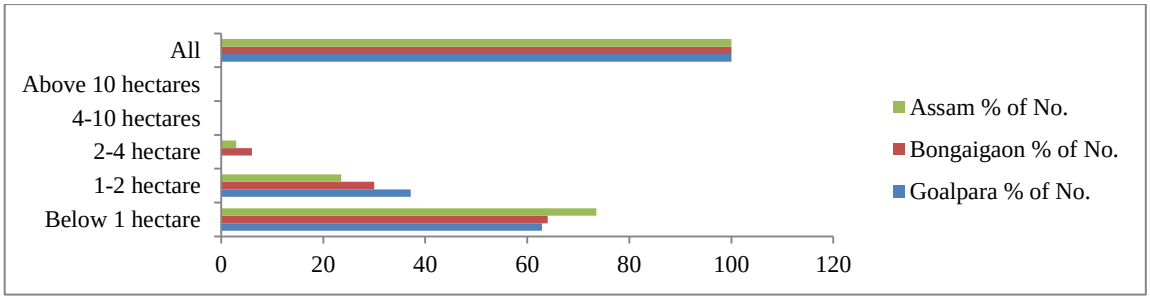

Fig.6.6: Percentage of no. of operational holdings of sample rubber growers in Goalpara and Bongaigaon and Aggregate.

In case of occupational profile of the head of the family and their family member in rubber cultivation, 92.31 percent growers reported rubber plantation as their primary occupation and the rest reported it as subsidiary occupation in Goalpara district. In Bongaigaon, 96 percent and 4 percent grower reported rubber cultivation as primary and subsidiary occupations respectively. Unlike rice and jute, there is no pure tenant in rubber cultivation among the respondents in Goalpara district. Among growers 63.46 percent are purely cultivating owner and 36.54 percent are cultivating owner cum tenant. Correspondingly, in Bongaigaon district, 70 percent growers are purely cultivating owner, 28 percent are cultivating owner cum tenant and only 2 percent are pure tenant. Thus, compared to Goalpara, extent of tenancy in rubber cultivation in Bongaigaon is less. In aggregate, 66.67 percent rubber growers in the study area are cultivating owner, 32.35 percent are owner cum tenant and rest 0.98 percent is tenant in the tenure group of rubber plantation. Share cropping is the major tenancy practice in rubber plantation in the districts.

Almost all the rubber growers (99%) have their own cultivable rubber land with average size of 1.145 ha. Growers in Bongaigaon district have bigger size, 1.25 ha of own rubber land than in Goalpara district, 1.05 ha. Like in winter rice and jute, the average size of leased in rubber land is higher in Goalpara (0.67 ha) than in Bonaigaon (0.47 ha). The maximum size of leased in area in Goalpara is 0.94 ha whereas in the Bongaigaon it is 0.54 ha. Contrary to leased in, only 3.85 percent growers have leased out rubber land in Goalpara whose average size is 0.97 ha. No rubber growers in Bongaigaon district have leased out their land.

Average size of rubber tapped area (owned plus leased in) among the sample growers in Goalpara district is 0.63 ha compared to 0.85 ha in Bongaigaon district. Thus, growers in Bongaigaon have not only larger plantation site but also have bigger tapped area than the growers in Goalpara. Moreover, rubber plots are less fragmented in

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Bongaigaon (max. 4 plots) than in Goalpara (max. 5 plots). The plantations have been grown either in natural forest or in barren land or by converting the land which was earlier used for other crops. In Goalpara, 40.38 percent sample growers' plots earlier fell under natural forest, 28.84 percent growers planted rubber in area which was earlier used for cultivation of other crops like, *ahu* paddy, black grams, sesame (*til*), vegetables, etc. or other plantation and 11.54 percent growers used their fallow land. Similarly, in Bongaigaon district, 48 percent growers have grown rubber in the plots where they earlier produced other crops, 28 percent growers grown rubber in natural forest and 14 percent utilized fallow lands for rubber plantation.

6.7.3: Use of Capital Goods:

Unlike rice and jute, rubber plantation does not require much capital goods during its plantation and tapping for latex. However, some of the growers use tractor, power tiller, plough shores, etc. for ancillary activities. Pesticide sprayer is used in rubber plantation and 65.5 percent growers in Goalpara and 72 percent in Bongaigaon have their own sprayer. Weed removing is a recurring activity particularly in the early 4 years of plantation. Most of the growers remove weeds manually; 19.23 percent in Goalpara and 18.63 percent in Bongaigaon have their owned grass weed removers. Before the start of tapping, some fixed assets like latex collection equipments, rubber sheet roller, smoke house, etc. are needed. At the 7-8 year age of rubber trees tapping process has to be started to collect latex. All the growers in the sample villages have their own set of latex collection equipments whose mean cost is Rs.2289.50. The average current expense on all capital goods used for rubber cultivation has been calculated as Rs.5842.40 per farmer in aggregate but it is higher in Goalpara district (Rs.6945.54) than in Bongaigaon district (Rs. 4739.24).

Proper storage facility can minimize the risk of crop damage and helps in sales proceed. Latex and rubber sheet require sufficient space and proper arrangement to store. But only 35.3 percent respondents have proper storage houses in the study area and growers in Bongaigaon are ahead in this respect. There is no public sector storage house in the study area.

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6.7.4: Input Use in Rubber Cultivation:

Rubber plantation is a purely commercial cultivation and growers generally follow the prescribed instructions in its cultivation. Rubber Board in India has prescribed to plant 448 to 485 saplings in a hectare. Sample growers have followed the norms and they planted 443 saplings in Goalpara and 449 in Bongaigaon per hectare on average. In the earlier years, the Rubber Board supplied the planting materials freely; but in recent years, they are supplied at subsidized price. A few of the growers have set up their own nurseries. Almost all the sample growers in Goalpara and Bongaigaon districts (i.e., 96.15% and 96% respectively) have purchased the planting materials either from Rubber Board or from the private nurseries. But a risk of genuineness and quality of planting materials is involved in collection from the private nurseries. The average price per sapling is Rs.16.52 and Rs.12.37 in Goalpara and Bongaigaon respectively. Table 6.22 presents the uses of inputs in rubber plantation in the study area in Goalpara and Bongaigaon districts.

Table-6.22: Input use in Rubber Plantation in Goalpara and Bongaiaon districts (per hectare in a crop session):

Inputs	Items	Unit	Goalpara	Bongaigaon	Aggregate
Use of Planting Materials	No. of growers	No. (%)	52 (100)	50 (100)	102 (100)
	Mini	No.	448	410	410
	Max		485	463	485
	Avg.		443	449	446
Use of Fertilizer- Urea	No. of growers	No. (%)	29 (55.77)	40 (80)	69 (67.65)
	Mini	Kg	15	15	15
	Max		149.2	74.6	149.2
	Avg		38.72	26.48	32.6
SSP	No. of growers	No. (%)	24 (46.15)	39 (78)	63 (61.76)
	Mini	Kg	15	17.90	15
	Max		63.4	89.52	89.52
	Avg		28.57	27.08	27.83
MOP	No. of growers	No. (%)	23 (44.23)	38 (76)	61 (59.8)
	Mini	Kg	11.2	7.46	7.46
	Max		37.3	186.5	186.5
	Avg		19.77	29.69	24.77
DAP	No. of growers	No. (%)	25 (48.08)	4 (8)	29 (28.43)
	Mini	Kg	15	22.38	15
	Max		223.8	67.14	223.8
	Avg		54.31	41.03	47.67
Cow dung	Nos. of grower	No. (%)	18 (34.62)	20 (40)	38 (37.25)
	Mini	Quintal	22.38	15	15
	Max		37.3	30	37.3
	Avg		26.56	20.89	23.87
Use of Weedicide	No. of growers	No. (%)	43 (82.69)	45 (90)	88 (86.27)
	Mini	ML gram	750	750	750
	Max		7500	7500	7500
	Avg		3500	2000	2750
Use of labour in plantation activities (FL+HL)	Mini	Mandays	60	67	60
	Max		276	254	276
	Avg		134	143.5	138.5
Use of labour in tapping	Mini		201.4	201.4	201.4

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and processing (FL+HL)*	Max		604.3	604.3	604.3
	Avg		416.4	398.8	407.6

Note: FL: family labour; HL: hired labour;
*Usually labour used in alternative days for tapping and processing for nine months in a crop season and each tapper could collect latex in 300 trees (approx) in a tapping day that means in 5 *bighas* area in a tapping day.
Source: Field Data and author's calculation.

Generally it is believed that irrigation is not required in rubber plantation. Growers of rubber in the sample villages are completely dependent on natural rainfall. However, irrigating the saplings at least upto 4 years of age is recommended. Only a single grower in Bongaigaon district has used his STW to irrigate occasionally in his planting site. Moreover, although 75 percent rubber growers in Goalpara and 94 percent in Bongaigaon district have electricity connection but no one uses electricity in rubber cultivation.

Sample rubber growers have also applied chemical fertilizers like Urea, SSP, MoP, and DAP and manure, cow dung in varied quantity in their plantation particularly in early age of rubber trees. It is observed that some of them applied one time in a year while others twice in the year. 55.77 percent growers in Goalpara have used 38.72kg Urea per ha in average whereas in Bongaigaon 80 percent growers have applied the same in the quantity of 26.48kg per ha in average. Similarly, 46.15 percent rubber growers in Goalpara have applied SSP by 28.57kg and in Bongaigaon, 78 percent growers applied SSP by 27.08kg in average in a ha. About the use of MoP, 44.23 percent farmers in Goalpara and 76 percent growers in Bongaigaon have applied 19.77kg and about 29.84kg in average per ha respectively. Another variety of fertilizer mainly used by the growers in Goalpara district is DAP, 48.08 percent growers have applied this chemical fertilizer at the rate of 54.3kg per ha and in Bongaigaon district only 8 percent growers have applied the same at 41kg per ha in average. Besides chemical fertilizer, 34.62 percent growers in Goalpara and 40 percent growers in Bongaigaon have applied cow dung in the pits at the time of planting the saplings in the amount of 26.86 quintals and 20.89 quintals per ha on average respectively. From the above data we can come to the conclusion that the growers of Goalpara have consumed more chemical fertilizer and manure in rubber plantation than the growers in Bongaigaon district except in MoP.

Influence of diseases and pests on growth and yield of rubber is profound and therefore timely plant protection operations are warranted to ensure healthy growth and to get economic production of rubber trees (Rubber Grower's Companion, 2016). However, no reliable and sufficient data about the use of pesticides or herbicides in

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rubber plantation could be collected from the respondents in the study area. They have used limes for plant protection and applied 'dusting', spraying pesticides or herbicides at the canopy for leaf protection. Use of weedicide in rubber plantation is becoming popular in Goalpara and Bongaigaon district and its popularity has increased to reduce the labour cost on weed removing. Compared to Goalpara (82.69%) more growers in Bongaigaon (90%) have applied weedicide in rubber plantation.

Rubber plantation is a highly labour intensive where material cost is much lower as compared to labour cost. Labour is required throughout the year for various operations right from land preparation to tapping and processing. During the establishment period of first six years, labour is required for land preparation, lining, pitting, filling and planting, cultural operations, plant protection, fencing, fertilizer application, weed removing, watch and ward, etc. During the tapping period, the main labour oriented operations are tapping, collection and processing of latex. From the field survey it is estimated that in the above mentioned farm activities in rubber plantation excluding tapping and processing total 93.5 mandays is needed in Goalpara and 89.97 mandays in Bongaigaon on average in a hectare in a crop season. However, tapping and latex processing is a regular exercise and growers usually tapped rubber trees either in one day or two days interval. In a single tapping day in an average 12 mandays in Goalpara and 10.5 mandays in Bongaigaon is needed in a hectare. Among different activities of plantation, more labour is used in land preparation and fencing in the rubber site. Compared to Goalpara, use of hired mandays in rubber plantation in Bongaigaon district is more.

6.7.5: Production and Sale of Rubber Crop:

Usually production of latex from rubber tree may vary if sapling is grown from seeds, while uniform production is forecasted if it is grown from budded sapling. Usually from the 7^{th} year to 12^{th} year production of latex is less, 700 to 800 kg per hectare in a year while after 12^{th} year upto 20^{th} year it is about 1.5 MT per ha per year. We observed that growers in Goalpara produce higher output than the growers in Bongaigaon district although average size of rubber tapped area is smaller. Table 6.23 shows the average tapped area, production and yield of rubber among the growers in study area and mode of sale of their produce. Yield as well as production of rubber among the growers in Goalpara is higher than the growers in Bongaigaon. Like winter rice and jute, difference in output of rubber between the districts is accounted by differences in yield. Nath (2009)

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found that a rubber tree can yield 4-5kg per month and 2.5 MT of production per hectares in a month in Goalpara. Sample rubber growers of study area have sold their produce in different modes of market accessible to them. In Goalpara, few registered rubber traders are found very active in procurement of sheet and scrape rubber. Growers are updated with the domestic price of raw rubber in India and they are able to get reasonable price for their produce. No respondent growers have faced any problem to sell their produce. It is observed that growers in Bongaigaon sold their produce at higher price than the farmers in Goalpara. Although some crises in price of natural rubber are prevailing in recent years, growers in the study area are still optimistic about the future of their rubber cultivation.

Table-6.23: Production and Sale of Rubber Crop in Goalpara and Bongaigaon districts:

Sl. No.	Item	Unit	Goalpara	Bongaigaon
1.	Average Tapped Area	Ha	0.56	0.85
2.	Average Production of Rubber	Kg	1277.12	834.80
3.	Average yield of rubber in a crop session	Kg/ha	2054.48	988.90
Mode of Sale				
4.	Traders collected	%	57.70	10
5	Delivered to traders	%	30.76	28
6	Procurement agencies	%	11.54	58
7	Processing units	%	-	04
8	Price	Rs./kg	105.76	111.52

Source: Field Data

6.7.6: Expenditure Incurred and Revenue Earned in Rubber Cultivation:

Rubber is a plantation crop which requires high amount of capital especially during the establishment period. Cash capital is required mainly for making payments to the labourers employed. From the field survey it is found that growers have to incur cash expenses on the purchases of different farm inputs, fencing materials, for payment of labour wages, rent on hired capital or rent on borrowed money, expenses on tapping and processing, selling, etc. Table 6.24 gives an estimation of the average total cost incurred in establishment years, i.e., from 1st year to subsequent five years and annual expenditure on tapping and the total revenue annually expected by farmers in rubber production.

Table-6.24: Estimation of average total expenditure and revenue on cultivation of rubber in Goalpara and Bongaigaon districts: (in Rs./ha)

From the establishment year (from 1st to 6th year) to the 1st year of tapping		
A. Establishment Cost		
Input/Items	Goalpara	Bongaigaon
(i) Bamboo Fencing & boundary drainage (Materials plus Labour) (2 times)*	29725.30	28624.00
(ii) Planting materials (saplings) (1 time)	7417.00	5541.70

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(iii) Fertilizers & Manure (5 times)**	6857.30	4053.10
(iv) Pesticides & Weedicides (6 times)***	2050.75	2601.45
(v) Payment for wage lobour for land preparation, lining and pitting and plating (1 time)	7827.50	7740.60
(vi) Payment for wage lobour for weed removing (3 times)	9000.00	11250.00
(vii) Imputed value of family labour involved in various activities****	68005.35	56636.30
Total Labour Cost (v+vi+vii)	84832.85	75626.90
(viii) Interest on borrowed money (both for fixed and working capital)	40760.00	8692.60
(ix) Imputed interest cost $	14400.00	16800.00
(x) Total Establishment Cost	**186043.20**	**141939.80**
(B) Maintenance Cost		
(i)Fertilizer & Manure and Plant Protection	2246.00	1834.00
(ii)Expenditure on Tapping & Processing (Labour & material) in a year	33818.40	33587.50
(iii) Expenditure on Selling in a year	746.00	-
(iv) Total Maintenance Cost	**36810.40**	**35421.5**
Total Cost/Expenditure upto 1st year of tapping {A (x) + B (iv)}	**222853.60**	**177361.30**
Total Revenue earned at the 1st year of tapping	**217282.20**	**110281.90**
Profit (+)/ Loss (-) at the 1st year of tapping	**(-) 5571.40**	**(-) 67079.40**
From 7th year onwards		
Total Expenditure	**36810.40**	**35421.5**
Total Revenue	**217282.20**	**110281.90**
Total Profit	**180471.80**	**74860.40**

Note: *about 50% of 1st year's cost on bamboo fencing again incurred on 3rd year; ** about 30% of 1st year's cost spent in subsequent years; ***almost equal amount from 2nd year to 6th year, (weedicide used upto 4th year); ****Imputed value of family labour is calculated by taking minimum market wage rate for manual workers prevailing in the study area @200/- multiplied by no. of mandays; Tapping activity is done in each alternative days; Times refers to the no. of years; $ the interest rate is 8% per year.

Source: Field data and author's calculation

Among the different components of cost of cultivation of rubber, highest cost is involved in wages of labour followed by fencing, interest on borrowed money, cost on planting materials, etc. Farmers in Goalpara district pay more interest on borrowed money compared to Bongaigaon district. The total establishment cost is calculated by accounting for all costs in the first six year of farming. The imputed cost of interest is added to it. The rate of interest used for imputation is 8 percent per year, this is the opportunity cost from the point of view of the farmer, since most farmers use their own fund.

In the first year of tapping (the sixth year) there is no profit in either district. This is because the revenue falls short of the total cost, which comprises of establishment cost accumulated over the six years, and the maintenance cost for that year. So on the sixth year there is loss in either district. The loss is higher in Bongaigaon.

From the seventh year onwards, not only is the deficit of the previous year taken care of, there is handsome profit as well. This profit is due to the high revenue flow. Profit is higher in Goalpara (Rs.180472) than in Bongaigaon (Rs.74869). This is because the yield in Goalpara district is more than twice the yield in Bongaigaon (while average

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yield in Goalpara is 2054.48kg; in Bongaigaon it is 988.90kg per hectare). The reason for higher yield could be because of more area of mature plantation and better administrative set up of Goalpara district. We shall confirm this point through statistical method in the next chapter.

6.7.7: Capital Expenditure during the last 5 Years:

Respondents incurred expenses on major farm equipment like tractors, power tiller, etc. more in Goalpara district while investment in minor farm equipments like sprayers, weed remover, tapping equipments, etc. during last 5 years is more in Bongaigaon district. Numbers of growers who purchased and developed rubber land during last 5 years are very small both in Goalpara and Bongaigaon. However, number of growers investing in processing and storage facilities is larger in Goalpara than Bongaigaon. Thus, compared to Bongaigaon growers of Goalpara have invested more on capital goods in aggregate for rubber crop production.

Table-6.25: Capital expenditure in rubber cultivation during the last 5 years in Goalpara and Bongaigaon district:

Item	Goalpara		Bongaigaon	
	% of growers	Average capital expenditure	% of growers	Average capital expenditure
Major farm equipment	21.15	Rs. 35636.40	6	Rs. 48666.67
Minor farm equipments	80.77	Rs. 2548.80	100	Rs. 2307.70
Purchase and development of land	5.77	Rs. 117333.33	8	Rs. 120000.00
Processing and storage facilities	13.45	Rs. 14571.43	8	Rs. 55250.00
Aggregate	94.23	Rs. 35745.92	100	Rs. 25280.00

Source: Field Data

6.7.8: Sources of Finance and Access to Credit for Rubber Cultivation:

From the field survey it is estimated that initially around Rs.52000 per hectare is invested for rubber plantation in the first year of establishment. Self financing is the main way both in fixed and working capital. Farmers have to rely on their own capital and resources for rubber plantation. No grower in the study area accessed credit from any formal sources. However, only 5.77 percent farmers in Goalpara and 6 percent farmers in Bongaigaon have borrowed money from the informal sources at 5 percent rate of interest per month. Subsidies sanctioned by the Rubber Board are the biggest relief for the respondent growers. Although it is not paid in advance or in the establishment year, growers are able to get subsidy at recommended rate in 5 to 6 installments. However, compared to Goalpara (80.77%), lesser number of growers in Bongaigaon (58%) received subsidies. Due to budgetary shortfall Rubber Board has been facing some

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financial constraints to disburse the subsidies to the eligible growers in last couple of year particularly in Bongaigaon district.

6.7.9: Scope of Extension Services and Role of Institutional Support:

Unlike growers of winter rice and jute, growers of rubber in the study area are getting ample assistance in respect of public extension service and support. Growers are getting all kinds of information and suggestions from the Rubber Board, and from the Rubber Producers' Society. The Board provides technical, logistic and financial services to the growers. However, in different aspects of rubber plantation growers have given different responses about public extension services. Among the respondents, 63.46 percent in Goalpara and 64 percent in Bongaigaon have accessed public extension services in overall aspects. Rubber growers have the information about the presence of Field Officer or Development Officer in their locality; in aggregate 82.35 percent growers are aware. Compared to rice and jute growers, extent of participation in different awareness/training/workshop on farming of the sample rubber growers is high. In aggregate, 72.55 percent growers gathered information and 68.63 percent have taken part in farming programmes. More than 90 percent rubber growers in the study area are satisfied with the services and support of Rubber Board and Government agencies in rubber plantation. Table 6.26 highlights the responses of growers in different aspects of extension services received from private and public sources.

Table-6.26: Source wise extension services:

Farm Matters	Unit	Goalpara			Bongaigaon		
	% of growers	Self	Private Extension Services	Public Extension Services	Self	Private Extension Services	Public Extension Services
Advice on crop variety		48	27	25	38	18	44
Fertilizer application		9.62	5.76	84.62	8	20	72
Pesticides & weedicide application		13.85	7.3	78.85	0	28	72
Other farming matters		0	38.46	61.54	0	42	58
Access to market		1.92	94.23	3.85	6	94	0
Knowledge about FO or DO	% of growers	Yes=76.92; No=23.08			Yes=88; No=12		
Consult farm problems		Yes=67.31; No=32.69			Yes=88; No=12		
Meet FO or DO once in a year		38.46			36		
Meet twice or more in the year		28.85			52		
Followed advices of FO or DO		Yes=84.62; No=15.38			Yes=88; No=12		
Met during last six months		28.85			34		
Information on awareness/ training/workshop on farming		65.38			80		
Participated in the programme		61.54			76		
Participation in exhibitions/fairs or any exposure tours		39			23		
Grading performance of Rubber Board		Very Good=3.85;Good=67.31; Satisfactory=19.23; Not satisfactory=9.62			Very Good=4; Good=74; Satisfactory=18; Not satisfactory=4		

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Source: Field Data

Unlike winter rice and jute farmers rubber growers in the study area are more organized and associated in different groups. Rubber planters are also involved in local Farm Management Committee (FMC). Almost equal numbers of growers in two districts or in aggregate 44.12 percent growers are members of different self help groups or non-government organizations (NGOs). In an aggregate 75.5 percent growers in the study area have membership in their local Rubber Producers' Societies (RPS). In Goalpara 67.31 percent respondents and 84 percent respondents in Bongaigaon are attached with RPSs. About the attachment of rubber cultivators in mass media programmes, 50 percent growers in Goalpara listen or watch Radio/TV programmes compared to 42 percent in Bongaigaon district. In the field study, it is found that 64 percent growers in Bongaigaon and 44.23 percent in Goalpara have studied rubber guide books or news bulletin which was rarely found among rice and jute growers. In Goalpara, 96.15 percent and in Bongaigaon 98 percent rubber growers have cell phone.

6.7.10: Brief Review in Problems of Rubber Cultivation:

Inadequate supply of quality planting materials from public agencies, complete dependence on rainfall, long gestation period, etc. are some of the problems commonly raised by the rubber growers in the study area. Rain guarding or polythin protection material used in patting the tree can increase yield; otherwise tapping may be stopped during the rainy season and yield loss may result in. But the rate of rain guarding or use of rain coat is very low which causes low yield in latex during rainy days. Growers face the problem of shortage of hired labour or high cost of labour. No rubber growers took bank credit. Pre-matured tapping caused low productivity in rubber production in Goalpara. It is seen that small and marginal growers usually sell their produce to the middlemen. The price offered by the middlemen is about 8 percent lower than the price offered by the traders. Gradually middlemen are becoming active in the trade of rubber sheets and scrape rubber. There is no recommended minimum support price for the growers and prices in natural rubber in recent time is declining. Wind, elephant attack (upto 6/7 years of age of the plant), weed, storm, cattle grazing, detaching the main root in budded wood sapling, rat attack, fire, fungus attack, etc. are main enemies of rubber plantation. About 30 to 35 rubber trees are damaged per year in a hectare but their

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replacement is poor. Growers are not aware about insurance schemes of the rubber plantation. Moreover, there is no clear cut government policy on rubber plantation. State Forest Department obstructs the growth of rubber plantation in Goalpara district from time to time. Now-a-days growers have to face 3 tier surveys from Revenue Department, Forest Department and Rubber Board for sanction of subsidy which makes the process clumsy.

6.8: Conclusion:

The economy of Goalpara and Bongaigaon districts is basically agrarian. Poor infrastructure/administration of the district and insufficient use of factors of production may have caused low yield. The field survey on growers of winter rice, jute and rubber that has been undertaken in Goalpara and Bongaigaon districts seems to bear this out, but this needs to be confirmed through econometric exercise. Some exceptions are observed particularly in rubber plantation. The average sizes of winter rice holdings are smaller than the state average. In aggregate, 71.2 percent respondents are marginal and 22.29 percent are small growers among respondents. Land size in traditional variety of winter rice is bigger than modern variety and land size in rubber plantation is bigger than other select crops in the sample. Pure cultivating owners are more in Goalpara than in Bongaigaon. Tenancy practice in Goalpara is less. Among different forms of tenancy practices, share cropping and yearly fixed money rent are dominating. Cropping intensity in both the districts is higher than the state average. While area under HYV of winter rice and extent of irrigated land in total cropped area in Goalpara is more than Bongaigaon district, reverse the situation in consumption of fertilizer. The existence of canal, tank, DTW (deep tube well) and medium and major irrigation system is almost nil or negligible in the sample villages. Use of Urea and SSP is prevalent and it is perhaps because of low price. In sowing and transplanting activity of winter rice growers have engaged women labourers because the wage rate of women laboureres are relatively lesser than the male counterpart. The cost of sowing is comparatively less than other activities of cultivation in the sample villages. Informal sources of credit have been playing a vital role for rural people. There is a big difference in target fixed, number sponsored and sanction made in formal credit. Extension services in the sample villages are suffering by shortage of staff strength as well as infrastructure. Officially VLEWs should visit a village fortnightly and ADOs once in a month. But in practice growers

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meet them in field only occasionally. In different farm related problems fellow growers and other private agencies have played important role. Participation of the growers in different government programmes like awareness/training/workshop on farming is very poor.

It is observed that rice growers of Goalpara district produce more than the output produced by the growers in Bongaigaon district and it is because of higher yield. However, cost of cultivation of winter rice, both traditional and modern verities is higher in Goalpara than in Bongaigaon.

The Muslim community in the sample area is still dominating jute cultivation in these two districts. Jute farmers are less educated than paddy and rubber growers and illiterate growers are more in Bongaigaon compared to Goalpara district. Almost all the sample jute growers are marginal farmers. Contrary to winter rice, tenancy practices in jute cultivation are more in Goalpara than in Bongaigaon. Average size of jute land is bigger and more fragmented in Goalpara than in Bongaigaon. Rise in price of jute seeds in every crop season, untimely and inadequate distribution of free seeds, labour shortage and higher wage of labour create problems for jute cultivation. As in winter rice, yield as well as production of jute among the growers in Goalpara is higher than the growers in Bongaigaon. The good thing is that growers did not face any problem to sell their produce or in terms of the price of raw jute that they received. Considering total expenditure incurred in cultivation and revenue earned by sale of jute, growers can earn more than three times profit in jute cultivation than in paddy cultivation per acre. Although most of the growers bear expenses from self finance on jute cultivation, fellow farmers and informal sources are significant for credit as in winter rice. Role of the public extension services in jute cultivation is not satisfactory. Availability of alternative crops like paddy, maize, vegetables, etc. has reduced jute lands and early harvesting is causing low yield in jute.

The potential of rubber plantation in the state can be realized by expansion of its cultivation in Goalpara and Bongaigaon districts. Its cultivation is concentrated in tribal and the backward class (OBC) people. 62.85 percent sample growers are marginal farmers and they possess 62.85 percent of total rubber tapped area. Growers of rubber crop have more education than the growers of rice and jute. Unlike rice and jute, there is no pure tenant in rubber cultivation among the respondents in Goalpara. In aggregate, 99

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percent respondents of rubber plantation have their own cultivable rubber land with average size of 1.14 hectares. Growers in Bongaigaon have not only larger plantation site with less fragmentation but also have bigger tapped area than the growers in Goalpara. However, the yield in Bongaigaon is lower compared to Goalpara.

Growers followed the prescribed instructions in its cultivation, use of farm inputs and its processing. Labour is required throughout the year. Growers in Goalpara have produced higher output with higher yield than the growers in Bongaigaon as in winter rice and jute although average size of rubber tapped area in Bongaigaon is bigger. This is perhaps because of the older age of rubber plantations in Goalpara (rubber plantation have been popularized in Goalpra district from early eighties while in Bongaigaon it got momentum since middle of nineties, according to the sample growers), applying more chemical fertilizer and manure and a better administrative set up. Growers are updated with the domestic price of raw rubber in India and they get reasonable price for their produce, although deduction of commission by middlemen has been a problem. After deducting material cost and depreciation of fixed assets from the gross value of output, the profit from rubber plantation is found to be higher than rice or jute cultivation. No grower in the study area accessed credit for rubber plantation from any formal sources. Although subsidy sanctioned by the Rubber Board is the biggest support, growers can avail it after 3-4 years of start of plantation. The public extension services in rubber plantation are encouraging contrary to winter rice and jute. Unlike winter rice and jute farmers rubber growers are more organized and associated and took part in different awareness/training/workshop. In spite of different shortcomings confronted in rubber cultivation in recent time, growers believe rubber plantation is a profitable and promising cultivation.

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Chapter-VII: Estimation of Production Functions and Technical Inefficiency:

This chapter intends to fulfill the second and third objectives of the study, the estimation of the production functions of crops (allowing for stochastic technical inefficiency). Thus, we address research questions 2 and 3 that are stated below:

"What are the underlying production functions of these three crops?" and

"What are the estimates of production functions if technical inefficiency is accounted for? Does technical inefficiency exist?"

To address these research questions, we estimate the production functions of rice (traditional and modern varieties), jute and rubber. To address the research question 2 we estimate the production function using the ordinary least square (OLS) methods. This will be taken up in section 7.2 of this chapter. In section 7.3 we estimate the production functions of the crops using the stochastic frontier (SF) model. In the first case, we assume that there is no technical inefficiency. In the second case, we will be estimating the production functions under the assumption that technical inefficiency could be present. For rice, we analyzed the winter rice (*sali*) data, as noted in the previous chapter.

We will also like to draw attention on a possible inverse relationship between farm size and productivity. In the section 7.1 of the chapter we investigate the relationship between yield of crops and the size of the land holding. This theme has a long literature in the context of analysis of the Indian agriculture (Sen (1962), Mazumdar (1963), Shrivastava, (1996), Despande (1998), etc.). In our study of the performance of Assam agriculture we look into the following question: does an inverse relationship exist between farm size and productivity? This question is important for the following reason. If an inverse relationship is found, the policies will have to be framed accordingly, probably more support to smaller farms can be granted vis-à-vis the large farms as the former are more productive land-wise. Thus, the result of the exercise may have a direct bearing on the study of agricultural performance of the state.

The discussion proceeds below with the data gathered from the two districts of Goalpara and Bongaigaon in western Assam during 2015-16.

7.1: Farm Size and Productivity:

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Part-I: Correlation co-efficient between Farm Size and Yield: We look at the data of each of the four crops, winter rice (Traditional), winter rice (Modern), jute and rubber and estimate the correlation co-efficient between yield and farm size. In table 7.1 the results are reported with the corresponding *p* values.

Table-7.1: Correlation Coefficient of Yield and Farm Size:

Crops	Value of correlation coefficient	*p* values	No. of observations
Winter Rice (Traditional)	-0.0262	0.7242	184
Winter Rice (Modern)	-0.2388	**0.0352**	78
Jute	-0.1368	0.145	115
Rubber	-0.1363	0.172	102

Source: Field Data

There is an inverse relation between farm size and productivity of winter rice (T) as well as winter rice (M) varieties. Estimation shows that per 1 acre land increase is associated with a decrease in yield by (-) 0.0262kg in winter rice (T) and by (-) 0.2388kg in winter rice modern variety. Similar relations have also been observed in jute and rubber crops. However, among these four crops the inverse relation is statistically significant only in winter rice modern variety.

Part-II: Regression of Yield on other factors:

In this section we take into account the possibility that factors other than land size can affect the yield. The factors that we are considering are land size, labour, capital, fertilizer and irrigation. These are considered to be the standard set of inputs which could affect the farm performance.

Labour is measured in terms of mandays. Both hired labour and family labour have been taken into consideration. We have measured capital into two alternative ways. First, capital has been measured as the total amount of money spent on machines, equipment, etc. at the time of purchase. This measurement of capital is denoted by 'Ca'. There is precedence in the existing literature on agricultural economics especially in the context of Assam where this sort of measurement of capital has been used (Bhattacharyya and Mandal (2016); Mazumder and Gupta (2013)).

On the other hand, authors like Siddhu and Baanente (1981) have used a different measurement of capital. Here capital is the annualized flow cost of total expenditure and investment on machines and equipments. We denote this measurement by 'Ct'. We take

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15 percent as the depreciation rate (current depreciation cost in farm sector in India is about15 percent) and 7 percent as the interest cost (usually normal bank rate of interest on term deposit which is around by 7 percent which is the opportunity cost of investing money in machines). Thus, we impute 22 percent on the value of machines and equipment to estimate 'Ct'. While measuring 'Ct' we also include the cost of running the equipment (e. g., payment made to the operator, etc.). We have taken both this measurement of capital. But our preferred measurement is 'Ct' because it takes into account the flow value of capital.

Cost of fertilizer is taken the fourth component which may affect the yield. Finally, proportion of irrigated land is taken the fifth component which may also affect the yield. We estimate equation (1) through OLS method for winter rice with specifications 'Ca' & 'Ct'. The results of winter rice are given in table 7.2.

$y_i = \beta_0 + \beta_1 Ln_i + \beta_2 Lb_i + \beta_3 Ca_i$ (or $\beta_3 Ct_i$) $+ \beta_4 F_i + \beta_5 Ir_i + \varepsilon_i$……...……(1),

where,

y_i=yield of winter rice per acre of the ith household.

Ln_i=land size (in acre) of the ith household.

Lb_i=number of mandays used by the ith household

Ca_i= total amount of money spent on machines, equipments, etc. at the time of purchase by the ith household,

Ct_i = annualized flow cost of total expenditure and investment on machines and equipment by the ith household,

F_i= fertilizer cost by the ith households.

Ir_i = proportion of irrigated land in percentage.

$\varepsilon_i \sim N(0, \sigma^2)$ i.i.d.

Diagnostic Tests:

Before we estimate the model (1) through the OLS method we need to make sure that the data we are using satisfy the assumptions of the OLS method. These assumptions are, (1) the error terms should have the same variance, that is, homoscedasticity assumption has to be satisfied, (2) the regressors should not be sufficiently interrelated, that is,

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multicollinearity problems should not be there. For each of the OLS estimations in this chapter we have conducted the heteroscedasticity test, the Breusch-Pagan test for heteroscedasticity. When the data displayed heteroscedasticity we have used the appropriate STATA command (vce (robust)), which gives heteroscedasticity-consistent standard errors.

To take care of possible multicollinearity present in the data we have estimated the VIF (variance inflation factor) for each of the regressors. We have eliminated those regressors with more than 4 VIF in an iterated manner. When some regressors are eliminated for particular cases, the regression co-efficient displayed in the table for that regressor is a blank (-). It is true that many explanatory variables we dropped. But this was only because of the technical requirement of avoiding multicollinearity. This is the standard way to understand the relationship between input and output. Existence of multicollinearity between variables doesn't mean that the variables are not important. Never the less in future we shall explore the possibility of using different methods which does not dropped many variables.

Regression Result:

In table 7.2 we present the results of the regression. Here M-1 and M-2 correspond to regression models (1), with M-1 and M-2 corresponding to two alternative measurements of capital Ca and Ct respectively. As depicted in table 7.2 for either traditional or modern variety of rice, the co-efficient of land is negative, but statistically significant for modern variety only. So the inverse relationship between land size and yield does not hold in the case of traditional variety of winter rice. As a comment we can add that for both these crops 'Ct' has a positive and significant impact on yield. In case of traditional variety 'Ca' has a positive and significant impact on yield. For the traditional variety of rice fertilizer has a positive impact on yield. This holds irrespective of how we measure capital. Irrigation has significant but negative impact on yield of modern variety of rice.

Table-7.2: Yield Regression of Winter Rice-Traditional Variety (TV) and Modern Variety (MV)

Variables	Coefficients			
	TV		MV	
	M-1	M-2	M-1	M-2
Land (Ln)	-30.44927	-32.84009	**-152.2732***	**-194.5679***
Labour (Lb)	-	-	-	-
Capital (Ca & Ct)	**0.0009262****	**0.0050575****	0.0039131	**0.0183718***
Fertilizer (F)	**0.0304527*****	**0.0308199*****	0.2599758	0.2583085
Irrigation (Ir)	4.357965	4.240772	-1.718608	**-2.415877****
Constant (C.T.)	**1006.806***	**997.4319***	**1555.607***	**1546.509***

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Note: *: p < 0.01; **: p<0.05; ***: p < 0.1; M-1 and M-2 correspond to Ca and Ct measurements of capital respectively.
Source: Field Data

We estimate equation (2) for jute and equation (3) for rubber through OLS method with specifications 'Ca' & 'Ct'. The results for jute and rubber are given in table 7.3.

$y_i = \beta_0 + \beta_1 Ln_i + \beta_2 Lb_i + \beta_3 Ca_i \text{ (or } \beta_3 Ct_i) + \beta_4 F_i + \beta_5 PW_i + \varepsilon_i$ ……..……..(2)

$y_i = \beta_0 + \beta_1 Ln_i + \beta_2 Lb_i + \beta_3 Ca_i \text{ (or } \beta_3 Ct_i) + \beta_4 F_i + \beta_5 PW_i + \beta_6 PM_i + \varepsilon_i$ ……..…...……..(3), where

yi = yield of jute/rubber per acre/hectare of ith household.

Ln_i = land size (in acre/hectare) of ith household.

Lb_i = number of mandays used by ith household

Ca_i = total amount of money spent on machines, equipment, etc. at the time of purchase by the ith household.

Ct_i = annualized flow cost of total expenditure and investment on machines and equipment by the ith household.

F_i = fertilizer cost by ith households

PW_i = pesticide and weedicide cost by ith households

PM_i = cost on planting materials by the ith households

$\varepsilon_i \sim N(0, \sigma^2)$ i.i.d.

Table-7.3: Yield Regression of Jute and Rubber:

Variables	Coefficients			
	Jute		Rubber	
	M-1	M-2	M-1	M-2
Land (Ln)	-62.87139	-58.7881	**-203.8084***	**-203.9044***
Labour (Lb)	-	-6.520161	-	-
Capital (Ca & Ct)	0.0007178	0.0027509	0.0002684	0.0011968
Planting Material (PM)	-	-	**0.0653953****	**0.0654063****
Fertilizer (F)	0.0096955	0.0123789	0.044589	0.0445933
Pesticides&Weedicides(PW)	-	-	-0.0112951	-0.0112742
Constant (C.T.)	**1198.484***	**1338.084***	**650.1202***	**650.2225***

Note: *: p < 0.01; **: p<0.05; ***: p < 0.1; M-1 and M-2 correspond to Ca and Ct measurements of capital respectively.
Source: Field Data

As depicted in table 7.3 for jute once again the regression co-efficient of land is not significant, although it is negative. Thus, for jute land size does not have any impact on yield. We find for jute capital has a positive impact on yield, so does fertilizer, but it is

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not significant. For rubber crop the co-efficient of land is found to be negative and significant. Therefore, the land size has a negative impact on the yield. Furthermore, planting material has a positive significant influence on the yield and fertilizer has a positive but no significant impact on yield of rubber.

7.2: Estimation of Production Functions:

7.2.1: Introduction:

In this section we will try to estimate the production functions of rice (traditional and modern) as well as, jute and rubber. This will enable us to answer the second research question. We shall assume the Cobb Douglas production function. Cobb Douglas production function is a standard form of production function which is often used for agricultural input and output relation (Aigner and Chu (1968), Russell and Young (1983), Dawson and Lingard (1989), George E. Battese (1991), etc.). We shall be using the OLS method for the estimation of production function.

The regression model of winter rice that we are estimating is given below:

$\ln Yi = \beta_0 + \beta_1 \ln Ln_i + \beta_2 \ln Lb_i + \beta_3 \ln Ca_i$ (or $\beta_3 \ln Ct_i$) $+ \beta_4 \ln Ir_i + \beta_5 \ln F_i + \beta_6 \ln Frag_i + \beta_7 \ln Fam_i + \beta_8 \ln Age_i + d_Edn_i + d_Extn_i + d_Credit_i + d_Ca_i$(or d_Ct_i) $+ d_Ir_i + d_F_i + Loc_i + \varepsilon_i$ ….....(4), where

Y_i = Output of winter rice per acre of the ith household,

Ln_i = Land size (in acre) of the ith household,

Lb_i = Number of mandays used by the ith household,

Ca_i = Total amount of money spent on machines, equipment, etc. at the time of purchase by the ith household,

Ct_i = Annualized flow cost of total expenditure and investment on machines and equipment by the ith household,

Ir_i = Proportion of irrigated land of the ith household,

F_i = Fertilizer cost by the ith households,

$Frag_i$ = No. of winter rice plots of the ith household,

Fam_i = No. of family members in the ith household,

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Age_i = Age of the household head of the ith household,

d_Edn_i = dummy value of primary, matric and higher education of the household head of the ith household,

d_Extn_i = dummy value of extension service received from either private or public by the ith household,

d_Credit_i = dummy value of credit received from either informal or formal sources by the ith household, three categories of no credit, formal credit and informal credit are included,

d_Ca_i (or d_Ct_i) = dummy value of capital (Ca or Ct) used by the ith household,

d_Ir_i = dummy of irrigation use by the ith household,

d_F_i = dummy of fertilizer use by the ith household,

Loc_i = Location of the ith household, 0 = Goalpara, 1= Bongaigaon

$\varepsilon_i \sim N(0, \sigma^2)$ i.i.d.

We have run four regressions. These are denoted as model-I (M-I), model-II (M-II), model-III (M-III) and model-IV (M-IV). In M-I and M-II we have included the usual inputs of production, viz., land, labour, capital, irrigation and fertilizer. As in the previous section, the difference between M-I and M-II is, in M-I, 'Ca' has been taken as the measurement of capital whereas in M-II 'Ct' has been taken as capital.

In contrast, in M-III and M-IV, we have included factors other than the standard technical economic factors which can affect output. These factors are

Fragmentation (Frag): Fragmentation denotes the agriculture plots that a household operates,

Family Size (Fam): Family size denotes the total number of the members of the household,

Age (Age): Age of the head of the household,

Education dummy: Four categories of education have been taken, illiterate (reference category), primary, matriculation and above matriculation (d_primary, d_matric, d_high),

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Extension Services dummy: It is represented by d_expv, d_expb variables denoting private and public extension services. Those who have not received any extension service are the reference category.

Credit dummy: Recipients of credit are denoted by dummy variables d_crinf, d_crfm denoting received of credit from informal and formal sources respectively. Those who did not receive any credit are the reference group.

Dummy for capital: d_Ca and d_Ct denote the dummy variables for two kinds of capital as cited earlier.

Irrigation (Ir): Irrigation is measured by the fraction of the land under all kinds of irrigation operated by the household. d_Ir is the dummy for households who have land under irrigation.

Dummy for fertilizer: d_F denote the dummy variables for fertilizer, if positive 1 otherwise 0.

Location (Loc): We have taken Goalpara as the reference district; Bongaigaon is given the dummy value 1.

7.2.2: Empirical Results:

We estimated the production function of winter rice output in a multiple regression model using the OLS method. First we need to make sure that the model is free from multicollinearity. Multicollinearity is problem that we can run into when we are fitting a regression model with many regressors. It is caused by the inclusion of a variable which is computed from other variables in the data set or repetition of the same kind of variable and an inaccurate use of dummy variable. To address multicollinearity problems we removed those predictors from the model which have high VIF (Variance Inflation Factor). VIF measures the degree of multicollinearity that exists in a regression analysis. The high VIF (more than 4) regressors have been removed in a sequential manner.

We have also done heteroscedasticity test of the model. The violation of homoskedacity is heteroscedasticity, which violates the assumption of "same variance" of the errors terms. The Breusch-Pagan test for heteroscedasticity has been conducted for each set of data. In order to make the estimation consistent with heteroscedasticity

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appropriate statistical methods have been used. For data without heteroscedasticity the usual OLS method has been deployed.

7.2.2.1: Winter Rice (Traditional Variety):

In table 7.4 we reported the empirical results of the estimation of winter rice (T) production function after multicollinearity test and heteroscedasticity tests have been conducted. We have removed those regressors in the model (4) which have a VIF more than the number 4. We have kept the rest of the variables whose results are shown in table 7.4.

As reported in table 7.4, as far as M-I and M-II models are concerned, the variable labour has been dropped due to multicollinearity. In case of model M-III and M-IV more variables have been dropped; these are land, proportion of irrigated land, fertilizer, dummy of irrigation and fertilizer. Capital (Ca and d_Ca) in M-III model has also been dropped due to multicollinearity problem.

Models M-I and M-II:

From table 7.4 we can see that land and fertilizer have a positive and statistically significant impact on output level. The co-efficient of lnLn is close to 1. This means that elasticity of output with respect to land size is near 1. On the other hand the elasticity of output with respect to fertilizer is 0.014 which denotes low although positive response of output to fertilizer. Other inputs do not seem to impact the output level in a significant manner.

Table- 7.4: Output Regression of Winter Rice (T): Aggregate no. of observation= 184

Variables	Coefficients			
	M-I	M-II	M-III	M-IV
Land (lnLn)	**.9838732***	**.9823391***	-	-
Labour (lnLb)	-	-	**0.6795549***	**0.6867912***
Capital (lnCa & lnCt)	-.0017539	.0041322	-	0.0262876
Irrigation proportion (lnIr)	.0107777	.0084784	-	-
Fertilizer (lnF)	**.0142266*****	**.0141381*****	-	-
Fragmentation (lnFrag)			**0.3346477***	**0.3116841***
Family size (lnFam)			0.0138396	0.0105424
Age (lnAge)			-0.0301159	-0.0249276
d_Primary			0.0055471	-0.0033801
d_Matric			-0.0526092	-0.0712222
d_High			-0.0688019	-0.0913134
d_Expv			-0.0254735	-0.0219442
d_Expb			-0.0637178	-0.0495606
d_Crinf			-0.0778271	-0.0892047

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d-Crfm			-0.1124427	-0.1368803
d_Ca & d_Ct			-	-0.0315091
d_Ir			-	-
d_F			-	-
Location (Loc)	-.0490246	-.0510625	-.0497775	-0.0449911
-cons	**6.866291***	**6.824564***	**4.767302***	**4.577075***

*: p < 0.01; **: p<0.05; ***: p < 0.1
Source: Author's estimates based on field sample data

Model-III and Model-IV:

For models III & IV we can see that labour is significant and positively related to the output of winter rice. Fertilizer does not have any significant influence in output level any more. Paradoxically, we find that fragmentation increases the level of output. The value of the co-efficient of fragmentation is low. But why does increasing fragmentation increase the output is an interesting question. Perhaps smaller land plots leads to greater intensification of use of inputs resulting in greater output level. We shall obtain similar positive impact of fragmentation in case of some other crops, as shall be reported in the coming sections. Hence it can be concluded that this positive impact of fragmentation in case of winter rice traditional variety is not an aberration. Rest of the explanatory variables does not impact output level significantly.

We have estimated production functions of winter rice (T) for the districts separately also, which is reported in the appendix Tables VII.1 & VII.2.

7.2.2.2: Winter Rice (Modern Variety):

The estimation of production function of winter rice (M) output in a multiple regression model using the OLS method with multicollinearity test has been conducted and its results are reported in table 7.5. In the table 7.5 we find that variable labour in models M-I and M-II has been dropped like in the case of traditional winter rice due to multicollinearity. In models M-III and M-IV, labour, irrigation proportion, fertilizer, dummy of capital (d_Ca), irrigation (d_Ir), and education (d_primary) have been dropped. Moreover, capital (lnCa) in model M-III has been dropped from the estimation due to multicollinearity problems.

Model-I and Model-II:

From table 7.5 we can see that land (for both M-I and M-II specifications) and capital (for M-I specification) have a positive and statistically significant impact on output level.

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Irrigation (both in M-I and M-II) is statistically significant but it has a negative effect. This is a curious result; we shall examine the issue later. The co-efficient of lnLn that is log of land is close to 1. On the other hand the elasticity of output with respect to capital is 0.026 for M-I. This denotes low although positive response of output to capital. Other inputs do not seem to impact the output level in a significant manner.

Table-7.5: Output Regression of Winter Rice (M): Aggregate no. of observations = 78

Variables	Coefficients			
	M-I	M-II	M-III	M-IV
Land (lnLn)	**.855689***	**.8518587***	**.857257***	**.8515017***
Labour (lnLb)	-	-	-	-
Capital (lnCa & lnCt)	**.0260271****	.0565684	-	.0077283
Irrigation proportion (lnIr)	**-.0434837****	**-.0425598****	-	-
Fertilizer (lnF)	.0214962	.0289867	**.1016482*****	**.1019563*****
d_Ca			-	-
d_Ir			-	-
d_F			-.3376498	-.3334082
Fragmentation (lnFrag)			.0277992	.0275518
Family size (lnFam)			-.0652574	-.0611262
Age (lnAge)			.0560279	0.0612381
d_Primary			0	0
d_Matric			-.055418	-.0546412
d_High			-0.1153456	-.1154883
d_Expv			-.1496056	-.150885
d_Expb			.2053421	.2029099
d_Crinf			.1740064	**.1741973*****
d-Crfm			-.0955576	-.093123
Location (Loc)	**-.2327602****	**-.1881243*****	-.004061	-.0013198
-cons	**7.180401 ***	**6.813249***	**6.909476***	**6.808761***

*: p < 0.01; **: p<0.05; ***: p <0.
Source: Calculated from field data

Model-III and Model-IV:

For models M-III & M-IV we can see that land continues to impact the output level positively, with the elasticity close to 0.85. Fertilizer has a positive and statistically significant impact on output level at 90 percent level of confidence. The estimated elasticity is close to 0.10. In M-IV, farmers who use informal credit tend to produce more output compared to farmers who have not taken any credit, formal or informal. The elasticity is 0.17. Rest of the explanatory variables does not seem to impact output level. Individual districts results are included in the appendix Table VII.3 & VII.4.

7.2.2.3: Jute:

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Since the proportion of irrigated land in jute cultivation is negligible, we have not taken irrigation input for jute cultivation unlike paddy. The regression model of jute that we are estimating is given below:

$\ln Yi = \beta_0 + \beta_1 \ln Ln_i + \beta_2 \ln Lb_i + \beta_3 \ln Ca_i$ (or $\beta_3 \ln Ct_i$) + $\beta_4 \ln F_i + \beta_5 \ln PW_i + \beta_6 \ln Frag_i + \beta_7 \ln Fam_i + \beta_8 \ln Age_i + d_Edn_i + d_Extn_i + d_Credit_i + d_Ca_i$ (or d_Ct_i) + $d_F_i + d_PW_i + Loc_i + \varepsilon i$…….....(5), where

Y_i = Output of jute per acre of the ith household,

Ln_i = Land size (in acre) of the ith household,

Lb_i = Number of mandays used by the ith household,

Ca_i = Total amount of money spent on machines, equipment, etc. at the time of purchase by the ith household,

Ct_i = Annualized flow cost of total expenditure and investment on machines and equipment by the ith household,

F_i = Fertilizer cost of the ith households,

PW_i = Pesticides and weedicides cost of the ith households,

$Frag_i$ = No. of jute plots of the ith household,

Fam_i = No. of family members in the ith household,

Age_i = Age of the household head of the ith household,

d_Edn_i = dummy value of education-primary, matric and high of the household head of the ith household,

d_Extn_i = dummy value of extension service received from either private or public by the ith household,

d_Credit_i = dummy value of credit received from either informal or formal sources by the ith household,

d_Ca_i (or d_Ct_i) = dummy value of capital (Ca or Ct) used by the ith household,

d_F_i = dummy of fertilizer use by the ith household,

d_PW_i = dummy value of pesticides and weedicides of the ith household,

Loc_i = Location of the ith household,

$\varepsilon_i \sim N(0, \sigma^2)$ i.i.d.

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Interpretation of the factors (other than PW) influencing output level of jute used in the regression model are same as cited earlier. We have included the pesticides and weedicides (PW) as an additional input of production. Here also we have run four regression models M-I, M-II, M-III and M-IV as in winter rice. Their differences are like before. In the first two only traditional economic variables are included, whereas in the latter two social, educational, locational and other aspects are added.

Model-I and Model-II:

The estimation of production function of jute output in a multiple regression model has been conducted after dropping the variables with has multicollinearity problems. The results have been reported in table 7.6. Land is the only regressor which has a significant impact on output. The elasticity of land is positive and high, close to 1. Thus, a 1 percent rise in land leads to 1 percent rise in jute output.

Table-7.6: Output Regression of Jute: Aggregate: No. of observations = 115

Variables	Coefficients			
	M-I	M-II	M-III	M-IV
Land (lnLn)	**.9731796***	**.9771889***	**1.014433***	**1.013304***
Labour (lnLb)	-.1250164	-.1129666	-0.2124131	-.1498271
Capital (lnCa & lnCt)	.0041406	.0290899	-	0.021054
Fertilizer (lnF)	.0088474	.0059042	-	-
Pesticides & Weedicides (lnPW)	-.0096058	-.0100436	-	-
d_Ca & d_Ct			-	-
d_F			-	-
d_PW			-	-
Family size (lnFam)			0.0331578	.0189979
Age (lnAge)			0.0571083	.0090987
Fragmentation (lnFrag)			-0.0902258	-.1047535
d_Primary			0.0790558	-
d_Matric			-.0878198	-
d_High			.1247354	-
d_Expv			**-.151497****	-
d_Expb			-	**.1311857*** **
d_Crinf			0.1165497	.1115497
d-Crfm			0.033696	.0513723
Location (Loc)	.090034	.0901792	**0.1256793*****	.1163499
-cons	**7.312927***	**7.111918***	**7.434331***	**7.174364***

*: p < 0.01; **: p<0.05; ***: p <0.1
Source: Calculated from field data

Model-III and Model-IV:

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As in models M-I and M-II, for models M-III & M-IV we can also see that land size continues to impact the output level positively. The value of input elasticity is more than 1. Thus, a 1 percent increase in land area raises output of jute by more than 1 percent. For M-III location is important. The co-efficient is 0.13. Thus, a farmer in Bongaigaon produces 13 percent more jute than a similar farmer in Goalpara district. The impact on private extension is paradoxically negative. Compared to a farmer who has not taken any extension service, a farmer taking private extension services produces less. How can we interpret this result? Many a time farmers get advices from traders and money lenders, and they rely on them. However, the traders or money lenders may not find it in their best interest to give prudent advices to farmers. Or, inadvertently, the advices themselves may be doing more harm than good. This difference of two parties could be a reason for this negativity.

In M-IV, aside from land, public extension services affect output. The co-efficient is a decent 0.14. This is on the expected lines.

Other explanatory variables do not seem to impact output level. We have estimated production functions of jute for the districts separately also which are reported in the appendix Table VII.5 & VII.6.

7.2.2.4: Rubber:

As in jute, since the proportion of irrigated land in rubber plantation is negligible, we have not taken irrigation proportion in the estimation. All the growers use capital and planting materials in rubber plantation, thus no need to take any dummy value on capital and planting materials. The regression model of rubber that we are estimating is given below:

$\ln Yi = \beta_0 + \beta_1 \ln Ln_i + \beta_2 \ln Lb_i + \beta_3 \ln Ca_i$ (or $\beta_3 \ln Ct_i$) $+ \beta_4 \ln F_i + \beta_5 \ln PW_i + \beta_6 \ln PM_i + \beta_7 \ln Frag_i + \beta_8 \ln Fam_i + \beta_9 \ln Age_i + d_Edn_i + d_Extn_i + d_Credit_i + d_F + d_PW + Loc + \varepsilon i$…….....(6), where

Y_i = Output of rubber per hectare of the ith household,

Ln_i = Land size (in ha) of the ith household,

Lb_i = Number of mandays used by the ith household,

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Ca_i = Total amount of money spent on machines, equipments, etc. at the time of purchase by the ith household,

Ct_i = Annualized flow cost of total expenditure and investment on machines and equipments by the ith household,

F_i = Fertilizer cost of the ith households,

PW_i = Pesticides and weedicides cost of the ith households,

PM_i = Planting materials cost of the ith households,

$Frag_i$ = No. of rubber plots of the ith household,

Fam_i = No. of family members in the ith household,

Age_i = Age of the household head of the ith household,

d_Edn_i = dummy value of education-primary, matric and high of the household head of the ith household,

d_Extn_i = dummy value of extension service received from either private or public by the ith household,

d_Credit_i = dummy value of credit received from either informal or formal sources by the ith household,

d_Ca_i (or d_Ct_i) = dummy value of capital (Ca or Ct) used by the ith household,

d_F_i = dummy of fertilizer use by the ith household,

d_PW_i = dummy value of pesticides and weedicides of the ith household,

Loc_i = Location of the ith household,

$\varepsilon_i \sim N(0, \sigma^2)$ i.i.d.

Interpretation of the factors other than PM influencing output of rubber used in the regression model is same as cited in jute. We have included the planting materials (PM) as additional input of production. Here also we have run four regression models M-I, M-II, M-III and M-IV as in rice and jute. The interpretation and difference of these four distinct models are as before.

Model-I and Model-II:

In the estimation of production function of rubber output in a multiple regression model using the OLS method has been conducted. Table 7.7 reports the empirical results of the estimation of rubber. Here in M-I and M-II models, land size has been dropped due to

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collinearity problem. Labour has a positive impact on output level and it is statistically significant. Interestingly location is found to be statistically significant in both M-I and M-II models. The farmers in district Bongaigaon fare worse compared to those of Goalpara. The magnitude of the difference is quite high: 0.78.

Table-7.7: Output Regression of Rubber: Aggregate: No. of observations = 102

Variables	Co-efficients			
	M-I	M-II	M-III	M-IV
Land (lnLn)@	-	-	-	-
Labour (lnLb)	**.9051496***	**.9057883***	**.9858436***	**.9857126***
Capital (lnCa & lnCt)	.0336726	.0281604	.0184834	.015206
Fertilizer (lnF)@	.0122638	.0125806	-	-
Pesticides & Weedicides (lnPW)@	.0294758	.0294076	-	-
Planting Materials (lnPM)@	.0591751	.0582732	-	-
d_F			.1701214	.1729794
d_PW			.0849427	.0834949
d_PM			.3810439	.3803693
Family size (lnFam)			.2204138	.2234232
Age (lnAge)			.2357629	.2336065
Fragmentation (lnFrag)			-.0757598	-.0753493
d_Primary			-.3123555	-.3187814
d_Matric@			-	-
d_High			-.1813935	-.1808048
d_Expv			.0050612	.0044559
d_Expb@			-	-
d_Crinf			.2943838	.2958117
d-Crfm@			-	-
Location (Loc)	**-.7794668***	**-.779227***	**-.7670063***	**-.7669746***
-cons	**2.100703***	**2.194247***	.8592907	.9140734

*: p < 0.01; **: p<0.05; ***: p <0.1chi2 (**1**)= **2.21,2.06, 5.75,5.72**Prob > chi2= **0.1370**,**0.1512, 0.0165,0.0168**
@: dropped due tomulticollinearity problems,
Source: Calculated from field data

Model-III and Model-IV:

In models M-III and M-IV, we confirmed that land size, fertilizer, pesticides and planting materials, dummy of education, public extension services and formal source of credit have collinearity problem and thus dropped from the estimation. Like before, labour and location are statistically significant; the impact of labour has risen while that of location has gone down a little. Districts results of estimation of rubber production are included in the appendix Table VII.7 & VII.8.

7.3: Stochastic Frontier Model Estimation: Measuring the Inefficiency:

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The traditional estimator like OLS does not account for technical inefficiency (TE) of production. But in reality inefficiency of production could be present for various reasons such as managerial wrong decisions. Different authors have applied stochastic frontier production function estimation for the simultaneous estimation of production function and technical inefficiency in farm production (Aigner et. al., 1977; Meeusen and Broech, 1977; Battese, 1991; etc.).

Theory of Stochastic Frontier Analysis:

Stochastic frontier approach has found wide acceptance within the agricultural economics literature because of its consistency with the theory, usefulness and relative ease of estimation. The model has been applied in a considerable number of empirical studies in agricultural economics in many developed and developing countries.

Aigner et al., (1977) and Meeusen and Broech (1977) developed stochastic frontier model that assume that the output of a firm is a function of a set of inputs, inefficiency and random error. A general stochastic production function with a single output is given by:

$y_i = f(x_i; \beta).\exp(\varepsilon_i)$, ...(7)

$\varepsilon_i = v_i - u_i$.....(8)

where, y is output, x is a set of inputs, β is a set of parameters to be estimated and i denote producers. ε_i is a compound error term consisting of two elements, v_i and u_i. The term v_i is a two-sided ($-\infty < v_i < \infty$) normally distributed random error [$v \sim N(0, \sigma_v^2)$] that represents the stochastic effects outside the farmer's control (e.g., weather, natural disasters, and luck), measurement errors, and other statistical noise. The term u_i is non-negative random error, independently and identically distributed as $N^+(0, \sigma_v^2)$ that represents the inefficiency effects of the farm. The technical efficiency of a farmer is between zero and one and is inversely related to the level of technical inefficiency effects. The u_i is zero when the farm produces the potential output (full TE) and is greater than zero when production is below the frontier (less than full TE). If the farm is efficient (inefficient), the actual output produced is equal to (less than) the potential output. Technical inefficiency is regressed on a set of farm specific factors or characteristics or exogenous factors (such as age and level of education of the farmers, farm size, access to credit, etc.) which may explain inter-farm variation in technical inefficiency. These

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factors typically are not inputs but may affect the way inputs are organized in production (Mazumder and Gupta, 2013). So, the technical efficiency of production of a given firm is the ratio of actual output or observed output Y_i to potential output or corresponding frontier output, given the levels of inputs used by that firm and it is estimated as:

$TE_i = Y_i/Y_i^*$ i.e.,……..(9)

$TE_i = f(x_i;\beta) \exp(v_i - u_i)/f(x_i;\beta) \exp(v_i)$……..(10)

$= \exp(-u_i)$

Where Y_i is the observed farm output and Y_i^* is the maximum possible output using the given level of inputs.

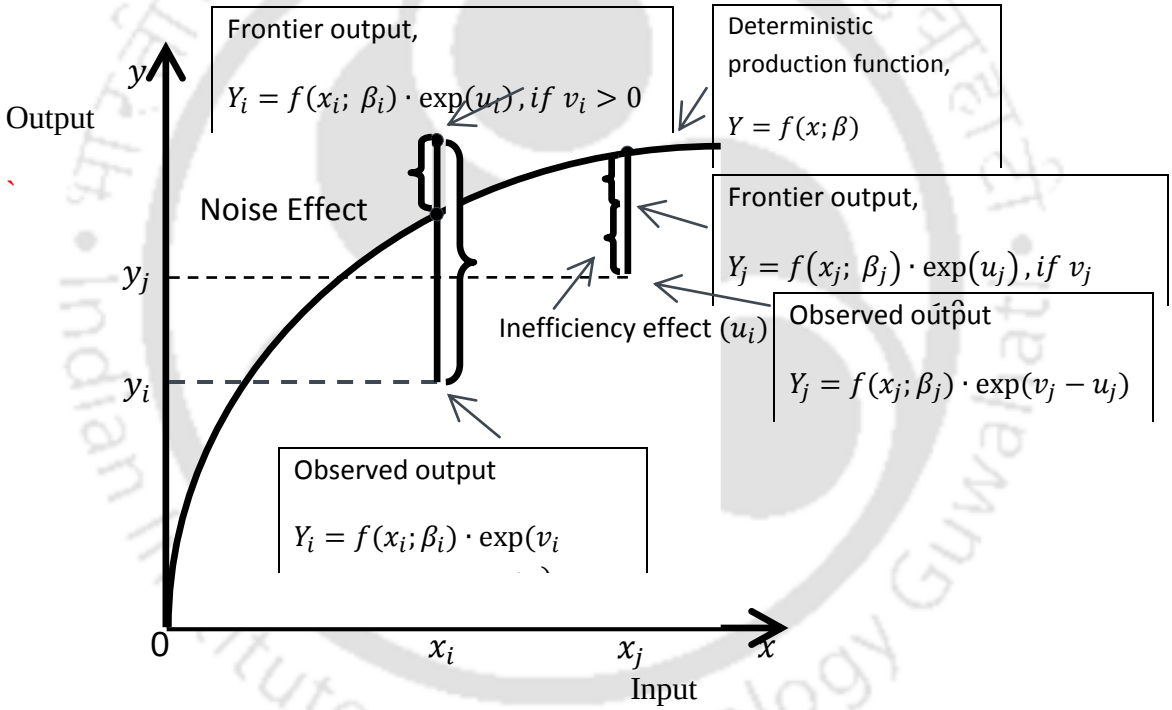

Fig. 7.1: Illustration of Stochastic Frontier Analysis (*Source*: Hong (2016))

The basic structure of the stochastic frontier model is illustrated in fig.7.1 in which the productive activities of two producers (*i* and *j*) are considered for illustration. Producer *i* use inputs x_i and produces output Y_i. If productive activity is associated with favourable conditions for which the random error v_i is positive, and had been utilizing the inputs in an efficient way ($u_i = 0$), production would have been $Y_i = [f(x_i;\ \beta).\exp(v_i)]$, which lies above the deterministic frontier $f(x;\ \beta)$. However, producer *i* is not utilizing inputs efficiently, hence production is y_i, which is below the deterministic frontier.

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On the other hand, producer *j* is producing output Y_j using inputs x_j which is less than the value on the deterministic frontier $Y = [f(x;\beta)]$ because its productive activities are associated with unfavourable conditions, for which the random error is negative ($v_j<0$). In addition, producer *j* is not utilizing its inputs efficiently ($u_j \geq 0$). Observed production is Y_j which is given by $f(x_i; \beta).\exp(v_i - u_i)$ and reflects both random error and inefficiency.

In both the cases, the observed production values are less than the corresponding frontier output values, and the frontier production values lie below or above the deterministic production function. Thus, the frontier itself is stochastic because of the presence of the '*exp (v)*' stochastic component in the function $[f(x;\beta).\exp(v)]$, observed outputs lie below the deterministic frontier in both cases presented here, and there is possibility that the observed output lies above the deterministic frontier $[f(x; \beta)]$ if $v_i > u_i$ (Hong, 2016).

7.3.1: Model Specification:

For empirical analysis, a Cobb Douglas production function is taken. We thus maintain consistency with the previous section, where Cobb Douglas production functions were considered. The model is specified as given below:

$\ln Y_i = \beta_0 + \sum \beta_i \ln X_i + v_i - u_i$ ……..(11),

where,

i refer to the ith farm households; ln represents the natural logarithm,

Y_i represents the output of crops in cropping season 2016 in kg,

$X_{i's}$ represent the vector inputs used,

v_i *and* u_i are the random disturbance terms defined above.

To maintain consistency, in (11) for each crop we have maintained the same set of explanatory variables which were taken into consideration in the earlier section 7.2. The maximum livelihood estimates for all the parameters of the stochastic frontier and

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inefficiency model by equation (7) and (8) are simultaneously obtained by using the programme STATA, version 8.2.[63]

7.3.2: Empirical Results - Winter Rice:

We specify a cross-sectional stochastic production frontier model for winter rice production using a generalized production frontier framework. Let i=1,……N, be the number of farm households. Assume that the relationship between inputs and the output norm is represented by a Cobb-Douglas production function and the generalized stochastic production model.

The vector of inputs in production function includes land size (Ln) in acre, number of total labour (Lb) in mandays, total amount of money spent on machines, equipment, etc. at the time of purchase (Ca) in rupees, annualized flow cost of total expenditure and investment on machines and equipments (Ct) in rupees, expenditure on fertilizer (F) in rupees and proportion of irrigated land (Ir) in percentage area. Many sample farmers do not use capital, fertilizers and irrigation, leading to zero values of these inputs for a considerable number of observations. In this regard, we introduce dummy variables to deal with zero values for these inputs. Acre has been kept as the unit of cultivated area. Thus, our production model of winter rice to be estimated becomes:

$$\ln Y_i = \beta_0 + \beta_1 \ln Ln_i + \beta_2 \ln Lb_i + \beta_3 \ln Ca_i \text{ (or } \beta_3 \ln Ct_i) + \beta_4 \ln Ir_i + \beta_5 \ln F_i + \beta_6 d_Ca_i \text{ (or } \beta_6 d_Ct_i) + \beta_7 d_F_i + \beta_8 d_Ir_i + v_i - u_i \quad \ldots\ldots (12)$$

Winter Rice (Traditional Variety):

The estimated results of the stochastic production frontier model of winter rice (T) are presented in the following section.

Model-I and Model-II:

Land and labour in M-I and labour in M-II are dropped due to multicollinearity problem. In M-I capital and fertilizer have a positive impact, whereas in M-II land and fertilizer have positive impact on rice output.

[63]The method of maximum likelihood is proposed for simultaneous estimation of the parameters of the stochastic frontier and the model for the technical inefficiency effects. The likelihood function is expressed in terms of the variance parameters, $\sigma^2_s \equiv \sigma^2_y + \sigma^2$ and $y \equiv \sigma^2 / \sigma^2_s$ (Battese and Coelli, 1995).

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Table-7.8: CD (stochastic frontier) production function of Winter Rice (T): Aggregate No. of observations =184

Variables	Co-efficients			
	M-I	M-II	M-III	M-IV
Land (lnLn)@	**-**	**.9823389***	-	-
Labour (lnLb)@	-	-	**.6795549***	**.6867912***
Capital (Ca & Ct)@	**.0345353*****	.0041322	-	.0262876
Irrigation proportion (lnIr)@	-.0013247	.0084783	-	-
Fertilizer (lnF)@	**.039185****	**.0141382****	-	-
Fragmentation (lnFrag)			**.3346477***	**.311684***
Family size (lnFam)			.0138396	.0105419
Age of H/H (lnAge)			-.030116	-.02493
d_Primary			.0055472	-.0033799
d_Matric			-.0526092	-.0712223
d_High			-.0688019	-.0913137
d_Expv			-.0254736	-.0219451
d_Expb			-.0637179	-.0495616
d_Crinf			-.0778271	-.0892047
d_Crfm			-.1124427	**-.1368804*****
Location (Loc)	-.0484957	-.0510623	-.0497775	-.0449912
d_Ca & d_Ct@			-	-.0315094
d_Ir@			-	-
d-F@			-	-
Constant	**8.203744***	**6.826069***	**4.769493***	**4.581756***
μ	1.262361	-.0557485	-.1636805	-.0856024
lnsigma2	-.1189415	**-2.008655***	**-1.71526***	**-1.730223***
Ilgtgamma	.817853	-7.306478	-6.180498	-5.987785
Sigma2	.8878597	.134169	.1799169	.1772448
Gamma	.6937804	.0006707	.0020651	.0025029
Sigma_u2	.6159797	.00009	.0003716	.0004436
Sigma_v2	.27188	.134079	.1795453	.1768012

H0: No inefficiency component: z = -0.560, 2.622, 1.976, 1.395prob<=z=0.288, 0.996, 0.976,0.918
Notes: *: p < 0.01; **: p<0.05; ***: p < 0.1; @=dropped due to multicolinearity problems

Source: Calculated from field data

Model-III and Model-IV:

For model-III and model-IV in estimation in table 7.8, we find that land, capital (Ca), irrigation proportion, fertilizer and dummy of capital, irrigation and fertilizer have multicollinearity problems and thus dropped from the estimation. Labour use and fragmentation of rice plots have positive elasticity and these are statistically significant. Increasing fragmentation of holding increasing the output is a result we obtained earlier also, perhaps smaller land plots leads to greater intensification of use of inputs resulting in greater output level. We find that as land fragmentation increases by one percent, output increases by 0.33 percent. Effect of fragmentation was investigated by Parikh and Shah (1994), Rahman and Rahman (2008), Bhattacharyya and Mandal (2016) before.

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Co-efficient of labour is positive and statistically significant. The co-efficient of formal credit is significant but negative which is somewhat unexpected.

We also tested for the presence of technical inefficiency for each of the four models. The *p*-values are found to be high, as reported in the bottom of table 7.8. The null hypothesis of absence of technical inefficiency is accepted. Thus, the level of technical inefficiency is not statistically significant for winter rice (T) production in the study area. Districts results of estimation of winter rice (T) production are included in the appendix Table VII.9 & VII.10.

Winter Rice (Modern Variety):

While trying to estimate the production of modern variety rice with the possibility of technical inefficiency, we found, the convergence of the MLE was not achieved. So far we assumed that the inefficiency error terms (u_i) are distributed in a truncated normal distribution, with the truncation taking place at zero, and a positive mean. According to Meesters (2014) a reason for the non-convergence could be that the underlying distribution is exponential, instead of truncated normal. We proceeded with the exponential distribution assumption of the disturbance terms. The estimated results of the stochastic production frontier model of Winter Rice (M) are presented in table 7.9.

Model-I and Model-II:

From table 7.9, we see that land and labour are dropped due to collinearity problem in M-I. In M-II only labour is dropped. In M-I, capital, irrigation are statistically significant while in M-II, land, capital, irrigation fertilizer, location are significant. Irrigation strangely affects output negatively. This perhaps indicates overuse of groundwater, which is not unexpected since modern variety of rice tends to attract high degree of irrigation. In the modern variety of rice production Goalpara has an edge, as can be seen by the negative location co-efficient.

Table-7.9: CD (stochastic frontier) production function of Winter Rice (M): Aggregate No. of observation = 78

Variables	Coefficients			
	M-I	M-II	M-III	M-IV
Land (lnLn)	-	**.9203129***	**.9219782***	**.9026539***
Labour (lnLb)	-	-	-	-
Capital (lnCa &lnCt)	**.0932763***	**.0565408*****	-	.028139
Irrigation proportion (lnIr)	**-.0707602****	**-.0367034***	-	-
Fertilizer (lnF)	-.0439174	**.0496786****	**.1260869***	**.1264564***

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Fragmentation (lnFrag)			.022586	.0226391
Family size (lnFam)			-.0792353	-.0597804
Age of H/H (lnAge)			.0231115	.0398856
d_Primary			-	-
d_Matric			-.0311874	-.027236
d_High			-.1053	-.1125252
d_Expv			-.0620922	-.0744768
d_Expb			**.2209361****	**.2068053*****
d_Crinf			.1101023	.1081647
d_Crfm			-.11012	-.105081
Location(Loc)	-.0098936	**-.2249582***	-.0632908	-.0541689
d_Ca & d_Ct			-	-
d_Ir			-	-
d_F			-.4415589	.1264564
_cons	**7.05035***	**6.951651***	**7.243051***	**6.887683***
Mu/ lnsig2v	-.0406247	-3.308993*	**-3.478342***	**-3.537543***
/ lnsigma2/lnsig2u	**-.8178518***	-2.756018*	**-2.946281***	**-2.907967***
Ilgtgamma	-5.610837	-	-	-
sigma2/ sigma_v	0.2307516	.1911883	.175666	.1705424
Gamma/ sigma_u	.0036447	.2520799	.2292045	.2336377
sigma_u2/ sigma2	.0016087	.1000973	.0833933	.0836713
sigma_v2/ lambda	.4397701	1.318491	1.304775	1.369969

H0: No inefficiency component: z = 0.090, Prob<=z = 0.536,
Likelihood-ratio test of sigma_u=0: chibar2 (01) = 14.71, 11.64 & 12.34 Prob>=chibar2 = 0.000, 0.000 & 0.000
*: p < 0.01; **: p<0.05; ***: p < 0.1;

Source: Calculated from field data

Model-III and Model-IV:

For models III and IV the results are as follows. Labour use, capital (Ca), and irrigation proportion, dummy variable of education of household head, irrigation and fertilizer are dropped due to multicollinearity problems. Land size, fertilizer use and dummy variable of public extension services are statistically significant in winter rice (M) production function in either specification of capital.

We have tested for the presence of technical inefficiency in each of the four models. The null hypothesis of absence of technical inefficiency is rejected in each of the four models, as evidenced by the low *p*-values reported at the bottom of the table.

We find that the null hypothesis of no inefficiency has been rejected; implying inefficiency does exist in the production of modern variety of rice. Districts results of estimation of winter rice (M) production are included in the appendix Table VII.11 & VII.12.

7.3.3: Empirical Results - Jute:

The proportion of irrigated land in jute cultivation is negligible. Hence we have not taken the proportion of land under irrigation in the models of jute production. We have

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included pesticides and weedicide (PW) value in rupees in case of jute. The jute production model to be estimated becomes:

$InY_i = \beta_0 + \beta_1 \ln Ln_i + \beta_2 \ln Lb_i + \beta_3 \ln Ca_i$ (or $\beta_3 \ln Ct_i$) + $\beta_4 \ln F_i + \beta_5 \ln PW_i + \beta_6$ d_Ca_i (or β_6 d_Ct_i) + β_7 d_F_i + β_8 d_PW_i + $v_i - u_i$……(13)

Model-I and Model-II:

From table 7.10 it is seen that land, labour, capital and pesticides and weedicides are statistically significant in jute output in M-I. While land and labour have positive impact, capital and pesticides and weedicides have negative influences, indicating their overuse perhaps. In M-II in addition to the above fertilizer is found to have positive impact on output. Location is negative, suggesting a better output level in Goalpara.

Table-7.10: CD (stochastic frontier) production function of jute: Aggregate No. of observations = 115

Variables	Co-efficients			
	M-I	M-II	M-III	M-IV
Land (lnLn)	**1.014673***	**.9053551***	**.9103225***	**.8502684***
Labour (lnLb)	**.0875553***	**.1316063***	**.1110106***	**.1154094***
Capital (lnCa & lnCt)@	**-.0272458***	**-.0365393***	-	**.0174727***
Fertilizer (lnF)@	.0109274	**.0124932***	-	-
Pesticides&weedicides(lnPW)@	**-.0153858****	**-.0039185***	-	-
d_Ca & d_Ct@			-	-
d_F@			-	-
d_PW@			-	-
d_Primary@			**-.1827399***	-
d_Matric@			**-.1432519***	-
d_High@			**-.0449978***	-
d_Expv@			**.0999191***	-
d_Expb@			-	**-.1026394***
d_Crinf			**.156597***	**.0627514***
d_Crfm			**.203361***	**.2186793***
Location (Loc)	-.0274688	**-.1518905***	**-.0067996***	**-.1110061***
Age (lnAge)			**-.248278***	**-.2190762***
Famsize (lnFam)			**.0108685***	**-.0613239***
Fragmentation (lnFrag)			**-.0496557***	**.038325***
_cons	**7.286067***	**7.27013***	**7.859395***	**7.802536***
/lnsig2v	-37.19669	-39.87844	-40.79866	-42.44452
/lnsig2u	**-1.223695***	**-1.650164***	**-2.205285***	**-2.11079***
Sigma_v	8.37e-09	2.19e-09	1.38e-09	6.07e-10
sigma_u	.5423479	.4381992	.3319927	.3480549
sigma2	.2941413	.1920185	.1102192	.1211422
Lambda	6.48e+07	2.00e+08	2.40e+08	5.73e+08

Likelihood-ratio test of sigma_u=0: chibar2 (01) = 48.38, 34.02, 85.79, 81.03Prob>=chibar2 = 0.000,0.000, 0.000, 0.000

*: p < 0.01; **: p<0.05; ***: p < 0.1; @=dropped due to multicolinearity problems.

Source: Calculated from field data

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Model-III and Model-IV:

Capital (Ca), fertilizer, pesticides and weedicides and dummy variables of capital, fertilizers, pesticides and weedicides are dropped due to collinearity problems. Land, labour, capital have a significant influence in output level and their co-efficients are positive although for capital and labour the values are relatively low. Credit and fragmentation have a positive impact on the level of output in M-IV. Rest of the regressors seems to impact output level negatively.

We also test for the presence of technical inefficiency in the production model. The null hypothesis of absence of technical inefficiency is rejected. There is statistically significant presence of technical inefficiency in jute production. Districts results of estimation of jute production are included in the appendix Table VII.13 & VII.14.

7.3.4: Empirical Results - Rubber:

The production model of rubber to be estimated is:

$$\ln Y_i = \beta_0 + \beta_1 \ln Ln_i + \beta_2 \ln Lb_i + \beta_3 \ln Ca_i \text{ (or } \beta_3 \ln Ct_i) + \beta_4 \ln F_i + \beta_5 \ln PW_i + \beta_6 \ln PM_i + \beta_7 d_F_i + \beta_8 d_PW_i + v_i - u_i \quad \text{.....(14)}$$

The model of the technical inefficiency distribution of rubber as:

$$u_{i=} \delta_0 + \delta_1 Fam_i + \delta_2 Age_i + \delta_3 d_Edn_i + \delta_4 Frag_i + \delta_5 d_Credit_i + \delta_6 d_Extn_i + \delta_7 Loc_i \text{.....(15)}$$

Model-I and Model-II:

In table 7.11 land has multicollinearity problem and thus dropped. Labour and planting material are positively significant in output level of rubber. Interestingly, location variable has a significant impact on output but its co-efficient is negative as in earlier estimation by OLS method. It implies that differences in location bought about opposite impact in output. Here reference district is Goalpara. Thus, Goalpara has an advantage over Bongaigaon even after all other factors are taken into consideration.

Table-7.11: CD (stochastic frontier) production function of rubber: Aggregate No. of observations =102

Variables	Co-efficients			
	M-1	M-2	M-3	M-4

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Land (lnLn)	-	-	-	-
Labour (lnLb)	**.7502726***	**.7523635***	**.8932992***	**.8950355***
Capital (lnCa & lnCt)	.0237059	.0184268	.0032964	-.0026317
Fertilizer (lnF)	.0262042	.0265374	-	-
Pesticides& weedicides (lnPW)	.0303734	.0302173	-	-
Planting materials (lnPM)	**.0883438***	**.0876031***	-	-
d_F			.1192897	.1193787
d_PM			**.5939531****	**.5909227****
d_PW			.0872116	.0858227
d_Primary			-.155129	-.156239
d_Matric			-	-
d_High			-.0089933	-.0075003
d_Expv			-	.07456
d_Expb			-	-
d_Crinf			**.4169699****	**.4166825****
d_Crfm			-	-
Location (Loc)	**-.8231786***	**-.8235745***	**-.8274021***	**-.8289133***
Famsize (lnFam)			.0619887	.0654699
Age (lnAge)			.2677992	.269623
Fragmentation (lnFrag)			-.0635041	-.0651146
-cons	**3.176808***	**3.243314***	**1.833353****	**1.868348****
mu /lnsig2v	-1.808263	-1.942396	-10.51717	-10.81315
lnsigma2/lnsig2u	.6483565	.6856443	1.825546	1.850598
ilgtgamma/Sigma_v	**3.325423***	**3.342591***	4.14159	4.168615
sigma_u	-	-	6.206184	6.363621
sigma2	1.912395	1.98505	-	.9847621
Gamma	.9652907	.9658614	.9843512	6.266653
sigma_u2	1.846017	1.917283	6.109065	.0969682
sigma_v2	.0663778	.0677669	-	-
Lambda	-	-	-	-
H0: No inefficiency component:		z = -3.120, -3.142,-2.242,-2.245	Prob<=z = 0.001, 0.001, 0.012,0.012	
Likelihood-ratio test of sigma_u=0 & 0; chibar2 (01) =17.16, 17.12			prob>=chibar2=0.000 &0.000	

*: p < 0.01; **: p<0.05; ***: p < 0.1
Source: Calculated from field data

Model-III and Model-IV:

From table 7.11 it is seen that land, fertilizer, pesticides and planting materials and dummy variable of education, extension services and credit from formal sources are dropped in the estimation due to collinearity problem. Labour has a positive and statistically significant impact on the output level of rubber. Dummy for planting materials and credit from informal sources have positive and statistically significant influence in rubber output. As in earlier estimation by OLS method location variable has a significant impact on output and its co-efficient is negative.

We also test for the presence of technical inefficiency in the production model. The null hypothesis of absence of technical inefficiency is rejected since the *p*-values are very small. There is presence of technical inefficiency in rubber production in the study area.

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We have estimated production functions of rubber for the districts separately also which are reported in the appendix Table VII.15 & VII.16.

7.4: Summing up:

This chapter has examined three interrelated questions.

First, does the often observed inverse relation between farm size and productivity hold in the study area? On this, the answer is largely negative. Except for the modern variety of rice (in a limited number of specifications) and rubber cultivation, the inverse relation is not present. But, neither is a positive relation present.

Secondly, what is the nature of the underlying production functions of these crops? On this, we found that land affects output production in a positive manner for many crops (except in some cases where it has been dropped due to multicollinearity issues). This holds irrespective of how capital is measured. This difference of capital is measurement checks for the robustness of the results. So, our conclusion that land impacts output positively holds true even if we change the method of capital measurement.

In some cases labour, capital, fertilizer, extension services were found to be statistically significant. In most cases they were on expected lines, i.e., affecting the output positively. But in a few cases the impacts were just the opposite of what one expects. For example, fragmentation in case of traditional rice had a positive impact, or irrigation in modern rice had a negative impact (M-I, M-II), or private extension services have a negative impact in jute cultivation (M-III). These cases perhap under line factors such as diseconomies of scale of large farms, or the overuse of certain factors, or exploitation/misinformation/ignorance spread by unscrupulous elements in the agrarian economy. All these need further investigation.

We found the location of a farm to be significant in some cases. The sign was often negative. This implies that the farms in Goalpara are ahead of Bongaigaon in those cases, even after we include a host of control variables.

The third question was, if we allow for the presence of technical inefficiency then what is the nature of the relation between inputs and outputs? Is technical inefficiency present? Once again we found that land continues to influence output level in this case

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like before. This holds for all the four varieties of crops, except for the cases where land was dropped due to multicollinearity.

When land is dropped, in most cases labour or capital was found to be significant. For traditional winter rice, fragmentation was found to be positively impacting output, like before. In the estimation of production function in some cases we found that the fragmentation raises output. However, this is not true for every crop. It is true only for winter rice traditional variety and jute. This observation seems to contradict the absence of inverse relationship between farm size and productivity. However, we must note that farm size is different from fragmentation. Fragmentation can increase without farm size increase if a farmer has the same amount of total land but the land is fragmented into more pieces. Fertilizer was found be important for modern rice in 3 out of 4 specifications.

In the modern variety rice, like before, there seems to be over-use of water, as the irrigation co-efficient is coming to the negative in two cases. There is a positive impact of public extension services. This is not surprising since modern rice varieties are new crops whose farming knowledge many farmers do not have. Government's role in disseminating information regarding the methods of cultivating this variety of rice is valuable to the ordinary farmers, as one would have expected. Again the fact that fertilizers affect output positively is not surprising since these varieties are likely to be input intensive. There is evidence of technical inefficiency in modern rice cultivation.

For jute most variables are significant. There are cases of overuse in case of some variables such as capital or pesticides and weedicides, implying a negative co-efficient. There exists inefficiency in jute production.

For rubber cultivation planting material was very important. Labour, capital, location were all important for rubber. The signs were along expected lines. We find there are technical inefficiencies in rubber production.

Like in the case of OLS, in SF estimation also we find that location often has a significant impact. In most cases the sign is negative. There could be some district level fixed effects which are causing this negativity. These could be administrative policies, which put Goalpara in an advantage compared to Bongaigaon. In general the location

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variable captures those unexplained factors ("X"- factors) which we did not capture in our fairly extensive specification.

The analysis of the findings leads us to conclude that as most of the farmers are poor, especially in regard to land, it leads to sub-optimal use of inputs. A greater provision of land would add significantly to output. Capital, fertilizers, planting materials were found to be important for output increase. Public extension services were found to be critical in at least one case (winter rice modern variety). An increase in the use of these inputs would significantly raise the output level.

In the next chapter we conclude with a discussion on policy implications of the results we have derived.

Chapter-VIII: Summary of the Major Findings, Policy Prescriptions and Conclusion:

This chapter is the concluding chapter of the thesis consists of three sections. In the first section we bring together the different elements of the answer to the first research question. Let us recall that the first research question is:

"What has been the performance of agriculture in Assam compared to the national average and other agriculturally developed states in India, especially in regard to the three select crops?"

Chapters II, III, IV and V of the thesis have examined this research question. However, the discussion is spread over all these chapters in a disparate manner. In this chapter in the first section we consolidate those separate elements.

In the second section of the chapter we discuss in detail the conclusions from chapter VI and VII, thus consolidating the answers to the second and third research questions.

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In the third section we answer the fourth research question which was about the policy implications. Here we bring together the results from research questions 1, 2 and 3.

8.1: Answer to the First Research Question, Part-1:

The answer to this research question is given at two different levels. First, the comparison between Assam and other states at the general level of agricultural performance (i.e., at aggregate level). This is covered in the part 1 of this section 8.1. Second, the comparison can be done at the individual crop level. This is covered in the part 2 of this section 8.1.

Assam is lagging behind in agricultural performance to the national average as well as to some of the states in India. This backwardness is present in different fronts such as growth of production, farm size, yield, input use, etc.

Output:

The estimated average growth of agricultural GSDP of Assam during 1990-91 to 2011-12 at constant (2004-05) prices was 3.4 percent (Economic Survey, Assam, 2012-13) while in all India it was 3.7 percent (Economic Survey, 2013-14). The compound annual growth rate (CAGR) of agriculture output in Assam was 0.67 percent compared to 1.74 percent in India during 1990-93 to 2003-06 (post liberalization period). In 2011-12, food grain yield in Assam was 1792kg per hectare against its national average of 2059kg per hectare. CAGR of yield in Assam is also lower than India; 0.90 percent in Assam compared to 1.52 percent in India during 1990-93 to 2003-06. Productivity of major agricultural crops in Assam is comparatively lower than the national average (with some exceptions). More distressing is the fact that the gap in yield levels between Assam and the national average has widened for the year for a number of crops. Non-foodgrains crops do not add much to the agricultural production in the state, except the production of jute and tea and recently in rubber.

In the initial phase of Green Revolution (1962-65 to 1980-83), annual compound growth rate of agriculture in Assam was better than in other states of eastern region and

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even higher than all India average. In the maturing of Green Revolution (1980-83 to1990-93), while a marked acceleration of agricultural growth took place in other states of the eastern region, there was only a marginal increase in output growth in Assam and hence growth rate was lower than eastern region as well as national average. In post-liberalization period (1990-93 to 2003-06), deceleration of agricultural growth in Assam was more prominent than in other states of eastern region and in all India level.

Land:

The average size of operational holding in Assam is smaller than in all India which is a sign of lack of consolidation of land holding in agriculture. The average size of operational holding in Assam declined from 1.47 hectares in 1970-71 to 1.10 hectares in 2010-11, in spite of increase in operated area from 28.82 lakh hectares to 29.99 lakh hectares. While in India average size of operational holding declined from 2.28 hectares to 1.16 hectares during the period. There is a marked gap in the average size of operational holdings between Assam and all India in all the NSS rounds. In Assam, the large and medium holdings, at the top 4.68 percent bracket, owned 33.14 percent of the total land in rural area in 1970-71. It has declined to 23.98 percent in 2010-11. On the other hand, at the national level, the large and medium holdings, at the top 15.1 percent bracket, owned 60.6 percent of the total land (rural) in 1970-71 which has declined to 32.1 percent in 2010-11. At the bottom, the proportion of marginal holdings increased from 57 percent to 67 percent and operated area increased from 17.66 percent to 25.83 percent from 1970-71 to 2010-11 in Assam (Economic Survey, Assam, 2012-13) while in all-India marginal holdings increased from 51 percent to 67 percent and operated area from 9 percent to 22 percent respectively during the period. Thus, although percentage of marginal holding in Assam is almost same with India but operational area under marginal holding in Assam is more than all India level, signifying higher degree of land sub-division in the state. Area per household in the class of small and medium holdings is smaller in Assam than the all India level.

Seeds, Fertilizers, Irrigation and Other Inputs:

Proportion of area under HYV seeds of paddy in the state is low compared to agriculturally advanced states of the country as well as the national average. In 2013-14, total rice area under HYV seeds had reached to 63.5 percent in Assam compared to 96 percent in Punjab and about 78 percent in India. Although the fertilizer use in Assam is

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growing but compared to Punjab and all India average it is negligible. In 2009-10, farmers in Punjab used fertilizers 236.9kg/ha and in all India by 138.33kg/ha, but Assam has used only 59.1kg/ha. In 2011-12, consumption of fertilizer in the state was 74.58kg per hectare against 141.30kg/ha in national average. Similarly, consumption of chemical pesticides in Assam is also very low compared to national average. Percentage of irrigated cropped area is quite small and unirrigated cropped area both in *kharif* and *rabi* season was considerably high compared to all India figure. Percentage of Gross Irrigated Area (GIA) to Gross Cropped Area (GCA) was 96.31 percent in Punjab, 39.11 percent in all India but in Assam it was only 6.2 percent in 2003-04. In 2011, the percentage of area under irrigation in the state was only about 15 percent of the gross cropped area or 20.7 percent of net cropped area (Directorate of Economics and Statistics, Govt. of India, 2012). In Punjab, irrigation coverage was 98 percent of total cropped area in 2012-13.

Credit:

In 1996-97 per hectare credit disbursed in Assam was only about 30 percent of the national average (Goyari, 2007). The credit use in agriculture in the state as on 1998 stood at Rs.791 against the national average of Rs.3633 per hectare. Farm level studies on agricultural credit show that credit requirement per hectare of cropped area are substantially high at Rs.1300 in Assam as compared to credit availability. The analysis of credit availability indicates that direct short-term credit per hectare in the northeastern India is less than Rs.100 against a national average of Rs.421.50 per hectare (Baruah and Sarma, 2001). On March 2012, credit-deposit ratio of commercial banks in Assam was 37.3. The all India ratio was 78.1 percent (Economic Survey, Assam, 2012-13). While the credit advances to agriculture per hectare in Punjab and all India level had increased gradually, in Assam it was decreased. Both in case of per hectare credit advances and per capita credit to agriculture in Assam it is considerably lower than the all-India averages. Procurement of crops at MSP in Assam is very poor. Fund allotted for extension services is not sufficient; participation rate in the programmes of public extension services is poor in the state.

Answer to the First Research Question, Part-2:

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We now come to the comparison between Assam and the national level agricultural performance at the individual crop level. Here also the state lags behind the national average.

Assam produced only 1874kg rice per hectare compared to 2372kg per hectare in India in 2011-12. In comparison to Punjab, Haryana, Tamil Nadu and other high rice growing states of India, the productivity of rice in Assam is low. Among the states in India producing jute, Assam is the third largest producer (Raja, 2012). However, area and production of jute in Assam has declined while in India it is constant or has increased. The share of the state jute producing area in all India has declined from 10.9 percent in 1980-81 to 7.22 percent in 2009-10 and state's share of jute production in all India has also declined from 11.11 percent to 6.63 percent during the period 2000-01 to 2008-09. Yield of jute in Assam was 16.69 quintals per hectare compared to 24.22 quintal/ha in India in 2011-12. The growth rate of productivity of jute is positive but it was very low in comparison to all India during 1990-91 to 2011-12. However, an exception is observed in case of rubber production. As in national average, rubber production has also increased in Assam; yield of rubber in Assam (1272 kg/ha) was higher than all India (1211kg/ha) in 2011-12. However, growth rate of yield in rubber in Assam is lower than all India level during 1990-91 to 2011-12. Although percentage shares of Assam (in all India) of rubber area as well as production have increased, demand for the natural rubber grown in the state is basically derived from outside of the state; the state has no bulk consumer of natural rubber.

From the above evidences of secondary data we are led to conclude that the state of agriculture in Assam has been in relative backwardness. The gap between Assam and the all-India average is not converging, which is a greater concern. Next, we go into details to find the reasons for low performance in the state. We come down to micro-level primary data collected painstakingly from extended field surveys. We select three representative crops of different characteristics. We concentrate on two districts of Lower Brahmaputra Valley Zone, select the farm households, and gather the data. This helps us to answer the second and third research questions reported below.

8.2: Answer to the Second and Third Research Questions:

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In chapters VI and VII we have discussed in details about information collected from the primary survey. We have observed in chapter VI that as far as rice cultivation is concerned, farmers in both the districts-Goalpara and Bongaigaon earn negative profit. This is a puzzling phenomenon. But this lack of profit is observed in other parts of the country as well. Agarwal and Agarwal (2017) observed that 40 percent of Indian farmers did not like farming and would prefer any other alternative source of livelihood. 67 percent of the farmers who reported that they did not like farming said unprofitability is the main reason of not preferring farming. Peasants with small farm cited unprofitability more often as the reason of the desire to quit farming. Our study area has farms with very small pieces of land. Hence it is not surprising that on average they do not make profit in rice cultivation. The number of cultivators decreased in India in recent years, from 127.3 million in 2001 to 118.8 million in 2011 (from 54.4% to 45.1% of total agricultural workers) whereas agriculture labourers increased from 106.8 million to 144.3 million (or from 45.6% to 54.9% of total agricultural workers) during this period (Agriculture at a Glance, 2016). These evidences buttress the lack of profitability we found in our study area for rice cultivation.

Rice is the most important crop in the state and farmers earn negative profits in its cultivation. However, for the other two crops under study the profit per hectare is positive, as reported in chapter VI. In case of jute, profitability in Bongaigaon is higher than the Goalpara district. In case of rubber in Bongaigaon the profit per hectare is negative in the initial year of tapping which turns positive subsequently. We found profit to be lower in Bongaigaon district, and the loss to be higher there. It is likely that the young age of plantations in Bongaigaon is responsible for this. But there could be other factors also which may have played a significant role.

In chapter VII, first we took up the issue of the supposed inverse relationship between area and yield, which is a long-debated topic in Indian agriculture. If the relationship exists it implies that small farms although weak in economic power do enjoy a greater yield per acre. To raise the total production therefore more support should be provided to them as opposed to the large farms.

From our data we observed that the supposed inverse relationship between the farm size and productivity is largely absent in the study area. Except for modern variety of rice and rubber cultivation it is not present in a significant degree anywhere. In other

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words, for the important crops of traditional variety of winter rice and jute cultivation it is not true that smaller farmers have higher productivity per unit of land, once other variables are controlled. The reason for this lack of inverse relationship may lie in the intensive use of other inputs that the bigger farmers apply to make up for the low level of labour input. But neither did we find any evidence for greater productivity in bigger farms, which has been observed in agriculturally developed parts of India (Rakshit, 2011).

Secondly, let us come to the factors which influence the production of crops. This relates to our second research question. We find that as far as the different inputs of production are concerned land has been a very important input. In the estimation of production function, land has had a positive and statistically significant influence on the crop output. This holds for all crops, except for the cases where land was dropped due to multicollinearity problems. See column 3, table 8.1 below for a summary of the result.

In table 8.1, we have summarized the results from chapter VII. For the sake of brevity we have taken results of only M-IV in all cases. To our mind M-IV is the preferred specification as it takes the annualized cost of capital, as well as a host of variables.

The co-efficient of log of land lies in the neighbourhood of 1 (approximately). This indicates that 1 percent increase in land input leads to about 1 percent increase in output. In other words, the land elasticity of crop output is close to 1. This result holds irrespective of how capital is measured, whether at the purchase value of capital or at annualized cost of capital. Thus, the fact that land influences output in a positive manner is checked for statistical robustness.

Labour is also found to be an important input in two out of four case (see column 4, table 8.1). In case of traditional variety of winter rice and rubber, labour affects output significantly and in a positive manner. The co-efficient is found to be little less than 1. This implies that farms in Assam although small do not suffer from an over-supply of labour (as proponents of surplus labour tend to assume) at least for these specific crops. There could be several reasons for this, including shortage of labour in rural economy due to emigration.

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Fertilizer (in case of modern rice) and public extension services (in case of jute) are found to be statistically significant in specific cases. But in general these inputs do not affect output across the board. For these specific cases improvement in the uses of these specific inputs may have a significant impact on the level of crop production.

In case of traditional rice fragmentation positively and significantly affects the level of output. This is a somewhat surprising result. In other empirical works dealing with cultivation in Assam fragmentation usually had a negative influence on efficiency (Bhattacharyya and Mandal, 2016). Although output is not the same thing as efficiency, this is a surprising result. Perhaps the facts that we are focusing on a specific region of Assam and that our model specifications are different have led to this divergence of results. The co-efficient of fragmentation on rice output is about 0.31.

Informal credits (modern rice) and location (rubber) are found to affect output. These results are on expected lines. Greater availability of credit is likely to increase the ability of the farmers to undertake expenditure related to the production of modern rice which is a cash intensive crop. For location, Goalpara is the reference district. A negative co-efficient for the location dummy means Bongaigaon has disadvantages compared to Goalpara in rubber cultivation.

Table 8.1 includes the results of estimation of the deterministic production function (OLS) as well as stochastic frontier production function (SF). In the latter case, presence of technical inefficiency is allowed unlike in the first case.

Table-8.1: Relative significance of various factors on production functions of crops:

Crops/ Significant factors	Method of Estimation	Land	Labour	Fertilizer	Capital	Irrigation	PM	PW	Fragmentation	d_primary	d_matric	d_high	Pvt. ES	Pub. ES	Credit (FS)	Credit (IS)	Age of HH	Fml. size	Location
Winter Rice (T)	OLS	D	Y	D	-	D	-	-	Y	-	-	-	-	-	-	-	-	-	-
	SF	D	Y	D	-	D	-	-	Y	-	-	-	-	-	Y	-	-	-	-
Winter Rice (M)	OLS	Y	D	Y	-	D	-	-	-	D	-	-	-	-	-	Y	-	-	-
	SF	Y	D	Y	-	D	-	-	-	D	-	-	-	Y	-	-	-	-	-
Jute	OLS	Y	-	D	-	-	-	D	-	D	D	D	D	Y	-	-	-	-	-
	SF	Y	Y	D	Y	-	-	D	Y	D	D	D	D	Y	Y	Y	Y	Y	Y
Rubber	OLS	D	Y	D	-	-	D	-	-	-	D	-	-	D	D	-	-	-	Y
	SF	D	Y	D	-	-	Y	D	-	-	D	-	-	D	D	Y	-	-	Y

Note: OLS Ordinary Least Square; SF stochastic frontier; PM planting materials; PW pesticides & weedicides; d dummy; Pvt private; Pub public; ES extension services; FS formal sources; IS informal sources; HH household head;

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Fml family; Y significant; D dropped due to multicollinearity problem, 'blank (-)' insignificant or variable not included in the model.

In the stochastic frontier model estimation we have maintained the assumption of the Cobb-Douglas production function. Through stochastic frontier analysis we have been able to say something definitive about the nature of the influence of the inputs allowing for the presence of technical inefficiency.

Like in the previous case we find that land influence output level across the board except rubber and traditional rice where it was dropped due to multicollinearity. The elasticity estimate has remained more or less in the same numerical range, close to 1. Like before land consistently and positively affect output, except for the cases where it was dropped.

Apart from land, other factors are found to be statistically significant. For example, labour is statistically significant for traditional rice, jute and rubber; fertilizer for modern rice. Capital is significant in case of jute output. Planting material for rubber is significant. Although this is the dummy for planting material which is giving the positive and significant co-efficient result, the intuition is clear. Since rubber is a crop which relies on planting materials heavily, the co-efficient is coming to be significantly positive.

Fragmentation like in the case of OLS increases output in case of traditional rice and jute. The reason could be as we have mentioned before.

Public extension services raise the output of modern rice, which was expected. But it reduces the output of jute production. This is puzzling. Probably there has been a case of over-supply of certain inputs associated with public extension.

Formal credit and informal credits affect jute output positively which is not surprising. What is surprising is that formal credit affects traditional rice negatively. Again this could be caused by over-supply of formal credit.

For jute cultivation higher age of the household head reduces the output level. This is a novel result, unobserved in other crops. A bigger family size is found to be raising output presumably because of greater supply of labour. This is not surprising because jute is a labour intensive crop. Location also matters for both jute and rubber. Bongaigaon in both cases fare worses than Goalpara.

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Summing up, it appears land and labour are the most important factors as far as crop production is concerned. These factors are found to be significant with a higher degree of frequency. Other factors are important in fewer instances.

As far as technical inefficiency's presence is concerned, we do not find technical inefficiency in rice production for traditional variety. In modern rice, jute and rubber, technical inefficiencies are found to be present.

8.3: Answer to the Fourth Research Question:

As far as research question 1 is concerned, we have noticed that Assam lags behind the national average in the context of agricultural performance. The gap is wider if the comparison is with the agriculturally developed states. This is reflected in several indicators such as - irrigation, fertilizer, uses of capital equipments, bank credit, land consolidation, etc. This poor performance is not good news for the vast majority of the state's residents, most of whom are dependent on the agricultural sectors for their livelihood. It calls for pro-active policy interventions at different levels of government. Worryingly, the gap between Assam and other national average has been growing over the years, instead of coming down.

What should be done to address the yawning gap? The answers to the second and the third `research questions have given us a clue as to what should be the focus of the government policies.

As the discussion in the previous section concluded there are some specific areas which should be given serious attention. In most cases, we have found that land is a very important input for crop cultivation. Its limited availability constrained the output levels. It appears that the farmers have not been able to reach the optimal level of land holding which would have maximized their output level. The fact that rice farmers are incurring losses on average in both the districts under our study, namely Goalpara and Bongaigaon, could be an indication of the sub-optimal provision of land. In this scenario it implies that greater land availability could be an important policy intervention.

There are two ways in which land can be made available to the farmers. Firstly, distribution of ceiling surplus land, and secondly, diversion of land from other uses. The performance of the state in respect to the distribution of ceiling-surplus land has been

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disappointing as we have seen in Chapter III. At the same time it must be admitted that there is not a huge amount of land to be gained from this source. This is because most of the farmers in our study area are marginal and small as we have discussed in chapter III, there are not many large farms from which ceiling-surplus land can be gained.

As far as the second possibility is concerned (diversion of land from other uses), we need to have an idea of how much land is being used in different purposes. Table 8.2 presents the data of area under different categories of use in Goalpara and Bongaigaon districts.

Table-8.2: Class-wise volume of land in Goalpara and Bongaigaon districts in 2011-12:

Districts	Geographical Area	Forest Land	Area under non-agricultural uses	Barren and uncultivable land	Permanent pastures and other grazing land	Cultivable waste land	Total fallow land
Goalpara	184262 ha	29683ha (16.11%)	29727ha (16.13%)	32538 ha (17.66%)	3576 ha (1.94%)	675 ha (0.37%)	559 ha (0.30%)
Bongaigaon	151999 ha	44ha (0.03%)	28226 ha (18.57%)	28226 ha (18.57%)	5157 ha (3.39%)	3900 ha (2.57%)	9221 ha (6.07%)

Note: Parenthesis indicates percentage of total geographical area.
Source: Statistical Hand Book, Assam

From the table 8.2 it is observed that the total amount of fallow land is not available in great quantity in Goalpara (0.3 percent). It is 6 percent of the total land area in Bongaigaon. This land can be diverted if that does not adversely affect the local communities or the environment. A larger source of land could be barren and uncultivable land. In Goalpara and Bongaigaon their share is 18 percent to19 percent approximately. Government can take some concrete measures to reclaim less fertile lands to turn them to productive purposes. The same can be distributed among the small-scale growers and the landless peasants. Here again the government needs to ensure that when these land is made available to farmers the existing users of the land are taken on board. The issue of democratic consent building cannot be ignored.

Secondly, labour is also found to be a major factor. But we are less sure of the importance of labour compared to land. This is because labour is showing to be important once land is being dropped in most cases. If both of them are included, labour is not statistically significant in most cases. Nonetheless, there appears to be sub-optimal use of labour in some cases. A reason for the below-optimal labour use could be the rising cost of labour for which shortage of labour due to outward-migration, etc. could be responsible.

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Thirdly, capital and fertilizer were found to be of importance in some cases. Accessibility of the material inputs in terms of affordable price, and making sure that they are supplied at the right time and in assured quality must be guaranteed. Their supply chain should be streamlined. They should be available in the locality of the farmers, i.e., in the village economy. In this connection, rural marketing should be strengthened. Mechanization in farming, through greater use of capital, should enhance crop output in these specific cases.

In the same vein, banking services should be strengthened, so that farmers get loans to make these expenditures to buy machines and fertilizers without getting indebted to unscrupulous money lenders. Financial inclusion of the cultivators should be enhanced. Accessing micro finance facilities could be made easier for the small and marginal farmers.

Fourth, for rubber cultivation assured supply of quality planting materials will enhance rubber output. Government should take steps to establish approved nurseries so that growers can easily collect the planting materials at a cheap rate. Since rubber is a new crop in the region, markets of relevant inputs and output are not well developed. Support from the government and non-governmental agencies would be helpful in enhancing farmers' production.

Fifth, public extension services were found to be important in at least one case. In the cases where extension services were significant should be given attention. Area of extension service workers should be judiciously distributed and they should not be made to engage in works other than farm related activities. During our field visits we found that many of the workers are sent to work in sundry government works such as upgradation process of National Registration Certificate (NRC), socio-economic survey of villages, agricultural survey, etc. These engagements last for a long period and have had a harmful effect on providing services to the farmers.

Sixth, as mentioned earlier fragmentation in land holding has a positive and statistically significant impact on traditional winter rice output. Probably intensive cultivation should be given emphasis to bring better result in crop production.

Seventh, as far as location is concerned, let us remember that we took two districts to find out if any of these districts is doing things better compared to the other.

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In a few cases, we have been able to establish significant difference between the districts. For rubber cultivation Bongaigaon lags behind Goalpara (also for jute in the SF). Farmers of Goalpara have a head-start over Bongaigaon after controlling a number of relevant factors. As mentioned earlier this difference could be due to difference of age of plants for rubber plantation. But there could be other factors as well since the difference is present in other crops as well. Goalpara administration could be doing things differently which Bongaigaon can emulate.

8.4: Limitations and Scope of Further Study:

The present study is motivated by the evidence of secondary data that Assam was lagging behind India. A primary survey is conducted in a particular region of western Assam. We restricted our attention to western Assam due to limitation of time, and finance. We do not claim that our results can be generalized for the state or for the country as a whole.

Our attention was also concentrated only on three crops. Among the three seasonal varieties of rice, we considered only winter rice which is cultivated most widely in Assam, as well as in the sample area. Thus, there is ample scope to undertake similar studies for other crops and also in other regions of the state. For the field survey we considered one crop year, 2015-16. There is a scope to undertake such kind of study for multiple years, and make comparison over time.

8.5: Conclusion:

No one can deny the importance of winter rice in the agrarian profile in Assam. But its cultivation is becoming non-profitable, as evidenced by our study. Productivity of crops can improve by focusing on the prescriptions we outlined above. Land remains a very important input as per our study. This is not very surprising, as we know that the scope of expanding the net crop area is virtually non-existent. But there are other factors of production such as labour, fertilizers, and credits also which need to be paid attention to as our study shows. If government agencies function, if suitable policies are undertaken, as recommended above, productivity could be improved.

Jute cultivation in the state is suffering due to decline in jute land and labour shortage problems. But we find its cultivation is profitable, in comparison to rice

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cultivation at least. The good thing about jute cultivation is that farmers are able to get the market price for jute which is more than the minimum support price announced by the government. Thus, government should provide incentives to motivate the growers of jute (along with the policy recommendations listed above).

Rubber plantation is relatively new agro-economic activity to the region. It has been generating high income and employment in the districts we have studied. It has penetrated among tribal and economically backward population who are showing increasing preferences for its plantation. Backed by strong institutional support from the Rubber Board and also due to high rate of returns, more and more growers are getting attracted to this plantation activity. It is observed and also mentioned by researches like Maibangsa and Subramanian (2001), Nath (2009) that rubber plantation has led to economic betterment of the agrarian population of Goalpara and Bongaigaon districts. The policy interventions in case of rubber should be to provide the required inputs at proper time, for assured quality and at reasonable price.

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APPENDIX

Table-I.1: Sectoral Composition of GDP at 1993-94 & 2011-12 prices in India: (in %)

Year	Agriculture and allied sector	Industry	Services
1970-71	46.34	15.58	38.07
1980-81	39.71	17.62	42.66
1990-91	32.20	21.70	46.09
2000-01	24.00	21.80	54.20
2003-04	20.68	28.37	50.95
2010-11	17.20	26.40	56.40
2012-13	18.2	31.7	50.1
2013-14	18.3	30.8	50.9
2014-15	17.4	30.0	52.6
2015-16*	17.0	29.7	53.3

Note: *Provisional Estimates as on 31.05.2016; Figures from 2012-13 are at 2011-12 prices

Source: (i) Sastry et al., (2011& 2015); (ii) Index Mundi (n. d.); (iii) Appraisal Documents of 12th Five Year Plan

Table-I.2: Trend of area, production and yield of foodgrains in India along with coverage under irrigation:

Year	Area (million ha)	Production (MT)	Yield (kg/ha)	Area under irrigation (in %)
1970-71	124.32	108.42	872	24.1
1980-81	126.67	129.59	1023	29.7
1990-91	127.84	176.39	1380	35.1
1991-92	121.87	168.38	1382	37.4
1992-93	123.15	179.48	1457	37.4
1993-94	122.75	184.26	1501	38.7
1994-95	123.86	191.50	1546	39.6
1995-96	121.01	180.42	1491	40.1
1996-97	123.58	199.44	1614	40.0
1997-98	123.85	192.26	1552	40.8
1998-99	125.17	203.61	1627	42.4
1999-2000	123.10	209.80	1704	43.9
2000-01	121.05	196.81	1626	43.4
2001-02	122.78	212.85	1734	43.0
2002-03	113.86	174.77	1535	42.8
2003-04	123.45	213.19	1727	42.2
2004-05	120.00	198.36	1652	44.2
2005-06	121.60	208.60	1715	45.5

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2006-07	123.71	217.28	1756	46.3
2007-08	124.07	230.78	1860	46.8
2008-09	122.83	234.47	1909	48.3
2009-10	121.33	218.11	1798	NA
2010-11	126.73	244.57	1930	48.6
2011-12	125.00	257.40	2059	NA
2013-14*	126.00	264.80	2101	NA

Note: (i) The yield rates given above have been worked out on the basis of production & area figures taken in '000 units; (ii) NA: Not Available; (iii) * Fourth Advanced Estimate

Source: (i) Directorate of Economics and Statistics, Department of Agriculture and Co-operation, Govt. of India; (ii) Agriculture Census, 2010-11(provisional, Census Division), Department of Agriculture and Co-operation, GoI.

Table-I.3: Index Numbers of Area, Production and Yield under Foodgrains and Non-foodgrains in India: (Base: Triennium ending 1981-82=100 for the data given till 2006-07 and Base: Triennium ending 2007-08=100 for the data given from 2007-08).

Years	Fodgrains			Non-Foodgrains			All Principal Crops		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
1970-71	97.9	87.9	93.2	91.1	82.6	91.4	96.3	85.9	92.6
1980-81	99.8	104.9	105.1	99.4	97.1	99.2	99.7	102.1	102.9
1990-91	100.7	143.7	137.8	120.0	156.3	128.0	105.2	148.4	133.8
1991-92	96.0	137.6	136.5	124.8	158.8	123.7	102.7	145.5	131.0
1992-93	97.0	144.3	142.0	123.2	164.0	130.2	103.1	151.6	137.2
1993-94	96.7	150.2	146.5	127.3	169.5	132.7	103.8	157.3	140.7
1994-95	97.6	155.9	150.4	126.2	180.9	138.9	104.2	165.2	145.5
1995-96	95.3	146.1	143.1	131.8	185.5	135.7	103.8	160.7	139.8
1996-97	97.4	160.9	154.5	134.6	200.9	143.8	106.0	175.7	149.8
1997-98	97.6	155.7	148.4	133.6	181.6	132.3	105.9	165.3	141.4
1998-99	98.6	165.2	154.0	134.8	200.2	141.3	107.0	178.2	148.4
1999-00	97.0	169.7	159.8	130.7	189.0	136.4	104.8	176.9	149.6
2000-01	95.4	158.4	152.8	127.0	178.2	133.3	102.7	165.7	144.3
2001-02	96.7	172.5	164.1	127.6	189.5	139.1	103.9	178.8	153.3
2002-03	89.7	140.4	143.2	116.1	166.4	124.7	95.8	150.1	135.0
2003-04	97.3	172.0	165.3	125.7	201.5	151.2	103.8	182.9	159.2
2004-05	94.6	159.9	156.5	137.9	206.7	147.9	104.6	177.3	152.5
2005-06	95.8	169.2	176.7	140.9	230.3	163.5	106.2	191.9	180.6
2006-07	97.5	175.9	180.4	143.0	242.9	169.9	108.0	200.7	185.8
2007-08	101.2	105.4	104.2	103.0	108.6	105.4	102.1	107.0	104.8

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2008-09	100.9	106.5	105.6	106.0	107.6	101.5	103.4	107.0	103.5
2009-10	100.0	100.6	100.6	104.2	105.0	100.7	102.1	102.8	100.7
2010-11	104.4	114.3	109.5	113.8	127.9	112.4	109.0	121.0	111.0
2-11-12	104.3	118.8	114.0	115.5	129.5	112.2	109.8	124.1	113.0

Source: Agricultural Statistics at a Glance, 2008; Economic Survey 2009-10, 2011-12, 2012-13.

Table-I.4: Sector-wise allocation of credit in India (percentage to total) from 1980 to 2008:

Sectors/year	1980	1985	1990	1995	2000	2005	2008
Agriculture	14.8	16.9	15.0	11.3	9.9	10.8	11.3
Industry	48.0	42.0	47.5	48.0	46.5	38.8	38.4
Service	37.2	41.1	37.5	40.7	43.6	50.4	50.3
Total Bank Credit	100	100	100	100	100	100	100

Source: Basic Statistical Returns, Reserve Bank of India (Various Issues)

Table-I.5: Region wise credit-deposit ratio in India and Assam:

Regions	1980	1985	1990	1995	2000	2001	2005	2007	2009	2010	2011	2012
Northern	76.1	63.7	54.8	48.6	51.1	-	59.5	-	68.5	-	-	-
Western	70.5	79.9	74.0	63.2	75.4	-	83.5	-	85.2	-	-	-
Southern	77.6	84.4	87.4	69.4	66.2	-	78.1	-	88.4	-	-	-
Central	45.7	52.7	52.8	39.0	33.9	-	40.8	-	44.8	-	-	-
Eastern	56.1	52.0	52.6	47.1	37.0	-	45.5	-	48.9	-	-	-
North-Eastern	35.6	48.9	51.7	35.6	28.1	-	35.0	-	35.8	-	-	-
Assam	**40.6**	**53.3**	**55.5**	**38.7**	**32.0**	**32.**	**35.3**	**43.3**	**38.3**	**37.0**	**35.6**	**37.3**
India	-	-	-	-	-	**56.7**	**65.9**	**75.0**	**72.6**	**72.7**	**75.1**	**78.1**

Source: (i) Statistical Tables Relating to Banks in India, Reserve Bank of India (Various Issues); (ii) Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks, March 2007 to March 2012 of RBI, (iii) Basic Statistical Return of Scheduled Commercial Banks, June 2007, Reserve Bank of India.

Table-I.6: Index Number of Area, Production and Productivity of Select Crops in Assam and India from 1980-81 to 2011-12 (Base: Triennium ending 1981-82=100)

Years	State	Rice			Jute			Rubber**		
		Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
1980-81	A	-	-	-	-	-	-	-	-	-
	I	100.2	107.8	107.7	108.5	100.8	92.9	100.4	101.1	100.7
1990-91	A	-	-	-	-	-	-	-	-	-
	I	106.5	149.4	140.2	89.7	122.6	136.6	158.2	217.2	137.5
2000-01	A	117.5	177.71	151.05	65.5	78.24	119.45	-	-	-
	I	111.6	170.9	153.2	95.5	144.2	151.0	206.5	416.1	201.5
2001-02	A	117.5	177.71	151.05	65.5	78.24	119.45	-	-	-
	I	112.0	187.7	167.5	100.7	163.8	162.7	206.9	416.8	201.4
2002-03	A	112.8	166.61	137.41	64.0	80.88	126.39	-	-	-
	I	-	-	-	-	-	-	-	-	-
2004-05	A	-	-	-	-	-	-	-	-	-
	I	104.6	167.2	159.9	89.3	145.5	163.0	227.1	494.8	217.9
2005-06	A	107.5	159.25	136.03	53.5	67.78	126.74	-	-	-
	I	108.9	184.6	169.4	87.7	154.3	176.1	230.8	529.8	229.5
2006-07*	A	97.26	129.25	123.44	54.34	65.40	120.35	-	-	-
	I	109.3	187.7	171.7	91.5	159.7	174.6	234.4	563.0	240.1
2007-08	A	-	-	-	-	-	-	-	-	-
	I	109.6	194.4	177.4	93.9	158.2	168.4	328.1	544.7	166.0
2008-09	A	110.3	178.96	147.86	56.6	64.1	113.17	107.6	104.5	-

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	I	113.2	199.4	176.2	91.2	149.1	163.5	341.8	570.6	166.9
2009-10	A*	112.4	197.36	159.89	61.5	70.62	114.83	111.4	100.5	-
	I	104.6	179.1	171.3	93.6	173.8	185.8	354.5	548.8	154.8
2010-11	A	112.6	151.64	134.64	104.1	95.24	91.53	-	-	-
	I	106.2	191.7	180.5	88.6	154.7	174.7	354.5	548.8	154.8
2011-12	A	111.9	142.09	126.99	109.6	92.57	84.50	-	-	-
	I	-	-	-	-	-	-	-	-	-

Note: * Provisional Estimate; ** Base; Triennium ending 2007-08=100; A Assam; I India

Source: (i) Statistical Hand Book Assam different issues, Directorate of Economics and Statistics, Assam
(ii) Economic Survey different issues, Ministry of Finance, Department of Economic Affairs, Govt. of India.

Table-II.1: Size of Operational Holdings and Gini's coefficient of concentration of the size distribution of operational holdings in Assam and all India in various NSS rounds: (Rural)

Years (NSS Rounds)	State/ Country			
	Average Size of Operational Holdings in Assam (in ha)	Average Size of Operational Holdings in all India (in ha)	Gini's Co-efficient of operational holdings of Assam	Gini's Co-efficient of operational holdings of all India
1961-62 (25th Round)	-	-	-	0.58
1971-72 (26th Round)	0.83	1.25	0.406	0.59
1981-82 (37th Round)	1.03	1.60	0.465	0.63
1991-92 (48th Round)	0.85	1.27	0.412	0.64
2002-03 (59th Round)	0.69	1.06	0.366	0.62

Note: Gini's Co-efficient is computed here by using fewer size classes of operational holdings.

Source: NSS Various Rounds, NSSO.

Table-II.2: Percentage distribution of area leased in by terms of lease for Assam and India (Rural):

Terms of lease	State	Percentage distribution of leased-in area				
		1961-62 (NSS 17th Round)	1971-72 (NSS 26th Round)	1981-8 (NSS 37th Round)	1991-92 (NSS 48th Round)	2002-03 (NSS 59th Round)
Fixed Money	Assam	-	17.05	15.40	17.00	15.8
	India	25.6	15.4	10.9	19.0	29.5
Fixed Produce	Assam	-	9.83	8.40	4.5	3.6
	India	12.9	11.6	6.3	14.5	20.3
Share of Produce	Assam	-	41.83	35.3	31.17	55.0
	India	38.2	47.9	41.9	34.4	40.3
FromRelatives -no terms	Assam	-	-	-	-	0.0
	India	-	-	-	-	4.0
Other	Assam	-	31.29	40.9	47.33	25.6
	India	23.3	25.1	40.9	32.1	5.9

Note: Figure related to the *kharif* season

Source: Govt. of India, NSS Report No.215: Some aspects of landholdings in India (26th Round), 1971-72; NSS Report No.331 (37th Round), 1982; NSS Report No. 407: Some aspects of operational holdings in India (48th Round); 1991-92; Report No. 492, NSS 59th Round, 2003

Table-II.3: Percentage of Gross Irrigated Area (GIA) to Gross Cropped Area (GCA) in Assam, Punjab, Andhra Pradesh and all India from 1980-81 to 1999-2000:

Period	Assam	Punjab	Andhra Pradesh	All India
1980-81 to 1984-85	7.5	88.2	36.2	29.8
1985-86 to 1989-90	13.0	92.2	38.2	32.5

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1990-91 to 1994-95	12.2	94.7	40.3	35.9
1995-96 to 1999-2000	12.7	93.6	43.0	38.9
1980-81 to 1999-2000	11.3	92.2	39.4	34.3
2003-04	6.2	96.31	-	39.11
2011-12	-	98	-	-

Note: For Assam, GIA is total irrigation potential created & GCA is sum total of crop acreages

Source: (a) Chief Engineer, Irrigation Department, Govt. of Assam

(b) For Punjab, Andhra Pradesh and all India, data are from Fertilizer Statistics & CMIE (Various Issues)

(c) Calculations are by the author

Table-III.1: All-India Area, Production and Yield of Rice along with coverage under irrigation

Area- Million hectare; Production-Million tone; Yield- kg/ha

Year	Area	Production	Yield	Area under irrigation (in %)
1970-71	37.59	42.22	1123	38.4
1980-81	40.15	53.63	1336	40.7
1985-86	41.14	63.83	1552	42.9
1989-90	42.17	73.57	1745	46.1
1990-91	42.69	74.29	1740	45.5
1995-96	42.84	76.98	1797	49.9
1999-2000	45.16	89.68	1986	53.9
2000-01	44.71	84.98	1901	54.4
2001-02	44.90	93.34	2079	53.2
2002-03	41.18	71.82	1744	50.2
2003-04	42.59	88.53	2077	52.6
2004-05	41.91	83.13	1984	54.7
2005-06	43.66	91.79	2102	56.6
2006-07	43.81	93.36	2131	56.7
2007-08	43.91	96.69	2202	57.8
2008-09	45.54	99.18	2178	58.7
2009-10	41.92	89.09	2125	58.0
2010-11	42.9	96.0	2239	58.6
2011-12	44.01	105.3	2393	58.7
2012-13	42.75	105.24	2462	NA
2013-14*	43.95	106.54	2424	NA

Note:* Advance Estimates; The yield rates given above have been worked out on the basis of production & area figures taken in '000 units

Source: Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Govt. of India.

Table-III.2: Compound Growth Rates of Area, Production and Yield indices of Rice during 1981-1991, 1991-2001 and 2001-2011 in India and Assam: (Base: TE 1981-82=100)

State	1980-81 to 1990-91			1990-91 to 2000-01			2000-01to 2010-11		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
India	0.61	3.32	2.67	0.47	1.35	0.89	(-) 0.49	1.16	1.65
Assam	1.26	2.63	1.68	0.47	2.03	1.81	(-) 0.29	2.33	2.38

Source: Calculated from the data obtained from Economic Survey different issues, Ministry of Finance, Govt. of India and Statistical Hand Book Assam different issues, Directorate of Economics and Statistics, Govt. of Assam.

Table-III.3: Comparison of cost and return of cultivation of paddy by SRI and Conventional Methods:

Sl. No.	Particulars	SRI Method		Conventional Method	
		Expenditure and return in Rs.	%	Expenditure and return in Rs.	%
1	Seeds	136	0.63	1812	6.99
2	Human Labourers	9444	43.61	10850	41.87
3	Machine Labourers	4545	20.99	2380	9.19
4	Fertilizers	4798	22.16	4726	18.24
5	Irrigation	2131	9.84	5001	19.30
6	Plant protection chemicals	600	2.77	1143	4.41

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	Total Cost of Cultivation	21655	100.00	25912	100.00
	Gross Return	Rs 48664	-	40411	-
	Net Return	Rs 27009	-	14499	-

Source: Devi and Ponnarasi (2009).

Table-III.4: District-wise Area, Production and Yield of Total Rice in Assam during 1990-91 to 2013-14: Area in '000 ha; Production in'000 MT; Yield in kg/ha

Districts	Items	1990-91	1991-92	1993-94	1994-95	1995-96	1997-98	1998-99	1999-00	2006-07	2008-09	2013-14
Baksa	A	-	-	-	-	-	-	-	-	91.18	94.794	98.68
	P	-	-	-	-	-	-	-	-	116.7	165.76	184.5
	Y	-	-	-	-	-	-	-	-	1280	1749	1893
Barpeta	A	200.2	197.0	210.4	190.5	204.0	195.4	188.6	206.8	111.9	164.34	134.7
	P	189.5	164.0	193.9	167.5	162.0	199.4	172.6	239.1	114.2	223.5	298.02
	Y	947	832	922	879	794	1020	915	1156	1020	1360	2234
Bongaigaon	A	-	104.0	101.6	90.0	95.0	92.8	96.3	98.9	63.55	68.44	56.78
	P	-	93.0	95.2	104.0	85.0	87.2	91.9	98.3	60.4	82.39	122.49
	Y	-	894	937	1155	895	940	954	994	950	1204	2183
Cachar	A	105.1	97.0	101.2	100.5	99.0	103.5	102.9	103.5	101.6	111.52	96.48
	P	176.6	164.0	119.4	183.2	177.0	165.1	202.7	181.9	165.61	238.74	176.29
	Y	1680	1691	1180	1823	1788	1595	1970	1757	1630	2141	1853
Chirang	A	-	-	-	-	-	-	-	-	51.49	51.38	46.86
	P	-	-	-	-	-	-	-	-	63.35	49.87	75.94
	Y	-	-	-	-	-	-	-	-	1230	970	1644
Darrang	A	160.5	166.0	175.8	176.4	161.0	169.7	158.9	186.6	50.33	73.64	69.69
	P	171.9	173.0	202.1	188.3	156.0	179.4	174.2	210.0	68.0	131.81	161.32
	Y	1071	1042	1150	1068	969	1057	1096	1125	1350	1790	2341
Dhemaji	A	95.1	72.0	64.2	67.9	77.0	62.0	51.1	71.9	77.75	72.19	82.35
	P	88.0	77.0	77.5	84.1	99.0	72.1	57.9	95.8	93.3	77.8	129.15
	Y	925	1069	1207	1239	1286	1163	1133	1332	1200	1068	1591
Dhubri	A	132.7	119.0	130.3	122.9	129.0	137.4	135.0	151.6	88.96	88.51	86.60
	P	135.1	86.0	138.9	129.0	117.0	112.8	138.9	220.5	151.3	151.24	236.29
	Y	1018	723	1066	1050	907	821	1029	1454	1700	1709	2747
Dibrugarh	A	84.7	87.0	89.0	86.4	87.0	88.2	84.6	85.1	71.92	70.54	78.07
	P	125.2	143.0	139.3	133.7	159.0	154.5	130.3	134.8	110.8	138.12	148.05
	Y	1478	1644	1565	1547	1828	1752	1540	1584	1540	1958	1925
Dima Hasao	A	13.3	14.0	15.1	15.0	15.0	14.2	11.9	13.9	13.99	14.54	15.82
	P	18.6	19.0	22.3	27.6	29.0	24.1	19.7	22.4	18.61	25.95	31.84

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	Y	1398	1357	1477	1842	1933	1697	1655	1723	1330	1785	2044
Goalpara	A	100.7	61.0	67.4	67.6	71.0	71.7	67.5	71.1	72.21	83.31	83.16
	P	113.2	81.0	112.1	94.3	89.0	88.8	91.6	107.2	101.1	151.16	208.28
	Y	1124	1328	1663	1395	1254	1238	1357	1508	1400	1814	2531
Golaghat	A	92.7	90.0	84.7	81.3	78.0	82.2	82.3	85.2	62.79	80.04	124.15
	P	140.7	139.0	137.4	136.7	157.0	156.2	145.1	155.2	101.1	160.98	295.08
	Y	1518	1544	1622	1681	2013	1900	1763	1822	1610	2011	2412
Hailakandi	A	42.8	42.0	43.9	42.0	41.0	42.8	42.4	45.8	42.55	49.86	46.68
	P	65.0	69.0	54.7	67.3	70.0	67.9	65.6	67.4	83.4	117.62	113.87
	Y	1519	1643	1246	1601	1707	1586	1547	1498	1960	2359	2475
Jorhat	A	106.6	109.0	102.1	95.5	94.0	99.2	81.5	111.0	75.12	86.85	94.11
	P	205.7	188.0	169.5	141.2	149.0	152.7	138.2	193.7	86.4	139.7	188.73
	Y	1930	1725	1660	1479	1585	1539	1696	1745	1150	1608	2034
Kamrup(M)	A	-	-	-	-	-	-	-	-	-	29.47	29.23
	P	-	-	-	-	-	-	-	-	-	53.02	69.55
	Y	-	-	-	-	-	-	-	-	-	1799	2406
Kamrup(R)	A	142.3	131.0	150.7	157.9	165.0	177.7	173.9	169.2	113.5	122.24	121.34
	P	176.9	114.0	182.5	212.6	204.0	261.4	225.3	240.2	174.7	230.21	274.26
	Y	1243	870	1211	1346	1236	1471	1296	1420	1540	1883	2284
Karbi Anglong	A	120.2	120.0	121.6	121.9	124.0	120.7	111.9	114.5	124.2	125.9	130.20
	P	168.1	149.0	169.4	210.3	188.0	178.1	154.1	170.5	180.1	193.03	219.92
	Y	1399	1242	1393	1724	1516	1476	1377	1489	1450	1533	1714
Karimganj	A	83.3	73.0	80.7	78.5	80.0	73.4	74.9	74.0	74.13	76.31	77.5
	P	127.5	121.0	112.5	120.5	124.0	124.5	117.9	123.7	143.8	184.0	153.97
	Y	1531	1658	1394	1535	1550	1696	1574	1672	1940	2411	2014
Kokrajhar	A	160.5	89.0	99.2	90.4	96.0	82.1	95.3	99.6	98.21	104.6	109.5
	P	134.6	85.0	93.7	87.1	106.0	96.4	98.0	110.5	113.0	139.6	223.1
	Y	839	955	944	964	1104	1047	1028	1109	1150	1335	2063
Lakhimpur	A	96.0	123.0	109.9	109.3	112.0	107.4	101.0	124.4	121.8	123.6	141.10
	P	125.8	154.0	171.1	131.5	149.0	132.6	101.1	137.5	84.05	75.79	260.56
	Y	1310	1252	1557	1204	1330	1235	1001	1105	690	613	1872
Morigaon	A	89.2	68.0	90.0	89.3	99.0	98.0	110.5	114.6	67.86	76.73	90.12
	P	108.9	63.0	137.9	104.2	130.0	139.1	169.6	221.6	92.97	141.41	248.5
	Y	1221	926	1532	1166	1313	1419	1535	1934	1370	1843	2780
Nagaon	A	242.6	214.0	259.0	251.3	250.0	228.3	241.5	247.7	169.3	195.2	196.65
	P	342.5	283.0	357.6	375.6	387.0	353.	384.	457.3	272.	317.	436.

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							1	5		6	93	12
	Y	1412	1322	1381	1450	1548	1547	1592	1846	1610	1629	2244
Nalbari	A	141.5	147.0	144.6	144.4	143.0	147.8	143.5	146.9	81.57	80.35	77.93
	P	165.8	154.0	183.8	146.1	167.0	171.4	140.7	175.0	107.7	141.21	153.37
	Y	1172	1048	1271	1012	1168	1160	980	1191	1320	1757	1994
Sibsagar	A	108.6	106.0	105.8	106.5	103.0	104.7	90.0	98.0	97.17	106.41	96.53
	P	217.3	192.0	176.9	184.1	194.0	158.2	147.9	177.7	145.8	264.91	207.24
	Y	2001	1811	1672	1730	1883	1511	1643	1813	1500	2490	2179
Sonitpur	A	132.6	145.0	147.6	141.6	152.0	153.1	143.5	159.6	127.27	173.38	166.1
	P	175.3	175.0	222.4	199.0	215.0	231.8	188.1	220.5	129.8	256.8	340.73
	Y	1322	1207	1507	1405	1414	1514	1311	1382	1020	1481	2079
Tinsukia	A	68.9	69.0	68.0	59.5	65.0	63.4	65.1	66.7	60.44	65.73	62.32
	P	101.1	95.0	90.9	81.2	77.0	76.1	98.9	99.8	75.55	94.46	105.84
	Y	1467	1377	1337	1364	1185	1200	1519	1496	1250	1437	1724
Udalguri	A	-	-	-	-	-	-	-	-	79.55	94.31	90.62
	P	-	-	-	-	-	-	-	-	64.5	123.73	13.1
	Y	-	-	-	-	-	-	-	-	810	1312	1465
Assam	**A**	**2490.0**	**2527.7**	**2525.7**	**2450.5**	**2503.4**	**2489.8**	**2420.1**	**2610.1**	**2189**	**2484.13**	**2503.20**
	P	**3270.2**	**3197.2**	**3361.1**	**3309.1**	**3390.0**	**3382.9**	**3254.8**	**3860.7**	**2916**	**4069.99**	**5193.38**
	Y	**1313**	**1265**	**1331**	**1350**	**1354**	**1359**	**1345**	**1479**	**1332**	**1638**	**2101**

Source: (I) Hand Book of Statistics-B, Directorate of Rice Development, Patna (India), (ii) Rice Almanac, Rice Knowledge Management Portal (RKMP), Hyderabad (2009) (ii) Directorate of Agriculture, Govt. of Assam

Table-III.5: State-wise amount of institutional, non-institutional and all sources borrowings in India: (Rs./ha at 1993-94 prices)

State	Institutional Sources				Non-Institutional Sources				Average amount of borrowing (All sources)			
	1992	2003	2013	CAGR*	1992	2003	2013	CAGR*	1992	2003	2013	CAGR*
Andhra Pradesh	504 (25.6)	2418 (37.5)	2827 (41.6)	8.2	1466	4030	3974	4.6	1970	6448	6801	5.8
Arunachal Pradesh	81 (56.5)	71 (78.4)	443 (80.0)	8.0	62	19	111	2.7	143	90	554	6.4
Assam	**148 (45.0)**	**336 (46.4)**	**716 (71.5)**	**7.4**	**181**	**387**	**285**	**2.1**	**330**	**723**	**1001**	**5.2**
Bihar	275 (51.2)	387 (23.5)	1362 (28.9)	7.5	261	1259	3348	12.3	536	1646	4710	10.4
Chhattis garh	222 (74.4)	495 (57.3)	774 (64.6)	5.8	76	369	424	8.1	299	864	1199	6.5
Gujarat	582 (74.7)	1976 (75.7)	1551 (65.2)	4.6	197	633	829	6.8	780	2608	2380	5.2
Haryana	578 (52.7)	4308 (61.8)	2552 (61.0)	7.0	519	2666	1629	5.3	1097	6974	4181	6.3
Himachal Pradesh	1121 (60.3)	2624 (57.2)	9167 (85.2)	10.0	738	1967	1598	3.6	1859	4591	10765	8.3
J & K	296 (42.8)	1097 (82.7)	3008 (72.5)	11.1	396	229	1139	4.9	692	1326	4147	8.5

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Jharkhad	203 (94.4)	1609 (90.9	692 (44.9)	5.7	12	160	850	21.4	215	1769	1542	9.4
Karnataka	465 (62.8)	1817 (62.5)	2884 (53.6)	8.7	276	1090	2493	10.5	740	2907	5378	9.4
Kerala	4819 (81.8)	19270 (81.6)	60500 (79.2)	12.2	1073	6587	15921	13.0	5893	35857	76421	12.4
Madhya Pradesh	326 (57.8)	1035 (62.3)	1160 (62.0)	5.9	238	627	712	5.1	564	1662	1872	5.6
Maharashtra	721 (77.1)	1833 (78.1)	2066 (71.5)	4.9	215	513	823	6.3	936	2347	2890	5.3
Manipur	119 (53.2)	111 (7.8)	278 (33.7)	3.9	105	1316	549	7.8	224	1426	827	6.1
Meghalaya	45 (91.9)	70 (38.1)	316 (79.7)	9.3	4	114	81	14.6	49	185	397	10.0
Mizoram	98 (68.2)	282 (84.5)	676 (92.0)	9.2	46	52	59	1.1	144	334	734	7.7
Nagaland	164 (72.8)	911 (71.3)	360 (65.3)	3.6	61	367	191	5.3	225	1278	551	4.2
Odisha	209 (70.2)	1236 (69.3)	1600 (63.0)	9.7	89	548	941	11.3	298	1784	2542	10.2
Punjab	1398 (59.3)	5478 (53.8)	5414 (62.1)	6.4	961	4701	3304	5.8	2359	10179	8718	6.1
Rajasthan	166 (30.3)	483 (38.7)	1445 (46.1)	10.3	383	765	1692	7.0	550	1247	3137	8.2
Sikkim	390 (98.6)	1605 (75.8)	6064 (96.1)	13.3	6	512	245	18.4	395	2117	6309	13.4
TN	2388 (61.9)	6988 (46.6)	10350 (62.2)	6.9	1469	7998	6289	6.8	3857	14987	16638	6.9
Tripura	895 (84.0)	2449 (74.0)	1410 (61.6)	2.1	170	859	880	7.8	1066	3308	2290	3.5
UP	395 (54.8)	1164 (53.6)	2313 (60.7)	8.4	325	1007	1501	7.2	721	2171	3814	7.9
Uttarakhand	557 (29.0)	709 (53.9)	7105 (80.0)	12.3	1367	606	1776	1.2	1924	1315	8881	7.2
WB	641 (55.5)	1494 (48.6)	3285 (51.5)	7.7	514	1578	3088	8.5	1155	3072	6373	8.1
All-India	**545 (55.7)**	**1916 (57.1)**	**2926 (60.3)**	**7.9**	**435**	**1440**	**1924**	**7.0**	**980**	**3356**	**4850**	**7.5**
CV (%)	**145.1**	**206.2**	**236.1**	**34.9**	**108.2**	**131.1**	**152**	**62.1**	**118.1**	**168.2**	**208.4**	**30.9**

Note: Figure within the parentheses indicates percentage of institutional credit. * CARG during 1992 to 2013.
Source: Unit level data on Debt and Investment Surveys, 48th (1992), 59th (2003) and 70th (2013) rounds, National Sample Survey Organization, New Delhi

Table-IV.1: Area, Production and Yield of Jute in major jute producing states in India from 2000-01 to 2015-16: (A: Area in '000 ha; P: Production in '000 bales of 180 kg per bale; Y: Yield in Qtl/ha)

Year	Item	Jute Producing States					
		West Bengal	Bihar	Assam	Andhra Pradesh	Others	All India
2000-01	A	617	108	82	82	97	986
	p	7200	1100	1000	650	523	105
	Y	21	18	22	14	13.77	19.3
2001-02	A	518	108	86	72	89	873
	p	604	95	100	56	45	9000
	Y	21	16	21	14	12.75	18.5
2002-03	A	652	120	90	82	76	1020
	p	7720	1200	1000	640	405	11000
	Y	21.00	18.00	20.00	14.00	13.82	19.35
2003-04	A	546	90	72	71	42	83.9

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	P	6370	900	800	550	380	9000
	Y	21.00	18.00	20.00	14.00	13.28	19.35
2004-05	A	577.6	150.0	63.1	53.0	72.1	915.8
	p	7934.9	1180.2	435.8	458.0	263.5	10272.3
	Y	13.70	7.9	6.90	8.6	4.85	11.2
2005-06	A	569.3	147.5	62.7	50.0	68.2	897.7
	p	8114.5	1386.6	603.6	455.0	279.9	10839.6
	Y	14.2	9.4	9.6	9.1	5.6	12.1
2006-07	A	605.6	141.2	63.0	62.0	63.3	935.1
	p	8506.0	1389.8	583.3	544.0	249.9	1127.0
	Y	14.0	9.8	9.2	8.8	5.2	12.1
2007-08	A	617.2	154.2	65.0	57.0	66.9	960.3
	p	8293.5	1464.9	683.7	501.0	267.4	11210.5
	Y	13.44	9.5	10.52	8.79	8.52	11.67
2008-09	A	592.1	150.9	65.4	37.0	55.5	900.9
	p	7965.5	1220.1	674.3	295.0	210.4	10365.3
	Y	13.45	8.09	10.31	7.97	6.66	11.51
2009-10	A	623.6	141.8	62.0	23.0	62.3	912.7
	p	8893.3	1181.7	638.0	188.0	202.9	11103.9
	Y	14.26	8.33	10.29	8.17	1.76	12.17
2010-11	A	580.8	145.0	67.3	25.0	68.3	827.2
	p	8214.3	1310.4	650.7	224.0	780.2	10620.2
	Y	23.86	15.80	17.10	16.13	9.81	17.22
2011-12	A	608	158	67	0	68	901
	p	8800	1930	795	0	384	10690.7
	Y	26.05	21.99	21.36	0	5.35	-
2012-13	A	577	139.1	70.0	25.0	61.33	827.7
	p	8349.0	1690.0	823.0	225.0	319.71	11406.7
	Y	26.05	21.82	21.66	16.20	12.96	23.53
2013-14	A	0	0	81	133	99	866.5
	p	0	0	823	1540	531.4	11416
	Y	0	0	18.29	20.84	16.56	23.72
2014-15	A	576.1	111.2	75.0	7.0	33.6	802.9
	p	8969	1500	795	50	180	11494
	Y	28.02	24.28	19.08	12.86	5.54	25.77
2015-16	A	519	113.4	76.4	5.6	100.1	742.5
	p	8075	0	767	0	0	8842
	Y	28.01	0	19.17	0	0	0

Source: (i) The Jute Commissioner, Kolkata; (ii) Directorate of Jute Development, Ministry of Agriculture, Govt. of India; (iii) Directorate of Economics and Statistics, Department of Agriculture and cooperation; Economic Survey, 2011-12.

Table-IV.2: Index Number of Area, Production and Productivity of Jute in Assam and India from 1970-71: (Base triennium ending 1969-70=100, 1981-82=100 & 2007-08=100)

Year	Assam			India		
	Area	Production	Productivity	Area	Production	Productivity
1970-71	-	-	-	86.4	76.5	88.6
1980-81	-	-	-	108.5	100.8	92.9
1990-91	-	-	-	89.7	122.6	136.6
2000-2001 (P)	65.50	78.24	119.45	95.5	144.2	151.0
2001-02	-	-	-	100.7	163.8	162.7
2002-03	63.99	80.88	126.39	-	-	-
2004-05	-	-	-	89.3	145.5	163.0
2005-06	53.48	67.78	126.74	87.7	154.3	176.1
2006-07	54.34	65.40	120.35	91.5	159.7	174.6
2007-08	-	-	-	93.9	158.2	168.4
2008-09	56.64	64.1	113.17	90.6	149.1	163.5
2009-10	-	-	-	93.6	173.8	185.8

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2010-11	104.05	95.24	91.53	88.6	154.7	174.7
2011-12 *	109.56	92.57	84.50	102.6	107.1	104.4
2012-13*	108.77	84.95	78.10	-	-	-
2013-14*	116.68	109.20	93.59	-	-	-

*Base triennium ending 2007-08=100

Source: Statistical Hand Book Assam, Different Issues; Economic Survey 2009-10, Economic Survey Assam, 2007-08.

Table-V.1: Fertilizer recommendation for initial four years (for the period of April-May)

Year of Planting	Month after planting	Dose of Mixture (g/plant)		Quantity per hectare (kg)	
		NPK Mg 10-10-4-1.5	NPK 12-12-6	NPK Mg 10-10-4-1.5	NPK 12-12-6
First Year	0	Not Required		Not Required	
Second Year	9	450	380	200	190
Third Year	21	550	480	250	215
Fourth Year*	33	450	380	200	170

* In areas where no legume ground cover was established or no intercrops were grown, the doses of fertilizers recommended for the third year may be continued during the fourth year also.

Source: Rubber Board Bulletin, 2016

Table-V.2: Cost of Establishment of Rubber Plantations by Individual Grower (Rs/ha):

Sl. No.	Particulars	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	Total	% of Total
1	Preparatory Operation	3674	-	-	-	-	-	3674	5.6
2	Lining & Pitting	2355	-	-	-	-	-	2355	3.6
3	Cost of Planting Material	2884	-	-	-	-	-	2884	4.4
4	Filling & Planting	7534	-	-	-	-	-	7534	11.5
5	Fertilizer & Manure	1350	1340	1889	683	1640	2759	9661	14.7
6	Cultural Operation	292	2264	2264	4259	4163	3542	16784	25.6
7	Plant Protection	37	266	336	586	547	462	2234	3.4
8	Current Crop establishment	1388	333	100	193			2014	3.1
9	Boundary, Drainage & Footpath	5924	3470	1536	1140	1367	1422	14859	22.6
10	Watch, Ward & Miscellaneous	759	475	621	444	795	527	3621	5.5
11	Total Establishment Cost	26197	8148	6746	7305	8512	8712	65620	100
12	Percentage of Total	39.9	12.4	10.3	11.1	13.0	13.3	100	

Source: Nath (2009)

Table-V.3: Cost of Maintenance of Rubber Plantations by Individual Grower (Rs/ha):

Sl. No.	Items	Labour Cost	Material Cost	Total	% to Total
1	Fertilizer, manure and Application	276	1976	2252	5.9
2	Cultural protection	1261		1261	3.3
3	Plant protection	1310	835	2145	5.6
4	Tapping	24968	331	25299	66.3
5	Processing and marketing	2933	3294	6227	16.3
6	Miscellaneous	641	326	967	2.6
7	Total	31389	6762	38151	100
8	Percentage to Total	82.28	17.72	100	

Source: Nath (2009)

Table-VII.1: Output Regression of Winter Rice (T) (OLS): **Goalpara** No. of observations = 92

Variables	Co-efficient			
	M-1	M-2	M-3	M-4

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Land (lnLn)	**0.7520896***	**0.7208131***	**0.8228887***	**0.8450815***
Labour (lnL)	0.1879374	**0.2197844*****	0.1214159	0.1111402
Capital (lnCa & lnCt)	0.0100105	0.0179323	**0.0618034*****	**0.5472804***
Irigation proportion (lnIr)	0.082165	0.0063818	**0.1385131*****	**0.1478085*****
Fertilizer (lnF)	**0.0286355****	**0.0302137***	0.0969502	0.0937915
Fragmentation (lnFrag)			-0.0128177	**-1.865131***
Family size (lnFam)			-0.0765433	-0.0952181
Age (lnAge)			0.1009585	0.096681
d_Primary			-0.0020039	-0.0348404
d_Matric			0.0193445	0.0323215
d_High			-0.1438101	-0.140386
d_Expv			**-0.5884964***	**-0.6103354***
d_Expb			**-0.3843802****	**-0.3853675****
d_Crinf			0.0256626	0.0595269
d_Crfm			0.0067072	0.0433717
d_C_a & d_C_t			-0.4140546	**3.377215****
d_Ir			-0.5003724	-0.5007023
d_F			-0.4801502	-0.4505347
-cons	**6.090309***	**5.916855***	**6.4874***	**6.53832***

*: p < 0.01; **: p<0.05; ***: p < 0.1
Source: calculated from field data

Table-VII.2: Output Regression of Winter Rice (T) (OLS): **Bongaigaon** No. of observations = 92

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnLn)	**0.9761807***	**1.036039***	**0.9533963***	**1.071219***
Labour (lnLb)	-0.0237247	-0.0705051	0.0398834	-0.0692282
Capital (lnCa& lnCt)	**-0.0196419*****	-0.0044042	**-0.0498703****	-0.1540819
Irrigation proportion (lnIr)	0.0060096	0.0009329	-0.1920522	-0.152245
Fertilizer (lnF)	-0.0036473	-0.0033259	**-0.1539905****	**-0.1428963****
Fragmentation (lnFrag)			**0.0901522*****	0.5049244
Family size (lnFam)			0.0426345	-0.383583
Age (lnAge)			-0.1173467	-0.1464517
d_Primary			**-0.2388379*****	**-0.2495791*****
d_Matric			**-0.2617714*****	**-0.2392656*****
d_High			-0.2054275	-0.1858707
d_Expv			**0.2040966*****	**0.2127655*****
d_Expb			0.0586674	0.0780339
d_Crinf			-0.0605927	0.0808599
d_Crfm			**-0.1345155*****	**-0.1558407*****
d_C_a & d_C_t			0.2028876	-0.7132546
d_Ir			0.8588108	0.6826488
d_F			**1.15614****	**1.074342****
-cons	**7.120737***	**7.159806***	**7.0588354***	**7.559916***

*: p < 0.01; **: p<0.05; ***: p < 0.1
Source: Calculated from field data.

Table-VII.3: Output Regression of Winter Rice (M) (OLS): **Goalpara** No. of observations = 21

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnLn)	**0.8079622***	**0.716349***	**.8784875****	**.7018198***
Labour (lnLb)	0.1430506	0.0706079	-.086702	.3006276

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Capital (lnCa & lnCt)	0.043605	**0.2831321****	.1254331	-.1062184
Irrigation proportion (lnIr)	-0.0440946	**-0.0804217*****	**.5204875****	**.7044119***
Fertilizer (lnF)	0.126694	0.1690882	.1659067	.7044119
d_Ca and d_Ct			-1.104745	No dummy
d_Ir			**-2.531319****	**-3.424156***
d_F			No dummy	No dummy
Fragmentation (lnFrag)			.0046608	.125829
Family size (lnFam)			**-.5747844****	**-.6036315****
Age (lnage)			-.0969656	.4062513
d_Primary			--------	--------
d_Matric			-.2437282	.0092761
d_High			-.1210396	.3994456
d_Expv			-.2834068	-.127335
d_Expb			--------	--------
d_Crinf			-.1837798	-.4462277
d_Crfm			-.3345736	**-.5872123****
-cons	**5.924901***	**3.793782***	**8.576844****	**7.023395****

*: p < 0.01; **: p<0.05; ***: p < 0.1
Source: calculated from field data

Table-VII.4: Output Regression of Winter Rice (M) (OLS): **Bongaigaon** No. of observations = 57

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnLn)	**0.8041412***	**0.8010306***	**0.8207473***	**.8369068***
Labour (lnLb)	0.0312186	0.0553648	-0.0002624	-.0183158
Capital (lnCa & lnCt)	0.0099815	-0.0105362	-0.0139293	-.0021443
Irrigation proportion (lnIr)	-0.0304489	-0.0234824	-0.212725	-.2540225
Fertilizer (lnF)	0.0118198	0.0126684	0.0761594	.0820801
d_Ca and d_Ct			0.1825581	No dummy
d_Ir			0.8356243	1.021501
d_F			-0.2670977	-.2776777
Fragmentation (lnFrag)			0.0313063	.0238075
Family size (lnFam)			-0.0103529	.0109921
Age (lnAge)			0.1605921	.2212618
d_Primary			-------	---------
d_Matric			-0.0775864	-.0652698
d_High			-0.1587686	-.1605474
d_Expv			-0.1510819	-.1592882
d_Expb			0.1242528	.0977625
d_Crinf			**0.2518018*****	**.2503763*****
d-Crfm			-0.0055508	-.0125241
-cons	**7.006813***	**7.071738***	**6.459414***	**6.315128***

*: p < 0.01; **: p<0.05; ***: p < 0.1
Source: calculated from field data

Table-VII.5: Output Regression of Jute (OLS): **Goalpara:** No. of observations = 68

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnLn)	**.9655271***	**.9751658***	**1.115929***	**1.118484***
Labour (lnLb)	-.125028	-.1357025	-.1059861	-.1079193
Capital (lnCa& lnCt)	.010052	.0466009	.019713	.0086612

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Fertilizer (lnF)	.0100279	.0056367	-.1152362	-.1149634
Pesticides&weedicides(lnPW)	-.0038311	-.0063387	-.0343878	-.0329823
d_Ca & d_Ct			-.1312923	No dummy
d_F			.8835738	.8726779
d_PW			.0732919	.0608703
Family size (lnFam)			-.1080615	-.11167
Age (lnAge)			.0283048	.0378482
Fragmentation (lnFrag)			-.1590435	-.1623856
d_Primary			.1629622	.1517238
d_Matric			-.1242727	-.1244432
d_High			.2069518	.2136043
d_Expv			--------	----------
d_Expb			**.302875***	**.3046293***
d_Crinf			**.2734354*****	**.2707076*****
d_Crfm			.2182804	.229213
-cons	**7.256304***	**7.049439***	**7.234***	**7.168123***

*: p < 0.01; **: p<0.05; ***: p < 0.1
Source: calculated from field data

Table-VII.6: Output Regression of Jute (OLS): **Bongaigaon:** No. of observations = 47

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnLn)	**1.002941***	**.9976208***	**1.020182***	**.9779957***
Labour (lnLb)	-.0915551	-.0613585	-.2026459	-.21181
Capital (lnCa & lnCt)	-.0055335	.0112873	-.0136201	-.0314781
Fertilizer (lnF)	-.0017133	.0000985	-.0746134	-.0524083
Pesticides&weedicides (lnPW)	-.0158112	-.0182722	**.1194578****	**.1175269****
d_Ca & d_Ct			-.022751	No dummy
d_F			.5082977	.384898
d_PW			**-.7274837****	**-.7348674****
Family size (lnFam)			**.1571913****	**.1594093****
Age (lnAge)			.0972841	.0932271
Fragmentation (lnFrag)			.0893258	.1038209
d_Primary			.0545302	.0242447
d_Matric			-.0003151	-.0259656
d_High			**.2356559****	**.1989631****
d_Expv			-.1599627	-.1517114
d_Expb			-.2118027	**-.2073002*****
d_Crinf			**-.1137499*****	**-.12955*****
d_Crfm			-.0660741	-.053693
-cons	**7.463275***	**7.247843***	**7.32898***	**7.46444***

*: p < 0.01; **: p<0.05; ***: p < 0.1
Source: Calculated from field data.

Table-VII.7: Output Regression of Rubber (OLS): **Goalpara:** No. of observations= 52

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnLn)	0.2956885	.2250176	.4246655	.3835839
Labour (lnLb)	0.177428	.2477228	.127098	.1587094
Capital (lnCa & lnCt)	0.1066509	.0855533	.0922066	.0841426
Fertilizer (lnF)	0.2330306	.2141668	.2513537	.2437963
Pesticides&weedicides(lnPW)	-0.1360971	-.1301079	-.0994833	-.0937798
Planting Materials (lnPM)	**0.5337899***	**.5293626***	**.5032333****	**.5071567****

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d_PM	**-3.673411***	**-3.649506****	**-3.647967*****	**-3.679862*****
d_F	**-2.136391*****	**-1.983169*****	**-2.279714*****	-2.216252
d_PW	0.8912607	.8544185	.5669561	.5239486
Family size (lnFam)			.0995168	.1127248
Age (lnAge)			.0262895	.0185821
Fragmentation (lnFrag)			.0530171	.0551418
d_Primary			**-.9768234****	**-1.003355****
d_Matric			-.5186566	-.5206484
d_High			-.6230048	-.6307795
d_Expv			-.035512	-.0498579
d_Expb			---------	---------
d_Crinf			.4112993	.413256
d_Crfm			--------	---------
-cons	**4.89838*****	**4.934383*****	**5.7242*****	**5.810345*****

*: p < 0.01; **: p<0.05; ***: p < 0.1
Source: calculated from field data

Table-VII.8: Output Regression of Rubber (OLS): **Bongaigaon:** No. of observations= 50

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnln)	.3709144	.3775803	.7916546	.7903961
Labour (lnl)	**1.314222****	**1.309293****	.7750103	.7753004
Capital (lnC_a & lnC_t)	.0002712	.0080613	.0170275	.0221209
Fertilizer (lnF)	**-.298875*****	**-.2982233*****	-.2846844	-.2840157
Pesticides&weedicides(lnPW)	.0444403	.0374263	-.00323	-.0078231
Planting Materials (lnPM)	-.3802689	-.3783192	-.2117015	-.2069987
d_PM	3.607707	3.590665	1.93394	1.889139
d_F	**2.485109****	**2.487158****	**2.548669*****	**2.555363*****
d_PW	.1802797	.2333717	.1265218	.1561276
Family size (lnFam)			.3044158	.3041225
Age (lnAge)			.3757253	.3719774
Fragmentation (lnFrag)			-.3916384	-.3922111
d_Primary			.1491	.1480166
d_Matric			.4558314	.4495092
d_High			.2103029	.2007729
d_Expv			-.0309615	-.0321444
d_Expb			--------	--------
d_Crinf			-.3401459	-.3491295
d_Crfm			--------	--------
-cons	-.8948106	-.9412154	-.3625167	-.353929

*: p < 0.01; **: p<0.05; ***: p < 0.1
Source: Calculated from field data.

Table-VII.9: Output Regression of Winter Rice (T) (SF): **Goalpara:** No. of observations=92

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnLn)	**0.7520896***	**0.7208131***	**.8228889***	**.8451275***
Labour (lnLb)	0.1879374	**0.2197844*****	.1214159	.1111184
Capital (lnCa & lnCt)	0.0100105	0.0179323	**.0618034****	**.5472497***
Irrigation proportion (lnIr)	0.0082165	0.0063818	**.1385131*****	**.1478378****
Fertilizer (lnF)	**0.0286355****	**0.0302137***	.0969502	.0937644
Fragmentation (lnFrag)			-.0128177	**-1.86502***
Family size (lnFam)			-.0765434	-.0952377

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Age of H/H (lnAge)			.1009586	.0966312
d_Primary			-.0020039	-.0346959
d_Matric			.0193445	.0323224
d_High			-.1438102	-.1403881
d_Expv			**-.5884967***	**-.6104214***
d_Expb			**-.3843804****	**-.3854504***
d_Crinf			.0256626	.0595799
d_Crfm			.0067072	.0433686
d_Ca & d_Ct			-.4140546	3.377091*
d_Ir			-.5003725	-.5007359
d_F			-.4801502	-.450321
_cons	**6.091604***	**5.918159***	**6.489074***	**6.548938***
μ	-0.1059634	-0.1450136	-.1429403	-0.1299712
lnsigma2	**-1.807873***	**-1.810762***	**-2.097402***	**-1.842934***
Ilgtgamma	-7.003326	-6.682133	-6.19468	-6.549447
sigma2	0.1640026	0.1635294	.122775	0.1583522
Gamma	0.000908	0.0012515	.0020361	0.0014289
sigma_u2	0.0001489	0.0002047	.00025	0.0002263
sigma_v2	0.1638537	0.1633247	.122525	0.1581259

Ho: No inefficiency component; z = 4.800, 4.691, 3.107, 4.796 prob<=z=1.000, 1.000, 0.999, 1.000
*: p < 0.01; **: p<0.05; ***: p < 0.1
Source: Calculated from field data.

Table-VII.10: Output Regression of Winter Rice (T) (SF): **Bongaigaon** No. of observations = 92

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnLn)	**0.7520896***	**0.7208131***	**0.9854795***	**0.9394875***
Labour (lnLb)	0.1879374	**0.2197844*****	0.0363461	**0.0366578***
Capital (lnCa & lnCt)	0.0100105	0.0179323	-0.0164545	**0.0294812***
Irrigation proportion (lnIr)	0.0082165	0.0063818	**-0.180668*****	**-0.079028***
Fertilizer (lnF)	**0.0286355***	**0.0302137***	**-0.1709872***	**-0.1130002***
Fragmentation (lnFrag)			-0.0547652	**-0.1160562***
Family size (lnFam)			-0.0740308	**0.0518776***
Age of H/H (lnAge)			**-0.3411703****	**-0.3970568***
d_Primary			**-0.2753129****	**-0.1066181***
d_Matric			**-0.2640346****	**-0.183166***
d_High			**-0.2375895*****	**-0.2185193***
d_Expv			0.0771392	**0.2059538***
d_Expb			-0.0929404	**0.0095437***
d_Crinf			0.042946	**-0.0158578***
d_Crfm			**-0.1192833****	**-0.0981157***
d_Ca & d_Ct			0.0557906	**0.1604387***
d_Ir			**0.8389577****	**0.3234232***
d_F			**1.230992***	**0.9074603***
_cons	**6.091604***	**5.918159***	**8.729382***	**8.17765***
μ/lnsig2v#	-0.1059634	-0.1450136	**-4.387447***	-40.35655
lnsigma2/lnsig2u#	-1.807873	**-1.810762***	**-2.897811***	**-2.402301***
Ilgtgamma/sigma_v#	-7.003326	-6.682133	0.1115008	1.72e-09
sigma2/sigma_u#	**0.1640026***	0.1635294	0.2348272	0.3008479
Gamma/lambda#	0.000908	0.0012515	2.106059	1.74e+08
sigma_u2/sigma2#	0.0001489	0.0002047	0.0675762	0.0905094
sigma_v2	0.1638537	0.1633247		

Ho: No inefficiency component; z = 4.800, 4.691, prob<=z=1.000, 1.000
LR test of sigma_u=0: chibar2 (01)=24.57, 54.13 Prob>=chibar2 =0.000, 0.000

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*: p < 0.01; **: p<0.05; ***: p < 0.1; # exponential method

Source: Calculated from field data.

Table-VII.11: Output Regression of Winter Rice (M) (SF): **Goalpara** No. of observations = 21

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnln)	**1.206655***	**.9932849***	**.8784835***	**.7018253***
Labour (lnl)	**-0.2121451***	-.093411	-.0867009	**.3006432****
Capital (lnC_a & lnC_t)	**0.0623206***	**.2434025***	**.1254324****	-.1062438
Irrigation proportion (lnIr)	**-0.0443424***	**-.0700735****	**.5204855***	**.7044427***
Fertilizer (lnF)	**0.1827281***	**.2276732****	**.165906****	.0206881
d_Ca			**-1.104739***	No dummy
d_Ir			**-2.53131***	**-3.424282***
d_Primary			--------	--------
d_Matric			**-.2437265****	.009267
d_High			-.1210376	**.3994195***
d_Expv			--------	--------
d_Expb			**.2834049***	.127357
d_Crinf			-.1837794	**-.4462522***
d_Crfm			**-.3345727***	**-.5872218***
Fragmentation (lnFrag)			.0046611	.1258128
Family size (lnFam)			**-.5747816***	**-.6036731***
Age of H/H (lnAge)			-.096964	**.4062178***
_cons	**6.976765***	4.531939	**8.294382***	**6.898552***
μ	-	-	-1.298303	-.6928241
/lnsig2v//lnsigma2	-39.9606	**-3.378461***	-4.379919	-4.066795
/lnsig2u//ilgtgamma	**-2.263683***	**-3.078615***	-2.197937	-2.423831
sigma_v/ sigma2	2.10e-09	.1846616	.0125264	.0171322
sigma_u/ gamma	0.3224389	.2145296	.0999359	.0813734
sigma2/ sigma_u2	0.1039668	.0801228	.0012518	.0013941
lambda/ sigma_v2	1.53e+08	1.161745	.0112745	.0157381

Likelihood-ratio test of sigma_u=0 & 0; chibar2 (01) =14.97, 1.35 prob>=chibar2=0.000, 0.122
H0: No inefficiency component: z = 1.094, 0.466 Prob<=z = 0.863, 0.679
*: p < 0.01; **: p<0.05; ***: p < 0.1; M-1 &2 exponential method; M-3 &4 tnormal method

Source: Calculated from field data.

Table-VII.12: Output Regression of Winter Rice (M) (SF): **Bongaigaon** No. of observations=57

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnLn)	**.9216617***	**.8843347***	**.9944281***	**.9645701***
Labour (lnLb)	-.0341119	.0058336	-.1193727	-.106508
Capital (lnCa & lnCt)	.0162341	.0142771	.0238569	.0431565
Irrigation proportion (lnIr)	-.0271291	-.0209192	-.1197709	-.0914846
Fertilizer (lnF)	.0265148	.0288269	**.0974078****	**.1130937****
d_Ca & d_Ct			-.1277267	No dummy
d_Ir			.3764231	.2496335
d_F			-.2234454	-.3055142
d_Primary			d_primary dropped due to collinearity	d_primary dropped due to collinearity
d_Matric			-.0182065	.0015669

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d_High			-.1525882	-.1441979
d_Expv			-.102337	-.1060109
d_Expb			.1130096	.1011888
d_Crinf			**.205636****	**.2028313****
d_Crfm			.0087104	-.0083743
LnFam			.0026778	.0193846
LnAge			.1811847	.2115653
LnFrag			-.0008793	-.0239262
_cons	**7.316047***	**7.163878***	**6.768707***	**6.297232***
/lnsig2v	**-3.528707***	**-3.525163***	**-3.876581***	**-3.898126***
/lnsig2u	**-2.963424***	**-2.908554***	**-3.250243***	**-3.226671***
sigma_v	.1712975	.1716013	.1439498	.1424074
sigma_u	.2272483	.2335691	.1968878	.199222
sigma2	.0809846	.0840015	.0594863	.0599693
Lambda	1.32663	1.361115	1.367753	1.398958

Likelihood-ratio test of sigma_u=0: chibar2 (01) = 16.16, 14.97, 15.84, 16.13 Prob>=chibar2 = 0.000, 0.000, 0.000, 0.000

*: p < 0.01; **: p<0.05; ***: p < 0.1;

Source: Calculated from field data.

Table-VII.13: Output Regression of Jute (SF): **Goalpara** No. of observations=68

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnLn)	**1.049727***	**1.051311***	**1.02319***	**1.023859***
Labour (lnL)	**.1306983***	**.2551791***	**.023805***	**.2926291***
Capital (lnCa & lnCt)	**-.020777***	**-.0089643***	**.024458***	**-.0197986***
Fertilizer (lnF)	**.0370934***	**.0276617***	**.0007865***	**-.0215068***
Pesticides & weedicides (lnPW)	**.0105052***	**.0407536***	**-.0403429***	**-.0355386***
d_Ca & d_Ct			**-.2634428***	-------
d_F			**.0777359***	**.1703977***
d_PW			**.1466966***	**.157667***
d_Primary			**.0014306***	**-.1999865***
d_Matric			**-.1498483***	**-.1413955***
d_High			**-.0897392***	**-.010222***
d_Expv			-------	-------
d_Expb			**.1578171***	**.1037254***
d_Crinf			**.2294021***	**.1678444***
d_Crfm			**.0683038***	**-.0215365***
lnFam			**-.1288056***	**-.207807***
lnAge			**-.1867383***	**-.269206***
lnFrag			**.0221388***	**.0049599***
_cons	**6.835176***	**6.382412***	**8.092048***	**7.862017***
/lnsig2v	-38.84922	-38.98229	-39.0661	-39.14457
/lnsig2u	**-1.670215***	**-1.544773***	**-2.560546***	**-2.536331***
sigma_v	3.66e-09	3.43e-09	3.29e-09	3.16e-09
sigma_u	.4338278	.4619095	.2779614	.2813473
sigma2	.1882066	.2133604	.0772625	.0791563
Lambda	1.18e+08	1.35e+08	8.45e+07	8.90e+07

Likelihood-ratio test of sigma_u=0: chibar2 (01) = 49.48, 40.97, 92.25, 90.76 Prob>=chibar2 = 0.000, 0.000, 0.000, 0.000.

*: p < 0.01; **: p<0.05; ***: p < 0.1;

Source: Calculated from field data.

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Table-VII.14: Output Regression of Jute (SF): **Bongaigaon** No. of observations = 47

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnLn)	**.9734004***	**.9717482***	**.8496245***	**.8350431***
Labour (lnL)	-.1359936	-.1433123	**-.532427***	**-.613542***
Capital (lnCa & lnCt)	-.0104372	-.0083746	**-.0100559***	**-.0316643***
Fertilizer (lnF)	.0018307	.0070256	**-.0169378***	**-.0153594***
Pesticides&weedicides(lnPW)	-.0029629	-.0082853	**.0720215***	**.0783372***
d_F			**.083967***	**.0629224***
d_PW			**-.240248***	**-.2733439***
d_C_a & d_C_t			**.0129654***	**----**
d_Primary			**-.1967933***	**-.23818***
d_Matric			**-.0696493***	**-.0813197***
d_High			**.0637503***	**.0456677***
d_Expv			**-.0003397***	**.0097672***
d_Expb			**-.1867352***	**-.1903289***
d_Crinf			**-.1343882***	**-.1938993***
d_Crfm			**.1659053***	**.1413933***
Fragmentation (lnFrag)			**.2610344***	**.2815415***
Family size (lnFam)			**.0613646***	**.0835247***
Age (lnAge)			**-.0888308***	**-.0669122***
-cons	**7.703787***	**7.689973***	**8.969476***	**9.296614***
/mu &lnsig2v	-1.382822	-2.035166	-37.81505	-38.3136
/lnsigma2 &/lnsig2u	-1.331535	-1.112111	**-4.219185***	**-4.168045***
/ilgtgamma &/sigma_v	3.36491	3.302397	6.15e-09	4.79e-09
sigma_u			.1212874	.1244287
sigma2	.2640716	.3288639	.0147106	.0154825
gamma &lambda	.9665897	.964511	1.97e+07	2.60e+07
sigma_u2	.2552489	.3171928		
sigma_v2	.0088227	.0116711		

H0: No inefficiency component: z = -1.425, -1.137 Prob<=z = 0.077, 0.128
Likelihood-ratio test of sigma_u=0: chibar2 (01) = 38.37,39.76 Prob>=chibar2 = 0.000, 0.000
*: p < 0.01; **: p<0.05; ***: p < 0.1;
Source: Calculated from field data.

Table-VII.15: Output Regression of Rubber (SF): **Goalpara** No. of observations = 52

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnLn)	.6745663	.6798838	**-.9815382***	**-.9815386***
Labour (lnL)	.0253124	.0279194	**.9191186***	**.9191188***
Capital (lnCa & lnCt)	.0636207	.0466874	**.1408825***	**.1408825***
Fertilizer (lnF)	.0123719	.0128488	**.7275598***	**.7275597***
Pesticides&weedicides(lnPW)	.0173263	.0165065	**-.277592***	**-.2775919***
Planting materials (lnPM)	**.1408441***	**.1365095***	**.9146806***	**.9146806***
d_F			**-5.60784***	**-5.60784***
d_PW			**1.497572***	**1.497572***
d_PM			**-7.318433***	**-7.318434***
d_Primary			**-1.157368***	**-1.157368***
d_Matric			**-.3354696***	**-.3354696***
d_High			**-.4715281***	**-.4715283***
d_Expv			**.3026236***	**.3026235***
d_Expb				
d_Crinf			**.0753559***	**.0753559***

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d_Crfm				
Famsize (lnFam)			**-.4583586***	**-.4583586***
Age (lnAge)			**-.2617651***	**-.2617651***
Fragmentation (lnFrag)			**-.0040101***	**-.00401***
-cons	**5.350418****	5.584701	**5.315813***	**5.529126***
/mu &/lnsig2v	-.3626474	-.4538638	-38.4816	-38.13226
/lnsigma2 &/lnsig2u	.0516699	.0941117	**-1.287641***	**-1.260091***
/ilgtgamma &Sigma_v	**2.309081****	**2.29894*****	4.40e-09	5.24e-09
sigma2 &sigma_u	1.053028	1.098682	.5252818	.5325677
sigma2			.275921	.2836284
gamma& lambda	.9096264	.9087893	1.19e+08	1.02e+08
sigma_u2 |	.9578621	.9984708		
sigma_v2	.095166	.1002116		
H0: No inefficiency component:		z = -1.335,-1.381,	Prob<=z = 0.091, 0.084	
Likelihood-ratio test of sigma_u=0 & 0;		chibar2 (01) =39.73, 38.62	prob>=chibar2=0.000, 0.000	

*: p < 0.01; **: p<0.05; ***: p < 0.1
Source: calculated from field data

Table-VII.16: Output Regression of Rubber (SF): **Bongaigaon** No. of observations = 50

Variables	Co-efficient			
	M-1	M-2	M-3	M-4
Land (lnLn)	**-.010656***	**-.0397495***	**-.2756347***	**-.2644164***
Labour (lnLb)	**.7203122***	**.7487663***	**.9457743***	**.9316296***
Capital (lnCa & lnCt)	**.0415425***	**.0423936***	**.049968***	**.0498666***
Fertilizer (lnF)	**.0717795***	**.0725992***	**.1748679***	**.176657***
Pesticides&weedicides(lnPW)	**.0668323***	**.0671951***	**.1629466***	**.1625351***
Planting materials (lnPM)	**.1082749***	**.1085763***	**.277263***	**.2793307***
d_F			**-.5053801***	**-.5208913***
d_PW			**-1.167568***	**-1.166416***
d_PM			**-1.731981***	**-1.751115***
d_Primary			**.8984128***	**.9024416***
d_Matric			**.5406049***	**.5437035***
d_High			**.2976061***	**.2997879***
d_Expv			**-.2678316***	**-.2678074***
d_Expb				
d_Crinf			**-.1361913***	-.1344739
d_Crfm				
Famsize (lnFam)			**-.0335688***	-.0354963
Age (lnAge)			**-.4078856***	-.4131081
Fragmentation (lnFrag)			**-.5580341***	-.5586606
-cons	**1.702759***	**1.638262***	**2.8301***	**2.990052***
/lnsig2v	-36.60884	-36.19701	-38.13183	-36.90682
/lnsig2u	**-.8490424***	**-.8456054***	**-1.292153***	**-1.286223***
Sigma_v	1.12e-08	1.38e-08	5.25e-09	9.68e-09
sigma_u	.6540829	.6552079	.5240979	.5256543
sigma2	.4278244	.4292974	.2746786	.2763124
Lambda	5.82e+07	4.75e+07	9.99e+07	5.43e+07
Likelihood-ratio test of sigma_u=0 & 0;	chibar2 (01) =22.17, 21.97, 27.53, 27.19		prob>=chibar2=0.000, 0.000, 0.000, 0.000	

*: p < 0.01; **: p<0.05; ***: p < 0.1
Source: Calculated from field data.

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Table-VII.17: Summery Statistics for the Explanatory Variables used in WR (T): Aggregate

Variables defined	N	Mean	SD	CV	Min	Max
Land (Ln) (*bigha*)	184	6.02	5.02	5.015	0.5	35
Labour (Lb) (No. of mandays)	184	67.31	64.40	4147.28	2	435
Capital (Ca) (in Rupees)	161	28330.25	79949.62	6391941632.53	300	700500
Capital (Ct) (in Rupees)	176	7857.79	17367.2	301619477.67	66	156474
Irrigation Proportion (Ir) (in %)	29	76.67	32.47	1054.51	25	100
Fertilizer (F) (in Rupees)	99	2398.00	2331.90	5437712.83	300	11800
Family size (Fam) (no. of family members)	184	6.15	3.55	12.95	1	19
Age of the household head (Age) (in year)	184	46.30	10.58	112.03	20	73
Education: Illiterate	24	-	-	-	-	-
Education: below primary	24	-	-	-	-	-
Education: below Matric	72	-	-	-	-	-
Education: matriculation & above	64	-	-	-	-	-
Fragmentation (Frag) (No. of plots)	184	1.72	1.19	1.41	1	10
Extension service	164	-	-	-	-	-
Dummy extension service: private (d_Expv)	79	-	-	-	-	-
Dummy extension service: public (d_Expb)	85	-	-	-	-	-
Credit access	80	-	-	-	-	-
Dummy credit: informal sources (d-Crinf)	44	-	-	-	-	-
Dummy credit: formal sources (d_Crfm)	36	-	-	-	-	-

Note: N: No. of Growers; SD: Standard Deviation; CV: Coefficient of Variance; Min: Minimum; Max: Maximum
Source: Calculated from field data.

Table-VII.18: Summery Statistics for the Explanatory Variables used in WR (M): Aggregate

Variables defined	N	Mean	SD	CV	Min	Max
Land (Ln) (*bigha*)	78	4.45	22.37	165.47	01	20
Labour (Lb) (No. of mandays)	78	53.91	49.415	2441.84	08	220
Capital (Ca) (in Rupees)	68	19940.60	31022.1	962370261.59	400	143355
Capital (Ct) (in Rupees)	78	8996.40	10309.47	106285187.99	220	67341
Irrigation Proportion (Ir) (in %)	31	90.33	22.28	496.53	25	100
Fertilizer (F) (in rupees)	76	596.53	560.54	314209.75	50	3695.00
Fertilizer dummy (d_F) (yes=1; otherwise=0)	78	6.08	2.59	6.70	3	14
Age of the household head (Age) (in year)	78	46.99	9.99	99.73	26	65
Education: Illiterate	14	-	-	-	-	-
Education: below primary	10	-	-	-	-	-
Education: below Matric	32	-	-	-	-	-
Education: matriculation & above	22	-	-	-	-	-
Fragmentation (Frag) (No. of plots)	78	2.72	1.14	1.31	1	5
Extension service	71	-	-	-	-	-
Dummy extension service: private (d_Expv)	46	-	-	-	-	-
Dummy extension service: public (d_Expb)	25	-	-	-	-	-
Credit access	57	-	-	-	-	-
Dummy credit: informal	31	-	-	-	-	-

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sources (d_Crinf)						
Dummy credit: formal sources (d_Crfm)	26	-	-	-	-	-

Note: N: No. of Growers; SD: Standard Deviation; CV: Coefficient of Variance; Min: Minimum; Max: Maximum
Source: Calculated from field data.

Table-VII.19: Summery Statistics for the Explanatory Variables used in Jute: Aggregate

Variables defined	**N**	**Mean**	**SD**	**CV**	**Min**	**Max**
Land (Ln) (*bigha*)	115	2.66	1.785	3.945	0.5	8.75
Labour (Lb) (No. of mandays)	115	22.64	5.11	0.234	10	38
Capital (Ca) (in Rupees)	82	7211.53	21492.52	2.93	300	138300
Capital (Ct) (in Rupees)	115	2160.87	4236.17	1875	88	31276
Fertilizer (F) (in Rupees)	102	1281.75	1193.20	0.933	63	6180
Pesticides and weedicides (PW) (in Rupees)	69	401.20	345.26	0.856	35	1925
Family size (Fam) (no. of family members)	115	6.75	2.885	8.345	1	15
Age of the household head (Age) (in year)	115	46.41	11.476	0.24725	24	75
Education: Illiterate	49	-	-	-	-	-
Education: below primary	07	-	-	-	-	-
Education: below Matric	22	-	-	-	-	-
Education: matriculation & above	37	-	-	-	-	-
Fragmentation (Frag) (No. of plots)	115	1.57	0.79	0.7	1	5
Extension service	110	-	-	-	-	-
Dummy extension service: private (d_Expv)	69	-	-	-	-	-
Dummy extension service: public (d_Expb)	41	-	-	-	-	-
Credit access	42	-	-	-	-	-
Dummy credit: informal sources (d_Crinf)	29	-	-	-	-	-
Dummy credit: formal sources (d_Crfm)	13	-	-	-	-	-

Note: N: No. of Growers; SD: Standard Deviation; CV: Coefficient of Variance; Min: Minimum; Max: Maximum
Source: Calculated from field data.

Table-VII.20: Summery Statistics for the Explanatory Variables used in Rubber: Aggregate

Variables defined	**N**	**Mean**	**SD**	**CV**	**Mini**	**Max**
Land (Tapped area) (Ln) (ha)	102	5.5	3.62	13.5	1	22
Labour (Lb) (No. of mandays)	102	88.9	61.16	3.93	13	352
Capital (Ca) (in Rupees)	102	26094.08	65144.78	5366683659	1500	133100
Capital (Ct) (in Rupees)	102	5842.389	14406.4976	48805707.62	330	155570
Fertilizer (F) (in Rupees)	93	1894.93	2610.05	7877.15	80	6200
Pesticides and weedicides (PW) (in Rs.)	89	2102.25	3407.88	11613621.97	75.00	19500
Planting materials (PM) (in Rupees)	98	3190.11	3459.67	12005486.01	840	16368
Family size (Fam) (no. of family members)	102	6.1	2.67	7.27	2	19
Age of the household head (Age) (in year)	102	45.45	12.04	145.91	20	70
Education: Illiterate	8	-	-	-	-	-
Education: below primary	8	-	-	-	-	-
Education: below Matric	21	-	-	-	-	-
Education: matriculation & above	65	-	-	-	-	-
Fragmentation (Frag) (No. of plots)	102	2.087	1.023	1.05	1	5

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Extension service	100	-	-	-	-	-
Dummy extension service: private (d_Expv)	35	-	-	-	-	-
Dummy extension service: public (d-Expb)	65	-	-	-	-	-
Credit access	06	-	-	-	-	-
Dummy credit: informal sources (d_Crinf)	06	-	-	-	-	-
Dummy credit: formal sources(d_Cefm)	0	-	-	-	-	-

Note: N: No. of Growers; SD: Standard Deviation; CV: Coefficient of Variance; Min: Minimum; Max: Maximum

Source: Calculated from field data.

Annexure-I:

Agricultural Production in Assam in the Recent Decades: An Empirical Study of Select Crops in Two Western Districts.

(Questionnaire for Field Survey of Select Crops Growers)

Farm Household Schedule

Sl. No.: Date of survey:

1. District……..
2. (a) Development Block…….(b) Agriculture Circle……(c) Village…….
3. Head of the Farm Household……..
   Name of the Respondent……
   (a) Caste/Category:
   Gen-1; OBC/MOBC-2; SC-3; ST-4 ☐
   (b) Religion:
   Hindu-1; Muslim-2; Christian-3; Others-4 ☐
4. Language speak: ……
5. Household Size:……; No. of Dependent (<14 years of age)……
6. Details of the household members involved in cultivation

Sl. No.	Relation with HoH	Sex (M/F)	Age	Educational Qualification*	Agricultural Occupation**	Nature of Involvement***		
						Primary	Subsidiary	Supportive

*Code: 0: Illiterate; 1: Below Primary; 2: Primary Passed; 3: Middle School Passed; 4: Matric Failed; 5: Matriculation; 6: H.S. Passed; 7: Diploma; 8: Graduate; 9: Above Graduate

**Code: 1-Cultivating Owner; 2-Cultivating Tenant; 3-Cultivating Owner & Tenant; 4-Cultivating Owner & Rent Receiver; 5-Other.

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***Primary Occupation**: Involved in agriculture as primary occupation by trade and devote prime time of the day for production of agricultural raw materials and have the ownership right of the produce;

Subsidiary Occupation: Involved in agriculture to supplement family income but basic occupation is other than agriculture and have (or have not) the ownership right of the produce.

Supportive: Involved in agriculture as a family member and help in agricultural activities in a casual manner but no ownership right of the produce.

7. House type of the farm household:

Pucca-1; Semi-Pucca-2; *Kutcha* with tin roofed-3; purely *katcha*-4 ☐

8. Tenurial group of the cultivator:

Pure owner-1; Owner-cum-tenant-2; Tenant-3; ☐

If tenant, form of tenancy: share cropping-1; fixed crop rent-2; Yearly fixed money rent-3; Crop season wise fixed money rent-4 ☐

9. Land Holdings (in *Bigha*)

Sl. No.	Items	Area		
1.	Homestead/*Bari-Basti*			
2.	Details of Cultivable Land	Rice	Jute	Rubber
	(a) Owned			
	(b) Leased in Sharing Cropping with cost sharing			
	Leased in Sharing cropping without cost sharing			
	Leased in Fixed Money Rent			
	Leased in Fixed Crop Produce			
	Mortgage			
	Any Other			
	Total			
	(c) Leased out Sharing Cropping with cost sharing			
	Leased out Sharing cropping without cost sharing			
	Leased in Fixed Money Rent			
	Leased in Fixed Crop Produce			
	Mortgage			
	Any Other			
	Total			
	(d) Fallow Land			
	(e) Others (Specify)			

Note:

(a) Net area sown =
(b) Owned cultivated land =
(c) Total Land Holding =

10. No. of plots/holdings in which the cultivated area is fragmented/divided:
Rice……Jute……Rubber……

11. Area under the largest plot/highest compact holding: Rice……Jute……Rubber…….

12. Area under the smallest plot: Rice……Jute ……Rubber……..

13. Use of land before Rice/Jute/Rubber grown in the area
(i)Barren, (ii) Natural forest, (iii) Other plantation, (iv) Other season crop cultivation (specify), (v) Nil ☐

14. Whether you cultivate yourself: Yes-1; No-2 ☐

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If yes, (a) Own complete area……..*bigha*
(b) Own partial area……..*bigha*

(c) Cultivated land on hire……..……. *bigha*

15. Whether irrigation is using: Yes-1; No-2 [ ]

16. If Yes, source-wise area under irrigation (in *bigha*):

Items	High Land/Upland	Medium Land/Shallow land (0-30 cm water cover)	Low Land/Intermittent (30-100 cm water cover)
Canal			
Tanks			
STWs/LLPs			
DTW			
Other Minor			
Major or Medium			
Total			

Note: STW- Shallow Tube Wells; LLP-Low Lift Point; DTW- Deep Tube well; Deep water=>100cm water

17. If No, Why?

No public irrigation facility-1; Irrigation plant is out of order-2; High irrigation charge-3; lack of money for installing own irrigation system-4; other-5 [ ]

18. If you irrigated by water bought, what is the payment for irrigation water or cost for irrigation water? (in Rs./*bigha*)

19. Have your own crop storage house: Yes-1; No-2 [ ]
If yes, in what type?
Pucca-1; Semi-Pucca-2; *Kutcha*-3 [ ]

20. Is there any Private/Co-operative/Government storage house in your village?
Yes-1; No-2 [ ]
If yes, (i) Private-P; Co-operative-C; Government-G [ ]
(ii) What is the rate of rent to keep crop in the store? [ ]
(iii) How many months a year is storage used? [ ]
(iv)What is the cost of storage per year per *maund* (in Rs.)? [ ]

21. Access to electricity: Yes-1; No-2 [ ]

22. Whether electricity used for agriculture purpose?
Yes-1; No-2, [ ]
If yes, what is the expense on power per hectare/*bigha* per year/season? [ ]

23. Details of crop-wise use of capital goods and cost involved in each category:

Items/ Crops	**Rice**				**Jute**				**Rubber**			
	O (no.)	H (no.)	Price if purchased (in Rs.)/ Subsidy (in Rs.)/Free	Recurring cost*/Rent (PS in Rs.)	O (no.)	H (no.)	Price if purchased (in Rs.)/ Subsidy (in Rs.)/Free	Recurring cost*/ Rent (PS in Rs.)	O (no.)	H (no.)	Price if purchased (in Rs.)/ Subsidy (in Rs.)/Free	Recurring cost*/ Rent (PS in Rs.)
Tractor												
Power Tiller												
Bullock Pair												
Traditional Plough-												

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Shore												
STW/ pumpset/water motor												
Pesticide Sprayer												
Weed Remover												
Harvester												
Thresher Machine												
Tapping Equipment												
Rubber Sheet Roller												
Smoke House for Rubber												
Any others (Specify)												

Note: (i) O: Owned; H: Hired; N: Number; P: Price; Rs.: Rupees PS: Per Season;
(ii)*Recurring cost usually mean fuel cost and maintenance cost
(iii)For establishment cost of rubber plantation and maintenance and operational cost of the tappable area, a separate sheet will be used.

24. Details of crops grown, input used, input price/cost and production per year of select crops:

Sl. No.	Crop Group/ Crops	Rice						Jute***		Rubber
		Winter Rice (*Sali*)		Summer Rice (*Boro*)		Autumn Rice (*Ahu*)				
1	Variety	T	H	T	H	T	H	T	H	
2	Area (in *bigha*)									
3	**Seeds**- (per *bigha*) (i) amount (in kg) (ii) price (in Rs.) (iii) price before last 5 years									
4	Fertilizer/manure used (per *bigha*) (a) **Urea**- (i) amount (in kg) (ii) price (in Rs.) (iii) price before last 5 years (b) **SSP**- (i) amount (in kg) (ii) price (in Rs.) (iii) price before last 5 years (c) **MoP**- (i) amount (in kg) (ii) price (in Rs.) (iii) price before last 5 years (d) **DAP**- (i) amount (in kg) (ii) price (in Rs.) (iii) price before last 5 years (e) **Cow dung**- (i) amount (in kg) (ii) price (in Rs.) (iii) price before last 5 years (f) **Other**- (i) amount (in kg) (ii) price (in Rs.) (iii) price before last 5 years									

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6	**Pesticide**-(per *bigha*) (i) amount (in kg) (ii) price (in Rs.) (iii) price before last 5 years									
7	**Weedicide**- (per *bigha*) (i) amount (in kg) (ii) price (in Rs.) (iii) price before last 5 years									
8	**Others**- (per *bigha*) (i) amount (in kg) (ii) price (in Rs.) (iii) price before last 5 years									
3	Area Irrigated (in *bigha*)									
9	**Tilling** (no./*bigha*)									
10	**Details of labour used** (a)Tilling: (i)Family-M (ii)Hired- M -W(PM) (b) Sowing: (i) Family-M (ii)Hired- M - W(PM) (c) Weeding: (i) Family-M (ii)Hired- M -W(PM) (d) Harvesting & threshing: (i) Family-M (ii)Hired- M -W(PM)									
11	Yield per *bigha* (in kg/*maunds**/quintals)									
12	Production (in kg/*maunds*/quintals)									
13	Amount sold (in kg/*maunds*/quintals)									
14	Mode of sale#									
15	Price per kg/*maunds*									

Notes: T-Traditional; H-High Yielding Variety/Hybrid; M-Mandays; W-Wage; PM-Per Mandays;* *Maund*=40kg.

collected by traders-1; delivered to traders-2; village huts-3; procurement agency-4; sold to hauler mills/processing units-5; any other-6

** labour cost of cleaning/washing jute included in harvesting & threshing cost.

25. Cash expenditure on cultivation & harvesting (excluding capital expenditure) (per *bigha*):

Sl. No.	Heads/Items	Amount of Expenditure (in Rs.)								
		Rice						Jute		Rubber
		WR		SR		AR				
		T	H	T	H	T	H	T	H	
1	Seeds									
2	Fertilizers									
3	Pesticides & Weedicides									
4	Hiring capital goods like tractor, power tiller, etc.									
5	Fuel									
6	Payment for wage labour									
7	Interest on loans									

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8	Any Others									
9	Total expenditure on cultivation									
10	Cash expenditure on harvesting & threshing									
11	Cash expenditure on selling including transportation cost									
12	Grand total expenditure									

Note: WR Winter Rice; SR Summer Rice; AR Autumn Rice

26. Capital expenditure during last five years:

Sl. No.	Items	Amount (in Rs.)		
		Rice	Jute	Rubber
1	Major Farm Equipment, e.g., tractor, power tiller, pumpset, harvester, STW, roller, etc.			
2	Bullocks			
3	Minor Farm Equipment, e.g., plough shore, sprayer, weed remover, etc.			
4	Land purchase and development, like land plain, drainage, road construction, fencing, etc.			
5	Processing and storage facilities like construction of processing unit, crop house, smoke house, etc.			
6	Any other			
7	Total			

27. Source-wise, Crop wise Finance/ Capital investment on cultivation (per season):

Sl. No.	Sources	Amount (in Rs.)		
		Rice	Jute	Rubber
1	Self finance	A:	A:	A:
2	Borrowing from fellow farmers without interest	A:	A:	A:
3	Borrowing from land lord	A:	A:	A:
		I:	I:	I:
4	Borrowing from money lenders	A:	A:	A:
		I:	I:	I:
5	Borrowing from other non-institutional sources	A:	A:	A:
		I:	I:	I:
6	Borrowing from institutional sources	A:	A:	A:
		I:	I:	I:
7	Subsidy	A:	A:	A:
8	Other	A:	A:	A:
		I:	I:	I:
7	Total	A:	A:	A:
		I:	I:	I:

A: amount; I: interest

28. Have you received any Government assistance or loan?

Yes-1; No-2 ☐

If Yes, where from, for what crops and in what amount?

29. Have you got any information and suggestion about the crops that you cultivated from any government officials?

Yes-1; No-2 ☐

30. Sources of Extension Services

Sl. No.	Items	Sources*
1	Advice regarding crop/variety to be grown	
2	Dose of fertilizer application	
3	Pest and pest control	
4	Other farming matters	

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5	Access to market	

* 1: self advice; 2: fellow farmers; 3: extension workers/officer; 4: NGOs; 5: trader; 6: seed & fertilizer shop; 7: FMC or any other farmer's organization; 8: marketing agencies including contact farming; 9: guide books or any other materials

30. (i) Do you know the Village Level Extension Workers (VLEW)/*Gram Sevaks*/Field Officer of your locality?

Yes-1; No-2 ☐

(ii) If yes, did you consult him on farming problem during the last year?

Yes-1; No-2 ☐

(iii) How many times during the last season? ☐

(iv) Have you followed the advice?

Yes-1; No-2 ☐

(v) If yes, was the advice useful?

Yes-1; No-2 ☐

(vi) Did the VLEW/ADO/AEO/FO visit your village during the last 6 months?

Yes-1; No/ cannot say-2 ☐

(Note: VLEW: Village Level Extension Worker; ADO: Agriculture Development Officer; AEO: Agriculture Extension Officer; FO: Field Officer)

31. Have you informed to attend any awareness/training/workshop by agriculture department or any other organization during last year?

Yes-1; No-2 ☐

32. If yes, have you attended the programme?

Yes-1; No-2 ☐

33. Did you participate in any exhibition, fair or exposure tour sponsored by agriculture department or any other organization during last five year?

Yes-1; No-2 ☐

34. What do you think about the services of Agriculture Department?

Very Good-1, Good-2, Satisfactory-3, Not satisfactory-4, No comme ☐

35. Membership of farmer's association:

Sl. No.	Association	Yes	No
1	Field Management Committee (FMC)		
2	Water Users Association/Canal/Dong Committee		
3	Self Help Groups (SHG)/NGOs		
4	Any other agriculture based organization		

36. Have you got any Government support regarding seeds, fertilizers, capital goods, any other implement or financial support for growing particular crop?

Yes-1; No-2 ☐

37. If yes, details of such support:

38. Have you listen/watch any agricultural programme telecast by Radio/T.V.

Yes-1; No-2 ☐

39. If yes, how often do you listen/watch the programmes?

(i)Daily, (ii) once in a week, (iii) occasionally, (iv) suddenly. ☐

40. Do you have any hand book/hand bill/guide book for crops you grown?

Yes-1; No-2 ☐

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41. Do you have any telephone contact number?

Yes-1; No-2 ☐

If you have, give the contact number:

Signature of the Investigator

Annexure-II

Agricultural Production in Assam in the Recent Decades: An Empirical Study of Select Crops in Two Western Districts.

(Questionnaire for Field Survey of Officials)

Departmental Schedule

Sl. No.: Date of survey:

District……..……Agricultural Circle……

Name of the Informer……..Designation……

(1) How many irrigation projects are in functional stage in the district?

(2) What is the utilization rate of irrigation potential in the district?

(3) What is the current area under irrigation for rice, jute and rubber crops in the district?

(a) Rice: (i) Gross Irrigated Area ……..(ii)Net Irrigated Area ……..……

(b) Jute: Gross Irrigated Area ……..……(ii)Net Irrigated Area ……

(c) Rubber: Gross Irrigated Area ……..……...(ii)Net Irrigated Area ……

(4) What is the rate of sanction against applications for KCC and other agricultural loans in the district in the last five years?

(5) Is there any budget provision for extension services to the farmers? Yes-1; No-2 ☐

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(6) How much fund is allotted for extension activities in the district for last five financial years? Give details annually.

(7) Was the fund sufficient for extension services in the district? Yes-1; No-2 [ ]

(8) Is the fund sanctioned at due time? Yes-1; No-2 [ ]

(9) How much fund is utilized during last five years? Give details annually.

(10) Which are the services extended to the farmers under extension services?

(11) How frequently the activities are organized?

Once in a week-1; Once in fortnight-2; Once in a month-3; Quarterly-4; Halfyearly-5; Annually-6; Occassionally-7 [ ]

(12) How many awareness/training/workshop programme hold during last year at the circle/district?

(13) How do select the participants or beneficiaries?

(14) What is the participation rate?

Very Good-1; Good-2; Average-3; Poor-4 [ ]

(15) Is there any feedback collection system? Yes-1; No-2 [ ]

(16) How much time is required to give the solution of any farm related problem reported?

(i) Instant; (ii) week; (iii) Month; (iv) 3 months; (v) 6 months; (v) Year

(17)How many employees are there for extension services in the District?

(18) How many villages have no VLEW/Gram Sevak/Field Officer?

(19) How many villages are assigned against a VLEW/Gram Sevak/Field Officer?

(20)How frequently VLEW/Gram Sevaks/Field Officer should visit the village to meet the farmer?

Once in a week-1; Once in fortnight-2; Once in a month-3; Quarterly-4; Halfyearly-5; Annually-6; Occassionally-7 [ ]

Signature of Investigator,

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